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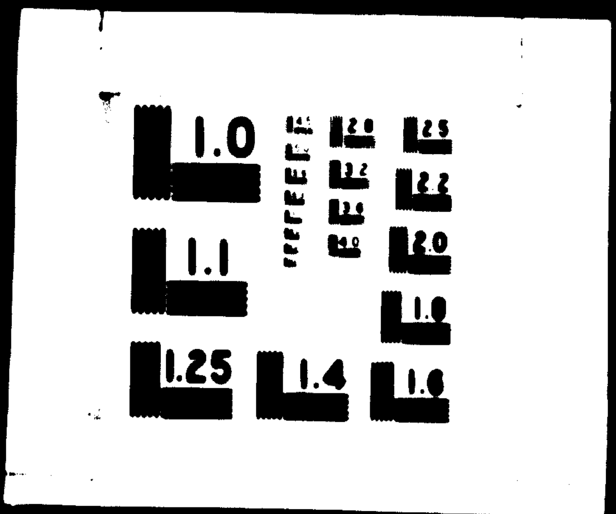

QUALITY CONTROL FOR DEVELOPING AREAS

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Report prepared for the Centre of Industrial Development
of the United Nations

51 p. + app.

by

J. van Ettinger
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and
Chairman of the Board of International Quality Centre

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S/F Quality control/Standardization

December 1966

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QUALITY CONTROL FOR DEVELOPING AREAS

by J. van Ettinger and J. Sittig

C o n t e n t s

Part A QUALITY IN MODERN ECONOMY

1. The history of quality control in industry

Quantity and quality

Economic development, as we know it from the industrially developed countries, has been centred on the concept of quantity of manufactured products and services. It is quite usual that we judge the development of a country by, e.g., the number of private motor-cars per 1000 inhabitants.
The question, however, as to what kind of motor-cars they possess is not taken into account, nor is the one as to their ages.
Very many statistical data are available about the number of houses built in several countries, the quality of these houses does not enter the picture.
Economic theories have tried to formulate laws describing the customer's decision to buy or not to buy a given article. But these laws take the form of a "demand function" showing the quantity - and the quantity only - of a certain product to be sold as a function of price.

This preponderance of quantity in economy is not just an accident, but the necessary result of the way in which modern industry has grown.
Profit-maximising activities of the entrepeneur tended towards an ever-growing volume of the manufacture of standardised products, which was made possible by the technological innovations of the devision of labour, and, consequently, mechanisation. At the same time this mechanisation resulted in an enormous growth of the productivity of labour, so that the selling price of the products could decrease, and this, of course, was necessary in order to attain an extension of the market without which the increased production possibilities could not have been realised
No production can exist without consumption; mass production needs mass consumption.

The quantitative economy, concerned only with raising the volume of production and consumption by lowering costs and prices could, of course, be quite satisfied with an economic theory which was centred around the model of the demand function, in which theory quality considerations had no place. But, in fulfilling its quantitative task, industry undermined its own basis. High mass-consumption leads to saturation effects. The market cannot accept the ever-growing stream of products.

It is in this situation that quality in the interest of producer and consumer, and of the whole society, becomes more and more important.

The appearance of quality consciousness

As mass production continued its expansion and the problems of mass distribution received greater attention, it gradually became clear that not only the retail price, but especially (in view of the rising prosperity) the quality of the product would be a decisive factor in the successful invasion of a permanent market.

The manufacturer began to find that his customers became increasingly powerful, difficult and critical as prosperity continued its advance. The poor man required more, the prosperous consumer demanded better goods.

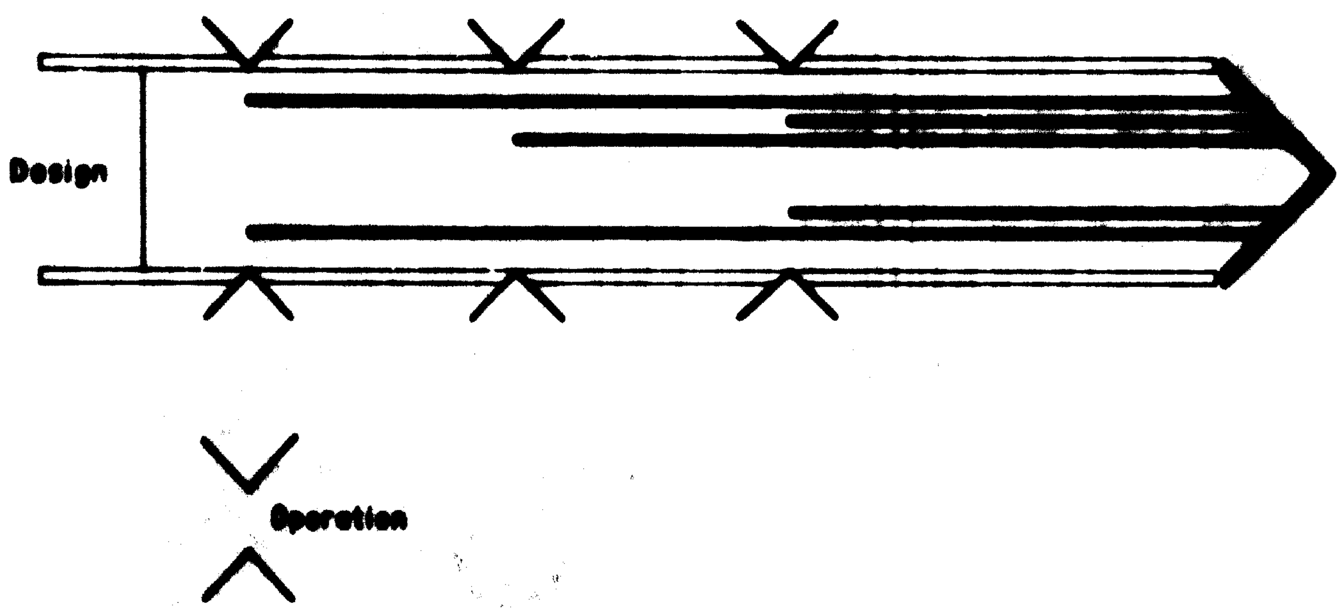
In order to maintain his competitive position and expand his market without endangering it, the manufacturer had to try and restrict the number of customer complaints to a minimum. In addition, the products often became more complex and called for greater precision and accuracy.

Also the growing network of ancillary industries (i.e. specialized factories making components to be assembled in another plant) necessitated a more intensive control of quality in order to set up sound methods for correct fit.

Thus, there existed various important reasons for the manufacturers to pay greater attention to the quality of their products. This attention had to be directed simultaneously to the purchase and arrival of raw material supplies, semi-manufactured and finished products to obtain more reliable points of departure, to production, to reduce waste, repairs and customer complaints, and to sales to stimulate the market.

Originally, the manufacturer carried out incidental checks on one of the products, chosen haphazardly, in order to see whether it satisfied the quality requirements. This method failed to provide sound guarantees with regard to quality, however. Customer complaints often gave rise to considerable repair costs; when no complaints were made even greater damage was sometimes caused through loss of goodwill and dropping sales figures.

Figure 1 No inspection or incidental inspection

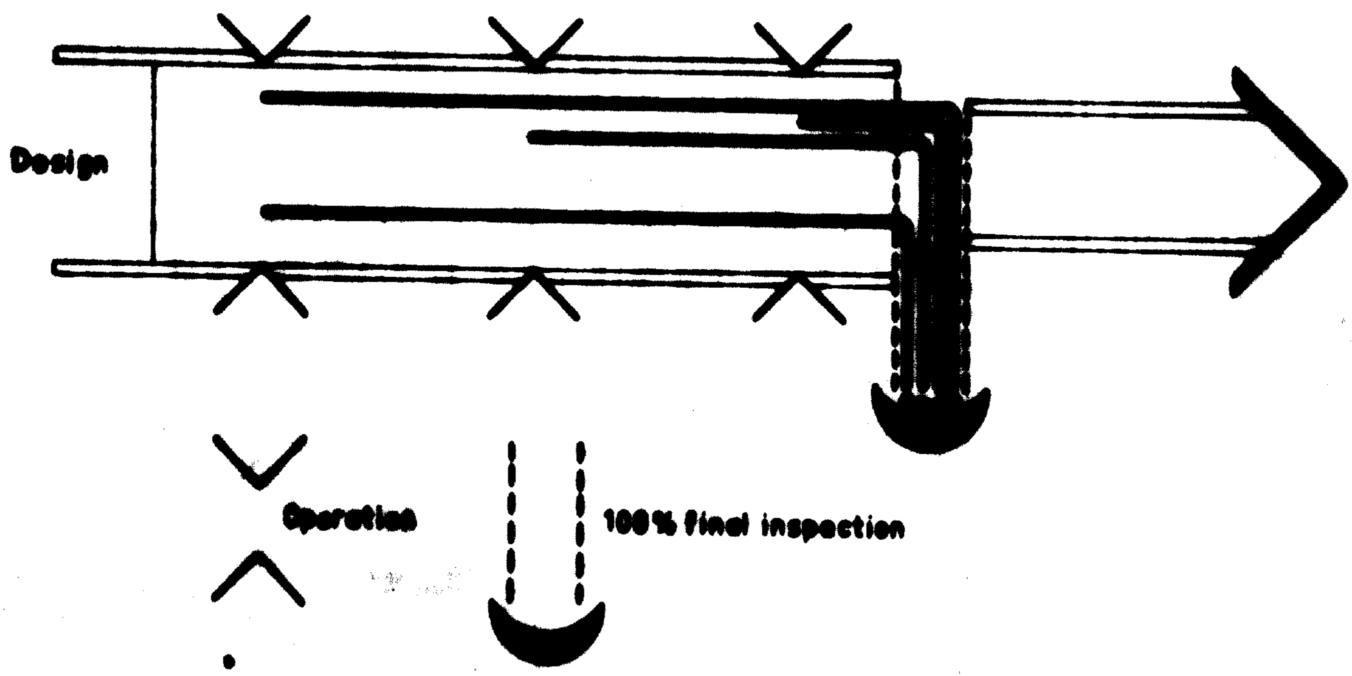


High costs of returns and repairs + dissatisfied customers

The manufacturer now had to choose between dissatisfied customers with all the attendant costs, or an expensive 100 per cent. inspection. In some industries such as the ready-made clothing industry in most countries, this 100 per cent. final inspection is virtually the only form of control at the time of writing. An efficient 100 per cent. final inspection which clearly distinguishes good products from defective ones is a type of inspection which completely protects the customer against receiving unsatisfactory products.

Figure 2 100 per cent. final inspection

High cost of inspection (methods not always applicable), no customer complaints, no loss of goodwill, no dropping of sales figures.



