The role of engineering laboratories in the establishment of a quality culture in higher education in Greece

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An academic legislative reform of the public University Sector was recently initiated in Greece (since 2005). It was designed to respond to the requirements of convergence to a common frame of the European Space of Higher Education. This reform found significant resistance from University personnel and students, resulting in a very slow degree of implementation. A careful examination of possible causes for the slow pace of reform usually points to the reluctance of a significant part of the academic and administrative personnel (tenured public service employees), to follow quality assurance procedures and undergo performance evaluation. Engineering schools, on the other hand, are more apt to adopt such principles, since they are taught in engineering curricula and widely applied in Industry and Services sectors. In this paper, the authors comparatively describe their experience in applying basic quality principles and practices to the University laboratory environment, motivated by cooperation with industry. The comparative discussion adds insight to the reasons for the resistance of the public higher education sector to quality assurance procedures and indicates specific directions to enhance the dissemination of quality culture in engineering faculties. After two decades of experience with the application and introduction of quality structures in the university and industry, the authors believe that engineering laboratories are a valuable tool in initiating and establishing a quality culture in the Greek higher education system.

Keywords: engineering laboratory; quality culture; university–industry cooperation

Introduction

Following the international revolution in higher education that marks the transformation of western society (Drucker 1993, Crosier \textit{et al.} 2007) occurring in the last few decades, a legislative reform of the public University Sector was introduced in Greece in the period 2005–2007, aiming to respond to the convergence requirements of a common European framework of higher education. According to the guidelines of the \textit{European Association for Quality Assurance in Higher Education} (ENQA) (ENQA 2005), each University should formulate a policy (as well as associated procedures) for quality assurance in their programs (and awards) and commit themselves to the development of a quality culture. To this end, a strategy should be devised with a role for students and other stakeholders (UTh 2004).
According to Greek State Law 3374/2005, the evaluation procedures pertaining to higher education institutions are coordinated and supported at a national level by a new administrative authority titled Hellenic Quality Assurance Agency for Higher Education (HQAA) (Greek State Law 3374/2005 2005). A 'Quality Assurance Unit' (QAU) is established, by a resolution of the relevant supreme administrative body, in every higher education institution in order to coordinate and support the institution evaluation procedures. QAU meetings are presided by the Deputy Dean of Academic Affairs of the relevant institution. Its composition consists furthermore of three members of the Teaching–Research Staff or Educational Staff, one joint representative of the remaining scientific and administrative staff, one representative of the undergraduate students and one representative of the postgraduate students, appointed by their respective bodies. The organization, operation and responsibilities of the QAU are determined by a resolution of the relevant supreme administrative body of each institution. Three years after the issue of the above-mentioned Law, no Greek University has yet established a QAU. This fact cannot be due solely to students' reluctance. Many aspects of the recent educational reform efforts are facing resistance by many academics refusing to raise teaching standards and submit themselves to peer reviews. Since 2007, HQAA started to organize internal and external audits on Greek University Departments on a voluntary basis. Whenever a Department’s Council decides to undergo performance evaluation, the Chairman notifies HQAA and the Department initiates the process of gathering information material necessary for the self-assessment report. Since QAU are not yet established in most universities, no administrative support is available to assist the internal audit procedures. Thus, the support must be based on Departmental staff, in the form of an ad hoc committee consisting of academics and administrative staff. The above situation, along with a reported reluctance by some of the faculty to undergo evaluation, can explain the observed slow pace of carrying out performance evaluation in Greek University Departments. Analogous delays are reported elsewhere, but usually outside Europe and North America (Ali et al. 2008). The people-based nature of higher education institutions requires a strategic approach to ensure successful quality initiatives. The main reasons reported for people’s resistance to quality initiatives are lack of knowledge and information on the quality program, lack of motivation and complacency attitudes, and the quality program being perceived to cause more burden rather than benefit.

