# Utilization of the Physical Models of Industrial Aggregates for Improvement in University Education Quality

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**Abstract:** Paper deals with main principles of total quality management (TQM) with application to the area of university education processes. To the main principles fall into: synergistic relationships, - continuous improvement and self-evaluation, - system of ongoing processes, - leadership. Part of this TQM tools are used in approach to the design of new laboratory education forms by realization of physical model hot-air aggregate (HAA).. Stand HAA presents miniature function module of air conditioning and it is used on the experimental laboratory education for pregraduate even postgraduate study, not only on the Faculty of Mechanical Engineering VSB-TU of Ostrava, but also on other five technical faculties at Czech Republic. Stand HAA allows to realized by TQM principles all important tasks connected with: - identification of static and dynamic technological system and sensors properties, - intuitive even experimental verification of controller synthesis results, - verification of the new control algorithms (fuzzy, neuron, genetic, ...).

Laboratory stand HAA is also used for demonstration of function multilevel control systems in environment of the program support SCADA/MMI - InTouch, ControlWeb and Promotic. Air condition plant - stand HAA allows to connect the approach with simulation program tools (for instance MATLAB - Simulink or SIPRO) with physical function model, which is much more similar to real industrial plant with all its function defects (noise, nonlinear properties of sensors and actuators, disturbances).

**Keywords:** education, quality, physical model, verification

## 1. Introduction

Total Quality Management (TQM) involves a set of general principles about the fundamental culture and norms of practice of a working organization dedicated to quality. Many of the educational reforms being implemented today are based on this concept, which has been revolutionizing U.S. business and industry for the past decade. Only recently have leaders in education begun to adopt TQM as an operational philosophy. "The role of the university in the 21st Century is to transfer technology or ideas out of our labs into the commercial world," says Michael Hooker, president of the University of Massachusetts. [DION, D. 1995].

Fundamental part of university education creates connection of theoretical approaches with experimental or simulation methods for verification of coincidence. Illustration of practical physical models is cardinal importance for engineering experimental exercises, for comparing of the computer simulation tasks with practical experiences and with real-time measured signals from the technological plants. Experimental verification of the theoretical knowledge responds to need for accelerated acquisition and adoption of "best practice" techniques and methods and it increases the quality engineering education by TQM principles. Experimental stands allow easy understanding principles of the real industrial plants parts, measurement and control devices, signals character, noise, dynamic responses and easier crossing to the real technological systems.

One concrete example with instrumental laboratory stand of physical model hot-air aggregate connected to the different types of computers, PLC and controllers for measurement, control and diagnostic tasks will be presented with good experiences from the experimental education on the Department of Control Systems and Instrumentation VSB-Technical University of Ostrava.

## 2. TQM in education

TQM in education applies at three levels:

1. The lowest level is to **the management processes of a school**. The main benefit is in improved efficiency and lower cost.
2. The second level is **teaching total quality to students**. Quality philosophy and methods/tools are covered.

3. The highest level is **total quality in learning**. This is a learning philosophy supported by a comprehensive tool kit and driven by students and staff in order to identify, analyze, and remove the barriers to learning.

Students want schools to equip them to deal with very uncertain futures. Parents want greater choice and involvement in their children's education. Employers require greater learning skills, teamwork, and self-motivation based on a good grasp of the basics. Government is under intense pressure to reduce public spending. In these circumstances, quality is the answer, not the problem. It is the only way to increase outputs and reduce costs, as the leading industrial practitioners discovered in the 1980s.

Four pillars of Total Quality Management (TQM), which fill these levels, are:

**Principle 1: Synergistic Relationships**

In one sense, the student is the teacher's customer, as the recipient of educational services provided for the student's growth and improvement. Viewed in this way, the teacher and the university are suppliers of effective learning tools, environments, and systems to the student, who is the school's primary customer. The university is responsible for providing for the long-term educational welfare of students by teaching them how to learn and communicate in high-quality ways, how to assess quality in their own work and in that of others, and how to invest in their own lifelong and life-wide learning processes by maximizing opportunities for growth in every aspect of daily life. In another sense, the student is also a worker, whose product is essentially his or her own continuous improvement and personal growth.

**Principle 2: Continuous Improvement and Self-Evaluation**

The second pillar of TQM applied to education is that everyone in the organization must be dedicated to continuous improvement, personally and collectively. One implication of this TQM principle for education involves an increased emphasis on training, "quality circles" (in which everyone involved discusses ways for improvement), research (especially department research) and communication (with students, parents, business leaders, community representatives, and so forth).

Grading systems such as the bell curve result in one student's success at the expense of another student's failure. These win/lose paradigms are counterproductive to the spirit of cooperation for a community of learners. Many assessment reforms are focusing on "authentic assessment," which many educators believe provides a more accurate representation of a student's learning and abilities. Authentic assessment includes actual examples of students' work presented in portfolios and exhibits.