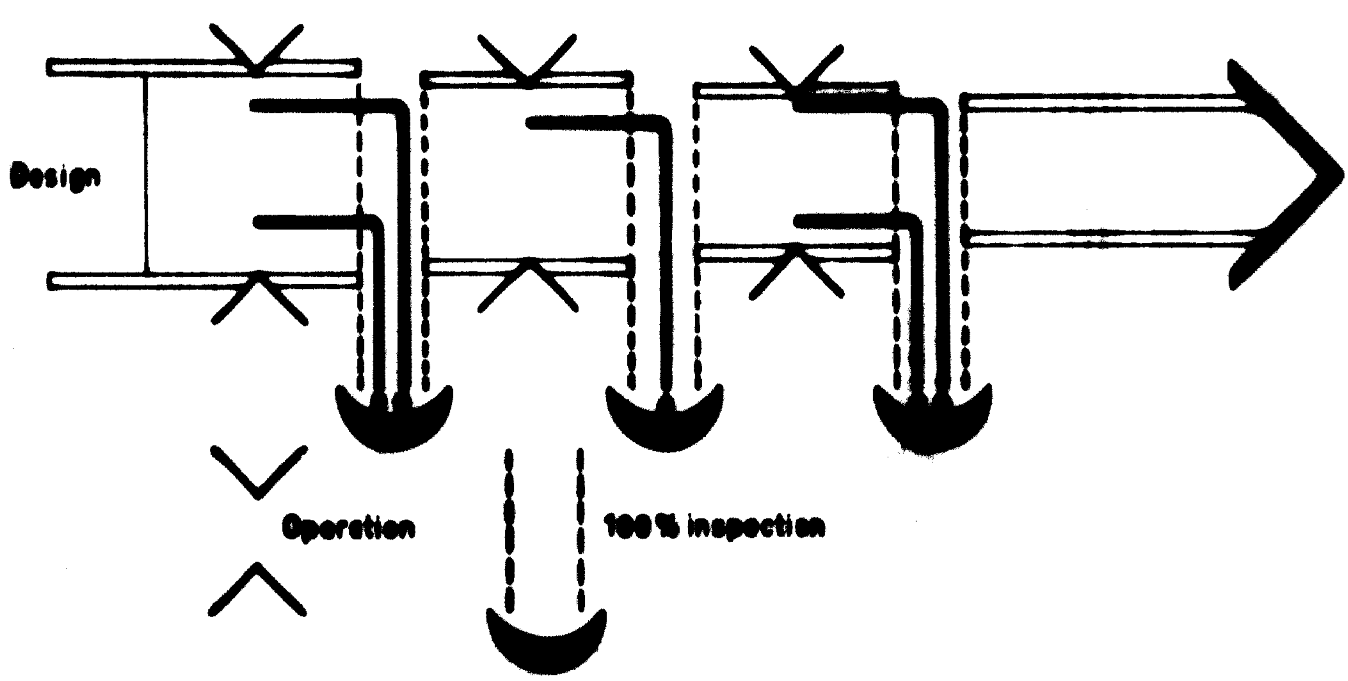
One hundred per cent final inspection presents certain unsurmountable disadvantages, however. This particularly applies to those tests on specific properties which call for the destruction of the product (destructive tests, testing for useful life and resistance).

But also in cases where the final inspection is not of a destructive nature, this method presents serious drawbacks. As a matter of fact, 100 per cent. final inspection is a very costly procedure, since the goods that are removed for testing purposes are finished products which have gone through all the sometimes very expensive stages of manufacture. Thus, the losses incurred by the rejection of finished products are often considerable.

Irrespective of this economic drawback, 100 per cent. inspection also presents disadvantages of a technical nature. In practice, this type of inspection has proved to be far from flawless. Inspectors who have to judge the same product day after day begin to show symptoms of fatigue and a certain "blindness to faults". Thus, certain products are allowed to pass which definitely fail to meet the quality requirements.

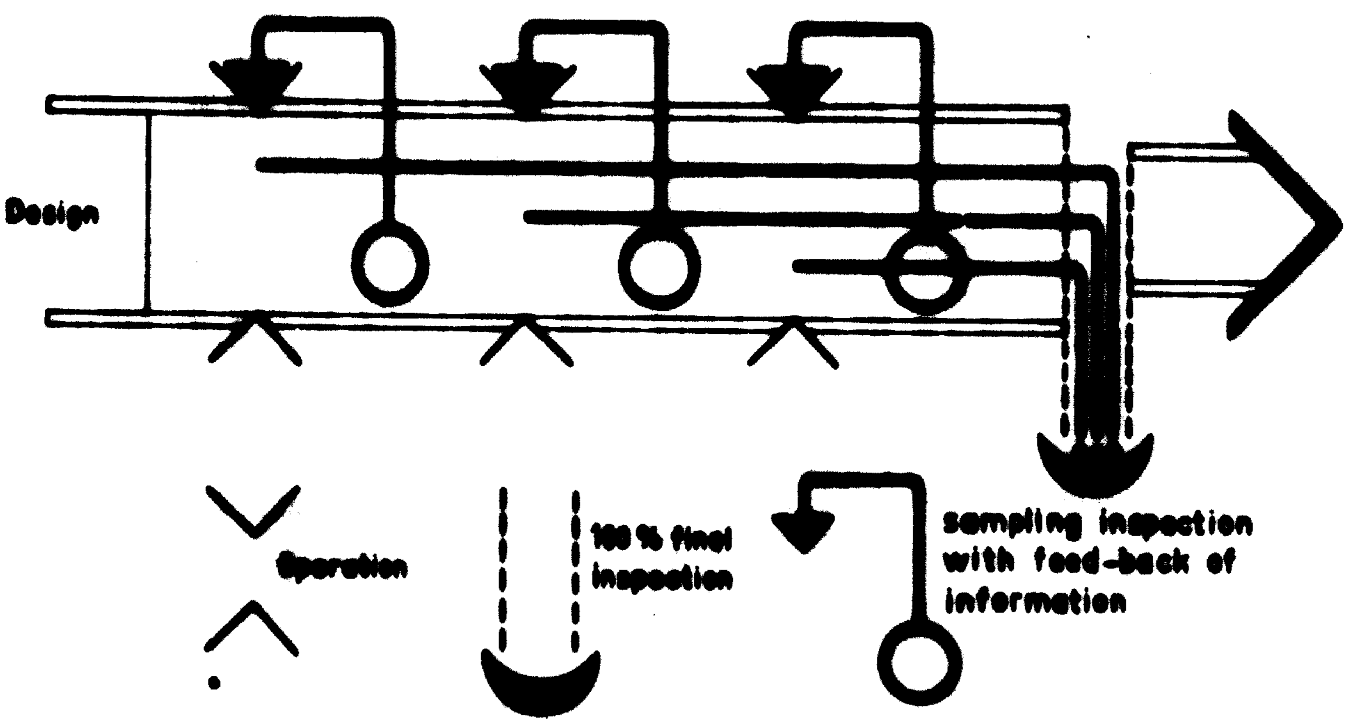
Figure 3 '100 per cent. inspection at critical points

High cost of inspection, savings on manufacturing costs



These drawbacks - and specially the first mentioned - may be obviated by inspecting not only the finished product, but also certain important intermediary operations. Although by this method the cost of inspection will go up, the manufacturing costs will be reduced to such an extent, that the total cost price of the product - i.e. the cost price per good quality product delivered - is liable to decrease considerably. Thus, for example foundry casting will be subjected to inspection immediately after casting, and not when all the subsequent cutting operations have been carried out.

Figure 5 Sampling inspection at critical points and feed-back of information



Saving on cost of inspection, reduction of costs of sales, customer complaints and repairs

Although the application of 100 per cent. inspection to the most important operations yields considerable savings in manufacturing costs, it still does not constitute an ideal solution, since it fails to make up for the drawback presented by the high cost of inspection. Only a switch-over from 100 per cent. inspection to sampling inspection offers a satisfactory solution to this problem.

Sampling inspection is a far cry from the haphazard, incidental examination of the properties of a single finished product. One can only speak of sampling inspection when numbers of products are systematically separated from the manufacturing process according to a predetermined plan in order to be tested on their quality. In addition, the consequences which may result from such an inspection should also be previously specified.

Sampling inspection is based on the fact that, in order to know the properties of a given manufacturing process, it is not necessary to test each single piece, but only a certain - often small - percentage of the production. This is similar to the procedure to be adopted when the individual variations within a given species of plant or animal are determined: one can, and must be satisfied with the study of a limited number of specimens. It is, therefore, hardly amazing that the sampling inspection of manufacturing processes was carried out by the same methods which had already been applied in biology for several decades. Thus, sampling schemes marked the introduction of statistics in industry.

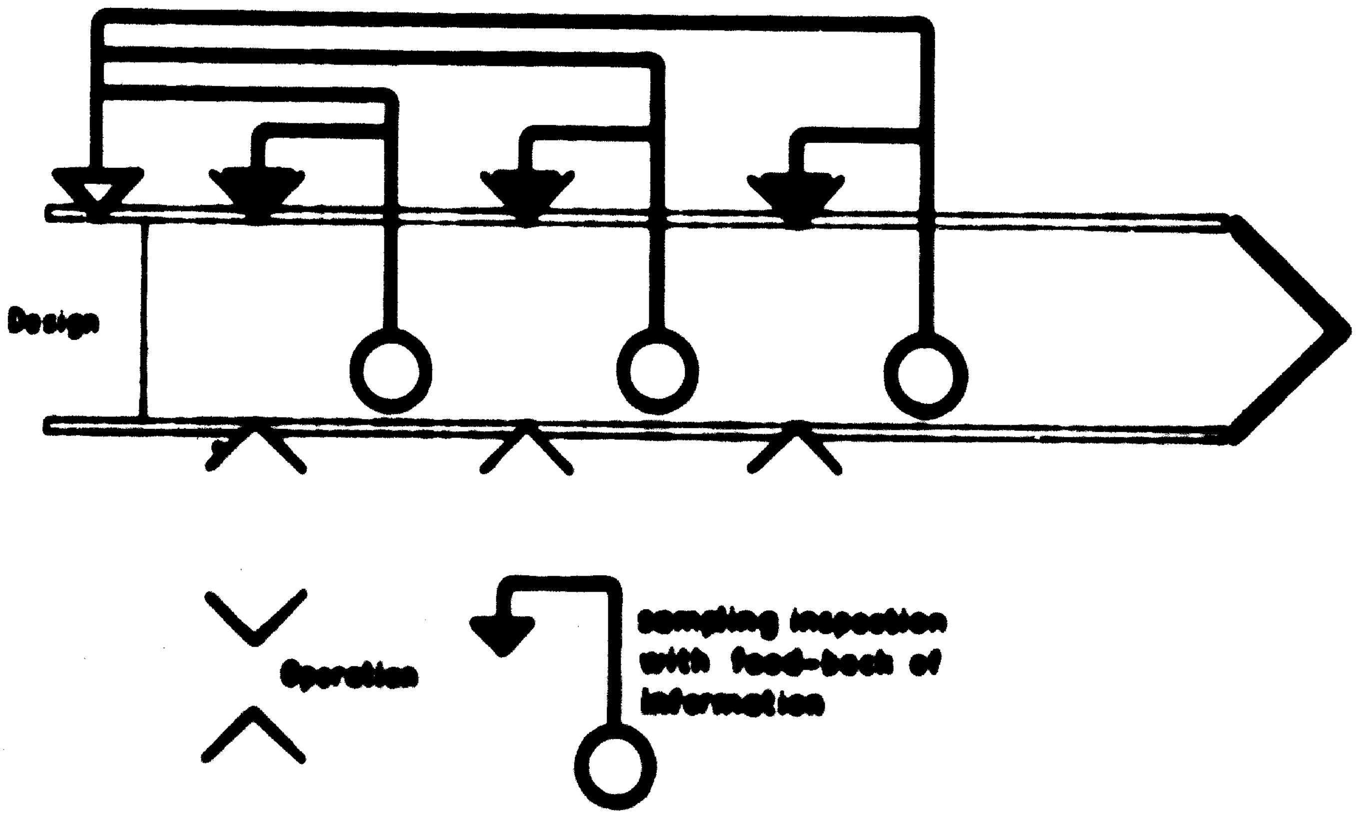
The application of sampling inspection to the properties of industrial products caused the accent to shift from the protecting function of inspection (safeguarding against the delivery of defective products) to the signalizing function (providing information concerning the quality of the products).

