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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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QUALITY CONTROL AND STANDARDIZATION AS CONDITIONS OF INDUSTRIAL GROWTH

by

J. van Ettinger, Executive President of Bouwcentrum, Rotterdam, and Chairman of the Board of the International Quality Centre

and

J. Sittig, Director of Quality Control and Operations Research Consultants, Rotterdam

Submitted by the Government of the Netherlands

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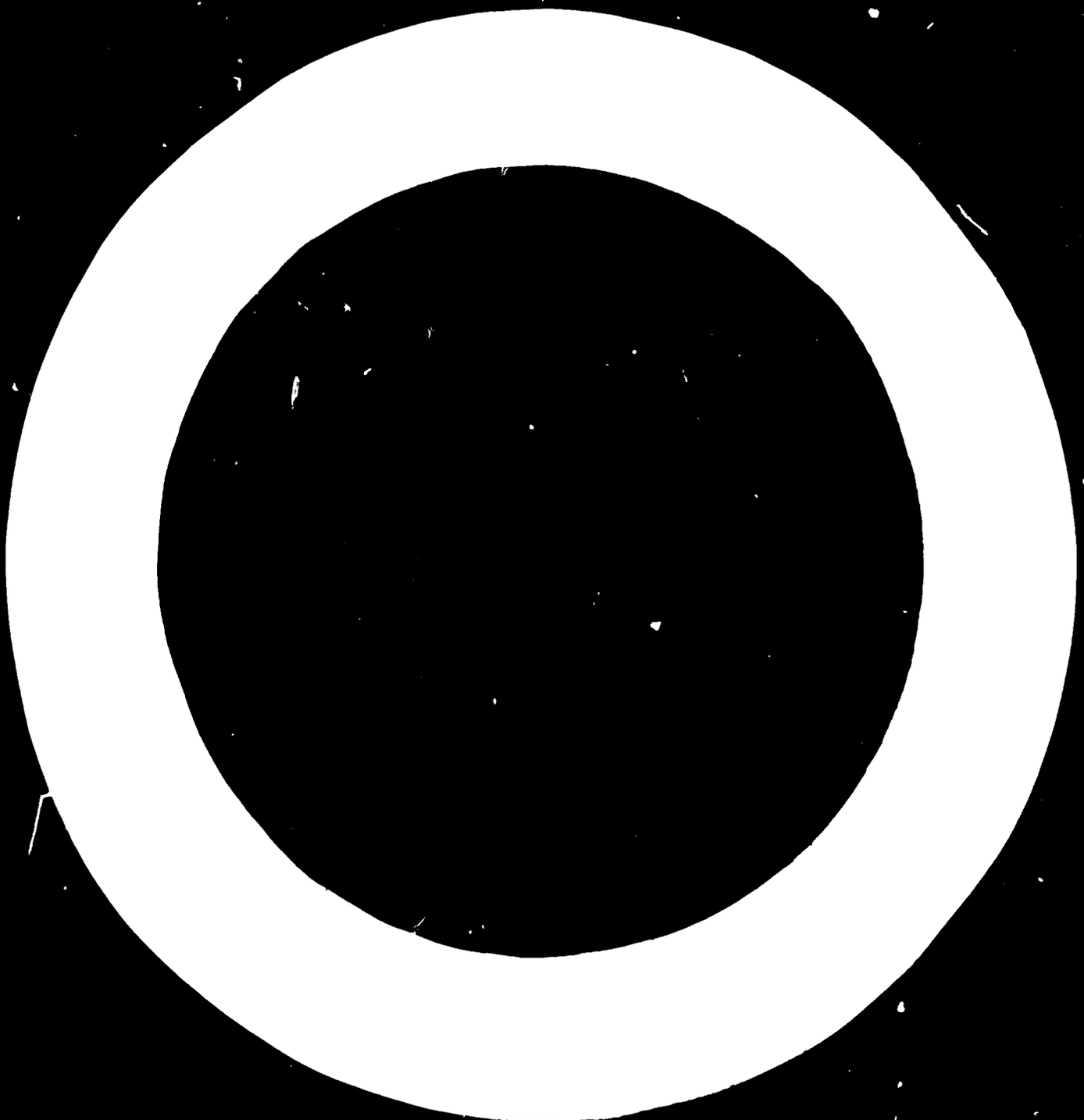

