



ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ

Α.ΔΙ.Π.

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HELLENIC REPUBLIC

H.Q.A.

HELLENIC QUALITY ASSURANCE AND
ACCREDITATION AGENCY

EXTERNAL EVALUATION REPORT

SCHOOL OF MECHANICAL ENGINEERING

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

May 2012

External Evaluation Committee

The Committee responsible for the External Evaluation of the School of Mechanical Engineering of the National Technical University of Athens consisted of the following five (5) expert evaluators drawn from the Registry constituted by the HQAA in accordance with Law 3374/2005 :

1. Professor Antonios Zavaliangos _____ (President)
(Title) (Name and Surname)

Drexel University _____
(Institution of origin)

2. Professor Petros Koumoutsakos _____
(Title) (Name and Surname)

Swiss Federal Institute of Technology _____
(Institution of origin)

3. Professor George Kardomateas _____
(Title) (Name and Surname)

Georgia Institute of Technology College of Engineering _____
(Institution of origin)

4. Professor Constantine Polymeropoulos _____
(Title) (Name and Surname)

Rutgers University _____
(Institution of origin)

5. Professor Michalis Yianneskis _____
(Title) (Name and Surname)

University College London _____
(Institution of origin)

Introduction

I. The External Evaluation Procedure

The External Evaluation Committee (EEC) visited the School of Mechanical Engineering at the National Technical University of Athens, during the period 12th – 14th March 2012.

The team arrived in the morning of March 12th to meet with the Chairman of the School, the Committee for Internal Evaluation (OMEA), members of the faculty (ΔΕΠ), and other representatives of the School. The meeting was obstructed by a group of students, who did not appear to be officially representing the student body. They stated their opposition to the external evaluation concept and demanded the process to stop. As a result the meeting was interrupted but continued at a different location.

During the meeting, the Chairman gave a presentation outlining the profile and basic characteristics of the School. The presentation was followed by a discussion during which the EEC requested clarifications and additional information on a number of topics and issues. Campus visits took place on March 13th and 14th. The visits were organized by Sections (Τομείς). In addition, the EEC met, during two working lunches, first with Lecturers and Assistant Professors and then separately with Associate and Full Professors. On March 13th, the EEC had a working dinner with representatives of the Sections and the Chairman of the School. The EEC also met the administrative staff of the School, doctoral students (more than 40 students were present) and visited a classroom (in which a lecture was taking place). The classroom was randomly chosen and gave the opportunity to meet with about 30 students without the presence of the instructor. No separate meetings were scheduled with members of Ε.Δ.Τ.Π, and Ι.Δ.Α.Χ. personnel. A visit to the library and athletic center was cancelled for lack of time. On March 14th, the EEC met with the Rector and Vice-Rector of NTUA. The visit concluded with a final meeting with the Committee for Internal Evaluation.

The EEC considered several of the documents provided by the faculty including:

- The internal evaluation report (IER).
- The School's program of studies.
- Information brochures provided by the various Sections describing their research, technical and teaching activities.
- Samples of course textbooks, course examinations, Diploma and Ph.D. theses.
- Additional information provided by the School during the visit including details of teaching load and research activities.

The visit took place in a cordial and collegiate atmosphere. The EEC members unanimously express their appreciation to both the School's faculty

and HQAA for the arrangements of the visit. We acknowledge the efforts of Professors Papantonis and Marmaras to facilitate the work of the EEC.

A signed draft was prepared from 15/3 to 17/3/2012.

II. *The Internal Evaluation Procedure*

The IER was prepared by a group consisting of the chairman of the School, the directors of the Sections, and three students. Input from other members of the faculty and administrative staff, as well as questionnaire-based feedback from the students were also included. Additional data were provided during the visit.

