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The East of Europe displays a radically different business scene than a year or two ago. Political upheavals ensued by an economic transition (to the market economy) embarked at the endeavor to join the European and global market economy.

But whoever would want to enter the world market has to have a passport as a proof of industrial quality. Most of the CMEA countries, now on their way to capitalism and its market mechanism, have already elevated industrial quality as one of the priority issues of their new conomic policy. They have to overcome the past indoctrinated rigid quality control structures and procedures, and develop an up-to-date innovative company-based quality management systems. Though the experience is far from complete, some rules seem to be conclusive. This study could facilitate the deliberations of policymakers, business communities and executives.

1 The Industrial Quality Story

Organized quality supervision was brought about along with the principle of interchangeability of parts. The handgun industry is credited for the breakthrough.

In the 1920s, the industrial way of mass manufacturing was introduced in the Ford factories, with detailed division of labor, universal or task-oriented (but inflexible) machine tools, and compulsory material handling. Manufacturing control was executed by taylorist stop-watch measurements, piece-work incentives and quality checking. Absorbing innumerable improvements, that way of production ruled until the 1950s (when it began to secede under the increasing pressure of post-industrial changes).

The industrial quality was focused on precision (accuracy) of parts and products. Quality control was generally done by coping with measurement standards. Sliding ruler, micrometer, calibre, etc., were the basic quality control devices. Another mark of industrial quality was the endurance established by hardness and wear out tests.

The logical way to supervise industrial quality was through technical inspection. In a company, quality control hierarchy was supervised by the chief quality inspector, subordinated either to the company general manager or chief engineer (later named technical and/or production manager). In the shopfloor, there was a shop-inspector (as a rule independent from the shop-supervisor or foreman).

The main objective of quality control was to prevent deficient or imperfect production, and separate defects and rejects, and therefore placed at the end of production cycle.

2 The Quality Revolution

The post-World War II story of industrial quality is a Japanese triumph. Before the war, Japanese products had suffered the bad reputation of being cheap and shabby, however during the late 1950s, the Japanese industry had become not only competitive in terms of quality but dominant as well.

During World War II, the American industry demonstrated a unique performative capability. The arms and outfits for the US combat forces were manufactured at a fast pace, low cost, and high reliability. Among other experts, it was E.W. Deming who generalized production experience during the war. He recommended to follow up the wartime industrial achievement by introducing a comprehensive survey of manufacturing process through a permanent statistical quality control. This brought about the industrial quality revolution.

Statistical measurement and evaluation of any production factor and the stage of manufacturing process provided a consistent insight into the production flow. It also it made possible to trace the causes of production failures. "Prevention rather than detection" was the rationale of that profound change. Another variation was "management prior to control".

However, the American industry did not realize the importance of E.W. Deming's lessons. The American post-war market was a "producer's market" until around 1955. Almost whatever was offered was also bought.

In the aftermath of World War II, E.W. Deming was sent to Japan in order to assist in carrying out the MacArthur plan. His message to the Japanese was to focus industrial management on high standard of quality. He predicted that it would be through high quality where the highest profits could be realized, and assured that the industrial world would learn from Japan.

The quality of products/services was linked not only to technical standards, but predominantly to ever-growing client, customer and user's needs. The product/service fitness must comply with the requirements of the latter. Japanese companies were first to "bring the market into the factory".

The quality control was turned into quality management. Quality had to be "built into the product/service" from the very beginning through all stages of manufacturing, to sales and post-sales duties. Quality improvement was based on a total approach. Most often, comprehensive and total approach are put equal. However, another distinction could be established: totality of quality management surpasses comprehensiveness. It is a term delineating not only the size of management reach, but also the qualitative aspect of mutual penetration between quality and management. The total approach signifies that the whole production process is quality-oriented, and that any quality improvement measure would find a corresponding quality favoring environment.

This new management philosophy prioritizing permanent quality perfection was introduced under the most usual denomination of "total quality management".

3 Toward an Extended Quality Concept

The transformation of industrial quality overlapped with its shift from parts to systems. As long as the mechanical mode of production prevailed, the central task of quality supervision was to establish first of all the accuracy and endurance of manufactured parts. But after World War II, manufacturing was gradually attached to increasingly complex devices, apparatus, control systems, etc. What had begun to matter was not the isolated part only, but the interdependent system as a whole.

Programmable systems became responsible for the operation of extensive machinery or other technical compounds. In the 1960s it was presumed that a control system incorporated into heavy engineering equipment, decided upon 10–100 times larger capital investment.