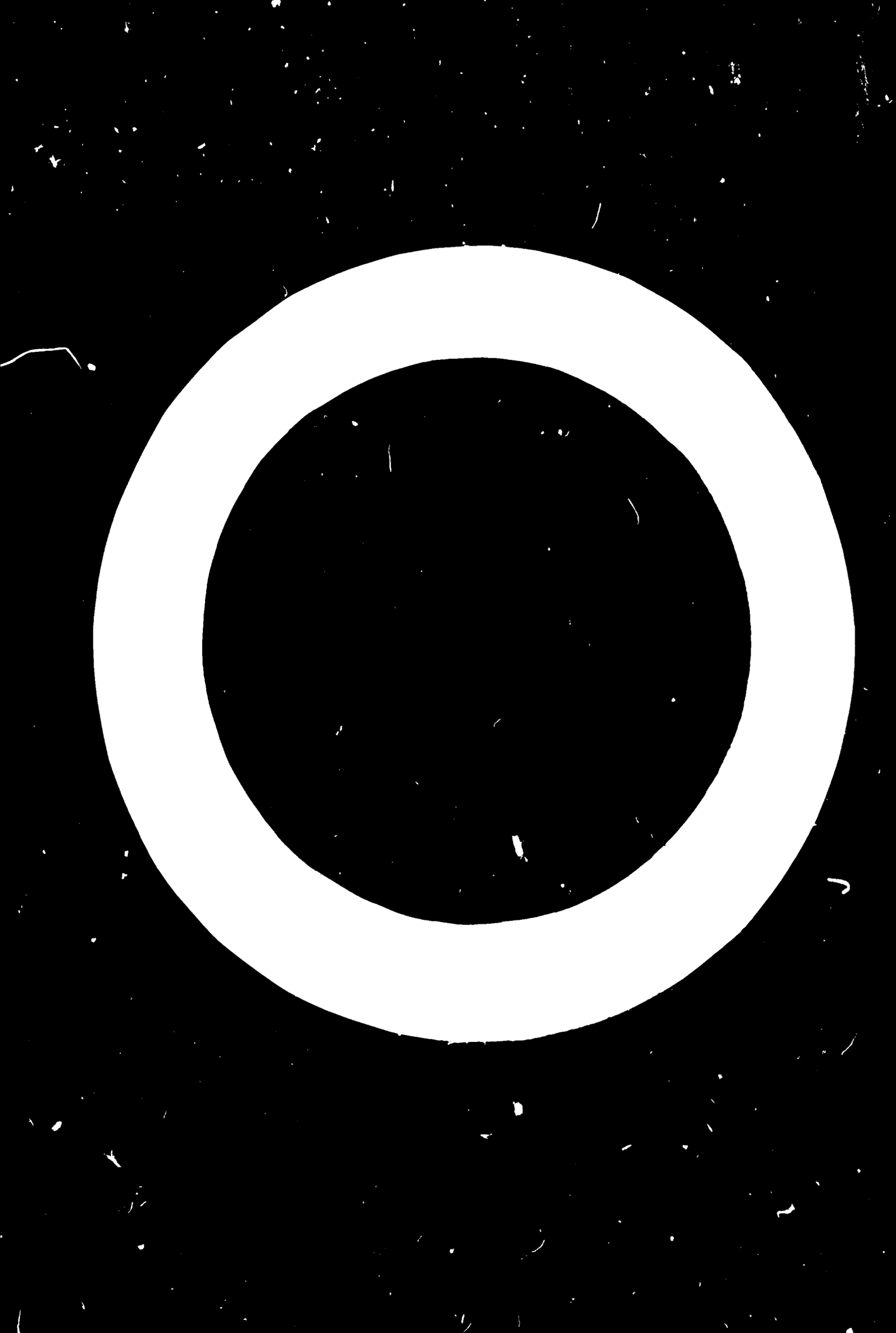

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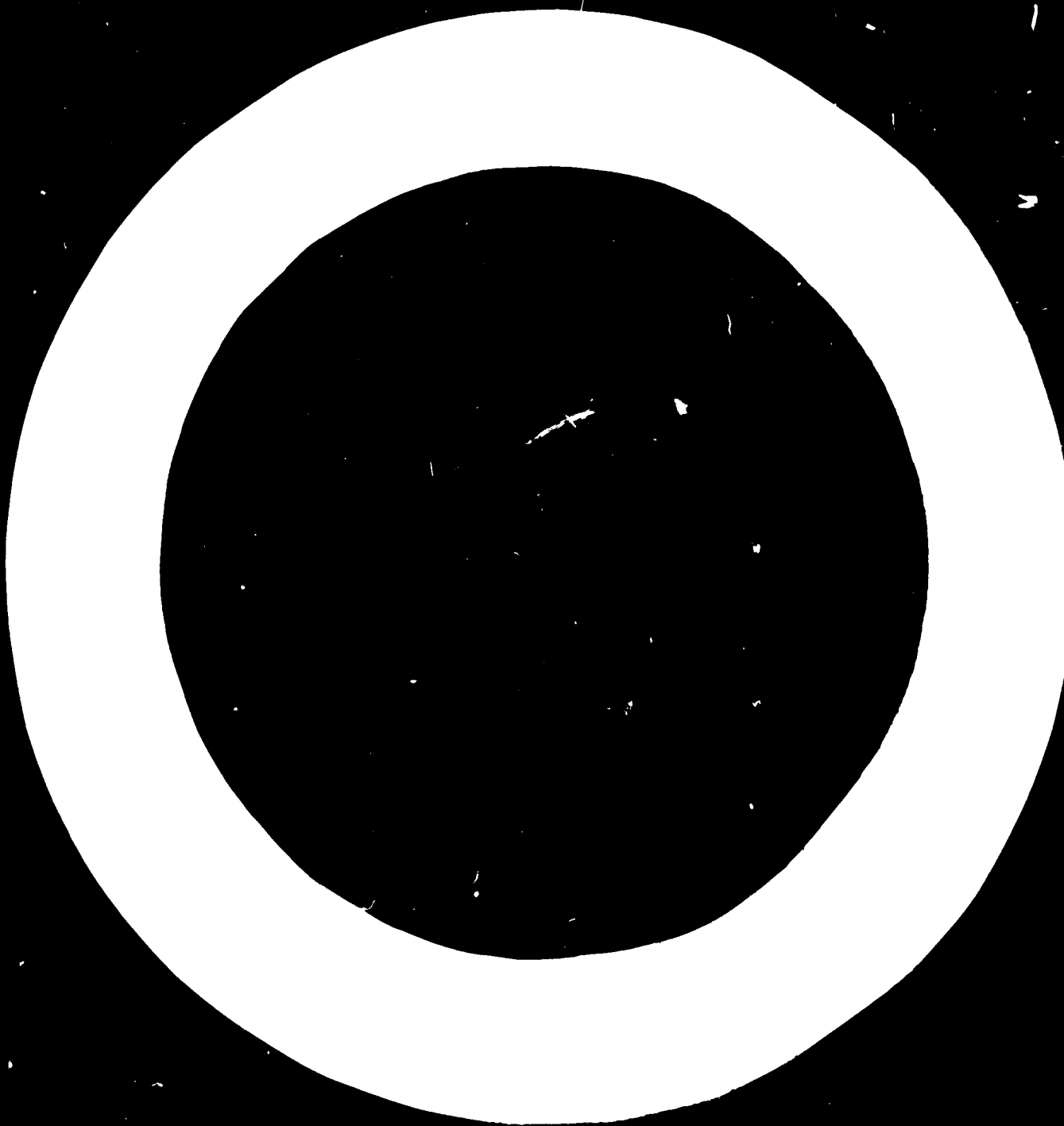


1. The objective of industrial growth

The industrialisation of developing areas is considered in its quantitative aspects only by most of the theorists and decision-makers in this field. The volume of manufactured goods is used as the criterion of industrial development.
This point of view is in accordance with economic theory. For, economic theory in its consideration of consumer behaviour, is centred on such concepts as the demand function, and on establishing a functional relationship between price and volume of products sold.