A. Curriculum

UNDERGRADUATE PROGRAMME

The undergraduate Mechanical Engineering (ME) curriculum is based on the 5-year, old central European model and consists of two series of courses: one core series in basic science and engineering fundamentals and one specialization series that includes required engineering courses and technical elective courses. No pre-requisites are required for any courses. The undergraduate curriculum concludes with the diploma thesis that links students with research and applied projects. The curriculum has an emphasis on applied technology and the diploma theses cover a very wide range of subjects.

The EEC feels that the following characteristics of the program merit action:

- (a) The undergraduate program consists of 64 courses for a total of ~290 teaching hours in addition to the Diploma thesis. We consider that this number inhibits active learning and student participation. We recommend that the School considers the educational program of international peer institutions and reconsiders its educational program. For comparison, US institutions have a maximum of about 130 teaching hours for the BSc degree and a maximum of about 30 teaching hours for the MSc degree for a total of 160 credit hours for a 5-year equivalent program. The large number of credit hours and the excessive number (~70) of offered elective courses have resulted in heavy teaching loads for most faculty members. We note a student overload in specialized courses, beyond the generally accepted mechanical engineering course load. A consolidation of offered courses by about 1/3 is recommended.
- (b) The lack of pre-requisites can disrupt the smooth progress of students, make the teaching of classes more difficult and result in many students being unable to follow a course. Thus, it is recommended that pre-requisites be introduced.
- (c) The program is not as strong in Probability/Statistics and Chemistry as needed for a modern engineering program aspiring to excellence. Furthermore, in view of the emerging trend towards bio-engineering, the addition of Biology should be considered.
- (d) There are overlaps in certain course contents. This was confirmed by faculty and students, as well as by the EEC upon review of course descriptions. It is recommended that an effective mechanism to identify and eliminate subject overlaps and repetitions be introduced.
- (e) In view of the increasing importance of Computation in Engineering, it is recommended that Computational Methods and Programming courses be strengthened, emphasizing in particular the links between Applications, Mathematics, Algorithms and Programming.

POST-GRADUATE PROGRAMME

The Post-Graduate Programme comprises 2 inter-disciplinary programs (Athens MBA, Control and Automation) in which the ME School is the lead and 11 inter-disciplinary ones in which the School is a participant. The Athens MBA is co-organized with the Economic University of Athens.

The post-graduate programmes provide multiple benefits, including:

- (a) Offering opportunity of contacts of the academic community with its industrial counterpart;
- (b) Satisfying the training needs of industry;
- (c) Offering the opportunity of graduate teaching to younger faculty.

The EEC notes that these programmes

- (a) Were instituted on a rather ad-hoc basis without strategic planning and revisions;
- (b) Some of these inter-disciplinary courses, as reported by the faculty, are taught at a lower than Master's level, to compensate for the lack of ME knowledge from the non-ME participants.

The EEC recommends that the School reconsiders the entire concept of the ME Post-Graduate Programme in light of its strategic goals in research and education.

DOCTORAL PROGRAMME

The School has an active doctoral program with PhD theses mostly relevant to current societal and industrial needs. The number of PhD dissertations was on average 17 per year over the last 5 years. As with the undergraduate program, there is a large number of non-active ("lingering") PhD students. In addition, many PhD students are effectively studying on a part-time basis due to the lack of adequate financial support, which results in a high average number of years for completion (mostly above 6 years).

The attendance of high-level courses by the PhD students is highly recommended. Furthermore we advocate the introduction of candidacy examination (in the form of qualifying exams, or on topics related to the thesis). The EEC recommends that an upper limit for the number of years required for the completion of PhD studies is established (with "safety valve" rules for exceptional cases).

