ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ

Α.Δ.Ι.Π.

ΑΡΧΗ ΔΙΑΣΦΑΛΙΣΗΣ ΚΑΙ ΠΙΣΤΟΠΟΙΗΣΗΣ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΣΤΗΝ ΑΝΩΤΑΤΗ ΕΚΠΑΙΔΕΥΣΗ

HELLENIC REPUBLIC

H.Q.A.

HELLENIC QUALITY ASSURANCE AND ACCREDITATION AGENCY

EXTERNAL EVALUATION REPORT

SCHOOL OF CHEMICAL ENGINEERING

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

GREECE

December 2013

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External Evaluation Committee

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

1. **Prof. Paschalis Alexandridis**
   University at Buffalo, The State University of New York, USA

2. **Prof. Konstantinos P. Giapis**
   California Institute of Technology, USA

3. **Prof. Vassily Hatzimanikatis**
   École Polytechnique Fédérale de Lausanne, Switzerland

4. **Prof. Triantafillos J. Mountziaris** (Coordinator)
   University of Massachusetts-Amherst, USA

5. **Prof. Eleftherios Papoutsakis**
   University of Delaware, USA

N.B. *The structure of the "Template" proposed for the External Evaluation Report mirrors the requirements of Law 3374/2005 and corresponds overall to the structure of the Internal Evaluation Report submitted by the Department.*

The length of text in each box is free. Questions included in each box are not exclusive nor should they always be answered separately; they are meant to provide a general outline of matters that should be addressed by the Committee when formulating its comments.

Introduction

The School of Chemical Engineering at the National Technical University in Athens, Greece, was established in 1917. In its almost 100-year long history the School has educated generations of chemical engineers who contributed to the Greek, European and World academia and economies. The School attracts some of the best students in Greece and among its graduates are distinguished academics, including members of the Academy of Athens and the National Academies of other countries, business leaders and politicians. The importance of the School to the Greek society and economy is very high.

I. The External Evaluation Procedure

- Dates and brief account of the site visit.
- Whom did the Committee meet?
- List of Reports, documents, other data examined by the Committee.
- Groups of teaching and administrative staff and students interviewed
- Facilities visited by the External Evaluation Committee.

The Evaluation Committee met in Athens over a period of five days, from December 9 to 13, 2013. The visit included meetings with the School's Dean, faculty, staff and students in the HQA offices in Athens (December 9-11), a site visit to the School on December 12 and a writing retreat (December 12-13).

The Committee was provided ahead of its visit with electronic copies of documents about the School's four Sectors, curriculum, five-year Diploma program, graduate programs, and faculty research activities including publications, research presentations. During the visit the Committee was provided with copies of all presentations made by the Dean and faculty, and CVs of the faculty and teaching staff.

The Committee interviewed the Dean, the Directors (Chairs) of the four Sectors of the School, the faculty members of each Sector in four individual groups, the Lecturers and Assistant Professors in a single group, the technical and administrative staff in a group, five-year Diploma candidates in a single group, and graduate students (Masters and PhD) in a single group.

The Committee visited the School and toured teaching and research laboratories, the School's computer room, faculty offices, classrooms during lecture time, laboratories during instruction time, and common facilities, a high bay area used for pilot scale experiments and the undergraduate study room. The Committee feels that the School has adequate space for research and teaching laboratories, lecture classrooms and common facilities. The efforts of

faculty and staff to operate the School and complete the academic semesters, despite frequent disruptions from strikes and demonstrations, is commendable. The upper administration of the Institution, led by its Chancellor/Rector, must exercise its authority to protect the faculty, staff and students from disruptive external elements, safeguard the School's facilities, and ensure the smooth operation of the School.

II. The Internal Evaluation Procedure

Please comment on:

- Appropriateness of sources and documentation used
- Quality and completeness of evidence reviewed and provided
- To what extent have the objectives of the internal evaluation process been met by the Department?

The internal evaluation documents provided useful information about the School, its faculty, curriculum, programs, facilities and research activities. Some of the internal evaluation documents had outdated information and were organized in a format that made the assessment of the current status of the School by the Committee a challenging task. A recent closure of the School due to a strike had an adverse effect on the preparation of the evaluation documents by the faculty. While the School organized the schedule of meetings and faculty presentations very well, some faculty were not prepared for the evaluation process and did not include important facts and data in their presentations. The School should adopt a more comprehensive and systematic approach for its internal evaluation that includes periodic assessment of all operations and implementation of the necessary changes.

A. Curriculum

To be filled separately for each undergraduate, graduate and doctoral programme.

APPROACH – 5-YEAR DIPLOMA CHEMICAL ENGINEER DEGREE PROGRAM

Goals and objectives of the Curriculum, structure and content, intended learning outcomes.

Information pertaining to the 5-year curriculum leading to a Chemical Engineer Diploma that has been provided to the EEC included the studies guide (ΟΔΗΓΟΣ ΣΠΟΥΔΩΝ) for 2012-2013, spring 2013 and fall 2013 course offerings, and presentations given by Professors Boudouvis (Dean of the School, Κοσμήτορας) and Koukios (Committee on Studies, Επιτροπή Σπουδών Σχολής ΧΜ). Further information about certain courses was included in the presentations delivered by Sectors (Τομείς), and gathered during the discussion sessions with faculty and students.

- What are the goals and objectives of the Curriculum? What is the plan for achieving them?

The 5-year curriculum leading to a Chemical Engineer Diploma aims to provide fundamental knowledge and practical skills to enable graduates to practice as chemical engineers, work together with other engineers and processionals in the context of the socio-economic environment, and instil life-long learning.

The curriculum currently consists of 55 courses spread over 9 semesters, plus Practical Training (Πρακτική Άσκηση) (an aspect of experiential learning) in the 9th semester and a Thesis/Diplomarbeit (Διπλωματική Εργασία), typically involving research, carried out during the 10th semester. The curriculum is organized in the context of "routes" (basic sciences foundation), "stem/core" (process engineering), "branches" (which include TEE requirements and processional development), and "leaves" (electives and specializations, Εμβαθύνσεις).