Economic practice in the fully developed countries, however, has already passed into another stage: the quality of goods and services provided for the user has become a major element of success or failure.

Purely quantitative growth of industry has lead to serious waste of resources in the fully developed countries. Such waste is unacceptable for the developing countries because of the relative scarcity of their resources.
Aiming at the optimal quality rather than at either the maximum or minimum quality of products seems to be the means of avoiding such wastage. Quality control may therefore be considered as being one of the important aids to industrial growth.

Quality control, according to the modern interpretation, takes the form of "integrated control of product quality". Standardisation is an important part of this process.

2. The meaning of quality

The quality of a certain product clearly is connected with its properties, but quality is being considered more and more in the relative sense: the quality of a product is defined as the measure in which its properties are adapted to the needs of the user.

In order to judge the quality of a product it becomes necessary, besides analysing the characteristic properties of the product, to also analyse the actual situation of the user.
Quality in this relative sense can be defined as "fitness for purpose".

Two definitions of quality are possible:
a) In a purely functional sense, abstracting from economic considerations, quality is the usefulness or use value of a product to a given user. This quantity is called "abstract quality".
b) By comparing the use value to a given user with the importance of the necessary sacrifices to the same user and, in this way, including such economic quantities as the price of the product and the purchasing power of the customer, one arrives at the definition of "economic quality", as the difference between use value and sacrifice.

In deciding the quality level on which a product must be manufactured two quantities appear:
a) The costs of quality being the sacrifices necessary in order to acquire the use of the product, as a function of the quality level. This is normally a progressively increasing function of the quality level.
b) The benefits of quality, representing the use value of the product. This is normally a degressively increasing function of the quality level.

The excess of benefits over costs is, in itself, a function of the quality level, having a maximum at a quality level which is called "optimal quality" (see figure 1).

Working on a quality level which is higher than optimal quality, means that one incurs considerably more costs than at the optimal level withour having at one's disposal a usefulness significantly higher than at the optimal level. Working on a quality level inferior to the cptimal level means a significant loss of usefulness without the compensation of important economies.
Both situations therefore imply a wastage, and optimal quality is consequently equivalent to elimination of waste.