B. Teaching

The EEC made the following observations related to teaching:

- a) Teaching within the School undergraduate program consists of lectures, class and laboratory exercises. Faculty teaches courses that lie only within their own Section specializations. Many courses require individual term projects (θέματα), which require individual term paper submission. Some of these projects are comprehensive and of high quality.
- b) Laboratory instruction is included as part of some courses, or in laboratory-only courses. Due to the large numbers of students some of the laboratories involve only demonstrations.
- c) With rare exceptions, all teaching is done by the faculty responsible for the course. The faculty is available for consultation by the students, and they should be commended for their dedication to teaching. There is, however, no organized mentoring of students.
- d) Incoming students have the highest entrance examination scores among Greek Mechanical Engineering Schools. The corresponding scores of transfer students can be lower and may hinder effective teaching.
- e) The level of teaching appears to be high as evidenced by the high faculty ratings in student evaluations, which the School has instituted, to its credit, on a regular basis. According to the IER, these evaluations rate highly the content of the course material and the whole program of study.
- f) The EEC notes that the quality of books available in each course is uneven. Presumably because of current budgetary constraints, these books are not always given to the students.
- g) Course information, grading requirements, exercises, and other course material are communicated via web pages for some of the courses.
- h) Higher-level classes with relatively small number of students require student homework, but large classes do not involve graded homework assignments.
- i) There is familiarity with computer usage by students but the EEC considers that the level can be significantly improved.
- j) A large number of students do not attend classes. This contributes to having a large number of students deferring the end of semester examinations and a large percentage of late graduations.
- k) Major problems, which are found not only within the Department, but are persistent in many institutions of higher learning in Greece are:
 - i. The large number of students;
 - ii. Low class attendance;
 - iii. Non-modern computer and laboratory infrastructure;

- iv. Large number of students deferring final course examinations;
- v. Persistent loss of teaching time because of student protests.

The School is aware of the aforementioned issues and has outlined actions in the IER aimed at improving many of the perceived weaknesses. The EEC supports and emphasizes the need to control the size of the student body to allow:

- a) Smaller class sizes;
- b) The control of absenteeism with the possible establishment of compulsory attendance;
- c) The reduction of deferred student examinations.

Additional actions to help increase teaching quality and student involvement and participation can be:

- a) The institution of homework, which we consider a useful educational component;
- b) The enhancement of web pages and the posting of online material for all courses including the faculty lecture notes;
- c) Establishment of a seminar series for incoming students where they can be introduced to the curriculum, its relation to the profession as well as School activities;
- d) Encouragement of teaching that crosses Section boundaries;
- e) Capping of the number of transfer students at a level less than 15% of the planned student pool. The EEC strongly emphasizes that the current reduction efforts must be sustained and by no means be reversed.
- f) Reducing the very large number of "lingering" (non-active) students by introducing academic performance criteria;
- g) Introducing the concept of a mentor for each incoming student as also suggested in the IER.

C. Research

Research in the School has industrial relevance and involves fundamental and applied topics, albeit with emphasis skewed towards the latter. The EEC was impressed by the dedication of faculty, staff and PhD students, under difficult conditions and infrastructure that, in certain cases, is not competitive by international standards. The EEC notes the existence of exemplary pockets of innovative research that are competing at world class level as quantified by publications, citations, funding and international student placements. The EEC applauds the participation of several groups in EU funded projects.

The NTUA provides faculty with incentives and favorable conditions for the acquisition of external funding (low overhead rates, salary enhancement) as well as ample, high quality space and access to incoming students that have the highest scores among Greek high school graduates. The Committee recognizes the current difficult situation in Greece and the structural problems inherent to Greek society, universities and State. The EEC appreciates, however, the overall tremendous intellectual potential among faculty and staff and as such it believes that the School should aim to be internationally recognized among the top 30 Mechanical Engineering departments in the EU.

The EEC believes that there is room for improvement on the research component in the School and suggests that:

- a) Research on *fundamental scientific and engineering problems* must be significantly enhanced in order to develop a solid scientific basis for Greek society and industry. Furthermore, research on fundamental research is necessary for the acquisition of European funding, to compete with the broader scientific community and serve the goals of enhanced scientific excellence of NTUA.
- b) Research on problems of *industrial relevance* is needed in order to address scientific problems of relevance to the Greek industry and to stimulate present and future growth.