With the advanced engineering achievements, such as nuclear plants, large/fast transport (in particular, air) and communication, space crafts, etc., the term of supra-reliability came into use, which elevated the expected functional safety to 1:10,000 and 1,000,000 perfect consecutive operations.

The outstanding importance of reliability as the crucial scale of quality led a number of scholars in the USA and then in Europe to a shift of the definition: they began to distinguish simple quality from reliability. Later, the previous terminology was restored, reliability being treated as an important feature of quality. At the same time, several studies initiated a wider understanding of quality. As the intensified approach to quality invoked higher unusual expenditures, the cost-benefit analysis had to be introduced in order to tame excessive quality involvement. Some firms were tinkering with the concept of a "sufficient quality" avoiding excessive expenses for quality improvement.

The usual cost of continuous quality promotion lays somewhere between 3% and 7% of the total production costs, in some cases being formented up to 20%. In a broader sense, investment in quality perfection pays back. At the beginning when radical changes could be implemented, the return on quality expenditures may reach 200%–300%. Later, the restitution of quality expenditures by increased profits or saved waste may recede, but in most cases quality promotion proved to be a profitable business.

The concept of "sufficient quality" was questioned many times. Quality has been subject to constant irreversible changes and rarely could be fixed for a longer period of time. To be really good today means striving to be better tomorrow.

Particularly, such challenges as increasing quality demands by customers, high-technology impact, globalization, and other up-to-date shifts convert quality promotion into a never ending progress.

Quality seems to be like a crystal in which one may follow the principal changes of the whole industry.

4 Contemporary Total Quality Management

Total quality management (TQM), being a historical outcome of post-World War II industrial quality endeavor, has not ceased to evolve, adjust to market and manufacturing advancement, and develop new features.

A variety of managers, engineers, and scholars contribute to the industrial quality promotion. Some of them lay an emphasis on earmarked components of TQM, others try to supplement additional characteristics. As a consequence, several deviating denominations are met, like comprehensive quality promotion, advanced quality management, company-wide and industry-wide quality organization, and many others.

As a matter of fact, existing differences of quality perfection approach do not revert the basic rationales of TQM which seem to expand as a common and well assessed leverage of industrial quality enhancement. Nevertheless, when acknowledging the supremacy and consistency of TQM concept, it is to be recognized that the TQM flux consists of several outlined streams. By the highest order of magnitude, these may be identified as the Japanese, American and European approaches.

Without pretending to grasp a full specificity, the Japanese way seems to point out the sway of organizational control, permanency of improvement and everybody's commitment, an extreme responsibility of the shopfloor. The American way emphasizes management skills, advanced manufacturing technology, computer control, and individual incentives. There are attempts to understand quality promotion in the same way as manufacturing innovation.

Conversion of the European common market into an internal single market has born a still nascent effort to develop a new variation of TQM with emphasis on strategic management, cooperative business schemes and educational advantages of the intellectual and manual labor.

One last experience exemplifies that TQM can be used not only in advanced companies and as a superstructure of some basic accomplishments of quality control, but also as a means of company sanation and consolidation. A number of cases testify, that a crisis management enriched by TQM components has proved to be surprisingly successful.

5 Fundamentals of the New Quality Approach

The transition to total quality management[1] is still an unfolding, "endless-frontier" process. Some significant achievements mark the current understanding of this quality promotion system.

Old	*New*
Production-bound	Market-bound
Technical standards	Customizing
Accuracy	Reliability
Final checking	Monitoring
Inspection stands	All stages of the production cycle (including pre- and post-production)
Control	Management
Retroactive action	Planning and prevention
Cost concerned factory	Profit concerned productive system as a whole (including subcontractors and suppliers)
Autonomous and closed	Incorporated into the whole model of production
Industrial	Post-industrial
Technocratic	People centered
Inspection professionals	Common involvement
Management supervision	Top management dedication
Public neutrality	Public expectations and acceptance

A number of scholars and experts used to abbreviate the aforementioned scheme into two distinctions: they understand the "totality" of modern quality management "as all production stages coverage" and "all company people involvement". However, such a definition being simple and persuasive clearly prefers the quantitative aspect, the size of professional and social containement. A more complete interpretation should accompany the evaluation of the progress and organic homogeneity of the system.

[1] Also comprehensive, company-wide quality control/management (when there are certain graduations for individual terms).

Indeed, the outer delineation of the quality promotion management has to be asserted through business achievements attained. Quality promotion when properly planned and led, is a profit generating activity, a powerful source of continuous company growth.