Figure 1 OPTIMAL QUALITY

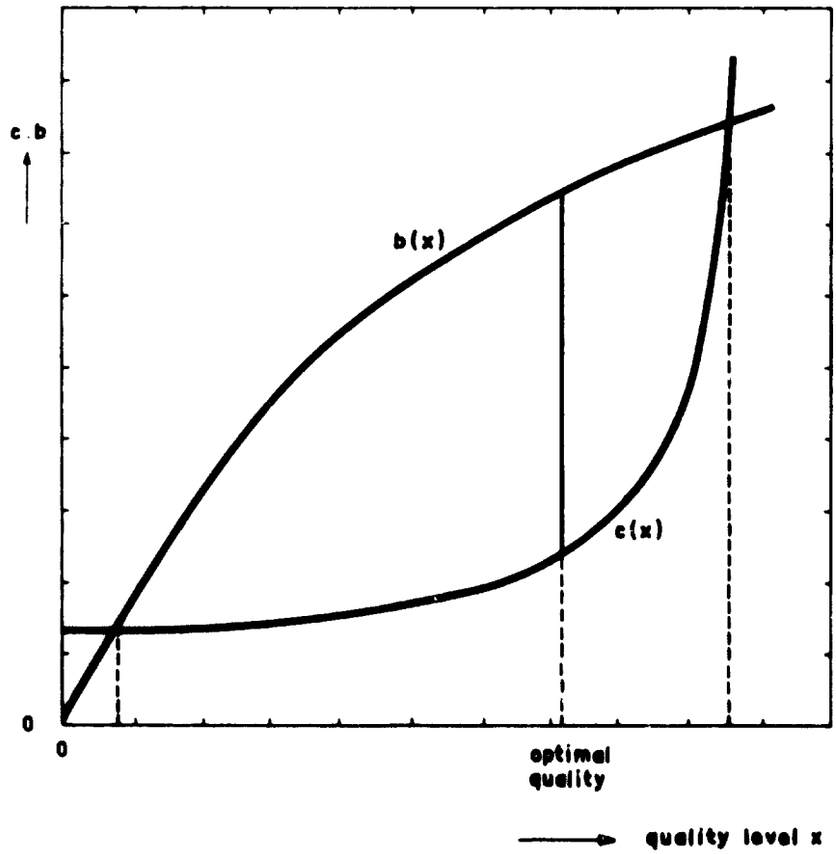
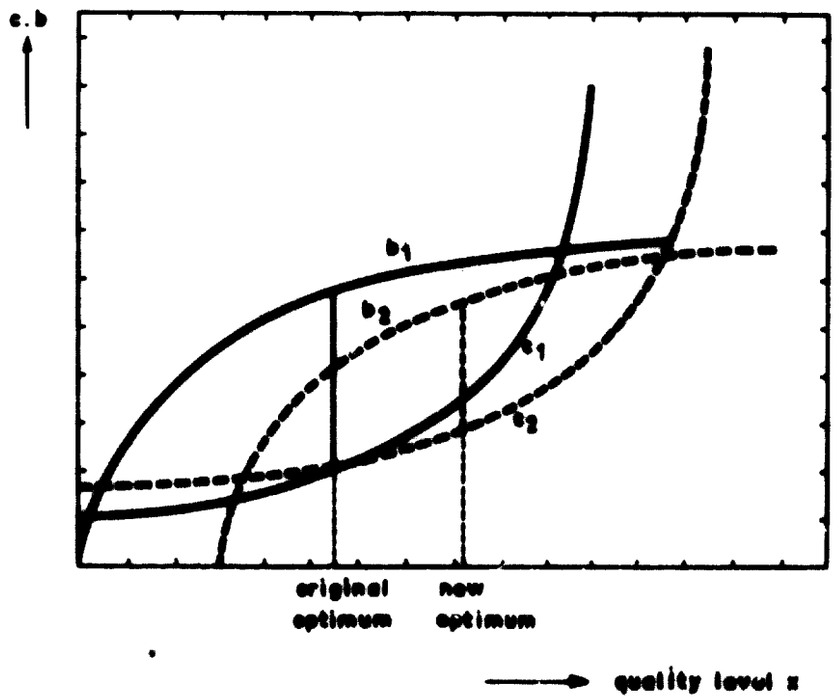


Figure 2 THE DYNAMICS OF QUALITY



3. Dynamics of quality

Costs of quality and benefits of quality are not functions which are stable in time. Generally speaking, both functions are moving continuously towards higher quality levels. That is to say that a given benefit of quality which at an earlier date occurred at a certain quality level, will occur in subsequent years at a higher quality level. The same holds good for the cost of quality.

The displacement of the benefit function of quality is the result of technological and social changes; displacement of the cost function of quality is the result of better organisation of the production process, and increased efficiency of design.

For the optimal quality level this dynamic character of the quality function means that the optimal quality is moving steadily towards higher quality levels (see figure 2).

In designing products which have a relatively long life one has to take the dynamics of quality into account. The same holds for the installation of machinery which produces articles on certain quality levels.

4. The need for standardisation

Production costs are directly connected with quality in the sense that economic quality increases if the production costs for a given product decrease. A high economic quality will be arrived at either by pushing up the functional use value of the product or by pushing down the production costs.
A lowering of production costs is one of the most important results of industrialisation.

It is effected primarily by increasing the lengths of production series. A longer production series means that the necessary time and cost inherent in starting a new series can be divided over a greater number of products and therefore represents a smaller load on each product. More important than this effect, however, is the possibility of introducing a greater degree of mechanisation or automation in production methods, so that production cost will go fall much more steeply.

Mechanisation and automation, typical for modern industrial production, are dependent on long series- or mass-production.

In the case of any specific product that means that modern industry aims at a division of the total production over as few different types of the product as possible.

The conscious selection of these types of product is standardisation.