In total, about 125 courses are offered every academic year, that cover a plethora of topics. The EEC was informed that all courses with enrolment over 80 students are spilt and offered in multiple Sectors.

The content, level of rigor, and organization of studies could enable diligent students to achieve the goals and objectives of the 5-year curriculum leading to a Chemical Engineer Diploma (assuming there would be no disruptions due to internal/external factors).

- How were the objectives decided? Which factors were taken into account? Were they set against appropriate standards? Did the unit consult other stakeholders?

The current curriculum has been in place since 2002/3. The curriculum incorporates the internationally accepted elements and course-offerings of chemical engineering. It also reflects the organization of the School in Sectors/Laboratories. The structure of the curriculum appears to follow the School's traditions and is worth revisiting and updating. Other than the faculty and the Technical Chamber of Greece (TEE), it is not clear whether other stakeholders (e.g., students, employers, alumni and an Advisory Board) have been consulted.

- Is the curriculum consistent with the objectives of the Curriculum and the requirements of the society?

The curriculum is consistent with the objectives of the Curriculum and attempts to meet the needs of the evolving scientific, professional, and socio-economic environment. However, some elements of the curriculum are outdated and others have significant overlap to necessitate a comprehensive review and update.

- How was the curriculum decided? Were all constituents of the Department, including students and other stakeholders, consulted?

Curriculum updates/revisions are discussed/proposed by the Committee on Studies (Επιτροπή Σπουδών) and approved by the school general assembly (Γενική Συνέλευση). The curriculum meets TEE requirements. It is not clear whether other constituencies (e.g., alumni or employers) are being consulted. It is not clear whether and how student input (e.g., from course evaluations) is being utilized. During the meetings of the EEC with students, they expressed a concern about the lack of response from the School to their course evaluations.

- Has the unit set a procedure for the revision of the curriculum?

Curriculum revisions took place in 1983, 1993, and 2002/3. According to the self-evaluation report provided to the EEC and the faculty presentations, a process for update/revision of the current curriculum is currently underway at the level of the Committee on Studies (Επιτροπή Σπουδών). The Committee recommends that the School forms and seeks input from an Advisory Board.

<u>APPROACH – GRADUATE PROGRAMS (ΜΕΤΑΠΤΥΧΙΑΚΕΣ ΣΠΟΥΔΕΣ ΕΙΔΙΚΕΥΣΗΣ)</u>

Goals and objectives of the Curriculum, structure and content, intended learning outcomes

The EEC considered the two inter-departmental programs of postgraduate study (Διατμηματικά Προγράμματα Μεταπτυχιακών Σπουδών) that the School of Chemical Engineering is coordinating (Επισπεύδουσα Σχολή): Materials Science and Engineering (ΕΠΙΣΤΗΜΗ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑ ΥΛΙΚΩΝ) and Computational Engineering (ΥΠΟΛΟΓΙΣΤΙΚΗ ΜΗΧΑΝΙΚΗ). The programs of study, names of faculty involved, number of students, and other related information were provided for these two programs.

- What are the goals and objectives of the Curriculum? What is the plan for achieving them?
- How were the objectives decided? Which factors were taken into account? Were they set against appropriate standards? Did the unit consult other stakeholders?
- Is the curriculum consistent with the objectives of the Curriculum and the requirements of the society?
- How was the curriculum decided? Were all constituents of the Department, including students and other stakeholders, consulted?

The goals and objectives of each of the two inter-departmental programs of postgraduate study considered here are spelled out in the documents provided, and there is a well-defined path to achieve them. The postgraduate programs were established in the late 1990's when the legal framework allowed it. The curriculum was designed to address valid scientific, professional and societal needs.

- Has the unit set a procedure for the revision of the curriculum?

A process for reviewing and revising the graduate curriculum is in place and should be implemented by the School.

APPROACH – DOCTORAL PROGRAM (ΕΚΠΟΝΗΣΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ)

Goals and objectives of the Curriculum, structure and content, intended learning outcomes

- What are the goals and objectives of the Curriculum? What is the plan for achieving them?
- How were the objectives decided? Which factors were taken into account? Were they set against appropriate standards? Did the unit consult other stakeholders?
- Is the curriculum consistent with the objectives of the Curriculum and the requirements of the society?
- How was the curriculum decided? Were all constituents of the Department, including students and other stakeholders, consulted?
- Has the unit set a procedure for the revision of the curriculum?

The goals and objectives of the doctoral program are provided, and a well-defined path to achieve them is spelled out in the document Γενικός Οδηγός Εκπόνησης Διδακτορικής Διατριβής, dated January 2004.

The School of Chemical Engineering has a large number of doctoral students (about 460) enrolled, however a fraction of them are not actively pursuing their research.
Possible revision of the curriculum leading to the doctoral degree has not been discussed during the EEC visit.

IMPLEMENTATION– 5-YEAR DIPLOMA CHEMICAL ENGINEER DEGREE PROGRAM

Rationality, functionality, effectiveness of the Curriculum

- How effectively is the Department's goal implemented by the curriculum?

The curriculum appears to implement the goals of the School of Chemical Engineering.

- How does the curriculum compare with appropriate, universally accepted standards for the specific area of study?

The curriculum is a hybrid that incorporates universally-accepted standards in the field of

chemical engineering and the central European tradition of technical chemistry and Thesis/Diplomarbeit, and is supplemented by courses that reflect the specific professional/research interests of current faculty.

- Is the structure of the curriculum rational and clearly articulated?

The structure of the curriculum is clearly articulated in the studies guide (ΟΔΗΓΟΣ ΣΠΟΥΔΩΝ). The structure of the curriculum appears to follow the School's traditions and is worth revisiting and updating.

- Is the curriculum coherent and functional?

