QUALITY PROJECT WITH HIGH TECHNOLOGICAL INTEGRATION

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1 Introduction

In the last decade production technology for tiles has made much progress, rapidly changing the production process. This great transformation has been achieved through the efforts of the production companies along with the collaboration of all those working in the sector: ceramicists, researchers and others. The progress made is characterized by a high level of automatization in the various process phases which has led to:

— increase in productivity of equipment and personnel
— widening of product range
— reduction of production costs

To these already achieved objectives we must add another: the computerization of the process. In these circumstances of highly integrated technology, quality assumes a new and special importance.

2 Important Factors in Quality

The principal points for determining quality can be summed up as:

A. Professionalism

To attain a high level of quality, people who are suitably qualified for the work necessary must be available. This work is connected to control and maintenance functions, and hence closely connected to the machinery and to the operations that the latter performs; all this requires a good knowledge of the ceramic process and of the equipment that is used in the different phases. Therefore, there must be careful selection and on—going training of personnel; the latter must be aware of the problems inherent in quality control and the importance of human contribution in improving quality.

B. Organization

If we define quality as "the set of product and service characteristics that will satisfy the customer's requirements", then we realise the importance of the organization of the company in the pursuit of quality, since the latter will be what results from all company activities. Thus, from the supply of raw materials, taking in research and production, up to the sale of the product, action can be taken to improve the quality of the product and service through the use of efficient organisational instruments such as:

—production programming
—control of finished products
—communication systems in company

Besides product quality it is also necessary to take care of quality of organization, as companies with high quality levels conquer markets.

C. Process Control

In the manufacture of ceramic tiles PROCESS CONTROL is growing in importance,especially in the area of raising and guaranteeing quality levels.

Since process control is costly, it must be efficient.

It has been shown that investing "in quality" is renumerative, as long as it is done in a rational way, that is by carrying out an efficient "quality project". (In other words, quality is efficient, that which isn't quality proves costly.)

Each phase of the production process is a potential source of control problems or damage, so the whole production cycle should be under control, using all possible instrumental applications, automatic and otherwise, and suitable collection and measuring systems; operation of this control should always be left in the hands of competent personnel.

The methodology of process control, with the aim of attaining maximum quality possible, determines:

— standards that must be observed
— frequency of control
— performance models
— management of data obtained
— formation of technical files
— personnel necessary
— instrumental equipment

The main items that must be controlled are:

— raw materials
— preparation of mixtures
— pressing and drying
— preparation of glazes
— glazing
— firing
— finished product

Technical standards are established on the basis of:

— general ceramic knowledge
— specific process technology

— product characteristics
— raw materials and available equipment
— past experience of the company

Frequency of control must be established as a function of the parameters examined and the specific circumstances of the company. Operation models are fixed on the basis of company structures.

The management of data obtained is an important stage in efficient control and must be carried out with maximum care in order to achieve significant results in quality.

The creation of technical files constitutes an important basis of documentation and experience which can be used as a reference during production. Personnel carrying out process control should be technically qualified and experienced in the control process.

Instrumental equipment should be adequate for normal controls; specialized laboratories outside the company can be used for special controls.

To carry out efficient process control, collection of data is essential; this will represent a basis for action and will be useful for examining the relationship between cause and effect and hence,for knowing if a process is under control. Information is power.

Knowing what is not working is power, data on what is not working is precious and useful if:

— it is given the utmost attention
— it is analysed
— it is used for improvement

Hence an effective control system also knows how to take advantage of errors that are detected, in order to improve quality.

Economic valuation of the product is linked to the standard of quality attained, since as quality has no limits, its process of improvement is endless.

3. QUALITY PROJECT WITH HIGH TECHNOLOGICAL INTEGRATION

This concerns developing the factors already described: professionalism, organization, process control, in a context of modern equipment that offers a wide range of operative possibilities in the different production phases. Consequently, SACMI is ever more active in trying to increase the technological content of its output and hence of its equipment and machinery. Indeed, it has recently constructed an important laboratory suitable for investigating new technology and which is available to all customers. In this complex, studies on raw materials, mixtures, glazes, and production techniques and elaboration of prototypes for new equipment and machinery are carried out. Some explanatory notes concerning the subsequent industrial processes and the actions taken arising from studies in progress are shown.