5. How far to go with standardisation?

A product with a relevant properties may be considered as a point in n-dimensional space. Standardisation therefore is, from a formal point of view, the selection of a limited number of points in n-dimensional space out of the infinite number of points which this space contains.

Standardisation may be more or less extreme in this sense, that the more extreme the standardisation is in a given case, the fewer points are selected in the space under consideration. Extreme standardisation therefore means also extreme variety reduction.

Given the fact that production and distribution costs decrease monotonously with the decreasing number of types of products in use, the best method of standardisation would be extreme standardisation and extreme reduction of variety to one single type of product, if standardisation were undertaken with the sole objective of minimising production and distribution costs.

Such an extreme standardisation and variety reduction would clearly defeat its own purpose by reducing the production cost on the one hand, but reducing for more the use value of the product on the other hand.

Reduction of the production and distribution costs cannot therefore be the sole objective of standardisation.

Considerations regarding the functional use value of the standardised product have to be included in the objective of standardisation.

Standardisation therefore becomes closely connected to quality in two ways:

1) By deliberate choice of the functional use value in relation to the degree of standardisation applied.
2) By influencing the costs of production and distribution of the product, again in relationship with the degree of standardisation.

Both components of economic quality are therefore directly connected with standardisation.

6. Adaptation losses

We still have to consider in which way standardisation affects the functional quality (use value) of a product. The basic fact here is that the situations of the users are not standardised, but unique for each case. The pattern of needs of any two families will not coincide perfectly; body measurements are not the same for any two people; necessary strength for a construction element varies from case to case.

These unique needs must be satisfied by standardised means. From this stems an "adaptation loss", that is to say a loss arising from the fact that the standardised product is not ideally adapted to the situation of demand, and indeed never can be.
Whenever it has been possible to calculate these adaptation losses, they were found to be rather important. Adaptation losses occur in the shape of waste of material, use of more expensive material than is functionally necessary, extra costs for alterations of the finished product, or non-ideal functional satisfaction of needs

It is perhaps no exeggeration to put adaptation losses in standardisation problems on the average at 10% of the total costs which can be influenced by standardisation. Cases are known where calculated adaptation losses are even higher.
Adaptation losses as discussed here, are the necessary consequence of standardisation. But their extent can be controlled in two ways:

a) By the way in which standardisation points are situated in the n-dimensional property space.
b) By the "intensity" of standardisation, that is to say by the number of standardised types of the same product.

7. Minimising adaptation losses

Even with a given number of standardised types adaptation losses in many cases could be reduced considerably by a better method of selecting standardisation points.

E.g., it has been found in many cases that the pattern of standardisation, as it has traditionally developed, consists in selecting standardisation points unnecessarily close to each other in one dimension and neglecting altogether a diversification in another dimension.

In the case of ladies' garments e.g., the "spacing" in waist girth formerly was 4 cm or even less, whereas 8 cm would have been quite acceptable. On the other hand, traditional standardisation allowed the customer no choice at all as to the length measurements. Actually length and girth measurements of the human body are not correlated, so that a good quality of the fitting makes the possibility of independent choice in girth and length measurements a necessary condition.

So, by the simple means of reducing (unnecessary) diversification in girth measurements and introducing some (very necessary) diversification in lenght measurements, adaptation losses may be reduced considerably without any increase in the number of standardised sizes.

Standardisation of flat steel sections may serve as another example of a non-optimal pattern of standardisation, leading to avoidable adaptation losses. A standard, being under consideration for this type of material and containing 111 standardisation points located in the traditional way, lend to a calculated cost of raw material of Dfl. 5.7 million in a certain market.
By keeping the same number of standardisation points but using another pattern of locating them, it is possible to reduce the cost of raw material to Hfl. 5.2 million and thereby reducing adaptation losses by an amount roughly equivalent to 10% of raw material cost.

In a number of other cases equally important economies are possible by applying the principle of "minimum adaptation losses" to standardisation.
There is one difficulty in the application of this principle:
the pattern of distributing the standardisation points so that adaptation losses are minimised can only be calculated if the distribution of the demand in the same property space is known, at least approximately. A good standardisation must always be based on the study of the needs of the users, a fact which becomes quite clear if one remembers the close relationship between standardisation and quality.