In Greece, the reform met with political resistance from University personnel and students. The core of the problem seems to lie in a lack of understanding of quality principles by a significant part of the academic, technical and administrative personnel, who are tenured public service employees with lifelong employment. The 20 years’ experience of the second author in two Greek Universities has furnished him numerous examples of this misunderstanding. Starting from the Academic Personnel, the same author, after 3 years’ efforts, managed to establish in his Department a Quality Assurance Office in 2002. This office is managed by a faculty member who reports to the Department Chairman and the Council. Among the tasks carried out by this office one could mention: design and implementation of a fully paperless instructor evaluation procedure, based on the completion of electronic forms and fully automated processing of results and Emailing to each academic staff member. Design and implementation of dynamic websites for all undergraduate courses offered by the Department, complete with syllabus, course material, bibliography, laboratory support material, etc. Design and implementation of a computerized procedure for processing grades of all courses and production of grading histograms. Organization of an alumni website and a process of regularly receiving alumni feedback for improvements in the Curriculae. Design and implementation of a staff information system in the form of a Staff Intranet (electronic reporting of staff absence, electronic assignment and monitoring of technical staff tasks, processing of job descriptions for technical and administrative staff, organizing staff development seminars, etc.). During the first years of its operation, the Quality Assurance Office, although strongly supported by the Department’s Chairman, faced strong resistance in the implementation of most of the above tasks. Even today, after 6 years of operation of this office, less than 50%
of the Departmental Staff seem to understand at least partially its role and significance. And one must take into account that engineering schools are more apt to embrace such principles, since they are taught in engineering curricula and widely applied in Industry and Services sectors. According to the authors’ experience, applying basic quality assurance principles and practices to their University laboratories has always been motivated by cooperation with industry. We argue in this paper that this approach indicates an alternative, more pragmatic path that could successfully lead to the dissemination of quality culture, at least for engineering departments.

The roots of quality culture in engineering laboratories

Many academics believe that the development of an engineering faculty must focus on quality and strategic research orientation. In that context, total quality management (TQM), which is recognized as the first step on the path towards excellence, can be defined as a holistic management philosophy aimed at continuous improvement in all functions of the University to deliver services in line with customer’s needs or requirements under the leadership of top management (Sakthivel 2007).

In the University context, the faculty should clearly define its teaching and research objectives and hire specialized staff to support them. This could be workable to a certain extent in the case of basic research, and provided that the recruiting of personnel is a quick procedure like that followed in a corporation. However, this necessary condition cannot be met in public Universities in Greece. Here the rate of renewal of personnel is extremely slow. However, if one focuses on applied research carried out by Engineering University Laboratories there exist further opportunities. Engineering laboratories frequently supply R&D services to industrial partners, striving towards an interactive synergy between research projects and students’ education. This kind of research needs to be carried out in conformance with quality assurance schemes, and this is the reason that engineering laboratories are increasingly being certified according to ISO 9001, EN 45001 and related quality standards.

Thus, although Greek Universities are public-funded institutions that do not charge their students tuition fees, engineering faculty can attract private-sector funding through their R&D programs/cooperation with industrial partners or private/public organizations. They may also be capable of taking advantage of significant European Commission funding allocated for the support of Research and Innovation among the member states. Establishing a high level of R&D services by fully utilizing the faculty members’ experience and the graduate students/researchers’ potential may decrease reliance on the limited public funding and lead to a systematic organization of Departments and Research Laboratories and hiring external personnel on a contract basis, aiming for international recognition in their field of expertise.

Previous efforts to promote the establishment of quality principles in the curricula seem to face reluctance from a significant number of faculty members and support staff: this could be understandable from the implied additional re-organization effort without immediate results foreseen. Also, the necessity of several quality procedures cannot be easily comprehended by the faculty and staff. What seems to be necessary in this case is to apply quality procedures in a gradual mode, hierarchically applying first the most important procedures. Additional time will be necessary in order to increase the number of quality supporters in the faculty, staff and students themselves. One should take into account that, although TQM was first applied in the late-1950s, with results that attracted global praise and financial success (Deming 1982), it took more than three decades for the US and European industry to exploit the advantages of quality systems, especially in their interfacing with their subsidiaries in developing countries. Universities have been much slower in this issue, and although activity started in the 1990s (BSI 1994, NACCB 1994, Willborn and Cheng 1994, Karapetrovic et al. 1997, 1998), it was soon understood that
significantly more refined quality systems should be devised for them. Keeping of a lot of records and paperwork could not be welcome in the traditionally liberal academic environment, which is known to produce high-quality products in a more or less unrestricted way. For this reason, it seems rational to restrict the scope of the quality system in the University environment to only the most essential elements (Lewis and Smith 1994, Willborn and Cheng 1994). Although research is an integral part of university processes and one of the distinguishing characteristics of academic staff, existing interpretations focus on the ‘learning opportunity’ and courses as a primary product of educational institutions (BSI 1994, NACCB 1994). Research performance is usually evaluated based on quantitative indices and the educational effect of participating in research is not usually assessed. However, when we focus on academic research supported by engineers and doctoral students, then this should be our first target in quality assurance. This interpretation will be explained in more detail in the following sections, with a suggested hierarchical assessment of the underlying quality system concepts.