**Principle 3: A System of Ongoing Processes**

The third pillar of TQM applied to education is that the organization must be viewed as a system, and the work people do within the system must be seen as ongoing processes. The primary implication of this principle is that individual students and teachers are less to blame for failure than the system in which they work. Quality speaks to working on the system, which must be examined to identify and eliminate the flawed processes that allow its participants to fail. Since systems are made up of processes, the improvements made in the quality of those processes largely determine the quality of the resulting product. In the new paradigm of learning, continual improvement of learning processes based on learning outcomes replaces the outdated "teach and test" mode. Content area literacy supports this principle by emphasizing an ongoing process for learning that involves setting goals, monitoring progress with respect to those goals, and making changes based on self-evaluation.

**Principle 4: Leadership**

The fourth TQM principle applied to education is that the success of TQM is the responsibility of top university, faculty and department management. Therefore, school leaders must establish the context in which students can best achieve their potential through the continuous improvement that results from teachers and students working together. Educational know that improving test scores and assessment symbols is less important than the progress inherent in the learning processes of students, teachers, administrators and all of the school's stakeholders. In the same way that a school's leaders set the tone for their school's teaching culture, teachers set the tone for their classroom's learning culture.

**Implementing TQM principles in the new paradigm**

Successful implementation of TQM principles requires a great deal of patience, because TQM is not a quick fix. It can take as long as ten years to implement and produce documentable results. TQM represents a system whose rewards begin to emerge when its ideas and practices become so embedded in the culture of the organization (i.e., the day-to-day work of its people and systems) that it becomes "the way we do things around here". With patience and persistence, TQM can lead to significant cultural changes in schools by providing a valuable organizational framework for restructuring.

## 3. Design and application of experimental stands for teaching purposes

Basic demands for design and education application of experimental stands for laboratory exercises [Smutny, L. 1999], are:

- Similarity of physical laboratory model with real industrial apparatus (plant).
- Miniaturization of dimensions, power input, etc.
- Good dynamical responses of output signals (quick reaction, short time konstants).
- Unified input and output electrical signals (U = 0-10 V, I = 4-20 mA).
- Good possibility of connection with miscellaneous computers or alternative numerical unit (Programmable Logic Controller - PLC, Industrial PC - IPC, Industrial microcomputer - IMC).
- Availability of model function parts and their reasonable price.
- Easy production in condition of Department Mechanical and electronic workshop.
- Cooperation of students on design and production of laboratory stand (on the subjects, for instance *Part project, Final project, Diploma thesis*).

Experimental verification of theoretical knowledge responds to need for accelerated acquisition and adoption of "best practice" techniques and methods and it increases the quality engineering education.

## 4. Experimental laboratory model of hot-air aggregate

On the Department of Control Systems and Instrumentation of VSB-TU Ostrava were designed and produced quantity of laboratory experimental stands, models and education aids (Smutny, L. 1999). They are utilized for practical exercises in department specialization subjects, mainly connected with group of "automatic devices subjects" (*Measurement and sensors, Means of automatic control, Microcomputer measurement systems, Design of process systems, Signal processing,* etc).

On the Figure 1 we can see the block schema of experimental laboratory model HAA (hot-air aggregate) as a physical model of air-conditioning and on the Figure 2 is an output graph of measured and control values – temperature, power to the heat source, disturbance of temperature by ventilator air flow. Stands HAA are used in more subjects for bachelor and master level (for instance *Automatic control, Automatic control devices, System identification, Design of process control systems, Final project,* etc..).

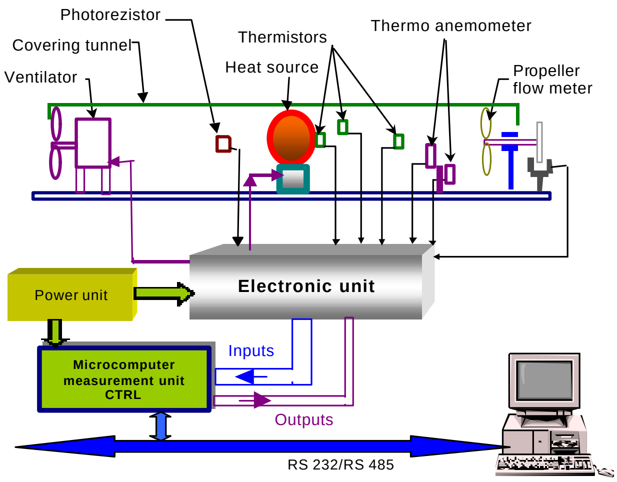


Fig. 1. Block schema of experimental laboratory model HAA (hot-air aggregate) as a physical model of air-conditioning