A. Preparation of mixtures. Continuous milling, using a microprocessor to regulate the proportion of each component in the mixture, offers the possibility of obtaining principal parameters from the milling process with immediate application in the preceding phases; this is in order to maintain required standards and, hence a high product consistency.

A microprocessor connected to the atomiser determines operative temperature by means of automatic humidity controls that guarantee minimum oscillations of + 0.2% and thus stability in powder characteristics and subsequent improvement of the following phases.

B. Pressing Presses use a microprocessor for continuous reading of principle pressing parameters, allowing the possibility of control of variations by maintaining operation conditions constant, with positive consequences for the product. Some special technical innovations have been recently adopted in the construction of pressing moulds, we mention in particular the "SMU" mould (universal multiple mould). This mould is linked to an adjustable hydraulic system at high pressure, this eliminates problems associated with loading and extraction operations, due to absolute precision in lowering and raising of the mould. All this helps to increase the mould life and reduce maintenance operations. Moreover the SMU can be successfully linked to the "SFS" (upper forming mould) which, used in the extraction of a piece with a smooth upper surface, eliminates all damage that the tiles can incur from rubbing against the "box" and belts, and from the overturning of the tiles themselves. As a result the quality in one of the most delicate points in the production cycle is improved.

C. Drying

The drying phase is one of the most delicate in the process. In the EVA vertical drier, numerous improvements have been carried out, in particular the addition of a microprocessor that allows automatic control of temperature and of relative humidity of the fluids, with the possibility of immediate attainment of data. These new improvements also make loading and unloading more versatile, protecting the material from mechanical damage such as blows, vibrations, etc., with notable benefit to the quality of the dry tile. The horizontal drier "EO" is made up of 2m long modules which are completely autonomous while in operation, allowing for the possibility of programming a specific outline for each type of product. Computerized control of the drying process permits the recording of drying curves of different qualitative and quantitative product types and thus for their subsequent repetition.

D. Firing

In recent times, the firing oven for ceramic tiles has become a machine equipped with sophisticated devices that permit the meticulous control of firing, which has now overcome the empiricism of the past. Some of the characteristics of materials used in the construction of ovens are becoming more and more relevant to their conditions of use, starting from the refractors with high insulating performance and a good resistance to chemical attack; the same can be said for materials used in the production of rapid cooling tubes that prevent contamination of tiles during firing. The burners have also been improved, both in their operation and in the automatic system that regulates them, with advantages to the functioning of the oven, and thus in the fired piece. The control of the rollers, which has been recently perfected, guarantees steady movement even in the case of oscillation. High co—axiality of the roller and support allows for more regular progression in the tile lines crossing the oven, avoiding damage to material. The oven is equipped with numerous security devices: mechanical, electrical, and electronic, controlled for the most part by computer, which permits the optimum use of the "machine"; these devices increase flexibility and economize energy consumption. The high degree of automatization that has been attained in modern ovens allows for the control of firing, even for more difficult products, with optimum qualitative results, unknown until recently.

E. Glazing

In the glazing and decorating phase considerable efforts have also been made, and appreciable results have been obtained, although these results do not compare to those achieved in other production process phases until now. The improvements have had affects on the whole glazing system, from the transport line to the various devices for applying glaze, including serigraphic decoration. All this is still not sufficient to give an operative guarantee to a complete and articulated process like the glazing of a fired or unfired piece. It is only fair to mention the efforts of the fitters and ceramicists who work in this sector in trying to identify, as soon as possible, innovative and technically valid solutions such as have been found in other process phases. The importance of this phase, which makes a decisive contribution to the quality of the finished tile, must not be forgotten, given that a large part of defects originate at the glazing stage.