The curriculum is functional, albeit possibly a bit rigid with respect to the specializations (Εμβαθύνσεις), as it appears to allow no course selection across specializations. The organization of course offerings along the four Sectors appears to limit flexibility in terms of coordinating course content and continuity, and eliminating duplication of content. The majority of courses include a laboratory component that expends a lot of time and energy from both the side of faculty/staff and that of students. Several of the electives/specialization courses are tied to the specific expertise of current faculty, and it is not clear how such courses are being staffed in the case of faculty sabbaticals or retirement.

- Is the material for each course appropriate and the time offered sufficient?

From the limited information provided (e.g., course descriptions included in the 2012-2013 study guide, ΟΔΗΓΟΣ ΣΠΟΥΔΩΝ) is appears that the material for each course is appropriate, and the time offered sufficient.

The EEC has identified a few issues regarding the current curriculum and offers a few suggestions:

- Prerequisites should be properly identified, implemented and enforced.
- Several faculty members pointed out that student attendance in lectures tends to be low, while in the lab sessions is very high (according to the 2012-2013 studies guide, attendance in lectures is not considered obligatory, while in the labs attendance is obligatory). To the extent that the lectures contribute to student learning, the faculty should consider implementing various pedagogical methods (and share best practices) to enhance the student participation.
- The lab exercises are integral parts of the majority of courses, and their presence in the curriculum constitutes an element of pride among faculty and staff. However, their contents and effectiveness should be evaluated in the context of current constrains and opportunities.
- It appears that the "core" chemical engineering courses are offered relatively late in the curriculum, culminating with Process Design being offered in the 9th semester. The earlier in the curriculum such courses were to be offered, the sooner the students would feel part of the chemical engineering profession, and the sooner they could contribute as chemical engineers during summer jobs or practical training (Πρακτική Άσκηση).
- While the contact hours of each of the "core" chemical engineering courses would appear adequate, the fraction of the sum of hours spent in the "core" chemical engineering courses within the 5-year curriculum is not adequate.
- There appears to be notable overlap between courses (e.g., in the case of Chemical Thermodynamics, Material and Energy Balances, Engineering Thermodynamics,

Chemical Engineering Thermodynamics), fragmentation (e.g., elements of Product Design are delivered across different courses, some offered by Sector II and others by Sector IV), and overspecialization (individual courses in narrow topics). The above could result in missed opportunities to streamline the curriculum, and render it more efficient and effective.

- The 5-year Diploma engineer curriculum is considered by many (including the EEC members) to be of higher level than a Bachelor of Science degree, but courses with graduate-level content and rigor do not appear to be part of the current curriculum in the NTUA School of Chemical Engineering. This is not doing service to those students who may want to pursue such courses within their 5-year degree, and potentially takes away a competitive advantage that NTUA-educated Diploma chemical engineers might have in the European and world job markets.
- Diplomatiki is currently delegated to the 10th semester. Having Diplomatiki offered in both fall and spring semesters of the 5th academic year could allow for more rational distribution of faculty/staff workload, allow those students who would like to start Diplomatiki earlier (or possibly carry it out abroad) to do so, and could potentially bring the time-to-graduation closer to the intended 5 years.
- Diplomatiki is currently written in Greek. In the context of developing the skills of NTUA students and promoting their research results outside Greece, it is worth considering allowing English as a language of the Diplomatiki.
- The credit hours (ECTS) should be defined in a way to facilitate student mobility (e.g., in European institutions) and to allow international employers to understand better the effort the students expended.
- Soft skills should be delivered to the students in a more organized/coordinated manner.
- Selected computational platforms (Matlab, Aspen) should be utilized throughout curriculum.
- Student advisement/mentoring should be offered in an organized manner (e.g., advisement sessions) so as to engage as many students as possible.
- Evaluation of teaching by students should be taken into account when assigning instructors and/or considering updates/revisions of course content and curriculum.

Note that United States-based , ABET-accredited Bachelor of Science (BS) in Chemical Engineering programs offer the vast majority of their courses within two academic years. In the US, where BS students, often with less preparation during high-school in math and sciences than their Greek counterparts, have to take several general education courses, chemical engineering courses are taken in academic year 3 and 4. In Greece, where general education courses are non-existent in the engineering curriculum, the core chemical engineering could be covered, for example, in academic years 2 and 3, allowing plenty of opportunity for breadth and/or depth over academic years 4 and 5.

- Does the Department have the necessary resources and appropriately qualified and trained staff to implement the curriculum?

The School of Chemical Engineering has appropriately qualified and trained faculty and doctoral students to implement the aspects of the curriculum delivered by humans (with the doctoral students supporting the laboratory components of courses).

Plenty of classroom and laboratory space, and adequate computing resources are in place.

It appears that the School of Chemical Engineering has currently no resources to cover operating expenses of the laboratory Sectors of the various courses, limited ability to maintain/repair laboratory equipment that are required for current lab exercises, and little

control over the physical space (buildings, grounds) where curriculum implementation takes place.

IMPLEMENTATION - GRADUATE PROGRAMS (ΜΕΤΑΠΤΥΧΙΑΚΕΣ ΣΠΟΥΔΕΣ ΕΙΔΙΚΕΥΣΗΣ)

Rationality, functionality, effectiveness of the Curriculum

- How effectively is the Department's goal implemented by the curriculum?
- How does the curriculum compare with appropriate, universally accepted standards for the specific area of study?
- Is the structure of the curriculum rational and clearly articulated?
- Is the curriculum coherent and functional?

The post-graduate programs in Materials and in Computational Engineering are in areas of interest to research activities of the School of Chemical Engineering, but also to other schools within NTUA. The structure of the two curricula is rational and clearly articulated.

The contribution of the post-graduate programs to the implementation of the goals of the School of Chemical Engineering has not been addressed during the EEC visit.
An opportunity for students in the 5-year Diploma curriculum and for doctoral students to attend (and potentially receive credit for) select courses offered in the post-graduate programs should be explored.

The language of instruction is currently Greek. It is worth considering instituting English as the language of instruction in post-graduate programs to enable a seamless collaboration with European partners and the recruiting of post-graduate students from outside Greece.