It was in the nature of things that the information obtained on the quality of the products would be used for making changes in the production process. At present, sampling inspection registering the effect of an operation serves as a tool for the readjustment of machinery, apparatus, and sometimes even of the people who carry out the operation. The information acquired from the operation is fed back to the operation proper, thus preventing the manufacture of defective products, quality control which, so far, had only played a comparatively passive role was transformed by this feed-back technique into a form of active process control.

The development of process control methods between the years 1930 and 1950 is perhaps the most important contribution made by industrial statisticians towards the systematic improvement of the quality of industrial products.

The above-mentioned feed-back of inspection data for the purpose of re-adjusting makes it possible to get the most out of a machine. There are situations, however, in which the discrepancy between the performance of the machine and the established quality level of the product is too great. Re-adjustment alone will not suffice here. In such cases, the inspection results should be fed back to a stage which precedes the production, i.e. the design stage. The design must be adapted to the possibilities of the production process, unless one succeeds in bridging the gap by changing the installation. This type of action is usually impossible in the short-term.

Figure. 5 Sampling inspection at critical points, feed-back of information, design directed to production



Further reduction of cost of inspection, minimization of costs of waste, customer complaints and repairs

The adaptation of the quality requirements [illegible] to the possibilities of realization of products determine whether the design is [illegible] from a quality point of view. A product adapted [illegible] to the production and its possibilities will often make it possible to [illegible] 100 per cent [illegible] inspection, [illegible] sampling inspection [illegible] the [illegible] well organized [illegible] employed [illegible] production process.

The orientation of the design towards the product [illegible] characteristic feature of the recent development of the quality concept. One of the characteristics of this development is the creation in various industries of quality teams in which designers, technicians and inspection officers co-operate to attune the quality requirements to the practical realization of the product and vice versa. In some of these quality teams, however, the persons in charge of marketing activities tend to exert an undue influence on the design of the product. They demand first and foremost that the design be focused on sales. This implies not only that there will be little or no customer complaints, but also that the appearance of the product will stimulate sales by making a hit with the public. Although the influence may (sometimes) lead to a well-conceived industrial design, it carries the inherent danger of a commercial juggling act directed to the bad taste of the general public and based on the erroneous idea that a product is a quality product when it sells easily.

The opinion gains ground, however, that the responsibility of the producers of industrial mass products and, in the long run, also self-interest call for more than a mere short-term increase of profits within the limits of the law. In industrial circles, people are increasingly waking up to the fact in businesses with a short-term trade policy quality is keyed to commerce, whereas in businesses with a long-term trade policy commerce is keyed to quality.

Organisation for quality

The awakening of quality consciousness - which is due, as we have seen, to the economic and technological development towards high mass-consumption - crystallised into theories, movements and organisations.

T h e o r i e s

Since quality problems in production presented themselves as problems concerning the observation and control of mass phenomena, it is not surprising that they were tackled with the aid of statistical tools. Mathematical statistics and probability had proved themselves able to cope with such mass phenomena in, e.g., biology.

But whereas in pure scientific applications mathematical statistics were mostly concerned with the testing of scientific hypotheses, applications in the industrial field very soon had to introduce a new factor, viz., the consideration of cost.

Acquiring more knowledge regarding a production process or a lot of manufactured products by statistical means can be justified only if the additional knowledge costs less than it is worth.

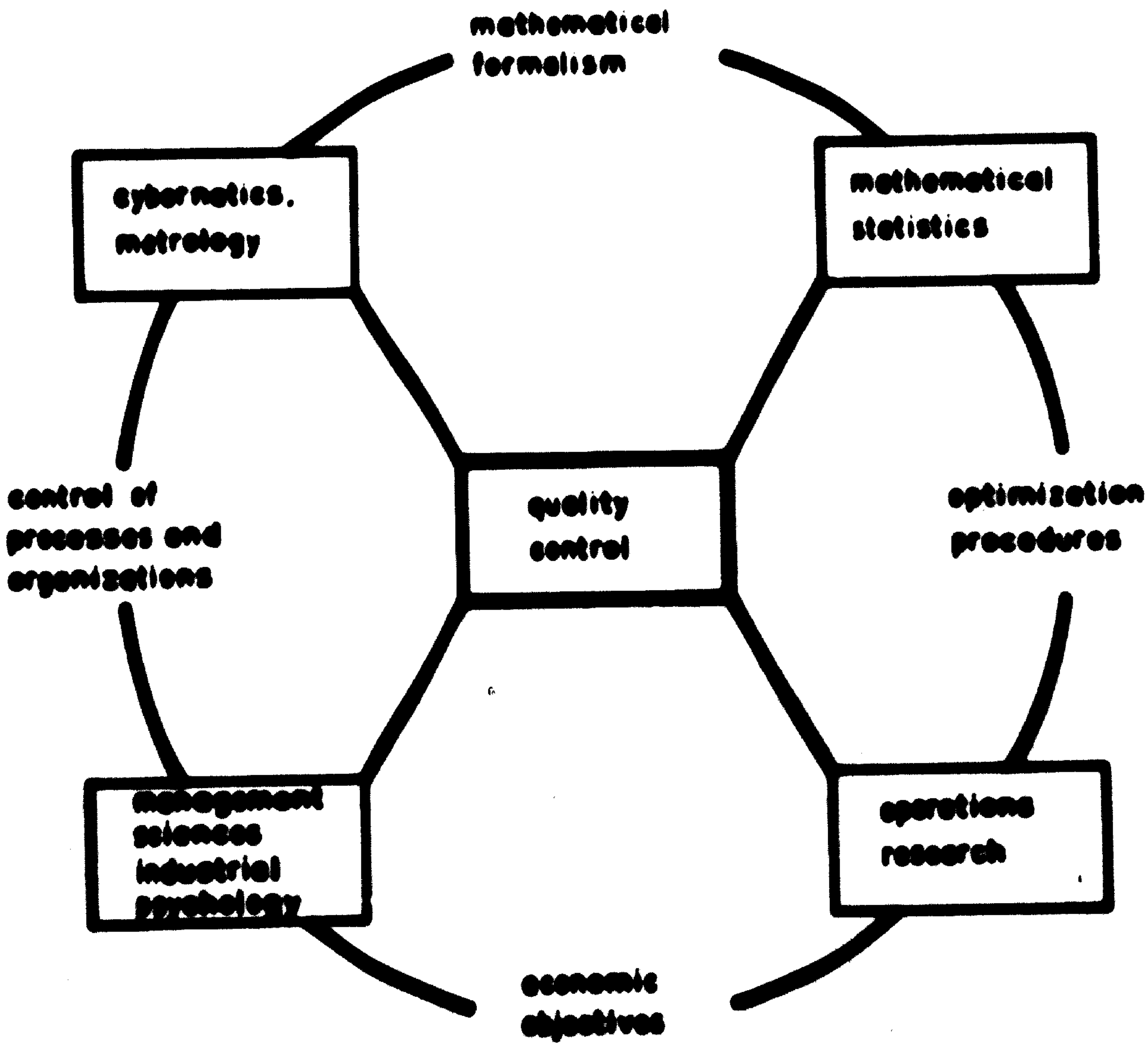
Thus balancing against each other of knowledge acquired and cost incurred was only added to the body of scientific methods by the development of operations research during World War II. Since that time, Operations Research (the science of decisions) has influenced quality control in industry rather strongly and this development is still in full swing.

On the other hand, quality control in industry must obviously be carried out by controlling people, industrial systems and manufacturing organisations. It therefore became connected with what is generally called "scientific management". It acquired an important place in theories concerning the running of industrial firms. So far, however, in the eyes of most managers quality control has been no more than just an efficient method of reducing the number of rejects and therefore of increasing production in the sense of quantity.

Of special interest are the relationships between quality control and industrial psychology. If quality depends on people's actions, their motivation becomes important for the quality programme and motivational research in industry becomes part of the quality control package.

Quality control is also connected with the control of technological processes, which in modern times tends more and more towards automation. Quality control therefore makes use of cybernetics, (the science of control in man-machine systems) and of metrology (the science of measurement).

Figure 6 The place of quality control in the industrial sciences



Besides the relations of quality control with the sciences mentioned, some indications are given here of the inter relationships of these sciences, touching upon the work of the quality control expert.

M o v e m e n t s

If we mean by "movement" the fact that a theory influences the minds of a group of people in such a way that they no longer look at it as one of a number of possible ways to describe and explain the real phenomena, and that the theory and its implications have become an undisputed and indisputable part of their thinking, then quality control theories have, on the whole, not yet become movements, save for two notable exceptions: the motivational quality programmes like "zero defects" in the U.S.A. and quality control in Japan, which is much more important, to our minds. Disseminated originally by experts from the U.S.A., quality control was taken up with tremendous alacrity in Japan and by now it forms part of the "industrial way of living" in Japan for the government, management, technicians and workers alike.

O r g a n i s a t i o n s

National organisations for quality control have grown during and after World War II. By far the most important of these organisations is the American Society for Quality Control (ASQC). In Japan, quality control is disseminated by the "Union of Japanese Scientists and Engineers" (JUSE); quality control organisations also exist in Argentina and India.

In Europe, societies in the field of quality control have grown in the United Kingdom, France, Germany, Sweden, Denmark, Italy, the Netherlands and other countries including some in Eastern Europe. About 10 years ago a number of these national organisations in Europe formed the "European Organisation for Quality Control" (EOQC) which, i.a. by its annual international conferences, promotes the exchange of experience between experts in different countries. Co-operation of quality control with other branches of science is reflected in the organisational relationships of national quality control organisations with other scientific societies: in some cases the quality control society is related to the statistical society of the country, in others it forms part of organisations in the field of scientific management, in other countries again the quality control society is autonomous.

In recent years plans were made for a worldwide international co-operation, starting with ASQC, EOQC and JUSE.

2. The modern concept of quality

Integrated quality control: a management function

Until a short time ago, the emphasis in quality control was laid on the manufacturing of products in conformity with the design. Quality control was therefore a technological function.

During the last 5 to 10 years, the scope of quality control has grown. A wrong design leads to a product of low quality, even with a production process which is perfectly controlled. There can be no good design without a good programme of requirements. A good programme of requirements is impossible without basic decisions about the product, based on facts.

Furthermore, sales and after-sales-service appeared to be related to the quality of the product, as, e.g., every owner of a motorcar has discovered.

Quality control in this wider sense is called "integrated quality control".
In the fully industrialised countries, quality has become more and more important according to the adage "the poor man asks for more, the wealthy customer for better things". In accordance with the growing importance of quality, quality control has become a management function.

Quality has become significant in practical economies. Economic theory, however, is only just beginning to concern itself with quality problems.

Definition of quality

In order to understand quality we must be able to answer the question as to what is quality.
Quality is one of those words which are used unthinkingly by everybody, but which stubbornly evade definition. In general usage and in publicity circles, the word "quality" is frequently used to designate the attractiveness or the excellence of a

product. When of two comparable products one is said to be "of higher quality" people often only mean to say that it is the more expensive of the two.