6 "High Manufacturing" and Quality Development

The latest manufacturing way, based on the fundamentals of leading-edge technologies, is profoundly changing the pattern of research, factories, and offices. The public and private sectors are increasingly concerned with technology and organization issues related to industrial competitiveness.

(a) *High technologies from the technical and organizational perspective*

In the last twenty to thirty years, remarkable shifts in manufacturing converged to a revolution of the mode of production. The "third industrial revolution" (after the mechanical and electrical) or a "post-industrial revolution" were frequently used for that paramount change.

Elements of the new mode of production were already available sporadically even prior to the World War II, but the majority of changes was brought about after the war and mainly in the last decades. It was in early 1980s when "high technologies" began to gain a particular reputation. High technologies are associated with several technical and organizational breakthroughs.[2] Given the engineering industry, where high technologies might be exemplified in a most telling way, advanced components could be:

- Programmable automation (NC, DNC, CNC), robotics
- Programmable conveyors and automatically guided vehicles (AG)
- Integrated and flexible manufacturing systems (FMS)
- Automation[3]
- Preventive programmed maintenance and high machinery loading
- "Ultra-reliable" equipment and tools
- Automated operation control
- Modular (aggregate) approach to design and manufacturing methods
- Computer assisted design and manufacturing (CAD/CAM)
- Computer integrated manufacturing (CIM)
- Computer informatics and communication[4]
- Just-in-time in-factory logistics

[2]Some examples of high technology products/services: VLSI semi-conductor devices (processors, memories), high-definition television, x-rays lithography, FSX fighter, superconductors, gene manipulated pharmaceuticals, human organs transplantation, AI expert systems, etc.

[3]Autonomous self-operating machines, "jidoka" in Japanese.

[4]Also called "triple C" (CCC—computer, communication, control).

- Multi-professional training
- Cooperative management
- Continuous improvement, etc.

The factory is now being placed into a ramification division of production and may be directly responsible for a minority of production factors. In general engineering, the proportion of externally supplied parts (modules, aggregates) may constitute some 70–80% and in the computer assembly 95%.

The manufacturing promotion has to involve all participants of the production process. Inter-factory technical and organizational advancement relates to:

- "Horizontal organizations" (collaborative schemes, "satellite" relationship, factory networking)
- Joint efforts in order to achieve a higher perfection of the design, methods, scale/scope economy, cost
- Unification of technical concepts, standards, certificates
- Computer integrated and assisted operation of the production complex[5] ("extended factory")
- Informatics and telecommunication among the participants
- Inter-factory just-in-time logistics
- Final producer and subcontractors' joint effort in continuous improvement

(b) *High technology from the economic, social and ecological perspective*

High technology is defined by its appurtenance to some scientific and engineering records, by an elevated input of R&D (R&E), proportion of scientists and engineers employed and their accelerated growth. However, more explicative than that could be an interpretation of high technologies from the socio-economic and socio-ecological point of view (thus explaining not only what the high technologies are like, but what they are good for).

For the first time in industrial history, high technologies introduce the opportunity to develop highly performative manufacturing as a flexible process capable to meet different and increasing consumption requirements. This marked the advent of advanced harmony of production and consumption (and at the same time a major source of their societal efficiency).

Universal products/services are "good for everything but excellent for nothing". The highest effects could be achieved when the product/service is fully cohesive with its use. It is the consumption process which ultimately arbiters the result of production. (Nitroglycerine may be used as an explosive that can kill or as a medicament to save life.)

"Bring the market into the factory", as the Japanese would say in order to pinpoint the final use orientation of the up-to-date production. All agents of the production should meet the vital final user's needs.

[5]Computer integrated/assisted industry (CI/AI).

Flexible manufacturing is driven by the economy of scope which in some industries has already surpassed the effects of traditional economy of scale, and is contesting for economic superiority. The high technologies are endowed with a remarkable humane and ecological potential. These are industrial technologies that "appeal less to human hands and more to human heads". A better education/skills and general culture of workers, engineers and managers are in demand.

The Industrial Revolution dismantled craftsmanship and introduced to the factories the "worst worker" (women and children). Times changed, however, and the demand for degraded work was not eliminated. In the developed industrial countries, a share of unprivileged minorities or "gastarbeiter" persists.

Unlike the traditional industrial technologies, the "high" segment of contemporary technologies asks for the "best worker" with broader horizon of thought, education and interchangeable skills, flexibility, and ingenuity.

Also from the point of view of the nature: high technologies display some novel advantages. They operate at a low "mass and energy" input, make a comprehensive use of the substrate, and leave a low waste and often appropriate for recycling. High technologies contribute to environment protection (and cultivation). In general, the production outcome may grow (in terms of values) unproportionately faster than the mass (raw material) and energy consumed.