- Is the material for each course appropriate and the time offered sufficient?

The information provided to the EEC lacked sufficient details to enable a thorough review of the content of the courses offered in the post-graduate programs in Materials Science and Engineering and in Computational Engineering.

- Does the Department have the necessary resources and appropriately qualified and trained staff to implement the curriculum?

The School of Chemical Engineering has appropriately qualified and trained faculty to contribute specific courses and topics for post-graduate thesis. The EEC was informed that there are currently no funds provided to support the operation of the post-graduate programs, and there is no current provision for seeking income from tuition.

IMPLEMENTATION - DOCTORAL PROGRAM (ΕΚΠΟΝΗΣΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ)

Rationality, functionality, effectiveness of the Curriculum

- How effectively is the Department's goal implemented by the curriculum?

- How does the curriculum compare with appropriate, universally accepted standards for the specific area of study?
- Is the structure of the curriculum rational and clearly articulated?
- Is the curriculum coherent and functional?
- Is the material for each course appropriate and the time offered sufficient?

The current curriculum appears to be rational, clearly articulated, and coherent. However, the current time-to-degree and the number of inactive doctoral students suggest that there are issues with respect to student supervision.

The progress of the doctoral students is assessed annually by their advisor and dissertation committee.

The current doctoral curriculum could be augmented by elements that facilitate the research and professional development of the doctoral candidates, e.g., external and internal research seminars, career guidance, ethics, and how to seek research funding.

- Does the Department have the necessary resources and appropriately qualified and trained staff to implement the curriculum?

The School has a significant number of research-active faculty members who serve as advisors to doctoral students.

It appears that the resources required to support the doctoral students reside within the laboratory of the specific faculty advisor. The School does not offer any financial support to doctoral students at the time they enrol.

RESULTS – 5-YEAR DIPLOMA CHEMICAL ENGINEER DEGREE PROGRAM

Maximizing success and dealing with potential inhibiting factors

- How well is the implementation achieving the Department's predefined goals and objectives?
- If not, why is it so? How is this problem dealt with?

The current curriculum implementation appears to be achieving most of the goals and objectives of the NTUA School of Chemical Engineering. However, there is a need for a strategic re-evaluation of the goals and objectives of the School of Chemical Engineering, and a corresponding realignment of resources. In this context, the curriculum should be revisited and revised accordingly.

- Does the Department understand why and how it achieved or failed to achieve these results?

The impression that emerged from the documents provided, presentations delivered and discussions held during the EEC visit is that individual faculty are passionate about their role as educators and dedicated to the teaching mission of the School of Chemical Engineering. They have identified certain shortcomings of the current curriculum and have good ideas on

how to address them. The crystallization of such good intent into a cohered plan (and its implementation) is encouraged.

RESULTS - GRADUATE PROGRAMS (ΜΕΤΑΠΤΥΧΙΑΚΕΣ ΣΠΟΥΔΕΣ ΕΙΔΙΚΕΥΣΗΣ)

Maximizing success and dealing with potential inhibiting factors

- How well is the implementation achieving the Department's predefined goals and objectives?
- If not, why is it so? How is this problem dealt with?

It has not become apparent during the EEC visit how the two inter-departmental programs of postgraduate study contribute to the predefined goals and objectives of the School of Chemical Engineering.

- Does the Department understand why and how it achieved or failed to achieve these results?

Faculty of the School of Chemical Engineering appear concerned about the future of the post-graduate programs if there are no additional resources dedicated to them.

RESULTS - DOCTORAL PROGRAM (ΕΚΠΟΝΗΣΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ)

Maximizing success and dealing with potential inhibiting factors

- How well is the implementation achieving the Department's predefined goals and objectives?
- If not, why is it so? How is this problem dealt with?
- Does the Department understand why and how it achieved or failed to achieve these results?

The School defines the broad parameters of the doctoral program, but the outcomes of a given doctoral dissertation are evaluated primarily by the advisor and committee.

IMPROVEMENT– 5-YEAR DIPLOMA CHEMICAL ENGINEER DEGREE PROGRAM

- Does the Department know how the Curriculum should be improved?
- Which improvements does the Department plan to introduce?

The School of Chemical Engineering has some broad ideas about a revised curriculum, according to the presentation given by Professor Koukios (Committee on Studies, Επιτροπή Σπουδών Σχολής ΧΜ). It appears that this discussion was initiated in 2011 on a sound basis, but it has not yet been concluded or led to specific actions. The issue of curriculum update and improvement has to be revisited soon, taking into account school-level strategic plans and input obtained from all stakeholders, in the light of the accreditation process that ADIP is tasked with overseeing. Specific timelines and outcomes should be identified.

IMPROVEMENT - GRADUATE PROGRAMS (ΜΕΤΑΠΤΥΧΙΑΚΕΣ ΣΠΟΥΔΕΣ ΕΙΔΙΚΕΥΣΗΣ)

- Does the Department know how the Curriculum should be improved?
- Which improvements does the Department plan to introduce?

There was no discussion during the EEC visit regarding curriculum improvement at the level of the two inter-departmental programs of postgraduate study.

IMPROVEMENT - DOCTORAL PROGRAM (ΕΚΠΟΝΗΣΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ)

- Does the Department know how the Curriculum should be improved?
- Which improvements does the Department plan to introduce?

There was little discussion during the EEC visit regarding curriculum improvement at the doctoral level program (the document *Γενικός Οδηγός Εκπόνησης Διδακτορικής Διατριβής* provided to the EEC was dated January 2004). The School recognizes the need to follow closer the professional development of its doctoral students.

B. Teaching

APPROACH:

Does the Department have a defined pedagogic policy with regard to teaching approach and methodology?

Please comment on :

- Teaching methods used
- Teaching staff/ student ratio
- Teacher/student collaboration
- Adequacy of means and resources
- Use of information technologies
- Examination system

The School has a comprehensive five-year curriculum that trains undergraduate students in Chemical Engineering. The academic year consists of two semesters. The coursework includes lectures, laboratory courses, and recitation sessions spanning nine semesters. The tenth semester is devoted solely to the completion of a Diploma Thesis based on a project supervised by a faculty member and evaluated by a faculty committee. A public defense of the Diploma Thesis is required.