When one comes to the management scheme of a Greek University Department, one is faced with a peculiar organigramme. For example, Figure 1 presents the main structure of the organigramme of an engineering department of a public University.

From the structure of this organigramme it becomes obvious that there are no clear management lines. Instead, there exist overlapping layers of management at different aspects of University work. For example, the Department’s Sectors manage the teaching assignments. However, the implementation of teaching, especially in engineering faculties, usually requires significant laboratory support. A significant role to this implementation is played, where applicable, by the Department’s laboratories, that are semi-autonomous entities managing their own research and laboratory-related course assignments/teaching support. For example, a strong laboratory with a lot of personnel (technical support staff and/or Ph.D. candidates or Post-Docs, can support quite efficiently the courses assigned to its academic staff by the sector to which it belongs. The Department’s Chairman and the Council develop and strive to apply operational guidelines inside the Department. The Chairman manages, in parallel, one part of the administrative personnel, as well as technical support for the Department’s core activities, etc.

![Figure 1. A tentative organigramme of the Mechanical Engineering Department, University of Thessaly, showing superimposed management lines.](image-url)
Further to the structural problems of this organigramme, additional problems are caused by the way the Department’s executives are elected and the short terms for which they are elected: the Department Head is elected for a term of 2 years by an electorate body that includes all academic staff, and an almost equal number of students and staff. The Sector Chair is elected for just a 1-year term by the academic staff belonging to the sector. Finally, the Laboratory Director is normally elected for 3 years by the academic staff belonging to the sector. However, the usual practice is that the Laboratory Director is agreed among the Laboratory Academic Staff, and a successful Director tends to stay in his position for many successive terms.

Out of this management structure, one academic unit has proved to-date to be capable of becoming operative and following the quality guidelines: that is, the University laboratory. The following quality-related requirements are typically present in any engineering laboratory, and could be a starting point in the process towards establishing a quality culture in higher education:

- Students write down everyday activity in the laboratory: maintenance, experimental setup, experiments, software installation.
- The Laboratory Director carefully designs and improves the working conditions, and manages cooperation among the personnel and undergraduate – postgraduate students.
- The laboratory staff adopts the philosophy of ‘common effort and goals’, in order to meet deadlines.
- The laboratory usually adopts an effective business information system.
- The Laboratory Director adopts a balanced allocation of duties and authorities to the staff, Ph.D. and undergraduate students cooperating in the laboratory.
- The existing personnel strive to develop the skills necessary to evaluate their duties and distinguish among them according to their importance, so that they can focus their efforts on the most significant ones.

Interfacing University laboratories with industry

Adhering of an engineering laboratories to the above quality-related requirements is becoming a necessity, whenever cooperation with industry becomes a main objective in an Engineering Department or one of its laboratories. Awarding a part of a professor’s time to study the problems of affiliated industrial partners, which on the other hand reciprocate by providing financial support to the laboratory and the students involved, is a well-established international mode of university–industry cooperation. In Greece, this mode is increasingly popular, although, from time to time, we face strong opposition by students and staff belonging to certain political spaces.

The experience shows that university–industry cooperation becomes more and more important in Greek Universities, with a lasting impact on Greek University Laboratories. In our view, one important reason that delays quality culture in Greek Universities is the lack of an established culture in university–industry cooperation. This can be due to a number of historical reasons, including but not limited to weak Industrial activity, lack of adequate Governmental support to university–industry cooperation, the low impact of their Industrial experience in the election of professors in Greece, etc. Also, we believe that a detailed understanding of the multitude of modes of university–industry cooperation, further enlightens many dimensions of a University’s role in society that are not very well understood in Greece.