4. The Cost of Quality

The realization of a quality project involves costs that arise from human, organizational and technical factors, which we have discussed above; these allow certain benefits to be attained which make the project worthwhile, since it has been shown that the pursuit of quality leads to productivity, whilst the contrary is practically impossible. Thus, quality has well defined costs which correspond to an optimum level for maintaining production. This qualitative level must be defined on the basis of some economic calculations derived from cost—profit results. To simplify the analysis quality costs can be divided into three principal points:

1—prevention costs
2—inspection and control costs
3—defective product costs

Prevention costs include the following:

— quality structure
— quality standards and procedures
— quality data and statistics
— quality education
— inconvenient reassessment and research
— customer service

Inspection and control costs include the following:

— quality structure
— quality data and statistics
— control of material on arrival
— inspection and control during preparation
— laboratory tests
— maintenance and adjustment of control equipment
— control at source (at suppliers)
— customer service

The cost of defective products include the following:

— quality structure
— quality data and statistics
— waste product
— remakes
— inconvenient reassessment and research
— returned products
— sales losses

These cost factors represent the result of sustained efforts and resources used by the company to ensure quality, or to be able to guarantee product characteristics and performance required by the market. The objective of an efficient operation project is to minimize the total cost of quality, working on three principal components, which are,as we have already seen, prevention, control and defects. Hence we can state that between them these three components combine the degree of "perfection" of the product, as illustrated in diagram A, and give the total cost of quality. Example A shows how there is a minimum total cost for quality, which is given by the cost of components, for a distribution. It is, however, very difficult to know this ideal distribution beforehand. Each company has its own minimum cost which must be found through trial and error, controlling displacements in the quality cost by varying the distribution of cost amongst the components.