The EEC considers that research of industrial and scientific relevance are complementary to each other and must be pursued in a coordinated fashion by collaborative efforts among School and University members.

The EEC considered in the evaluation of research output:

- a) publications in reputed scientific journals;
- b) citations (in Scopus, Web of Science, Google Scholar);
- c) availability of external (Greek and EU) funding for research projects;
- d) participation in reputed journal editorial boards;
- e) faculty honors and awards;
- f) organization of established international conferences and workshops.

Based on these criteria, the EEC finds that the average research output

should be significantly improved. Also, a more even distribution of such output among faculty is called for. Furthermore, we find no correlation between acquired external funding and teaching load.

The EEC did not find a clear evidence of strategic research directions for the school, that cut across section and school boundaries and enhance synergies. We observe in certain cases a relative isolation from the broader scientific community and a fragmentation of research themes even within research sections. There was no clear rationale in the selection of problems and no strategic emphasis on the solicitation of funding in “basic research” vs. “applied research” or “job-shop” projects. Notable is the need of a seminar series with prominent international speakers, who would broaden the understanding of international scientific horizons and motivate faculty and students.

The EEC encountered structural obstacles and practices that can be improved so as to enhance scientific progress. In particular, the EEC wishes to draw the attention of the School members to scientific in-breeding that is internationally considered adverse to scientific progress, may inhibit cross fertilization of scientific directions and can lead to the establishment of non-competitive scientific practices.

We note that there is room for modernization of experimental facilities. The overall computational infrastructure (including in experimental laboratories) needs a significant overhaul along with the elimination of bureaucratic hurdles, in order to enable researchers to compete at the international stage.

We propose that the School sets a clear mission for its scientific goals and its place in the Greek and international scientific community. We advocate that the balance between fundamental, applied research and services to the industry should be re-examined.

Consistent with the desire of the School, as stated in the IER, to perform research of the highest caliber, the EEC recommends:

- a) increased efforts in pursuing research fundamentals in areas where this is appropriate;
- b) a concerted effort in increasing the quality of scientific output by pursuing publishing in top-tier scientific journals;
- c) the introduction of post-doctoral fellows (of fixed term employment) as well as better start-up funds and reduced teaching load for new assistant professors and lecturers;
- d) the establishment of a School Research Committee as a forum to enhance cross-section communication and synergy, to identify potential of existing and/or new resources for joint utilization;
- e) the active encouragement of cross-school links and a flexible structure that allows the formation of scientific teams on a per-project basis;
- f) the introduction of scientific seminars, a yearly collection of faculty publications, and a yearly research activities report.

D. All Other Services

Services to students, staff and faculty are provided in coordination with central, university-level offices and School staff.

- a. Facilities and classrooms, in general, are sufficient in size. Lab space is ample, much larger than commonly found in many international universities. Enhancement and continuous, timely upgrades of computer infrastructure are essential.
- b. The management of the financial resources is, in general, transparent. It appears that most funds are equally distributed on a per-faculty basis. This approach may appear to be fair but cannot address strategic priorities or imbalances from the expected differentiation of individual Sections during their evolution.
- c. The School administrative office is well staffed and has access to databases and computer support. Most current student records are computer accessed. Residual paper-based records of older students should be converted to electronic format. The staff indicated that there is excessive paperwork (actually paper-based) associated with issues such as procurement, faculty meetings and recruitment. Electronic storage of such information would facilitate periodic auditing, which is essential for eliminating inefficient practices. Many of these are associated with a convoluted legal framework which creates efficiency problems in a number of areas. Procurement, for example, requires a time horizon, which according to faculty members, can span up to two years.
- d. In addition to the School administrative office, there is sufficient administrative support for each of the six current Sections. Moreover, there is an unconventional group of personnel (I.Δ.A.X – 79 according to the IER), which is supposed to provide administrative support. These are in fact technical personnel, who used to work on research projects on a temporary basis. This group provides flexibility but there is no rational correspondence of employee qualifications to job description.
- e. The assignment of support personnel of all types to the current Sections is not flexible and may be counterproductive as individual Section activity varies with time.
- f. The undergraduate students find the administrative support satisfactory. These services, however, can be further improved. For example, there are two web pages of the courses <http://cw.mech.ntua.gr/> and mycourses.ntua.gr/, which are both inadequate and in need of serious enhancements. The EEC notes an admirable effort of the students to compile the relevant information in independent web sites. The EEC considers that a better organization and the enhancement of electronic services provided by the School will enable a more effective dissemination of information to students on a multitude of issues such as opportunities for practical training, exchanges and visits to international universities, career planning,