In general, one may distinguish between the following two levels of university–industry corroboration:

- regional (national)
- international
Major industrial partners, especially at an international level, in their interaction with University laboratories, may expect benefits in a number of areas including the ones listed in Table 1, where also the associated industry requirements from the laboratory personnel are drafted.

In the following, we discuss in more detail the entries in Table 1 that address a number of different aspects of cooperation between University laboratories and Industrial R&D units.

Cooperation in fundamental research, on-going for a number of years, is particularly important for the industrial partners if they lack their own research in specific areas. This cooperation is usually strengthened by the exchange of researchers (e.g. Ph.D. students of affiliated Universities that do their work in industry research departments). A high level of competency is required by the University research unit in this case, but also a sense of reality (pragmatic approach), to produce useful results.

Usually, this type of relationship, along with the active involvement of academic staff in cooperative R&D projects also produces the necessary links for recruiting of competent engineering graduates from the affiliated departments by the industrial partner. Existence of quality culture in the laboratory is obviously a key factor here.

Another important form of university–industry cooperation is the supply of consulting services by faculty members and researchers to industrial partners. In this case, a fast response and punctuality in the supply of services, the willingness to restrict a part of their academic freedom in order to engage in a fruitful exchange of information is important, as well as the adherence to confidentiality requirements (which also extends to the laboratory staff involved in such projects), are attributes expected by the industrial partner.

Successful cooperation of the above types frequently results in a regular cooperation between the research unit and the industrial partner, which may proceed to a compilation of a list or database of affiliated Universities and their respective skills that may be used whenever necessary to find a partner for a particular R&D activity. Good knowledge of each other’s capabilities and interests, mutual understanding and respect of exclusive rights and intellectual property issues is necessary to develop such a long-lasting close and confidential cooperation, along with punctuality, non-disclosure of critical results and quality assurance in the work carried out by the University.

Keeping up-to-date with more recent developments is essential to industrial R&D. However, the ever-increasing volume of scientific/technical literature always requires a significant part of the

<table>
<thead>
<tr>
<th>Expected benefits from University laboratory cooperation</th>
<th>Associated requirements from the laboratory personnel</th>
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<tr>
<td>On-going fundamental or applied research in specific research areas of industrial interest</td>
<td>Existence of quality culture in the laboratory, realistic approach in the research</td>
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<tr>
<td>Links for recruiting competent engineers</td>
<td>Quality culture in the Department and its laboratories, engineering creativity of students, laboratory and computational skills, including commercial software</td>
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<tr>
<td>Supply of consulting services</td>
<td>Fast response, confidentiality on certain aspects of the work involved</td>
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<tr>
<td>Regular cooperation</td>
<td>Mutual understanding and respect of exclusive rights and intellectual property issues, quality assurance</td>
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<tr>
<td>Keep up-to-date with more recent developments</td>
<td>State of the art knowledge and knowhow in specialized areas, understanding priorities of the industrial partner</td>
</tr>
<tr>
<td>Non-routine laboratory work</td>
<td>Quality assurance, customization</td>
</tr>
<tr>
<td>Independent testing of products/independent verification of results – compliance with regulations</td>
<td>Quality assurance, high level of knowledge and knowhow in the specific areas</td>
</tr>
<tr>
<td>Software development and use. Specification of products or process components</td>
<td>Quality assurance, customization, efficient user interfacing, maintenance, training</td>
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<tr>
<td>Training of industry’s employees in specialized courses offered by University laboratories</td>
<td>Good mixture of basic scientific knowledge, applied engineering approaches and knowhow</td>
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time of industry R&D staff. A viable alternative to this is to partly rely upon affiliated University
researchers, who are aware of relevant scientific developments and specialized literature as part of
their academic role, and occasionally (or on a regular basis) consult with the industrial partners.
Naturally, this is a very demanding task requiring from the University researchers a high level of
knowledge in specialized areas, along with a good assessment of industry needs.

Contractual research in multinational projects is now becoming more and more usual in Europe.
A starting point to drop the barriers between different countries consists of the so-called European
research projects that always require academic institutions’ participation in cooperation with
industry. As an outcome of the long-lasting support from the European Commission, this form of
cooperation is now well established in the European Union, and also extends (and is not limited to)
most European countries. Being a good partner in this type of cooperation requires the University
department to be willing to cooperate constructively with industry, following a research quality
assurance policy.