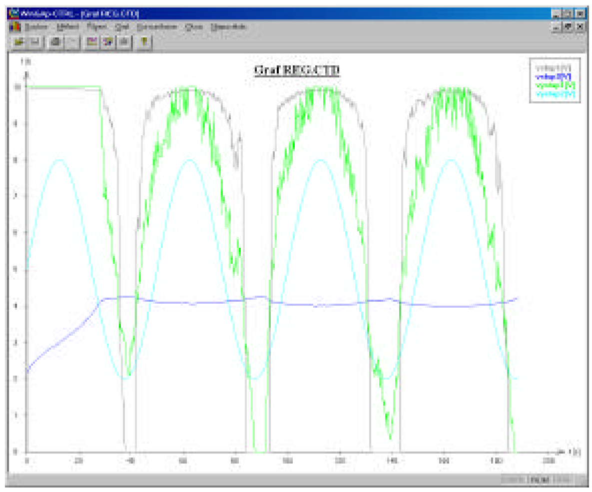


Fig. 2. Output graph of measured and control values of HAA model

On the Figure 3 we can see block schema of stand HAA with smart sensors of temperature (STS) and pressure sensor (SPS) and software support with SCADA/MMI program InTouch. On the Fig. 4. we can see photo of the experimental laboratory model HAA with external microcomputer measurement unit CTRL connected to PC.

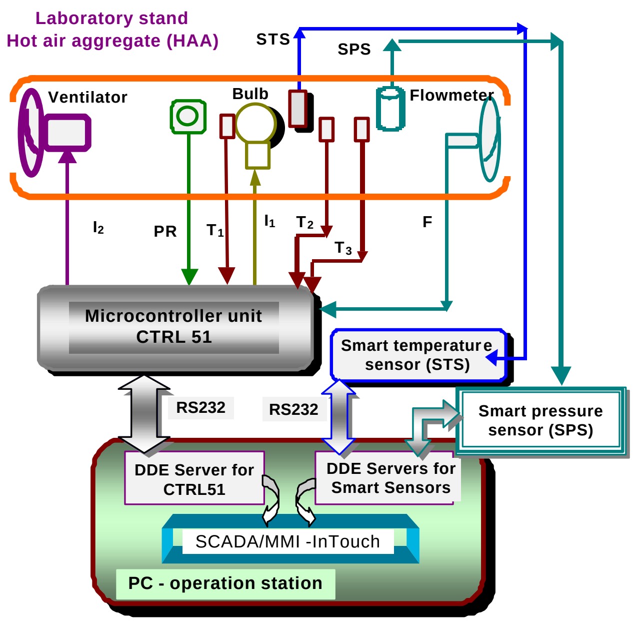


Fig. 3. Block schema of stand HAA with smart sensors of temperature (STS) and pressure (SPS) and software support with SCADA/MMI program InTouch

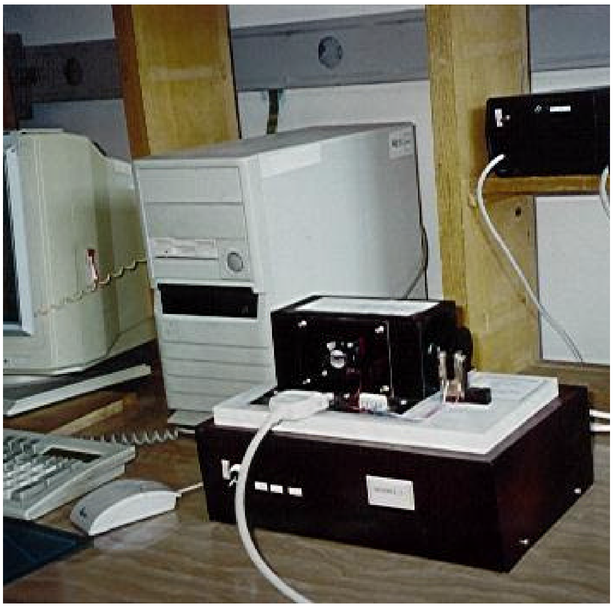

Fig. 4. View of the experimental laboratory stand HAA with external microcomputer measurement unit CTRL connected to PC and program support WinCTRL.

## 7. Conclusions

TQM in education helps all members of the university community by educating them in areas of involvement, measurement, improvement, partnerships, and empowerment. Students, teachers, administrators, and support staff have served as members of quality teams, been empowered to make suggestions for improvement, and taken part in surveys for the purposes of establishing measurement baselines.

Verification of theoretical findings is important part of education process as part TQM principles. Although increasingly significant methods are computer simulations, now typical with simulation programs aid (for instance MATLAB-SIMULINK, SIPRO), experiments with real physical models are not interchangeable. Experimental stands allow easy understanding to principles of industrial plant parts, measurement and control devices, signals character, noise, dynamic responses and easier crossing to the real technological systems. Experiences from practical exercises and *Final Project* on the Department of CSI confirm increasing motivation of students, better interconnection of theoretical knowledge with practical experiences and skills. The decisive role of the laboratory experimental stands with computers for quality engineering education was confirmed also in very good results of Diploma thesis and yearly hold Student Creative Research Competition.

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