links to alumni, entrepreneurship etc.

- g. The EEC did not have time to visit the Library, but, in general, staff and students expressed satisfaction during individual discussions. Students confirmed the IER mention of a month-long, complete interruption of Library e-services. Students also reported limited number of textbooks available in the library, and severe limits on interlibrary loans of journal papers (<10 annually), which should be examined and addressed by the University.
- h. The School in collaboration with the University should improve their connection with their alumni, starting from a process of generating relevant databases. Alumni can assist in generating opportunities for practical training, and enhancing career planning services.

The EEC noted that the university lacks a faculty and staff handbook that details policies governing the conduct of faculty, staff and students. Examples of such policies include non-discrimination, harassment, mentoring, employing and working with relatives and related matters. An example of a web site with policies from the University of Cambridge can be found at <http://www.admin.cam.ac.uk/offices/hr/policy/> and a faculty handbook from Duke University at <http://www.provost.duke.edu/policies/fhb.html>.

Collaboration with social, cultural and production organizations

Visits to individual Sections indicated that some faculty serve in government positions, and several certified laboratories of the School provide external services. These activities, however, were not documented in the IER and do not appear to be monitored on a regular basis. Such documentation is essential for periodic review as well as for prevention of conflicts of interest.

E. Strategic Planning, Perspectives for Improvement and Dealing with Potential Inhibiting Factors

One of the most rewarding aspects of the visit was to note that some sections of the School have been rather successful in attracting and appointing a substantial proportion of academic staff from high-ranking overseas institutions and have seen impressive growth in high quality research activity in recent years. Another was the ample space that the School has available. This could be utilised to propel new activities in teaching and research for the realignment of the curriculum and research suggested below.

Teaching

The EEC applauds and fully supports the School's suggestion that the 5-year diploma should be recognised as a postgraduate (Master-level) degree. This would not only achieve parity with other (often considerably far less demanding) European degrees, but would also facilitate a more flexible programme structure in future, should 3-year first degree programmes become the norm in Greece. This would necessitate a thorough restructuring of the current program that must include the introduction of new courses, both fundamental as well as in-depth postgraduate-level ones.

The issue of student transfers is rightly pointed out by the School as increasing the teaching workload to unacceptable and educationally inappropriate levels and being a considerable obstacle in planning and effective utilization of human and other resources. The number of students transferred in from other institutions has decreased recently, but is still unacceptably high and hinders the development of the School.

The workload issue is further exacerbated by the very intensive nature of the program. The EEC strongly suggests that the curriculum is consolidated as a matter of urgency by reducing the number of courses and student contact hours by around 1/3 to bring it in line with the practice in most other European and US universities.

Research and International Visibility

In terms of research, the following strategic issues should be addressed:

- a. Collaboration between different sections of the School and with other Schools of NTUA is rather limited and should be strongly encouraged and supported by both the School and NTUA. This also applies to collaboration in teaching.
- b. A clear strategic direction is not evident in all sections and despite the possibilities, there are few synergies. The management of NTUA and the School should establish a clearly-defined research vision and the means to further promote and encourage cross- and inter-school collaboration and reward activities that clearly enhance the reputation

of the School/University, using transparent and internationally-accepted measures.