In both humane and ecological aspects, high technologies represent a new breed of technologies with a remarkable contribution to what is called "sustainability" or "conviviability". Although their segment in the whole production does not exceed 5%, so far, they bear a unique futurist thrive.

In the next 100 years after the Industrial Revolution, productivity soared five times and had not been repeated since. Only now could another turnover of such a magnitude could be expected.

Indeed, the next drive in manufacture performance will not be limited to labor productivity alone, it has to enhance the productivity of knowledge, equipment, material, power, etc.

(c) *The quality promotion strategy in the framework of "high manufacturing"*

The progress of industrial quality always depended on the compatibility of quality perfection options with the advancement of manufacturing. Industrial companies which prepare for a world market penetration have to contest both high quality and high manufacturing.

Incorporation of quality concerns into the advanced mode of production being the main path to high quality, nevertheless, does not rest in the reach of technical and organizational improvements only. According to recent studies, technical and organizational shifts are to be supported by an offensive marketing, flexible financing, personnel training and management development. The companies are expected to monitor progress, provide supportive social environment, share results, develop the "human factor" (education, skills, professional pride, financial motivation, collaborative mutuality, humane values orientation, etc.). Not only highly professional management and control are the prerequisites of TQM drive, but also a dedicated leadership. There is an almost unanimous finding that the commitment of people is the most important driving force of quality improvement.

The public is more aware that there are some generic ties between the industrial quality and other societally worthy "qualities": consumption, social and natural environment, and the whole quality of life.

Although the new stage for high quality promotion is still unfolding, some basic concerns are commonly shared. Among them is a widespread consensus on:

- Improving the quality policy making mechanisms on the governmental or public and company level
- Further strengthening of the manufacturing base (and incorporating the TQM into the progressive ode of production)
- Encouraging high quality R&D (and experimentation)
- High quality infrastructure build up (educational and training programs, standardization, testing facilities)
- Favorable social "climate" (consumer and environment protection laws and codes of conduct, public acceptance of industrial quality as a constituent of the quality of life)

7 Recommended Measures for TQM Implementation

The manifold experience reduced to the core may be interpreted as a set of recommended measures which are mostly constructive for quality promotion.

As a preliminary step, some guidance is to be provided in order to formulate the purpose and give presentations of the basic rules of quality promotion in general, and of TQM in particular. After such preparation has been accomplished, further measures could be developed along these lines:

1. National policy formulation. Under the auspices of governmental or public bodies and with the assistance of quality experts and experienced managers and entrepreneurs the national policy should be focused on:

   - General assessment of the current state of industrial quality.
   - Priorities of quality promotion.
     - Leading industries
     - Export competitiveness
     - Consumer protection
     - Environment protection
   - Strengthening of traditional and broadly available measures (of quality control).
   - Role attributed to TQM (as a major innovation).
   - Research, consulting, teaching and training background.
   - Monitoring and competition, evaluating and awards.
   - Authoritative support and financial funding.
   - Publicity.

2. Company programs of quality promotion. First of all, the commitment of the leadership is a *conditio sine qua non*. Once the top executives and managers have embarked on quality promotion, the institutional basis for a continuous goal-oriented endeavor is to be established:

- Rationales of top managements policy explained to the engineers, other experts, workers.
- Company quality council (chaired by the top manager).
- Quality department (subordinated to the top manager).

These company structures are to formulate the company policy:

- Top management vision of quality development
- Company priorities
- Assessment of the current quality in the company and its substructures
- Support of the assessment by facts and figures
- Leading examples and "shock cases"
- Envisaged stages of quality development
- More detailed formulation of the next stage
- Tightening quality order and discipline
- TQM implementation
- Tasks for the company and its substructures (at the initial stage not longer than 2–3 months, later for a longer period of time, too)
- In-company training and outside training
- Consulting
- Continuous control and evaluation

3. Monitoring, evaluation, and awards. The company program has to be under permanent supervision. The results should be evaluated and explained to the company employees and workers. Without the adequate feedback the company program could gradually degenerate and pass into oblivion.

   Company prizes stimulate interest and initiative of the best, middle and low echelon managers, task group leaders, task groups, shops and offices, and workers.

   On the occasion of the ceremonial awarding, workshops, seminars, and exhibitions ("quality days") keep the whole company aware of the incessant quality advancement in the industry, gain self-confidence and offensive approach.

4. Publicity. The program and improved quality should be used as a component of competitive force of the company and brought to the market and the public.