The School has 68 faculty members (+5 under appointment) who teach Diploma candidates and 72 staff members who contribute significantly to teaching by preparing laboratory experiments, maintaining equipment and supervising laboratory instructional activities. In 2009-10 there were 1479 undergraduate and 597 graduate students enrolled in in the School (102 Masters candidates and 495 PhD candidates). The graduate students and some Diploma candidates also contribute to teaching undergraduates.

The School's teaching approach is based on traditional knowledge delivery techniques (lecture courses and recitations), small-group laboratory experiments, and interactive courses in a computer classroom. The teaching laboratories have ample space and are well equipped and staffed. The computer classroom is a dual purpose facility used for teaching or individual/ small group studies. It is equipped by 80 networked computers, projectors and printers. The School supports multiuser licenses for several modern simulation packages that are available to students and faculty for teaching and research. Most of the 40 core and 5 specialization courses include laboratory experiments and recitation sessions.

The four Sectors of the School receive very limited to non-existent financial support from the State to cover operational expenses (such as supplies and repair of instruments) of laboratory Sectors of courses.

A semester consists of 13 weeks of instruction and four weeks of final examinations. Graduation requirements include the completion of 55 semester-long courses from a total of 128 courses that are offered by the School. The 55 courses consist of:

- 40 required core courses in Chemical Engineering
- 5 specialization courses in a specific direction of study (the School offers 5 directions of specialization, each consisting of a 5 course curriculum)
- 9 elective courses, one per semester, out of about 60 such courses offered by the School.

- 1 foreign language course including technical terminology (English, French, German, or Italian).
- Five weeks of practical training in the 9th semester

Most core and specialization courses have laboratory and recitation Sectors in addition to the lectures.

The School's Curriculum Committee supervises and coordinates the course offerings.

The School does not have a policy regarding prerequisite courses.

IMPLEMENTATION

Please comment on:

- Quality of teaching procedures
- Quality and adequacy of teaching materials and resources.
- Quality of course material. Is it brought up to date?
- Linking of research with teaching
- Mobility of academic staff and students
- Evaluation by the students of (a) the teaching and (b) the course content and study material/resources

The teaching procedures that the Department implements are sufficient for covering the rather heavy curriculum. The few textbooks and teaching materials that were made available to the committee were up to date. Textbooks were either authored by Department faculty or were translations in Greek of popular foreign textbooks. There is significant linking of research with teaching due to the required Diploma Thesis and the mandatory participation. The faculty members can take sabbatical leaves and students participate in exchange programs (e.g., ERASMUS). The number of faculty members and students participating in exchange programs appears to be low. There are internal course evaluation procedures by the students.

RESULTS

Please comment on:

- Efficacy of teaching.
- Discrepancies in the success/failure percentage between courses and how they are justified.
- Differences between students in (a) the time to graduation, and (b) final degree grades.
- Whether the Department understands the reasons of such positive or negative results?

The committee felt that the curriculum contains some overlapping and repetitive material. There are several courses that can be streamlined and/or combined to reduce the overall number of courses. The committee became aware of significant discrepancies in the success/failure rates of students between the various courses taught in the School, but did not receive adequate justification for the reasons leading to such discrepancies. There is very limited or no rotation at all in the teaching staff and poorly taught courses could remain at that state for several years. No data regarding efficacy of teaching were provided to the EEC.

IMPROVEMENT

- Does the Department propose methods and ways for improvement?
- What initiatives does it take in this direction?

There were no comprehensive proposals or initiatives discussed by the faculty aiming at improving the curriculum and the teaching effectiveness of faculty members. A few sporadic efforts by individual faculty to integrate coursework between different Sectors and modernize the curriculum are commendable. The process of teaching evaluations by the students was not discussed and it is not clear to the Evaluation Committee how the feedback provided by such evaluations is being implemented to improve the teaching process.

RECOMMENDATIONS

(1) We recommend that the School's Curriculum Committee carefully reviews all core and specialization courses with the purpose of eliminating content overlap, reducing the total number of courses that the students need to take to graduate, and introducing rational course sequences, which are designed to build upon pre-requisite coursework.
(2) We recommend that the School modernizes its curriculum by horizontally integrating courses across its four Sectors and abandoning the current model of course offerings that appears to be based on a parochial "silo-like" structure.
(3) We recommend that the School develops and enforces: (a) pre-requisite course structures and (b) assessment of student learning.

C. Research

For each particular matter, please distinguish between under- and post-graduate level, if necessary.

APPROACH

- What is the Department's policy and main objective in research?

Research is performed at all three levels: undergraduate, MS, and PhD. In addition, a special class of salaried personnel (ΙΔΑΧ) supports research and teaching activities.

Research in the department appears to serve two objectives: (a) to promote generation of new knowledge and (b) to provide solutions to applied problems. In doing so, students are trained at all levels to perform independent and original research. The mandatory Diploma thesis has always been a plus for the Greek educational system. Typical numbers of Diploma theses completed were discussed in the presentation by Prof. D. Theodorou and an average quoted was ~70/year between 2005 and 2010. This number represents less than 50% of the number of entering students (~140-170) during the same years, which suggests a large accumulation (stagnation) of non-performing or inadequately supervised students. The EEC feels that this issue must be addressed by the faculty.

The total number of graduate students in the School was close to 500 between 2005 and 2012 (463 was the number for 2013), many of them participating in unpaid research, most of them being the School's own graduates. The committee finds this number of graduate students to be too high. The overall number of graduate students must be reduced by establishing a more rigorous selection process and minimizing the number of unsupported and underperforming graduate students.

Several faculty members (especially the younger members) appear highly motivated to compete for Greek and European grants. The grant moneys the School has received are significant. It was unclear whether all faculty members are actively seeking grants, but are not successful in the respective competitions. The School must develop mentoring procedures to help young faculty be competitive in research.