Sometimes, the epithet "quality product" is given to an article made by a manufacturer who enjoys - rightly or wrongly - a good reputation. It is, therefore, an understandable fact that in advertisements many manufacturers present themselves as "quality manufacturers". In many cases, quality is also associated with the notion of "nobler" or "purer" raw materials. Is butter of higher quality than margarine? Eight out of ten people who are asked this question will probably reply in the affirmative. But when the various properties are enumerated by which butter and margarine differ, such as calorie value, vitamin content, digestivity, keeping quality, easy spread, taste... it turns out that in some of these properties butter takes the lead, and margarine in others. When trying to answer the question why most people attribute the higher quality to butter, there remain two possible explanations, namely in the first place the difference in price, and in the second place the fact that most people regard one specific property - the taste in this instance - as the sole criterion for quality. People rationalise their preference for the tastier of the two by pretending that an industrial product can never be superior to a natural product. On this assumption, a cotton slip would be preferable to a nylon one. But if the question were asked here which of the two has the higher quality, the reply would probably turn out to be in favour of the nylon garment - the manmade fibre product - which, also in this case, happens to be the more expensive of the two.

Anyway, the notion "of higher quality" lies neither in the butter nor in the nylon as such. It is conceivable that certain articles made of nylon would be of lesser quality than similar goods in cotton such as diapers or handkerchiefs. On giving further consideration to such examples, one is bound to reach the conclusion that quality, being of a relative nature, does not exist in itself, and that one can only speak of the quality of an article in connection with the purpose for which it is used. This also implies that a product may be of excellent quality with regard to purpose A, but inferior with regard to purpose B.

When comparing the qualities of, say a Cadillac and a Minicar, our judgement is influenced by the criteria we apply with a view to the purpose we have in mind, or by our appreciation of specific properties. If we wish to cover great distances in comfort without having to bother about bad road conditions, and are willing to bear the high cost connected with the possession of a de luxe car, we will vote for the Cadillac. If we want a car, however, which is thrifty and easy to park in busy city streets, we will choose the Minicar. Thus we may find that an expensive product is less suited to a given purpose than a cheaper one. Quality may be understood as the degree to which a product satisfies the requirements imposed upon it by the purpose for which it is intended.

Acceptance of this definition has the following consequences:

1) Quality depends on a great number of properties of the product in question. In order to know its quality, it is not sufficient, however, to have a complete knowledge of all its properties. We must also be familiar with the situation in which the product will be used, that is to say with the "co-ordinates of the situation of demand".
2) As quality is only defined by the relationship between user and product properties, the same product in the hands of different users may have quite a different quality.
3) Wrong use of the product by the consumer may destroy its quality.
4) Even if we consider a given product in the hands of a given user, the quality may change in time because of changes in the situation of the user.

This "relativity theory" of quality is the result of a functional line of thought developed at "Bouwcentrum", Rotterdam, since World War II. The value of a building is not measured by its properties such as shape, size, proportions, etc., but by its suitability to perform the function for which it is intended; consequently, also here the adaptation of the properties of the product to the demand dictated by its use determines its value.

The extension of this functional line of thought to products (and services) deprives quality of its pompous and slightly mystic significance and makes a quantitative approach possible.

<u>The quality circuit</u>

From the relative definition of quality given previously it follows that there is no stage in design, production, and consumption during which quality is not being influenced.
If quality is taken as the degree to which the properties of a product are adapted to the needs of the consumer, then quality originates in all the phases in which the needs of the consumer are recognised, the properties of the product are formulated and realised, and the appropriate steps are taken to make the product reach the consumer for whom it is intended. In order to give visible form to this notion of "integrated quality control" we make use of a quality circuit. *)
Owing to the great variety of needs in the market, industrial production as a rule is only directed towards the satisfaction of the needs of a market sector. The choice of such a market sector is one of the <u>basic decisions</u> and can be considered as the first stage of the quality circuit.
It is followed by the establishment of a programme of requirements in which a great number of <u>functional decisions</u> are involved.
The programme of requirements is handed to the designing artist or the designing engineer. It is he who makes the <u>design decisions</u>.
Then follows the production stage which calls for numerous <u>production decisions</u>.

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*) Source: "More ... through Quality" by van Ettinger/Sittig, Rotterdam 1965.

But this is not all. A good quality product is a product which gets into the hands of the consumer for whom it is intended in accordance with the basic decisions.

Whether this is the case depends on the distribution system and on the distribution decisions to be taken in this respect. Thus, the distribution of the product also figures in the quality circuit as one of the stages which determine its quality.

Finally, the product should not only reach the right consumer; the consumer should also be placed in a position to enjoy a troublefree use of the product, which must be ensured by the service stage.

The after-sales service decisions often determine the useful life of the product which constitutes, of course, an important aspect of its quality.

The sum total of the above-mentioned stages results in the realised product as it reaches the consumer.

One of the fundamentals which should be kept in mind is that each transition to a subsequent stage causes some of the original good intentions to be lost. As regards the production stage, this fact has been known for a long time: it is technically impossible to make a series of products which entirely correspond to the design. This also applies to the other stages, however. A design can never completely materialise what was laid down in the programme;[a] the most perfect distribution system will never work without failures which cause the product to reach "wrong" consumers, etc. All this results in a "dilution" of the quality in the course of the quality circuit. The consumer gets a product which is not ideally adapted to his needs, if only because there exist mutual differences between the situations of demand within the market sector, which have to be satisfied by the same standardised product all the same.

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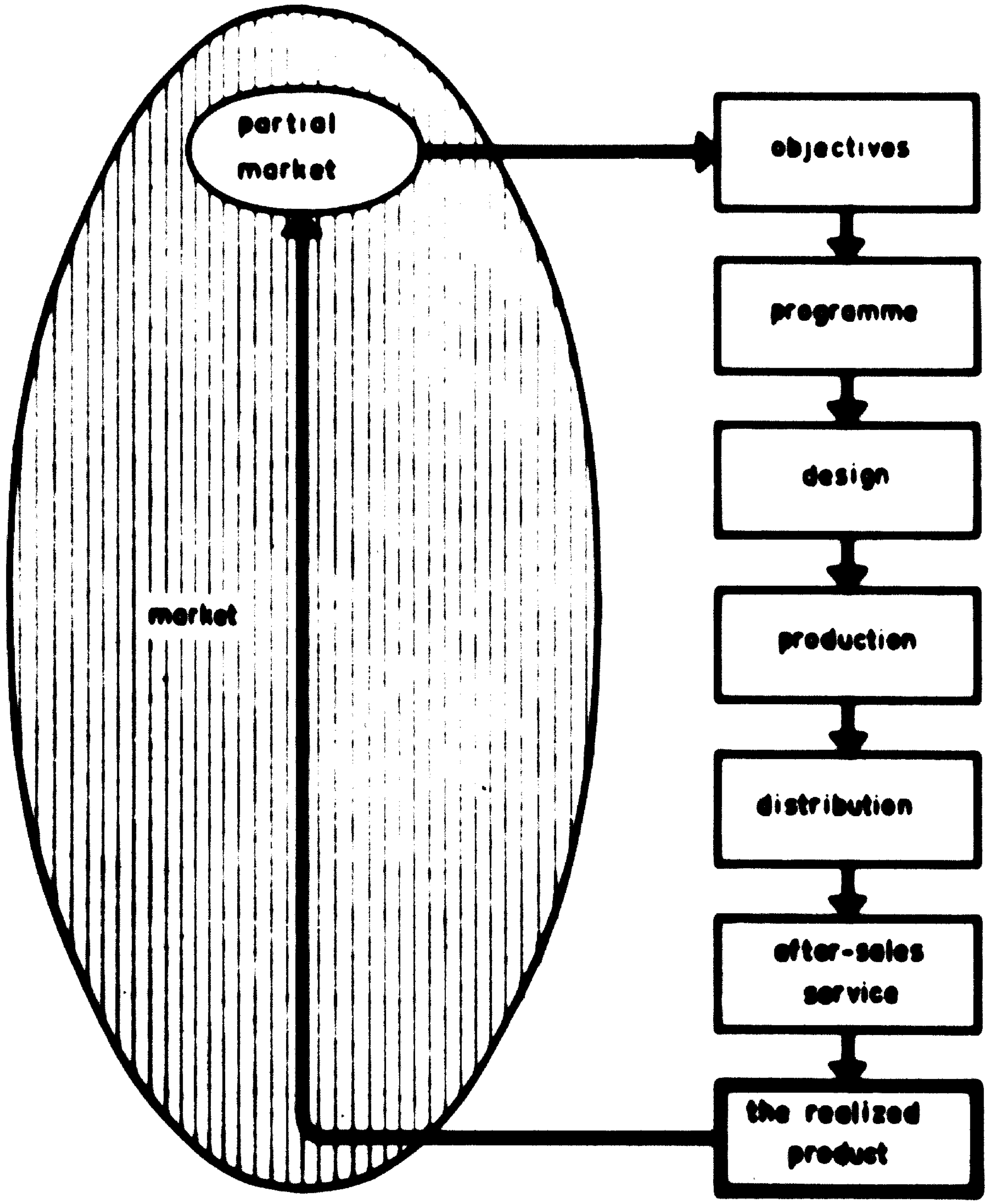
a) It may be noted, however, that the designer sometimes adds a few "subjective qualities" to the product which were not included in the programme.

Figure 7 Quality Circuit



5. The economics of quality

The development of an economic theory regarding quality is lagging behind badly.
In the following pages, some ideas will be expounded about the direction in which one could try to find the means of measuring quality and therefore integrate it in the body of economic decisions of families, entrepreneurs and government authorities.

The quality equation

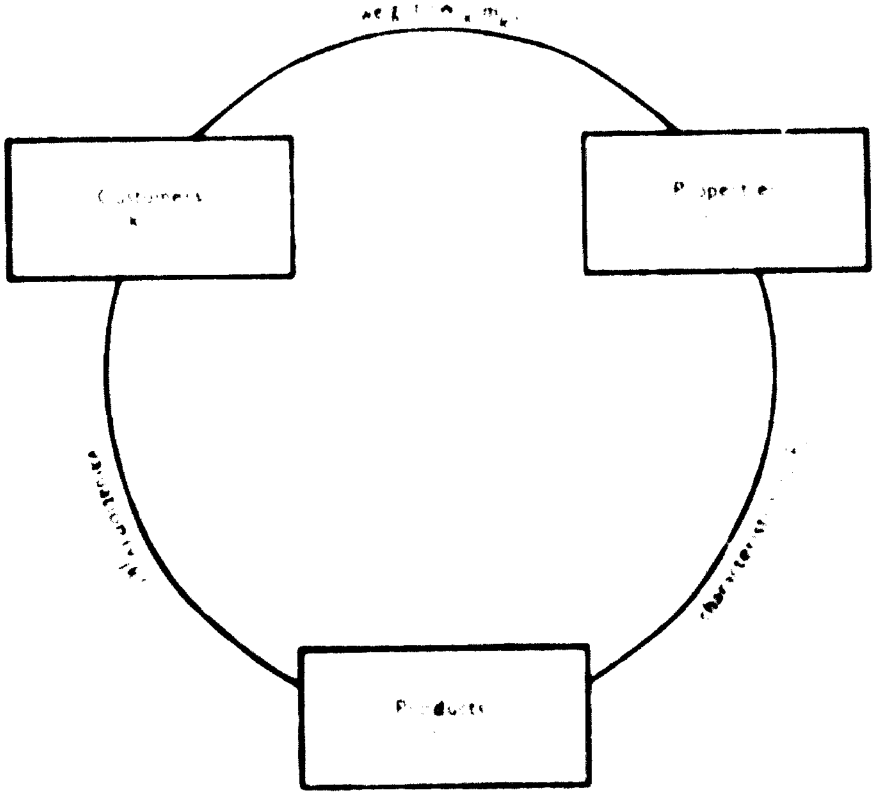
We need a model which enables us to measure the quality of a given product for a given customer. According to the definition of quality, the model must contain certain quantities pertaining to the situation of the customer and other quantities pertaining to the properties of the product.
For practical reasons, only those properties are included in the model which are relevant from the user's point of view independent of the fact whether the user is conscious of their existence or not.