The performance of non-routine laboratory work by specialized University Laboratory Units is
another well-established category of university–industry cooperation. In this case, the University
research unit must strictly adhere to quality assurance being regularly audited by external auditors,
including the industry clients to conform to international standards. Also it should be willing to
adopt a degree of customization to the specific needs of its industrial clients.

Another related category of cooperation is the independent testing of products, or independent
verification of results by University laboratories. This requirement happens many times due to an
occasional overload of industrial testing units, or due to the need of independent testing to spot
possible deficiencies of the testing units. Proof of compliance of the University laboratory with
international regulations in this respect is essential to the successful involvement in this type of
cooperation. Usually, the industrial partner is willing to share a part of the increased cost of this
quality assurance, whenever the specific type of testing is important for its production.

Software development, specification and use is another broad category of interest for university–
industry cooperation. The University laboratory may be requested to produce software, customized
to industry needs, and eventually become a useful design and optimization tool. This type of
development must follow well-established quality assurance criteria for software development,
and also take into account the real world conditions and requirements. This implies a good
interfacing with the industrial partner, and a good understanding of industrial processes and
procedures.

Short courses or other training of industry’s employees on specialized subjects is another service
that can be offered by engineering laboratories, at regional or even international levels. Tuition fees
are usually charged for attending these courses. Also, industry employees are subsidized to attend
University classes as part-time students, usually at a graduate level. In this way, the Department
laboratories receive feedback for curriculum modifications. For this type of cooperation to be
successful, the short courses must contain a good mixture of basic scientific knowledge and
applied engineering approaches.

In addition to the above, there exist unexpected benefits to industry–university cooperation. For
example, industry is known to respond quickly to changes in R&D directions, by respective human
resources reallocation. If a project is discontinued, the company would be prevented from know-
ing intermediate results and the accumulated knowledge to-date would stay with the University
partners. This material may be re-invoked at a later stage in the case of a long-lasting university–
industry relationship. Otherwise, when companies discontinue internal research projects, the
material can be lost between some internal research reports publications.

An additional, unexpected benefit for both sides, stems from the fact that the fundamental
research remains mainly motivated by the researchers as individuals, and will always reside in
the University environment. Many brilliant researchers are very keen in pursuing their funda-
mental research, even under difficult funding conditions. This academic liberty is essential to
the advancement of Engineering Sciences. However, it is also clear that industry needs young
engineers who can solve open-ended problems and produce quality design work (Nicolai 1998).
Efficient teaching of this ability requires the participation of a good part of the faculty, staff and
students in design and development projects that are important for the industrial partners.

Apart from international or local industrial partners, the region where the University is estab-
lished could largely benefit by the services of young engineers and faculty members, in facing a
variety of problems ranging from environmental issues (and sustainable development) to urban
planning choices and infrastructure development. University contributions to such activities in a
socially responsible manner represent an additional incentive to train our engineering students in
quality system issues (OECD 2007).

Priorities of quality culture in the University environment

In the previous section, the importance of university–industry cooperation in cultivating quality
issues in an engineering laboratory was made clear. In this section, we attempt to define a hierarchy
for the implementation of the most important issues of quality culture in the University environ-
ment. Of course, the most fundamental ideas of quality assurance are already known form classical
works that have been widely discussed during the last decades (Deming 1982). However, although
the application of classical quality principles in an engineering laboratory is straightforward, one
cannot state the same for the initiation of a quality culture at the Department’s level. According to
our experience, the introduction of quality culture in the University environment should start with
selecting a small number of issues, which would be expected to produce short-term rewarding
results that would further motivate the personnel. According to Sakthivel (2007), apart from the
absolutely necessary commitment of top management and leadership, the following six factors
affect the overall engineering education excellence:

- Customer focus
- Course delivery
- Communication
- Campus facilities
- Congenial learning environment
- Continuous assessment and improvement

As a first step, the laboratory personnel must understand the performance of a basic quality
loop in the laboratory, which follows the typical structure of the ISO 9000 (Schlickman 2003)
family of standards (Figure 2). A typical structure of a quality loop would start with a statement
of the laboratory’s objectives. These should cover both teaching and research, for example:

- To produce new knowledge and knowhow.
- To enhance students’ and researchers’ knowledge, abilities and competencies.