NTUA and, by proxy, the School provides the faculty with incentives and favorable conditions for the acquisition of external funding (low overhead rates, salary enhancement) as well as ample, quality space and access to incoming students who have some of the highest scores among Greek high school graduates. Most graduate students appear to be selected among Diploma holders of the School, which is a precursor to inbreeding. It appears that the Greek language is a barrier to attracting foreign students, though the recent permission to write and submit a PhD Dissertation in English should help, especially if combined with graduate-level courses taught in English. The faculty is encouraged to also seek and recruit qualified foreign students, who will bring a different mentality and approach to research that will leads to a healthier School.

- Has the Department set internal standards for assessing research?

The quality of research leading to all degrees is assessed internally by examination committees: (a) Diploma thesis (3-member committee), (b) MS thesis (3-member committee), and (c) PhD theses (7- member committee). According to the Faculty, safeguards are in place to ensure the independence of these committees, but concerns regarding favoritism were raised by graduate students who met with the EEC. The EEC was told that the vast majority of Diploma candidates are awarded the maximum possible grade

once they are permitted to defend. The committee finds this policy worrisome as it leads to grade inflation. The MS and PhD degree candidates appear to be held to a much higher standard.

The School expects and values dissemination of research knowledge through publications in peer-reviewed journals and presentations in Greek and international conferences. As shown in multiple presentations to the Committee, the metric of choice for evaluating research appears to emphasize quantity. The quality of the research published appears to be assessed by looking at the cumulative number of citations made to the published work. This metric is biased to older publications and it should be used in conjunction with the journal impact factor.

Common international standards for assessing published research are used (i.e., number of publications and citations; h-factor, though no reference was made on the impact factor of journals). Faculty presentations revealed that research productivity has been monitored for the periods 2005-10 and 2010-13. The former period included voluntary disclosure of research areas and publications with a relatively low 56.5% faculty participation. The latter period includes recent data from Scopus compiled by the Dean, and shows a total of about 179 papers per year published in peer-reviewed scientific journals with faculty co-authorship, averaging 2.6 papers per faculty member. Additionally, a total of 8 patents were awarded and the faculty had an average h-index of 16.1 between 2010 and 2013. These research metrics are deemed low by the EEC for the disclosed number of faculty (85 in 2010 and 68 members in 2013) and were not spread evenly among the faculty. We note that only ~30% of the faculty is responsible for most of the recently published research.

RESULTS

The collaborative research with Greek industry to solve applied problems is commendable and consistent with the role that NTUA must play in the Greek society.

The “Fee for Services” operation of some labs, while important for the Greek industry and for paying lab expendables for teaching or research, should not be done with graduate students. Other personnel must assist in this enterprise and be paid for this service consistently and accordingly.

There are very few patents resulting from the research work in the last decade. It is unclear what the barrier is for pursuing more patents.

- Is the Department’s research acknowledged and visible outside the Department? Rewards and awards.

The School’s research is recognized in the number of citations, on average ~800 per faculty. However, less than 30% of the faculty members have more than 1000 citations, with a notable leader who has 5400 citations. The average h-factor of 14 is deemed low. It is unfortunate that the School’s reputation for top-notch research appears to be diminishing, resulting in a drop of the School’s ranking among EE academic institutions from 10th place in 2011 to 90th place in 2013.

The ability to compete successfully for proposals from EE programs (such as FP7, LIFE, etc.) is a positive sign for future scientific recognition.

IMPROVEMENTS

The committee felt that there is no clear strategic planning for research within the School. Individual faculty seem to be aware of emerging research areas and it is up to them to pursue new research directions and decide how to integrate them with the curriculum. There should be internal encouragement and, perhaps, rewards associated with such pursuits.

The EEC recommends that rules be put in place to ensure and safeguard the independence of research evaluation committees, especially at the PhD level. In particular, there could be a requirement that at least one member must be from outside the department and/or from another institution.

The committee recommends that a policy is instituted to encourage the department's own graduates (Diploma holders) to seek a PhD experience elsewhere within Greece or abroad.

The EEC recommends mandatory evaluation of research output, productivity, and accomplishments for each member of the Faculty every year. This exercise should include an obligatory submission of an updated CV that includes publications and presentations. To the extent possible, the evaluation should be tied to some reward (monetary, space, first access to better students, etc.) for those excelling in research.

The School appears to be adversely affected from the structural problem of scientific in-breeding that may inhibit cross-fertilization of scientific directions and can lead to the establishment of non-competitive scientific practices. The School should make efforts to limit current inbreeding practices by actively seeking and appointing qualified PhD holders to faculty positions that are not members of its in-house PhD alumni pool.

Laboratory space intended for research and all related resources must be redistributed according to current research needs.

The current organization of the School in Sectors/Laboratories naturally promotes collaborations/co-authorship of papers within a Sector. It is worth encouraging and pursuing collaborations across Sectors, because current research funding opportunities reward such interactions. Sharing of instruments, materials and supplies across laboratories should be implemented whenever possible to improve efficiency. A chemical inventory should be developed and updated according to international standards. Protocols for chemical/biological waste disposal practices must follow international standards.

D. All Other Services

For each particular matter, please distinguish between under- and post-graduate level, if necessary.

APPROACH

- How does the Department view the various services provided to the members of the academic community (teaching staff, students).
- Does the Department have a policy to simplify administrative procedures? Are most procedures processed electronically?
- Does the Department have a policy to increase student presence on Campus?

University (NTUA) services to students

The School has a genuine interest in the high-quality education and welfare of their students, and the affordability of their education, as exemplified by the efforts made by the School to ensure that the students graduate as soon as possible. Indeed the School stated that the mean time to graduation is less than 6 years.

University (NTUA) services to the School

It was never discussed and documented whether NTUA, as an Institution, is actively engaged in providing services that would enhance the School's function and effectiveness. There is a need for supporting the efforts of faculty in education and research, as well us updating and protecting the facilities of the School.