- c. In tandem with this, research policy should be critically revisited, with the aims of redirecting effort to more fundamental topics and of identifying new areas that are topical and have growth potential as the main drivers of research planning. To this end, the establishment of a Research Committee is recommended.
- d. The EEC believes that the «Section» structure may have served the School well for many years, when the changes in the traditional sub-disciplines of mechanical engineering were infrequent. However, it no longer fits the rapidly changing research landscape of today: staff should be able to encompass new activities in areas adjacent to their core research expertise, rather than expecting new appointments to cover the gaps.
- e. It is refreshing to note the School's proposal for collaboration with foreign, mostly European, universities via student and staff visits and exchanges. The EEC further suggests that the NTUA and the School should urgently seek strategic alliances with top-quality European and US universities that would facilitate the aforementioned collaborations. Such a process could be launched at School level with a series of seminars by inspiring visiting speakers.
- f. In its strive for international excellence, NTUA should clarify and quantify what quality levels it strives to achieve, and assess what levels it actually achieves, through regular benchmarking exercises against measurable goals.

Recruitment

The EEC noted that there are endemic weaknesses in the process of appointment of new academic staff. The recruitment process is cumbersome, extremely slow and restricted by bureaucratic procedures and legislative issues that need to be urgently redressed.

At the State level, several process and procedural modifications are urgently needed:

- a. It should be made possible to offer positions to runner-up applicants, should the first-choice person be unable to take up a post;
- b. The emphasis of an appointment should be placed on scientific excellence and not in fulfilling criteria related to teaching a narrowly-defined subject;
- c. International letters of reference for the applicants should be sought;
- d. Internationally recognized experts should participate in the entire process; and
- e. The openness and transparency of the faculty hiring processes should be such as to ensure that applicants external to the unit are not disadvantaged.

At the local level, newly appointed young faculty should be systematically supported with reduced teaching load, and should be provided

with start-up funding.

In perspective, the low level of academic pay, combined with an (on average) excessive teaching load and highly restrictive legislation inhibit applications from many promising young Greek academics abroad and is partially responsible for the very low number of applicants in recent searches.

Legal Framework and Other Issues

The EEC noted with dismay the existence of an overbearing and restrictive legal framework that inhibits the rapid growth that is essential for a teaching and research environment to be world class. The School correctly points out the difficulties associated with the severe delays in the award of state funding, as well as in the utilization of state and other funding due to the extremely bureaucratic procurement processes; these processes can result in such substantial delays (sometimes 2 years) in the purchase of equipment, so that in effect it may already be outdated by the time it is delivered.

Further, the EEC recommends that:

- a. The School should establish an external Advisory Board to help provide links for the students with potential future employers, assist in developing the research mission and the evolution of the curriculum.
- b. NTUA should draft and implement a Code of Conduct for students (including plagiarism, vandalism, respect of opinions and persons), as well as for faculty and staff (including transparent and auditable relations with external bodies, identification of potential conflicts of interest, assurance of ethical conduct).

F. Final Conclusions and recommendations of the EEC

The EEC members concluded the following:

1. The School of Mechanical Engineering at the National Technical University of Athens is the first established such School in Greece. This tradition behooves the School to strive for exemplary leadership, innovation and professional ethos.
2. We applaud the existence of groups that conduct competitive research at an international level under quite difficult conditions.
3. We encountered notable examples of hard work, dedication and passion for teaching and research.
4. We advocate that the School addresses the following issues:
 - i. Curriculum reform.
 - ii. Enhancement of quality in research.
 - iii. Adoption of vigorous, internationally recognized, procedures in faculty hiring.
 - iv. Establishment of a rigorous policy to prevent and resolve conflicts of interest.
 - v. Initiation of procedures to ensure continuous improvement by benchmarking conducted on a regular basis.
5. There are significant issues that need to be addressed at a State level, such as the legal framework as discussed in the previous sections.

The Members of the Committee

| Name and Surname | Signature |
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