Each product can be described in terms of its relevant properties. Mathematically speaking, the product is a point in n-dimensional space if there are n relevant properties.

At the same time the customer's situation may be described by a set of n "weights" which he attaches to the relevant properties of the product.
If we denote the properties of the product by the subscript i, the products by the subscript j and the customer by the subscript k, then the product is defined by its "characteristics" c_{ij} and its price p_j. The customer's situation, on the other hand, is defined by the set of weights w_{ik} and the weight he attaches to a unit of money a_k.

Relationships between customers, properties and products are shown in figure 8.

Figure 8 Relationships between customers, properties and products



We are now going to calculate, with the aid of our model, the attractiveness of the given product to a given customer by multiplying the characteristics with the corresponding weights, and adding these products over all relevant properties.

The result is

$$\sum_i w_{ik} c_{ij}$$

This sum is termed "abstract quality" because in calculating it, we have abstracted from purely economic considerations. We may also call it the use-value or usefulness.

If we include the economy, we have to compare the usefulness of the product as given by the formula above, with the amount of money the customer has to sacrifice in order to get possession of the product, the price of the product p_j again has to be multiplied by the weight of money for the given customer m_k.

Thus we arrive at the "quality equation"

$$\sum_i w_{ik} c_{ij} - m_k p_j = v_{jk}$$

where v_{jk} is the value the customer k attaches to the product j. This quantity is called "economic quality".

<u>The meaning of the quality equation</u>

The quality equation is a mathematical model, describing in a rather approximate way the considerations which influence the user in his choice of the product to be bought. Of course, the user's considerations and therefore also his decision whether or not to buy a certain product may not be rational. What he thinks the characteristics of the product are, may not be its true characteristics, e.g., he may be misinformed about the useful life of a washing machine or about the cleaning capacity of a washing powder. Advertising plays a major part in this kind of misinformation.

On the other hand the user's decision may be irrational, not because of his being wrongly informed about the characteristics of the product (c_{ij}), but because he may have wrong ideas about the weight he attaches to certain properties of the product.

Take the customer who buys a wireless set because he is thus able to listen to broadcasts from Australia. He later finds out that he never does so, because the broadcasts from this country coincide with the time he sleeps.

The quality equation holds good whether the customer decides rationally or irrationally. Also in most cases he does not calculate nor even specify the separate terms of the equation, but he looks at the product as a whole. As a result the process of adding up the terms of the equation takes place only intuitively and implicitly. This particularity does not render the equation valueless either.

Optimal quality

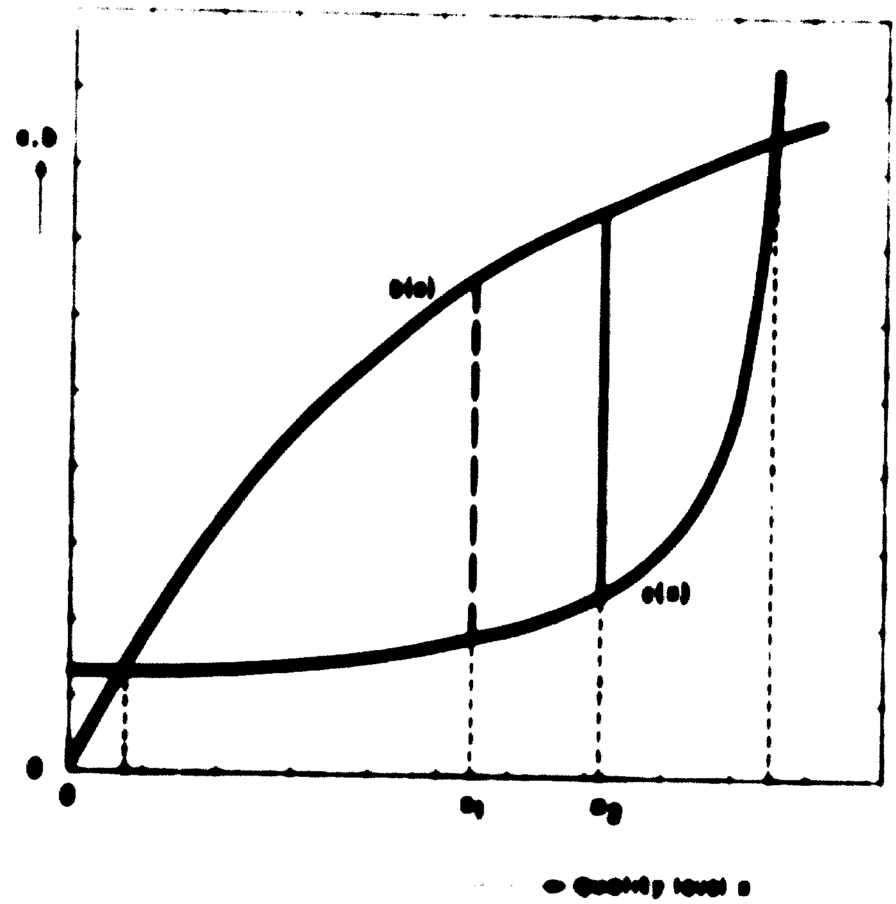
If we change certain characteristics of the product (e.g., its useful life), then we also change the production costs and consequently the selling price. Applying the quality equation to this problem we may ask whether a simultaneous change of characteristics and price results in a higher or lower economic quality of the product.

It is felt intuitively that the golden mean between a very low and a very high value represents a better economic quality. E.g., everybody feels that motor-car tyres that will last for 100 000 miles are just as impractical as tyres that are worn after only 2 000 miles.
If we call the value of such a characteristic (the useful life of the product) or a combination of characteristics the quality level of the product, then we may state that, normally, the most preferable quality level lies somewhere in between the lowest and the highest which are technically possible.
But how can we find this golden mean?
The solution to this problem depends on the existence of two techno-economic relationships, viz. :

a) the benefits -b(x)- of the quality as a function of the quality level x,
b) the cost - c(x)- as a function of the quality level x.

In figure 9 the typical shapes of these two functions will be found: benefits are increasing degressively, whereas costs increase progressively with the quality level.

Figure 9 Optimal quality



It may be noted that the costs at quality level zero generally have a positive value; this value we may term "fixed costs of quality". On the other hand, the benefits derived from a quality level zero are zero themselves.

Now, when the quality level increases from zero, there is first a region in which costs are in excess of benefits. Then there comes a region in which benefits exceed costs of quality; finally, if we increase the quality level still more, there comes again a region in which costs exceed benefits.

In considering a good choice of a quality level we are of course concerned with the middle region, that is to say, the region in which quality gains occur. We even want to maximise these quality gains. This can be done in two ways, either by maximising

$$b(x) - c(x)$$

or by maximising

$$\frac{b(x)}{c(x)} \quad {}^{*)}$$

Generally speaking, the first definition is applicable in the situation of an isolated choice between alternatives as in the case of a single customer choosing between brands of coffee. The second definition is generally more suitable for the situation where one is interested in a whole population of transactions, as is the case with the manufacturer.

Now an interesting thing is that the optimal quality, according to the "customer's definition" ($b(x) - c(x) \longrightarrow max$) always occurs at a higher level of quality than the optimal quality according to the "manufacturer's definition" ($\frac{b(x)}{c(x)} \longrightarrow max$).

This difference in approaching the problem of optimal quality, which is, by the way, equivalent to the difference between marginal and integral cost calculation, is perhaps the basis of a number of disagreements in the field of quality economics.

Aiming at optimal quality is of great economic importance, particularly for developing areas, because production at any other than the optimal quality level implies the waste of economic resources which are generally very scarce in the younger industrial countries.

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*) Cf. the concepts of profit and relative yield of capital in general economics.

Dynamics of quality

In the preceding paragraph we have considered optimal quality with benefits and costs given well-defined functions. This static examination of optimal quality has to be supplemented by an examination of the development of quality in time.

As production techniques are developing continually, two things happen at the same time:

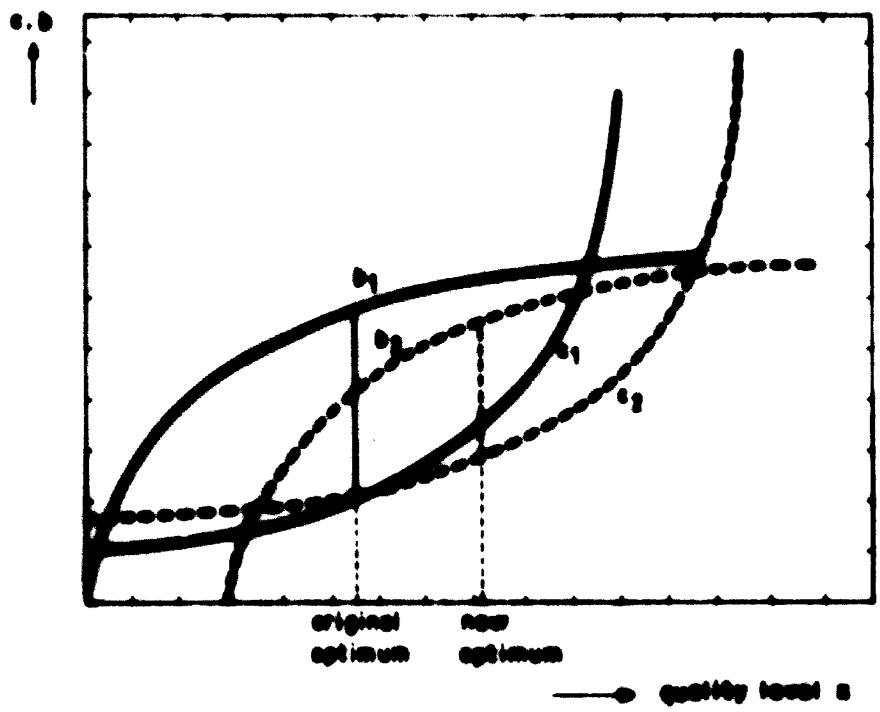
a) The quality demands of the customers or buyer grow. Consequently, the value attached to a certain quality is continually decreasing; for instance mechanisation of the bottling process in a dairy means that variations in the height of the bottles which formerly were acceptable, now give rise to serious troubles and are, therefore, no longer acceptable. In figure 10 this development is symbolised by function b_1 developing into b_2.

b) By experience, the development of new techniques and better organisation, so generally speaking by an investment of intellect, the manufacturer decreases the cost of quality. He is able to produce products of higher quality at the same cost, which is exactly what is needed in view of the increasing quality demands of his customer. In figure 10 the cost function c_1 develops into c_2

If the new quality functions b_2 and c_2 are realised at the same time, a new stage of optimal quality is established at a higher quality level than before. Whether at this new stage the quality gains have increased or decreased, depends on the relative speed with which the curves are moving towards higher qualities.

The race between the customer demanding higher quality at the same price, and the manufacturer producing it at the same cost never ceases.
The manufacturer who, instead of intensifying his quality control in all phases of the process, rests on his laurels, is well on the way to being out of business.

Figure 10 The dynamics of quality



c_1 : b_1, original costs and benefits

b_2 changed benefits as a result of progress

c_2 changed costs to match new situation

4. Quality and standardisation

Aggregation

In the preceding chapter the "quality equation" was used as a model describing a single user meeting a single product. The real problem in society is of course the meeting of one user with all the products or of one product with all its potential users. These situations can be described by some kind of aggregating procedure starting from the quality equation which we have used in its simplest form.