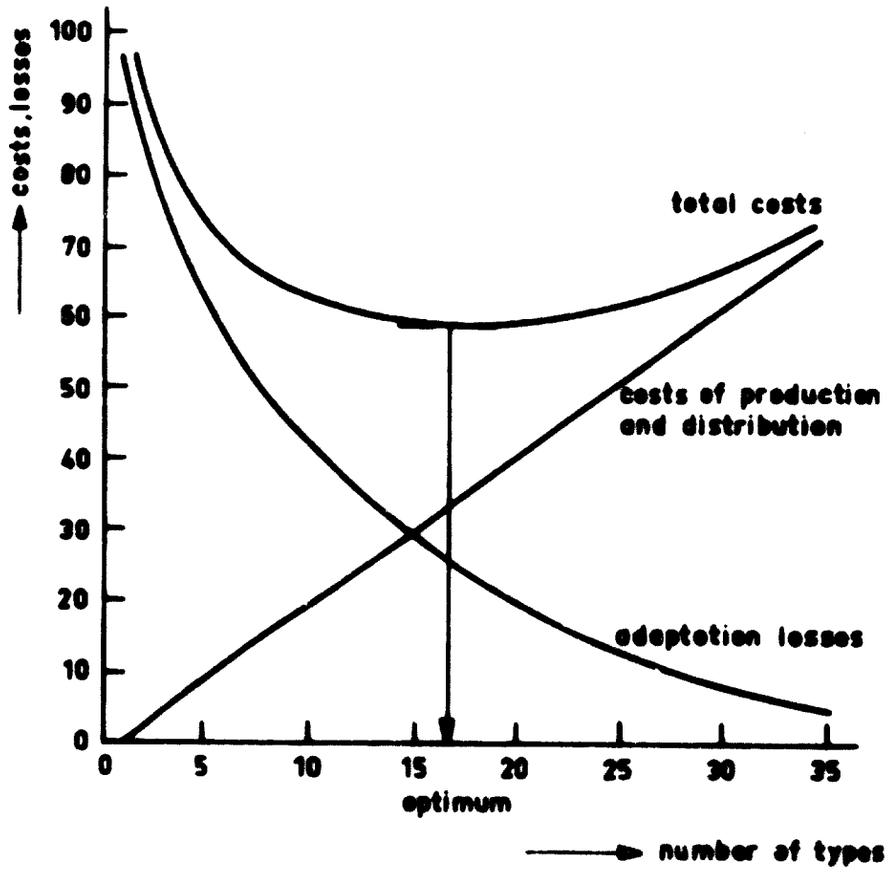
Standardisation must be preceded by market analysis.

8. Optimal standardisation

Optimisation of the quality level has been defined as determining that quality level which leads to the most advantageous relationship between costs and benefits of quality. In the same way, optimal standardisation can be considered as that type of standardisation which leads to the most advantageous relationship between costs and benefits of standardisation. This is equivalant to the following definition: optimal standardisation is that standardisation for which the sum of adaptation losses on the one hand and production and distribution costs on the other hand is a minimum.

Once the pattern of distributing the standardisation points according to the principle of minimising adaptation losses has been chosen, optimal standardisation is primarily concerned with the choice of the number of types to be standardised. The principle of this optimisation process is shown in figure 3.

Figure 3 OPTIMAL STANDARDISATION



It must be pointed out that this optimisation presupposes acquaintance with the way in which the length of production series influences costs of production and distribution.

9. Standardisation in developing areas

Optimal standardisation is - as is more generally optimal quality - of great importance for the industrial development of the -young industrial countries. The elimination of the waste of resources which is the result of optimal standardisation may be considered a most important contribution towards the take-off of their development.

No economy can permit itself easily a waste of from 10% to 20% of its resources. But if, as is the case with developing countries, resources are very scarce as compared with the requirements of industrialisation, it becomes essential not to waste them by bad standardisation.

Waste of resources by non-optimal standardisation is the more dangerous because it is invisible.
On the other hand the situation for optimal standardisation in the developing areas may be much more favourable than in the old industrial countries, because in the young industrial countries there are no vested interests which constitute an impediment to optimal standardisation whereas in the fully developed industrial countries, such is frequently the case.