The aim is primarily to achieve customer satisfaction by preventing non-conformity at all stages
from design through to servicing (Peach 1995) offered by the laboratory, in order to stay com-
petitive and to reward the personnel for its effort. That the above objectives should also form an
important part of the mission statement of the Department too. The joint adoption of a mission
statement by the faculty, staff and students of the Department is maybe the most critical step in the
initiation of a quality culture. An equally critical step would be to understand who our ’customers’
are. The following could be the customers in a University TQM context:

- Students
- Industry
Figure 2. A basic quality loop for application in an engineering laboratory.

- Government
- Regional stakeholders
- Society

Due to the fact that the customers of an engineering laboratory and the University in general are multiple, it is essential to place the satisfaction of the needs and wishes of the above customers in a hierarchy (Winn and Green 1998).

The personnel must acquire a good understanding of the laboratory’s mission to develop the necessary engineering skills and attitudes. They should encourage students to become capable of making positive contributions first to the laboratory environment, second, to the Departmental level and subsequently, to their future places of employment. This should include a number of fields including research, design, development, testing and servicing, and – last but not least – teaching. We should always keep in mind that the quality of support of the courses assigned to laboratory faculty members heavily relies upon the quality of the laboratory’s Ph.D. candidates who are also working as teaching assistants, as well as the laboratory’s technical and support staff. They should contribute the above performing in a technically competent and socially responsible manner. Assessment of the value added by a process may be done by checking if this process adds value to the laboratory’s mission – and the Department’s mission in general.

A minimal quality system design in the laboratory would start with a joint decision for the most important procedures to be written down including the basic document and data control procedures, as well as the confidentiality policy and documents. Excluding the time spent in education or information sessions, engineering companies must allocate the time devoted by their personnel to pure engineering work such as the following:

- Design
- Analysis and testing

In this process, they should also include accounting of other type of activities such as the following:

- Planning
- Time spent in meetings

This is done by means of special accounting procedures, in which each engineer must submit on a weekly basis an account of hours (or a percentage of time) spent on each project, with a differentiation among the above three categories. This procedure allows for a valid accounting by the company and a reliable cost analysis for future projects. The adoption of a similar, but much
leaner system in engineering laboratories would be valuable today, because of the variety of ways
in which the faculty, personnel and students could allocate their time. In this way the Department’s
research units would be able to do a rational costing of their research activities, and communicate
better with industrial partners. The supply of required resources should be completed by hiring
additional personnel that would be necessary for the projects. The extension of similar accounting
procedures to the Departmental level should be limited to the absolute necessary. In the second
author’s Department, the introduction of writing down of such procedures is currently limited to
the job description of all administrative personnel (including the Department’s Secretariat) and
technical staff, writing down of tasks assigned to the technical staff and development of rules for
the allocation of services of the technical staff, which traditionally lead to quarrels among the
faculty members.

A typical quality plan for the laboratory should include research objectives and specific knowl-
edge and competencies to be covered, research prerequisites and a statement of the necessary
researcher’s background knowledge, detailed schedule and description of deliverables, list of
required software and laboratory test equipment, instructions for laboratory staff, and detailed
description of tests planned.

As regards the quality system’s application, only the essential documents and data pertaining
to the quality system need to be addressed at a first step, in order to prevent overloading of the
faculty and personnel with paperwork. It should be limited to a compact version of the quality
manual, along with the most important procedures, instructions, records and research project work
programs. An initial form of a quality manual should make reference to procedures, instructions
and records, to allow for proper communication, audits and verification. Procedures explaining
who does what, when and where, referring to sets of instructions for laboratory measurements,
system testing etc., should be included.

As regards the responsibilities allocated to the various categories of staff, including students
involved in the projects, the following guidelines should be followed.

All students are responsible for the quality of their own work, as well as understanding and
implementing the quality system and quality policy within the department.

The Laboratory Director, faculty members and group leaders are responsible for:

• identifying resource requirements for management, performance of work and verification
  activities;
• ensuring that their collaborators understand the quality policy and have the training necessary
to do their job;
• reviewing quality issues at laboratory meetings;
• awarding excellence to encourage participation in the quality improvement process.