Services within the School

a. Computers, labs and instruments. The School has set as a high priority to provide good computational and research infrastructure services for students, staff and faculty. The PC lab and the available general and specialized software (Matlab, Aspen) are exceptional and on par with top departments internationally. The extent, variety and quality of instrumentation in both the teaching and research labs appears to be exceptional, although some members of the DEP and the teaching staff expressed the opinion that some instruments are aging and need replacement, and also that the maintenance and repair is sometimes problematic. A strategy should be developed to remedy the situation. Another issue, expressed mostly by younger DEP members and doctoral students, is that there is lack of information as to what instrument is available in which lab within or outside the School. Such information would facilitate progress in research projects and save money. Similarly, young DEP members with limited internal or external funding would like to have access to specialized instrumentation at discounted user fees. Overall, however, it appears that very few academic department of chemical engineering at the international level have laboratory spaces and instrumentation that could surpass the facilities of this School.

The School and NTUA must implement policies that protect its buildings and facilities from vandalism by extremist student groups and external "activists".

b. Administrative procedures and use of web-based electronic processes. Several DEP members expressed the opinion, that there is excessive bureaucracy in purchasing supplies, instruments, in processing external awards and contracts, and overall in facilitating the function of the School's DEP members and staff in carrying out their mission. They in fact suggested that the bureaucracy has become worse during the recent economic crisis. They gave examples that the forms and signatures needed for the purchase of simple supply items is frequently more than 5 or 6. These procedures must be reviewed and streamlined. We could not assess the extent of use of electronic processes by the students for registration procedures or for completing the School's requirements. The use of web-based tools in

courses appears to be increasing, but may not be yet at a level and effectiveness it ought to be.

c. Efforts by the School to increase the presence of students on campus.
The School is seriously concerned about increasing the presence of its undergraduate students on campus and about seeing an increased attendance of lectures. The School offers a large number of laboratory courses which are obligatory, and thus, the presence of the students on campus is to a good extent assured. DEP members also felt that seminar-type of courses are better attended by the students. Means to increase student attendance are suggested below.

IMPLEMENTATION

- Organization and infrastructure of the Department's administration (e.g. secretariat of the Department).

It is not clear what exactly the role and current state of the School's administrative staff (general or specialized) is and the extent to which they engage electronic/internet tools to simplify the administrative processes. Overall, the academic and administrative organization of the School in 4 Sectors, has both positive and negative consequences. Positive in the sense that smaller, more coherent units can be better managed and can exercise oversight of their goals and resources. Negative in the sense that it creates segregation of responsibilities and resources (teaching, administrative, research resources, etc.), as well as of outcome assessment (grades, expectations from and quality of Diploma and PhD theses, publication quality, etc.).

- Form and function of academic services and infrastructure for students (e.g. library, PCs and free internet access, student counseling, athletic- cultural activity etc.).

a. Textbooks. Good quality of textbooks. Notable are the textbooks used by Sector I (Chemistry), and especially those for analytical and inorganic chemistry. Exceptional research and education/training facilities. The PC labs and available software appear to be of first rate, as already discussed.

b. Student counseling: While formally established, student counseling is not as effective as it ought to be. It is recommended that a more pro-active counseling process is used by DEP members in order to engage the undergraduate students as early as possible (as early as the first semester) to make sure the students understand the scope of their education, the role of chemical engineers in modern society, the importance of the class attendance, and of the need to support and promote the establishment and maintenance of a clean and pleasing teaching and research environment. The goal will be to make sure the students take pride and ownership of their education, and pride in maintaining a creative and inspiring physical and intellectual environment at the School and beyond. Also, to appreciate that the limited financial resources must be used in the most effective possible way to ensure first-rate education and research activities that benefit both individual students and their families, as well as the Greek people.

c. Athletic facilities. This was not assessed, but one assumes this is a generic issue for the whole NTUA.

RESULTS

- Are administrative and other services adequate and functional?

Regarding the strictly administrative services (i.e. non-technical), the situation is not clear due to the "διαθεσιμότητα" initiative of the Ministry of Education, and the resulting strikes. The School appears distressed about the current situation although they recognize that part

of the problem is the large number of ΙΔΑΧ members who are formally counted as "administrative" ("διοικητικοί"). Several DEP members complained about of the inadequate support of technical staff for the teaching and research labs. While perhaps legitimate in some sense, given the large number of DEP and other technical staff (ΙΔΑΧ, etc.), the argument for additional technical support staff cannot be rationally made. This calls for assessment and duty re-allocation of the large number of teaching and research DEP and other staff members in the School. By well-established international standards, this School has a very large number of DEP and related teaching and research staff. An optimization of duties and responsibilities should be made to solve these problems.

- How does the Department view the particular results.

It was stated by several DEP members that the complexity of the situation and the classification of a large number of technical/scientific staff members as "administrative" has led to a situation that the School is effectively left with sub-minimal true administrative support. On the other hand, those classified as "administrative personnel" but actually being technical/scientific staff are protected from "διαθεσιμότητα". These individuals, were originally hired with external research funds, but are now being paid by the Greek Government. Many of these individuals are associated with specific labs and Sectors, and although they contribute to the overall teaching and research mission of the School, they appear to be unevenly distributed across the School. We recommend that the School reviews these individuals for their role and function. They should be promoted to the ranks of the formal DEP members only after a comprehensive evaluation that includes input from unbiased external referees. If they are promoted to the ranks of the formal DEP members without a specific plan and evaluation, then the total number of individuals involved in the teaching and research mission of the School will reach enormous proportions by national and international standards. The other two Chemical Engineering Departments in the country operate with a considerably smaller number of DEP and associated members for the number of students they handle.

IMPROVEMENTS

- Has the Department identified ways and methods to improve the services provided?

A good number of the School's faculty and other members and graduate students, recognize most of the problems discussed above and have suggested some actions that would resolve these problems along the lines discussed above. The NTUA administration must implement practices that enable the normal operation of the School without disruptions caused by small groups of activists. Several "structural" deficiencies were identified. The design of the School's building, with its large number of entries, makes it very challenging to guard the access to lecture halls and laboratories and prevent acts of vandalism.