A second stage of aggregation leads to an equation describing the confrontation of all the users with all the products.

Figure 11 Quality equations

one user - one product

$$V_{jk} = \sum_i w_{ik} c_{ij} - m_k P_j$$

one product - all users

$$V_j = \sum_{k=1}^{n_j} \sum_i w_{ik} c_{ij} - P_j \sum_{k=1}^{n_j} m_k$$

one user - all products

$$V_k = \sum_{j}\sum_{i} w_{ik} c_{ij} - m_k \sum_j P_j$$

all users - all products

$$V = \sum_{k=1}^{n_j} \sum_{j}\sum_{i} w_{ik} c_{ij} - \sum_j \sum_{k=1}^{n_j} m_k P_j$$

It must be kept in mind that all these quality equations describe the quality of a transaction or of some aggregate of transactions; in each case the usefulness bought is compared to the money spent.
The quality equation 'one product - all users' leads us to the standardisation problem.
The quality equation 'one user - all products' can serve to judge of the proper spending of the family income.
Finally, the quality equation 'all users - all products' makes it possible to discuss in an analytical way the optimal spending of the national resources. This, of course, is one of the basic decisions in a centrally planned economy.

<u>The problem of standardisation</u>

The difficulty is that the needs of the users are not identical. If that were the case, the aggregation would merely be a problem of multiplication.
The answer to the difficulty, arising from the uniqueness of needs of individuals, families, countries and technical situations is that the manufacturer develops not just one product, but a "family of products", meant to satisfy the needs in the market by giving the users a certain choice of size, type, colour, taste, strength, etc..

The method by which one arrives at the programme for such a "family of products" is standardisation. Standardisation means the conscious selection of a limited number of types in order to satisfy the infinitely variable needs and demands of the market. Satisfying unique demands by standardised products and services is the basic problem of standardisation.

<u>Adaptation losses</u>

An economy which uses - and has to use - standardisation, is not able to satisfy demands in an ideal way because of the discrepancy between unique needs and standardised products. This situation, generally speaking, results in losses which can be financial, economic, psychological, hygienic, etc.. These losses are called "adaptation losses" because of their being the result of products not ideally adapted to needs.

In many cases the amount of these losses can be expressed as a "loss function" which defines the losses as a function of the distance between need and product. By integrating the loss function over the whole market - that is over the aggregate of situations of the users - the total loss due to a certain selected standardisation system can be found.

These losses are rather important. In the situation of construction materials used for ship building and so on, adaptation losses arise out of using stronger or more valuable material than would be necessary from a functional or constructional point of view, and these losses may amount to 10 or 20 per cent. of the cost of the material.

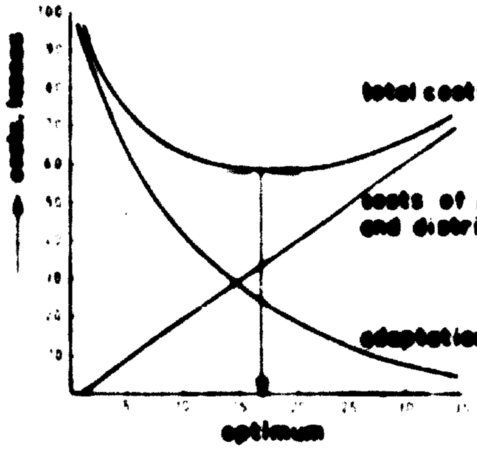
In garment sizing, adaptation losses arise out of bad fitting of the standardised product; losses, which in this case are the costs of the necessary alterations including the loss of material, are again in the order of 10 per cent.

<u>Minimising Losses</u>

Given a number of standardised types it is possible to arrange them in such a way that adaptation losses are minimised. With a finite number of types, however, adaptation losses can never be reduced to zero. Very great economies, nevertheless, are made possible by this minimisation process. Optimal standardisation, however, can only be arrived at if not only the arrangment of standardised types but also their number is included in the investigation. The more types are standardised, the more the adaptation losses will be reduced. But on the other hand a greater number of types means increased costs of production and distribution. The general solution is described in figure 12: for every number of types the total cost is calculated, which consists of:

a) the (minimum) adaptation losses with a given number of types,
b) the production and distribution cost belonging to the given number of types.

Figure 12 Optimal standardisation



The curve expressing the total costs, generally has a minimum, and the number of types at which this minimum occurs is called the optimal number of types. An arrangment of the types in such a way that adaptation losses are minimised, leads to optimal standardisation.

Developing countries embarking on a standardisation programme for the first time must try and use the concept of optimal standardisation as much as possible, because only in this way the enormous waste can be avoided which would arise out of a haphazard method of standardisation or of an imitation of the standardisation in fully developed countries.

part B QUALITY IN DEVELOPING AREAS

7. The significance of quality control for young industrial countries

The acceleration of economic development through quality

From the fact that in highly industrialised countries the concept of integrated quality control developed during their respective stages of high mass consumption, one would be inclined to think that integrated quality control is of no importance for the countries which have not yet reached that stage of development.

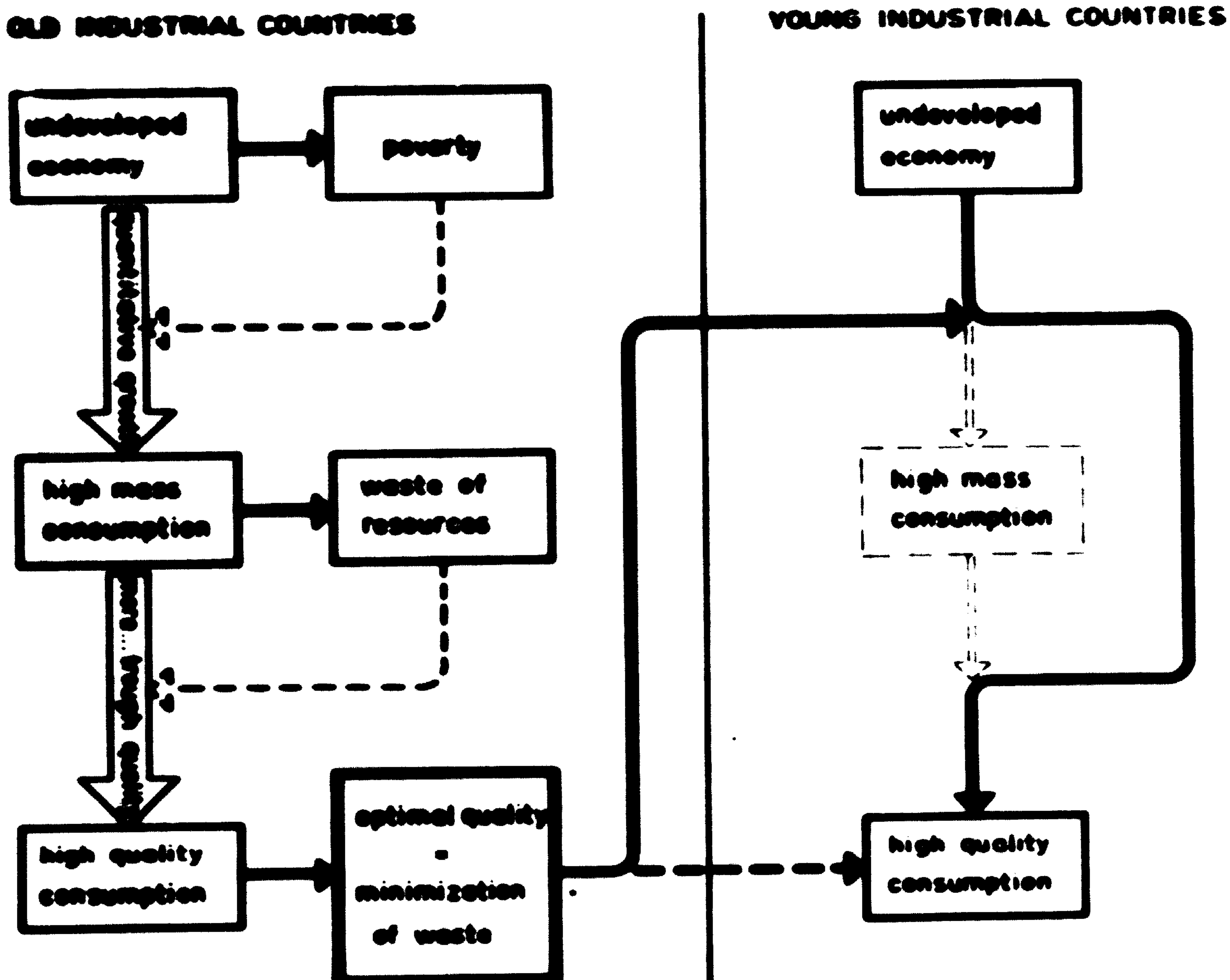
Such a line of thought would be equivalent to the statement that the first one hundred years of development of the textile industry in, say, Kenya, should be based on the steam engine and that electric power could be used only after A.D. 2050.

It is true that the modern theory of quality could only originate in a situation where it had become clear that the purely quantitative development has certain limitations, but now that this theory has been developed, it may be used profitably in those countries where industrial development is still in the beginning of its quantitative growth.
The reason is that the quality theory is centred on the concept of "optimal quality" which is equivalent to "minimum waste". Given the fact that restricted resources are the limiting factor in the actual development of industry, application of the quality theory can only accelerate this development.

In figure 13 this idea has been expressed:
Knowledge of the waste of resources, connected with purely quantitative growth without the lodestar of optimal quality, can help the next generation of industrialising countries, to avoid this waste. "One man's fault is another man's lesson".

Even if the developing countries cannot completely bypass the stage of "high mass consumption", they will be able to go through this stage much more quickly.

Figure 15 Acceleration of development through optimal quality



The importance of this lesson for the developing countries must not be underrated. Rough estimates put the waste resulting from the non-optimal quality of goods and services in industrially developed countries, at about 25 per cent. of the available resources. In undeveloped countries this percentage could easily become much higher: but even an economy of 25 per cent. of the available resources could mean the difference between further enlarging or diminishing the discrepancy in wealth between the two kinds of countries.

<u>No slavish imitation!</u>

It could be argued that the development of the young industrial countries could be greatly assisted by their taking over the experience of the old industrial countries in the form of product specifications, standardisation, inspection procedures, informative labelling etc., in short, by imitating, without independent and critical thinking, what has been done in the way of quality in the old industrial countries.

We are strongly convinced that such a way of trying to avoid the painful work of proper development would be disastrous for two reasons:

1) Optimal quality for young industrial countries does not coincide with optimal quality for fully developed countries. Not only are there great differences in climate and the other physical characteristics of the countries, but the differences in the amounts of available financial resources in themselves have a strong influence on optimal quality in both cases. (Cf. the quality equation and the concept of economic quality as opposed to abstract quality).

2) Optimal quality, in the economic sense, depends on what resources are available in the country under consideration. Moreover, the country's need of competing on the international market makes it necessary to use original designs, based on available raw materials, its own labour and its own artistic and cultural backgrounds.

It will be greatly to the advantage of developing countries to make use of the way of thinking in quality matters which, by the hard method of trial and error, was arrived at in the old industrial countries. Every attempt to go further than that and to adopt not the philosophy, but the product specifications etc., could be abortive.

The problems of the developing areas are the same as those of the developed areas plus a number of additional problems:

The population of the undeveloped areas has potentially the same needs as the people in the other countries but less training.