The adoption of analogous responsibilities by the rest of the faculty and TA’s of the Department
is a process that is expected to gradually evolve. Important, relatively simple steps taken to this
deal include the adoption of a reliable instructor (including
TA’s) evaluation procedure, combined with an award of excellence to the best instructor each
year. As expected, these awards are usually gained by faculty members from well-organized
laboratories on quality aspects. This significantly helped further evolution of the quality culture at
the Departmental level. Other related steps taken, include the selection of the best Ph.D. candidates
and staff of the Department to participate in the multi-year departmental program of undergraduate
studies’ reform. These students and staff have been financially rewarded for their participation,
and the Department further diffused the results of their participation as an example to the rest.

As far as supply of resources is concerned, the basic procedures for purchasing equipment and
maintenance services should be written down. Also, the basic procedures for hiring personnel
should be understood and practiced. Allocation of time among projects should be decided based
on the added value to the laboratory’s mission.
Design improvements and further development of the quality system should be based on the feedback received by the quality system application and reaching the quality objectives (e.g. fulfillment of industrial partner expectations, expansion of research collaboration, etc.). Whenever an objective is reached, it is reasonable to increase the goal so that constant improvement is maintained.

Training, qualification and competence: Everyone in the laboratory must be included in the education process. This is especially true for graduate and undergraduate students involved in laboratory activities. Rapidly evolving technologies require the faculty, researchers and staff to engage in all aspects of their laboratory work, to be willing to learn details of their equipment technology and to be able to meet or supervise service and troubleshooting themselves. This is absolutely necessary in an age of increased complexity, where we can no longer overload our technical staff with every kind of technical problem faced during research and teaching activities. Our students and future engineers should be motivated with this task-oriented philosophy that inspired the re-engineering of big international corporations in the 1990s (Hammer and Champy 1994). This requires a little more interest and interaction between each other’s job in the same unit.

Leadership should be emphasized in the laboratory instead of simple managerial practices. The Laboratory Director or group leader should create an inspiring work environment for his group, removing barriers to communication or productivity. For example, a classroom with inadequate lighting conditions or a poorly designed test rig can adversely affect students’ or researchers’ performance. The leader addresses this type of problem, providing a healthy, pleasant and safe work environment for his people. The possibility of self-funding of these provisions by the marketing of research results will further enhance their applicability to the whole department. Extension of the above practices from the laboratory to the Departmental level is straightforward. Usually, the most successful Laboratory Directors evolve to equally successful Department Heads.

This practice of encouraging cooperation instead of competition could be further extended to different research units in the Department. The problems faced by industry today nearly always require a multi-disciplinary approach in order to have a chance to find an acceptable solution. Our industrial partners feel much more comfortable when they address their problems to a harmoniously cooperating ring of laboratories in the same Department. An absolute prerequisite for this is that all laboratories share the same quality policy. This process is facilitated by the regular communication between researchers from different laboratories, in the form of seminars, unofficial presentations and discussions of intermediate research results, personal relations, etc. Again, this practice further promotes evolution of a quality culture at the Department’s level.

Conclusions

- The authors’ experience in the application of quality management schemes in academic engineering laboratories are summarized in this paper.
- We believe that the adoption of such schemes, motivated by university–industry cooperation in applied research and development projects can provide a solid step towards ensuring a quality culture in Greek University faculties.
- Systematic efforts in this direction can help engineering faculties to reorganize their structure efficiently, provide focus on quality and achieve international recognition in their fields of expertise.
- Priority in this respect should be given to applied R&D activities with direct industrial funding. The quality assurance for the curricula and the graduates quality will be strongly and positively influenced by the processes already in place for the research units quality assurance.
• Participating students and researchers can also see a validation and recognition of their work in their interaction with industrial/research partners. This further enhances their value and quality as TA's involved in the teaching assigned to the laboratory faculty members.

• Here we argued that since these academic units are an integral and important aspect of academic research, they should be organized with focus on quality and subsequently be used as a starting point for the introduction of quality assurance procedures in engineering education. Examples from the authors’ hands-on experience on these issues are cited to support our arguments.

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References


Author biographies

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