Furthermore, it must be kept in mind, that optimal standardisation is also optimal adaptation of the products to the needs of the market. There exist essential differences between the pattern of needs in the two types of country and that means that optimal standardisation, and of course optimal quality in general, must be determined in the developing countries on the merits of their own situation and not by imitating what has already been done in other countries.

A particular requirement for a good standardisation in the developing areas has its origin in the scarcity of skilled labour in those countries. In this situation industrial development will be much more dependent than in the old industrial countries on standardisation, because only in this way can the necessary division of labour and work simplification be archieved
In the developing countries the relationship between standardisation and productivity of labour is therefore much closer than in the old industrial countries.

Lastly, the time factor is much more stringent in the developing countries than in the fully industrialised countries because industrial development in the industrial countries must proceed at a much greater speed in order to close the gap between the two types of economy. There is only one answer to that necessity: not to follow the lengthy road of trial and error, but to start from a sound theory of quality and standardisation which allows one to make all the unavoidable mistakes on paper rather than in reality.

10. The role of the old industrial countries

The old industrial countries can assist the developing areas in the fields of quality and standardisation. In order to tender this assistance effective, emphasis must be laid on transmission of knowledge and know-how rather than on making available results, standards and products which have been developed in the industrial countries.

The International Quality Centre at Rotterdam has started courses for Industrial Quality Instructors for developing areas. The objective of these courses is to acquaint the participants intimately with the philosophy of modern quality control, the scientific methods used in this field and the special aids used in transmission of knowledge. It is expected that the participants will in their own countries form nuclei of modern quality thinking and quality activities.

The programme of the course is as follows:

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	7 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

In Part V of the course, standardisation is treated extensively as a quality problem.

Part VI (Specialised Practical Work) opens for the participants the possibility of selecting one of the following specialisations, according to personal background and preferences:

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

As one of the specialised subjects, Standardisation is taught as a part of the quality programme, and the principles and methods of optimal standardisation are discussed with the participants along with the practical difficulties of standardisation and the means by which they can be overcome.

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SUMMARY

by

J. van Ettinger, Executive President of Bouwcentrum, Rotterdam, and Chairman of the Board of the International Quality Centre

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J. Sittig, Director of Quality Control and Operations Research Consultants, Rotterdam

Submitted by the Government of the Netherlands

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1. Industrial growth in the fully developed countries has resulted in a waste of materials because quantity of production has been accorded high priority over quality. The developing countries, which have a scarcity of resources and skilled labour, must try to avoid such wastage. Integrated control of product quality, which includes standardization, must be considered as being an important aid in attaining this objective. Quality in this case is defined in a relative sense, i.e. the quality of a product is the measure to which it fulfils the needs of the user (abstract quality).

2. By comparing the use value to a given user with the importance of the necessary sacrifices to the same user, one arrives at the definition of "economic quality" as the difference between use value and sacrifice.

3. Since the rate of increase of the costs incurred in reaching a certain level of quality in production rises with the level of quality, while the rate of increase of the value of the product decreases with the quality level, an optimal quality level can be found in which the excess of value over costs is a maximum. This optimum is not stable in time, and should thus be treated as a dynamic factor.

4. To reduce production costs, particularly through mechanization and automation, large-scale serial manufacture of a restricted number of standardized types is necessary. As standardization involves reduced adaptation to the individual customer's needs, the phenomenon of adaptation losses occurs. In general, this means that the customer, in order to fulfil his needs, has to accept the next larger or better (i.e. more expensive) standardized type. This again leads to optimization: by choosing the best number of types and at the same time designing the pattern of distribution of these types in accordance with the needs of the market, the sum of production costs as a function of standardization on the one hand, and adaptation losses on the other, can be minimized.

5. Transmission of knowledge is one of the means which the industrialized countries can contribute to the development of others. The International Quality Centre at Rotterdam, therefore, has started courses for industrial quality instructors for developing areas. An outline of the subject matter of these courses is given in the paper of which this document is a summary.


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