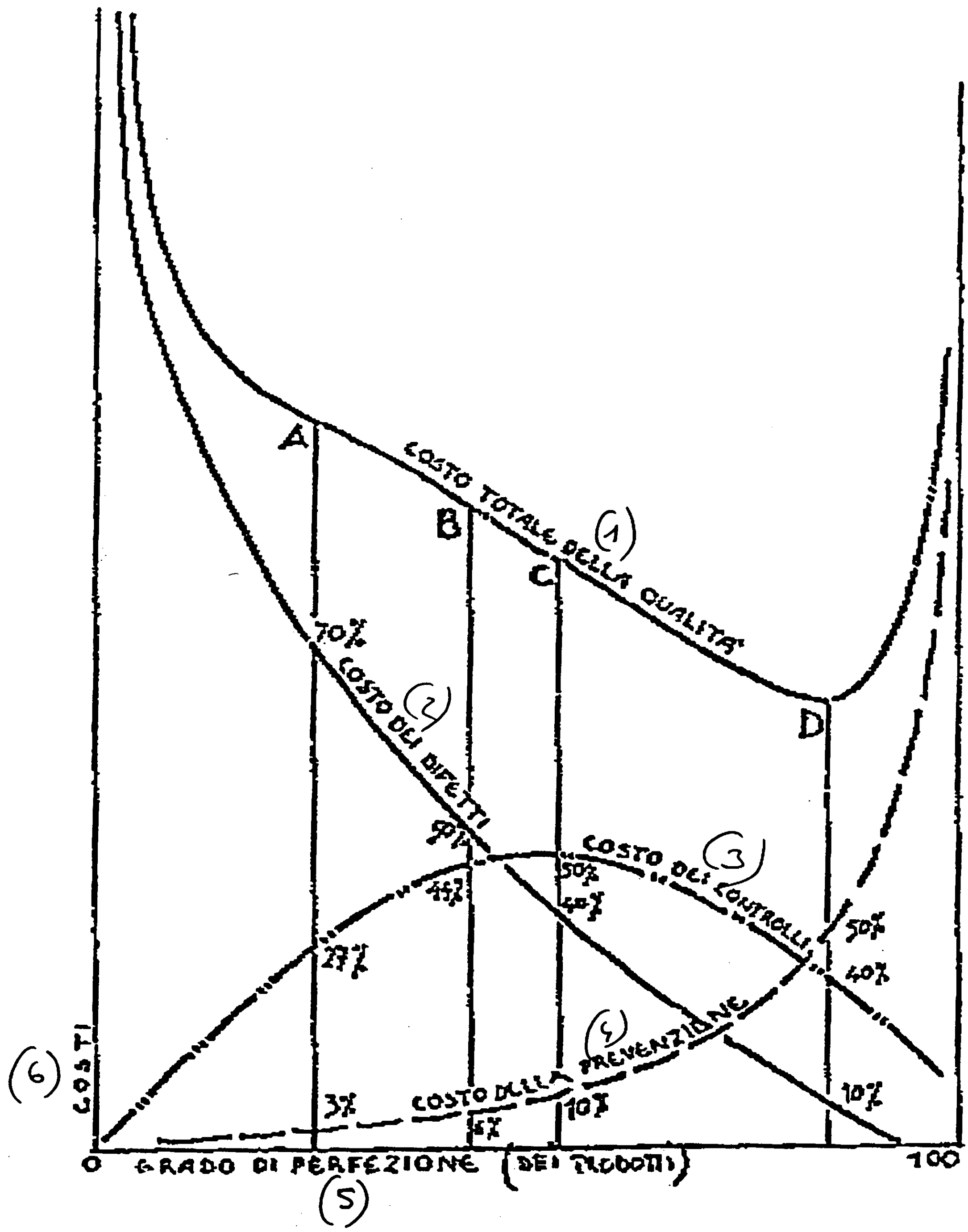

Diagram "A"

(1) Total Cost of Quality
(2) Cost of Defects
(3) Control cost
(4) Prevention cost
(5) Degree of perfection (in products)
(6) Costs

To quantify what has been stated above, a pilot quality project, recently carried out, is described giving examples of some of the prices involved.

(The figures below have been rounded off, as the project is still in progress and exact costs are not yet available.)

Production	**5,000m2/day**
Product Cost	6,000 Lira/m2
Selection Performance	Profits
80% 1st Selection	11,000 Lira/m2
15% 2nd Selection	8,500 Lira/m2
5% waste	

Average Income is 10,075 Lira/m2 Cost/profit difference 2,075 Lira/m2

Cost of quality project: Investments 300,000,000 Lira Operation Costs 130,000,000 Lira

As a group the figures above obviously represent one unique value on the "TOTAL COST OF QUALITY" curve in Diagram A, where they appear as the meeting point of the cost factors mentioned above.

The RESULTS OBTAINED from a series of interventions were as follows:

Process phases	**% Waste product**
pressing	2% to 1%
drying	2% to 1%
glazing	6% to 3%
firing	5% to 3%

Due to recuperation of raw material and glazes, the cost of the product goes from 8,000 to 7,910 Lira/m2 with a saving of 90 Lira/m2.

New selection figures were 83% in the first selection, 14% in the second election with 3% waste.

As a result the average income from sales has increased from 10,075 to 10,320 Lira/m2 with a recuperation of 245 Lira/m2. This gives an increase in profits of 90 + 245 = 335 Lira/m2 which is 636,256,500 Lira/year.

Taking away operation costs leaves 506,256,500 Lira annual gain, against a 300,000,000 Lira investment.

Moreover, there is an increase in turnover of 4.6% and of 1.5% in net performance. Diagram B shows all the various cost/profit parameters presented above, bearing in mind that, besides quantifiable economical benefit, there are advantages in operation control and company image which arise from an efficient quality project with a high level of integrated technology.