2 There is no time for the slow progress by trial and error which was typical for the development in industrial countries.

3. The undeveloped countries do not possess the opportunity of having their investments paid for by either sufficient saving, or the exploitation of other countries.

Therefore the only solution is found in technical aid, intelligently given and intelligently accepted, the investment of as much intellectual capital as possible and the banishment of the waste of resources.

The importance of the programme of requirements

In the old industrial countries an explicit programme of requirements is very often absent in the development process of a new industrial product. This situation is not disastrous because in these countries the development of what are called "new products" mostly consists of small alterations and "face liftings" of products which have already existed for years and for which the manufacturer has arrived over the years at some kind of implicit programme of requirements by trial and error. The situation in the developing countries however, is quite different. In some cases it may be a good thing to manufacture products which are already developed and which have proved their usefulness in a market similar to the one under consideration.

that in most cases the development of new products in those countries means really new products. There is no time to arrive at the suitable programme of requirements by trial and error. Good planning of the quality of product is absolutely necessary. Omitting the composition of the programme of requirements in this situation would entail a great loss of time, money and customer satisfaction.

<u>The use of typology</u>

The philosophy of integrated or total quality control expounded in the preceding pages is, when all is said and done, rather simple, quality being the degree of adaptation of the product properties to the needs of the user. It is quite clear that the quality of a given product is influenced by a sequence of activities carried out by or on behalf of the manufacturer: programming, designing, manufacturing, distributing, servicing.

The quality circuit is the model in which this sequence of activities is represented. Like every model the quality circuit is a simplification, perhaps even an oversimplification, of reality. Actually, quality control is less simple than the model suggests. On the one hand, actual quality control does not unfold itself in a simple sequential relationship of activities but rather in a permanent interaction between activities, later ones being continuously fed back to former ones.

On the other hand, the activities enumerated in the quality cycle are only the ingredients of quality control; the recipes of quality control, however, are very different for different kinds of products. We may arrange products according to what position they occupy in their development from the most natural to the most artificial state, which is also the road leading from complete anonymity to the most marked individuality.

According to these principles we can devide the products into

1) natural raw materials (crude oil, coal, iron ore...)
2) industrial raw materials (bricks, woollen cloth, sheet steel...)
3) industrial finished products (a garment, a bed, a motor-car...)
4) super-products (an airline, a hospital, a town...).

Whereas all phases of the quality circuit occur in all products the centre of gravity as it were shifts towards the earlier stages of the quality circuit as we move from natural to man made products and super-products.

Let us take natural raw material . There can be little programming of the quality of coal (nature having programmed the quality already). Neither can there be much designing because we can only design what we are going to make. The quality will be influenced by some production decisions, but not to a great extent because production does not really change very much the material we get out of the earth.

Quality activities will, with natural raw materials, be centred on after-production inspection, which in the quality circuit belongs to the stage of distribution because it forms part of the activities which direct the product to the user.

Taking next the industrial raw material, for instance sheet steel, we will find a simple programme and a simple design. The stress now is put on process control, because with this kind of material the properties are heavily dependent on production methods.

We will also find here a certain amount of after-production inspection, as an additional safety measure, like wearing a belt and braces.

The next group, the industrial finished product, comprises a much greater range than the preceding ones. A roller-skate falls into this category as well as a Rolls Royce. Nonetheless from the viewpoint of quality control these products are equal in that their properties are most strongly influenced by the design. A programme of requirements is necessary, though of course much more comprehensive with the complicated product than with the simple one. Process-control is also necessary, but one should not forget that production only realises what the design prescribed. If the quality of design is faulty, perfect process control will only result in a series of accurately made bad products. After-production inspection occurs too in this class of products, but again only as a safety measure.

Finally with super products, quality depends almost completely on the programme of requirements. Some design satisfying the programme is needed. Process control is negligible and after-production inspection in the acceptance or rejection sense should better be avoided, unless one is prepared to dynamite a newly built town and rebuild it. Some kind of after production inspection may, however, exist with super products in order to judge the efficiency of the product in action and so to learn from one's mistakes.
A rough outline of the way in which quality control recipes are composed in the four groups of products mentioned is given below.

Composition of quality control activities with various products

	Groups of products			
	Natural raw material e.g. iron ore	Industrial raw material e.g. sheet steel	Industrial finished product e.g. a railway carriage	Super-product e.g. a railway system
Programme	little	some	some	MUCH
Design	little	some	MUCH	some
Process control	some	MUCH	some	little
After production inspection	MUCH	some	some	little

By concentrating on a sound programming philosophy and design technique the young industrial countries will be able to avoid the uncontrolled growth of an infra-structure such as is often seen in the old industrial countries, where it is already crippling the economic and intellectual development. It may well be that, by using the available knowledge and experience, in 30 years time "the last shall be the first".

6. The programme for integrated quality control

Introduction

Speeding up the introduction of modern quality control in new industrial countries requires work to be done on several fronts at the same time:

1) Convincing decision-makers in government and industry that quality control can play an important role in the solution of their actual and future problems.
2) Training a sufficient number of specialists on all levels particularly the management level in the theory and practice of quality control.
3) Adapting existing governmental, semi-governmental and industrial organisations to the requirements of the incorporation of quality control.

These three items correspond to the three fields of

1) promotion
2) training
3) implementation.

The introduction of quality control in developing areas will only succeed if these activities are undertaken in the right place, in the right way and at the right time. Success, moreover, will depend on a close co-ordination of the activities. It is for this reason that we add to the activities already mentioned a further group of activities, namely

4) guidance, co-ordination, financing and control of the whole programme.

The last item will be discussed in part C of this report, "Realisation". Some remarks on the other parts of the programme will be made in this chapter.

Promotion

Decision-makers in developing countries, both on the government and on the industrial management level must become interested in quality control in order to give it a fair chance.

Foremost requirement is the acceptance of an active philosophy by means of which the developing countries give expression to their desire to steer their own course.

We think that the mental climate in the developing areas is favourable because their wish to plan their economy stems from the same mentality. What is needed, however, is perhaps a more scientific kind of decision making.

Traditionally, management decisions were taken by applying intuition, personal experience or imagination to the problem in hand. During the last 20 years a science of decisions has grown under the name of "Operations Research" which aims at optimising decision methods and making their results reproducible by the application of scientific methods.

As integrated quality control with its aspect of optimising the quality level etc. is very closely related to Operations Research, it is desirable for decision-makers in developing countries to acquire a certain measure of familiarity with the methods of scientific decision making. Concepts such as objective, objective function, restriction decision space, etc., should be incorporated in their thinking. Experience shows this to be not too difficult because these concepts are more or less a logical formalisation of the elements of thinking which traditional decision-makers already possess, be it that they are not clearly defined and not explicit with them.

Promotion of the concepts of quality control is necessary to influence national decision-makers. Without their co-operation quality control will achieve nothing.

Training

Once decision-makers are convinced of the value of integrated quality control the experts can go to work. But the experts themselves are lacking in some countries, too few in number in others, and not sufficiently experienced in yet other countries. The training of experts in integrated quality control therefore becomes the next task

Quality control is an inter-disciplinary activity: economy, technology, marketing and organisational theory come into it, together with mathematical and statistical methods. It is therefore necessary that quality control experts in the developing countries have at least a working knowledge in all the fields mentioned, as they are not able to fall back on all kinds of specialists.

The exprience gained from the first "International Course for Industrial Quality Instructors" given in 1966 by the International Quality Centre and Bouwcentrum in Rotterdam, has proved that it is possible to transfer the essential knowledge of integrated quality control in rathera short time of intensive training (4 months) to participants from developing countries, provided they possess a sound background of scientific thinking comparable to at least a bachelor's degree in a science discipline.

It is not accidental, perhaps, that the 19 participants in this first course came for the greater part from semi-developed countries in Asia, South America and South-Eastern Europe. In these countries there are rather large numbers of people with an academic education and for this reason it proved not too difficult to find participants with the kind of background required.

We consider a training course such as the one which was held in Rotterdam during the last 4 months, a sound method of disseminating expert knowledge in the field of quality control.

The interdisciplinary character of integrated quality control makes it necessary for such a course to be given by rather a large number of specialists (mathematicians, statisticians, organisation people, designers, standardisation experts, etc.), some of whom give only a limited number of lectures.

It would therefore be uneconomical to organise this course in one of the developing countries. Apart from the consideration of cost, the necessity of including practical work of the participants in the curriculum makes it highly desirable to organise the course in a country where enough industries and institutes are working along the lines of modern quality control.

In the opinion of the authors a course such as the one held in Rotterdam is the best way to transmit the necessary basic knowledge of integrated quality control to the experts in the developing industrial areas. This knowledge, being of a basic character, is identical for all, for the greater part at least. Any further knowledge the experts wish to acquire, however, must be specialised and directed to the specific quality problems of their countries or industries.

The first step towards specialisation has already been taken at the Rotterdam Course, where, during the second stage of practical work, the participants select one of a number of specialised fields like product development, standardisation, organisation for quality control etc.
The continuation of the specialisation takes place in the participants' own countries. There, they will study specific quality problems which are of importance to their countries or their industries. It will be necessary, however, to coach them during the time when they first set out to apply their knowledge to practical problems. This coaching can be carried out by either a consulting specialist from the international or regional quality centres, or a specialist in the service of one of the international concerns operating in the country under consideration.

Some remarks about these regional quality and training centres will be made in chapter

Another means of the specialised training of the experts consists in holding international seminars (in which the emphasis is laid upon the contributions by the experts themselves) and also refresher courses (in which the lectures play the most important role).

This specialisation in quality control can be visualised along the lines of the types explained in chapter 5 of this report.

The necessity may be considered of organising five different "second stage quality control training programmes":

1) Programme for the problems of the extracting industries (ores, crude oil)
   Principal subjects: sampling - metrology - statistics - operations research.

2) Programme for the problems of industries producing industrial raw materials (chemicals, steel, textiles, building materials)
   Principal subjects: process control - organisation of production process - cybernetics - standardisation

3) Programme for the problems of industries producing simple finished products (foodstuffs, clothing, furniture, pharmaceutical products)
   Principal subjects: technical design - industrial design - production organisation - standardisation - distribution problems.

4) Programme for the problems of industries producing complex finished products (buildings, means of transport and communication, electronic equipment)
   Principal subjects: Programming - planning - design - process control - service problems - reliability.

5) Programme for the problems connected with super products ("systems"), (transport systems, social systems, health systems)
   Principal subjects: Programming - physical planning - economy.

Whereas the industry of a whole country may fall to a certain extent into one of the classes mentioned, every country is confronted with the problem of the quality of its "export products". Even a country which is just starting on the way towards industrialization has to take a number of basic decisions concerning its industrialization. It is therefore that quality control will have to concern itself in every country, whatever its stage of industrial development, with the programming problems related to the quality of the export products.

In the way mentioned above a small number of quality control experts with university training will be made available to every developing country. These, in their turn, will be able to train a larger number of quality control people on a secondary level. In order to be able to perform this task, the experts must not only be experts, but instructors as well, that is to say, experts in the methods of the communication of knowledge. Didactic methods, therefore, are an important part of the "International Course for Industrial Quality Instructors" given in Rotterdam, and a working manual for quality control training on a secondary level is included in the "packet" the participant takes home.

The training capacity of the Rotterdam Course is 30 participants per year at the moment. It may be estimated that each of them will be able to give two courses in his own country every year, thus training an average of 40 secondary level experts a year.