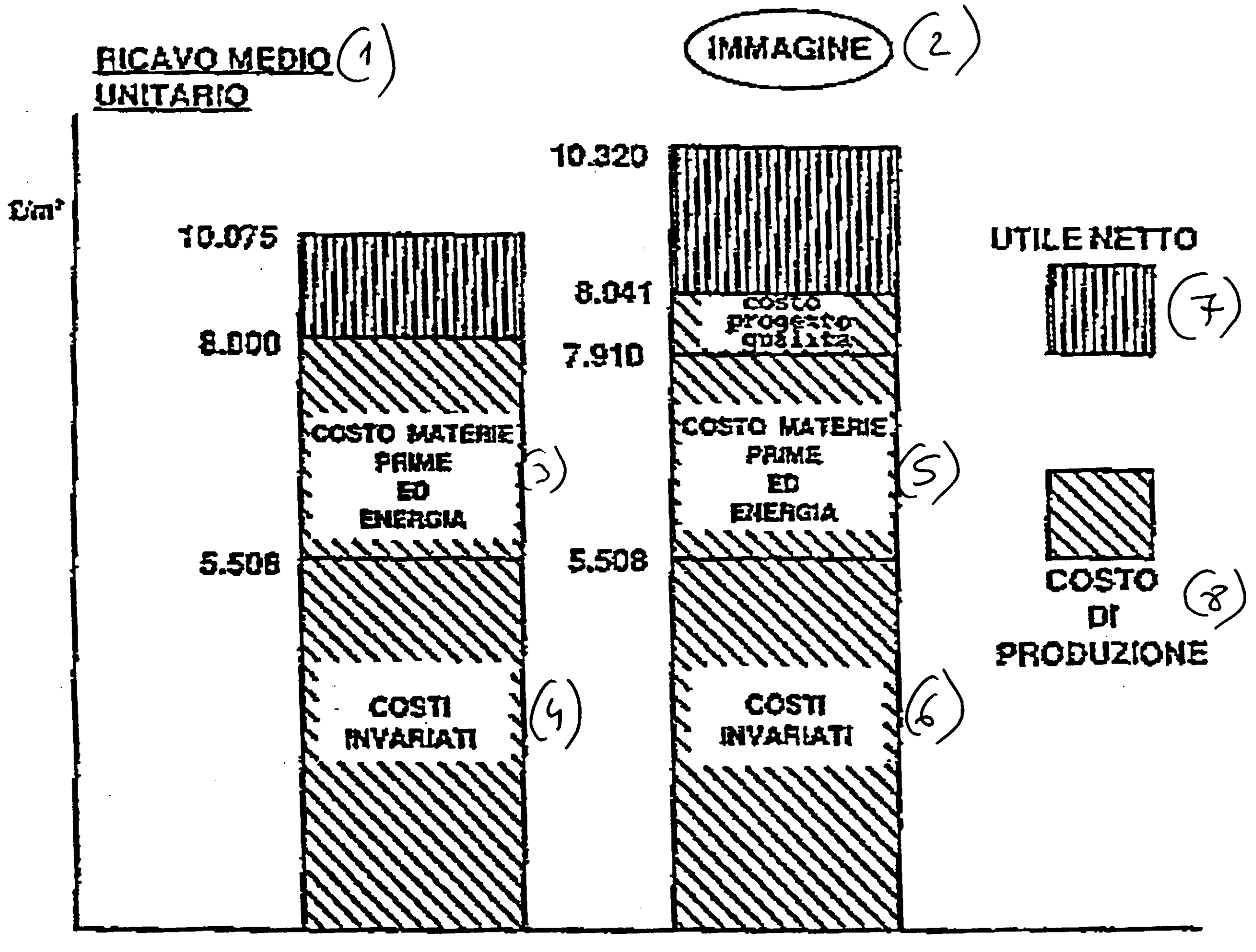

Diagram B

(1) AVERAGE UNITARY INCOME
(2) IMAGE
(3) RAW MATERIAL AND ENERGY COST
(4) FIXED COSTS
(5) RAW MATERIAL AND ENERGY COSTS
(6) FIXED COSTS
(7) NET PERFORMANCE
(8) PRODUCTION COSTS

A quick examination of the initial data obtained clearly shows that the interventions considered show appreciable results and, referring back to diagram A, we are still to the left of point "D". Only successive interventions at an investment and control level would indicate exactly how far away the maximum profit point "D", shown in Diagram A, is.

5— Conclusions

Technological knowledge, organisational techniques and new computerized installations allow for the achievement of significant economic results, by pursuing the improvement of quality that, even in ceramics, does not happen by accident but by the implementation of a contemporary company strategy. In fact, it has been demonstrated that to satisfy ever more exigent market demands, superior quality products and services must be offered; this is a result of a modern business culture that makes quality a strong point in the company and which allows the ceramics industry to enter into the more advanced industrial sectors.