It is of the greatest importance for the success of the quality control programme for developing countries to impress upon the experts the necessity of their teaching activities. Some of them will only wish to use the knowledge they acquired for the enhancement of their personal jobs.
There will be, of course, a reduction of the training productivity in the course of time, because some of the academic experts will leave the quality field or leave their countries, and at the same time some of the experts, trained on the secondary level, will be promoted to other functions in their industries.

Indeed, the fact that a well trained quality expert has a thorough knowledge of many aspects of his industry as well as a good understanding of the relationships between the technical, economic and commercial problems in it, has often made him eligible for other functions and has therefore proved to be a drawback for the growth of the quality organisation in the industry concerned.

We estimate that, for the reasons mentioned, about 10 per cent. less than the original number of trainees per instructor will be produced every consecutive year while another 10 per cent. of the experts trained on the secondary level will be vanishing from quality functions each year.

<u>The training capacity of the Rotterdam "International Course for Industrial Quality Instructors"</u>

Production of experts on the secondary level

	1966	1967	1968	1969	1970	1971
	15 R →	450	400	350	300	250
		30 R →	900	800	700	600
			30 R →	900	800	700
				30 R →	900	800
					30 R →	900
Cumulative total of secondary experts less 10 per cent. yearly losses		400	1500	3200	5500	7700

[.... R] indicates number of instructors trained at the Rotterdam Course

Along these lines we can [illegible] that in 5 year time there will be available in the developing areas about [illegible] quality experts of the secondary level [illegible] results of the activities of the Regional Centres.

Experience shows that a minimum of one quality expert of this level is required to every 1000 employees in an industry; industries which do not reach this level [illegible] for tackling their quality problems. [illegible] the 7000 experts [illegible] personnel for quality control [illegible] total number of 5 000 000 employees.

The [illegible] training centres and [illegible] of the capacity of the [illegible] will [illegible] widen the range of industries capable of applying [illegible] control.

Implementation

In the preceding paragraphs, some remarks were made about promotion and training for quality control. The will, however, of decision-makers to introduce quality control in their organisations and the availability of trained quality control personnel are necessary but not sufficient conditions for the success of a quality control programme.

Quality control in industry is not an isolated function. It influences, and is influenced by, the way in which an industry is managed. If, e.g., an industry is used to the existence of quantitative standards for production and if it accepts without discussion that real performance must always be checked against the standards, then such an industry will easily accept control in the quality sense, viz., the existence of quality standards, the measuring of samples from the production process, a comparison with the standards and a feed back of this comparison into the production process itself.

If on the other hand an industry is used to looking at the quantitative production as a random variable which is not tested against any prescribed value, then it will be almost impossible in such an industry to make a real start with quality control.

Another important aspect of the implementation of quality control in industry is the necessary "cost-mindedness". If there is no clear relationship between technical and economic quantities in the minds of the staff, they will turn a blind eye to the problems of quality economy.

Another example: the introduction of quality control requires a certain minimum of clerical work. If there are not enough people who can read and write, quality control may be impossible. Therefore the implementation of quality control means in fact that there must exist a sufficiently high level of general education and of industrial education.

As far as we know, not enough has be done about these aspects, especially in a systematic way. For in the industries where quality control has been applied until now, the implementation was generally sufficient.

It may well be that in this field lies one of the major difficulties of the introduction of modern quality control in developing areas.

Part C REALISATION

7. The role of the United Nations

In the old industrial countries the growth of quality consciousness has taken about 50 years and even after these 50 years, its spread is by no means sufficient.

If a similar growth of quality thinking is to come about in the young industrial countries in a much shorter time, it is quite clear that this will be possible only if there is some centre from where this growth will be guided, stimulated and controlled. Here, in our opinion, lies a task for the United Nations because no other body or institute has the authority and the goodwill which are necessary.

The quality programme for developing countries cannot be executed by a single nation, however powerful: not only would quality control be looked upon as a means of industrial penetration by this powerful nation, but apart from this psychological argument, the fact remains that no single nation possesses the intellectual capacity needed for this task.

The United Nations already have an organisation for industrial development. If quality is recognised as an essential aspect of industrial development it is obvious that quality control becomes one of the tasks of this organisation for industrial development.

Quality Control for Industrial Development is not just a question of teaching statistics and organising inspection in a large number of factories. The United Nations should recognise the importance of quality for the future growth of industry in young industrial countries as well as in the old ones. Quality Control therefore should enter the sphere of political consideration.

The technical knowledge necessary to guide and control the development of quality all over the world, must be incorporated in the organisations of the United Nations by attracting specialists to the central organisation as well as to the regional economic commissions.

It will be useful if the Centre for Industrial Development co-operates with existing organisations, institutes, societies etc. which have experience and technical knowledge in the quality field.
We are thinking of the American Society for Quality Control, the Japanese Union of Scientists and Engineers, the European Organisation for Quality Control and last but not least the International Quality Centre at Rotterdam.

The institutes already existing, however, will not be sufficient. It seems necessary to stimulate the foundation of quality and teaching centres in developing countries, at least one in each continent. The following activities should be carried out in these quality centres:

1) Systematic investigation and documentation in the field of the integrated quality control of industrial products.
2) Transmission of knowledge regarding techniques and know-how in the field of quality control by means of
   a) training of specialists
   b) systematic implementation of quality control in industry by consulting activities
   c) organisation of conferences, seminars and round-table discussions for management and staff of industries
   d) permanent and non-permanent exhibitions of quality products
3) Enhancement of the quality level in subscribing industries by
   a) informative labelling
   b) quality information
   c) quality marks for industry together with standardisation
4) Implementation of the quality control function in industry by means of:
   a) application to single enterprises of standardised methods of diagnosis
   b) treatment of quality troubles in these industries by means of advice, training and organisation

e) special surveys regarding the quality characteristics required for export goods

5) Stimulation of standardisation of product properties

6) Education of the user regarding quality.

The regional quality centres should co-operate by forming an international chain of quality centres sponsored by the United Nations' industrial development organization.

8. Programme of action

In order to start the quality activities in developing areas in an efficient way it seems wise not to begin everywhere at the same time, but to concentrate the initial efforts on a limited number of "pilot institutes" each operating in a limited number of "pilot industries"

It seems possible to approach the quality problems during the first two years of the activities on:

2 pilot institutes in Latin America
2 pilot institutes in Africa
2 pilot institutes in Asia
2 pilot institutes in Eastern and South Eastern Europe.

These regional institutes could operate under the direction of the Regional Economic Commissions.

Dependent on the success of this limited programme, quality activities will then spread and become more general.

The steps to be taken by the United Nations' Centre for Industrial Development in order to set such a programme in motion are the following:

1) Attracting quality experts for the central organisation as well as for regional economic commissions,
2) Selecting countries for the Pilot Institutes,
3) Organising an International Conference in order to discuss the need, and the execution of the programme with all concerned.
4) Stimulating the foundation of regional quality and teaching centres or establishing co-operation with existing ones.
5) Training about 10 experts for each of the pilot institutes in the philosophy theory and practice of integrated quality control.
6) Sending at least one senior expert in quality control to each of the pilot institutes in order to direct the secondary education of the trainees.
7) After one or two years: organising another Conference in order to discuss the results obtained.

Appendix I **THE INTERNATIONAL COURSE FOR INDUSTRIAL QUALITY INSTRUCTORS**

The Course, given for the first time in the second half of 1966, is organised by the International Quality Centre and Bouwcentrum, Rotterdam.

The Course is made possible by the funds for Bilateral Technical Assistance provided by the Netherlands Government, and more particularly by the Directorate for Technical Assistance of the Netherlands Ministry of Foreign Affairs.

Aim:

It is intended that the participant who successfully completes the course will be fully equipped to:

a) impart to others the philosophy and practice of quality control, aiming at a high quality of production in the concern
b) effectively analyse for a given industry the extent to which integrated quality control is, or is not, applied
c) render assistance to industry and government regarding one phase of the quality circuit (see diagram page 21) according to the specialisation chosen

Programme

Part I	INTRODUCTION History and meaning of industrial quality control	½	day
Part II	QUALITY OF PRODUCTION Statistical quality control during the production process - acceptance sampling - process analysis - improving the production process - quality and cost - introduction of quality control - organisational aspects	20½	days

Part III	PRACTICAL WORK CONCERNING QUALITY OF PRODUCTION The participant works in the quality control department of an industry in Western Europe during this period		20 days
Part IV	STATISTICAL METHODS AND OPERATIONAL RESEARCH Some chapters on mathematical statistics and the science of decisions needed for the understanding of integrated quality control		5 days
Part V	ELEMENTS OF INTEGRATED QUALITY CONTROL The philosophy of integrated quality control - planning and preparation of basic decisions, decisions on programming, designing, production, distribution and service - the development cycle - classification of industries		10 days
Part VI	SPECIALISED PRACTICAL WORK According to the specialisation chosen, the work during this period is carried out either in an industrial department or in an institute or laboratory outside industry		15 days
Part VII	DIDACTIC EXERCISES Transmission of knowledge - classroom techniques - management games - didactic aids		4 days
Part VIII	FINAL REPORT Each participant will have to write and defend a final report		9 days
			86 days

Excursions

5 days

Excursions are held in order to acquaint the participants with industrial and general aspects of the country or countries where the course is held.

Specialisations

The participants have to specialise in one of the following subjects, according to personal background and preferences, during the latter part of the course:

- Market analysis and product development
- Standardisation
- Design for production
- Process analysis
- Organisation for quality control
- Metrology
- Problems of optimisation

Language

The course is given in English.

Personal Requirements

It is emphasised that this course gives advanced training at a post-graduate level. Candidates are therefore required to submit documentary evidence that they hold a degree of at least bachelor or equivalent standard from a recognised University or higher Education Institute, in the fields of science, technical science, economics or public administration.
They will also be required to show that at the time of applying, their employment in their own countries is concerned with industry.
A fluent command of English is a prerequisite for admission.

Appendix II **SHORT BIBLIOGRAPHY ON QUALITY CONTROL**

This bibliography is compiled for the reader who wants to acquaint himself with the modern theory of quality control. It was selected from the list of compulsory or recommended literature in use at the International Course for Industrial Quality Intructors Rotterdam.

Section 1: Quality Control

Ettinger, J. van and J.Sittig	"More ... through Quality" Rotterdam 1965
Feigenbaum, A.V.	"Total Quality Control" New York - Toronto - London 1961
Juran, J.M.	"Quality Control Handbook" New York - Toronto - London 1962
Schaafsma, A.H. and F.G.Willemze	"Gestián Moderna de la Calidad" Eindhoven 1962
idem	"Gestion Moderne de la Qualité" Eindhoven 1964
idem	"Moderne Qualitatskontrolle" Eindhoven 1964

Section 2: Mathematical Statistics and Probability Theory

Bennett, C.A. and N.L.Franklin	"Statistical Analysis in Chemistry and the Chemical Industry" New York - London 1954
Hald, A.	"Statistical Theory with Engineering Applications" New York - London 1952
Moroney, M.J.	"Facts from Figures" Harmondsworth 1951
Wilks, S.S.	"Elementary Statistical Analysis" Princeton 1951

Section 3: Operations Research

Churchman, C.W., R.L.Ackoff and E.L.Arnoff — "Introduction to Operations Research" New York 1957

Morse, Ph.M. and G.E.Kimball — "Methods of Operations Research" New York and London 1951

Magee, J.F. — "Production Planning and Inventory Control" New York - Toronto - London 1958

Sasieni, M., R.Friedman and A.Yaspan — "Operations Research" - Methods and Problems" New York - London 1959

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