- Initiatives undertaken in this direction.

Several DEP members suggested that effective security practices should be developed and engaged to solve the security and facility-protection issues.

Collaboration with social, cultural and production organizations

Please, comment on quality, originality and significance of the Department's initiatives.

Student/faculty visits to industrial facilities to see actual production facilities and relate them to instructional material are very positive and should be continued.

Some Sectors indicated that some faculty serve in government positions. These activities, however, were not documented in the IER. It is not clear if they are monitored on a regular basis. Such documentation is essential for periodic (preferrably annual) review of each DEP member as well as for prevention of conflicts of interest.

Recently, good outreach activities, notably visits from High Schools mostly of Athens area but not only have been organized. Such activities are very positive and should be continued.

Some members of the School are active in the organization of national and international conferences that attract quality researchers.

Several laboratories (especially from Sectors I & II) provide services beyond the School through chemical, environmental and food analysis whether to Government agencies, municipalities or private industrial entities. Such activities support of the infrastructure of the School and the training of students in modern techniques, such as ISO training, and the associated applications. Such services are provided to organizations and municipalities in Greece, as well as to European entities. In addition, for some labs, the income from such services supports a large number of PhD students, as well as Staff that is being hired due to the demand for these services. The process (ELKE) of providing and being paid for such services is well thought out and sets an excellent framework for such activities especially for the current times of tight budgets and limited availability of funds. Other notable and high impact activities include services to the Greek Government to support its obligations to international organizations.

Several Sectors and laboratories have extensive collaborations with industrial companies in Greece and some outside Greece. Such collaborations are indeed quite impressive and far exceed the average number of related activities in major Departments of Chemical Engineering in Europe and the USA.

There exist also some interactions and collaborations with non-Greek institutions through student exchange programs (ERASMUS) and faculty-driven research projects.

The Sectors operate a good number of seminars, some more systematically than others. A notable one for its extent and breadth is the series organized by Dr. Kokosis of Sector II. This seminar series is supported by the industrial sector. This is an exceptional initiative and should be supported and expanded. The School is encouraged to organize a systematic series of seminars to bring all faculty and students (both undergraduate and graduate) together, in an integrative way that captures future directions of the discipline.

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

For each particular matter, please distinguish between under- and post-graduate level, if necessary.

Please, comment on the Department's:

- Potential inhibiting factors at State, Institutional and Departmental level, and proposals on ways to overcome them.
- Short-, medium- and long-term goals.
- Plan and actions for improvement by the Department/Academic Unit

- Long-term actions proposed by the Department.

Present situation

The School has performed a SWOT analysis which they have seriously considered in formulating *Plans for Improvement*. The plans are well thought out and they involve short term, mid-term, and long term planning in order to address the inhibiting factors and to improve and capitalize on current strenths and promising opportunities.

The School has worked on the development of a strategy for academic development. The main components of this strategy include:

1. The introduction and development of new subject areas such as biochemical sciences, product design, nanotechnologies, innovation, environment and sustainable energy.

2. Support and recognition of research excellence.

3. Promotion and recognition of teaching quality and educational services.

4. Emphasis on extroversion and preparation of students for the competitive international market.

5. Development of strong rapport and collaborations with the Greek academic diaspora.

6. Exploration and emphasis of the collaborations with other Schools within EMP and with the Chemical Engineering Departments in Thessaloniki and Patras.

7. Successful competition for research grants .

8. Support and modernization of postgraduate program.

9. Strengthening of the collaborations with local industrial companies and the Greek power company, which helps create strong and active links between the education system and the labor market.

Recommendations

While these are commentable strategic plans, they are common and straight forward. The School has a large number of creative and imaginative members at all levels that could work together to formulate a more imaginative, creative and aggresive stratetic plan. While it is clear that the School operates under important financial and regulatory constraints, there is plenty of room for creative solutions under these constraints.

Strong Points

The School has identified several strong strategic areas that will likely lead to improvements in educational and research opportunities.

The ability of the School to attract the best students through the very competitive national examination system.

Inhibiting Factors

Present Situation

The current inhibiting factors in formulating and implementing an effective strategic plan are as follows:

1. The number of undergraduate courses is very large; the School has identified ways of reducing the current course load by 20% without affecting the overall content. The large undergraduate course load may be a result of professional certification requirements.

2. There is an accumulation of students in several core courses, which increases workload, and impacts negatively teaching effectiveness.

3. The high frequency and long duration of examination periods is turning the School from an educational center into an examination center. This also cultivates an unhealthy student mentality.

4. Stagnant PhD students and student activism remain two of the biggest inhibitng factors of the School, which are difficult to address due to the large political cost and the unwillingness of the central NTUA admistration to effectively address such problems.

5. The lack of course prerequisites in the undergraduate curriculum threatens the quality of the educational output and increases the accumulation of students who fail to pass higher-level courses.

6. The upcoming large numbers of retiring faculty may reduce the teaching resources of the School.

7. The graduate program is dysfunctional and its continuing operation is threatened by the current financial crisis.

F. Final Conclusions and recommendations of the EEC

For each particular matter, please distinguish between under- and post-graduate level, if necessary.

Conclusions and recommendations of the EEC on:

- the development of the Department to this date and its present situation, including explicit comments on good practices and weaknesses identified through the External Evaluation process and recommendations for improvement
- the Department's readiness and capability to change/improve
- the Department's quality assurance.

Recommendations

• Proposals for action by the School's Administration

In addressing many of the problems it faces, the School must solicit the help from its Alumni who are successful in academia and industry, especially the ones located abroad who have experience from healthy academic and entrepreneurial environments. This could be done though the formation of volunteer task force groups, who could operate independently and provide their recommendation to the Dean, the University administration, and the Ministry of Education. The use of modern means of telecommunication and teleconferencing can help engage people from various geographic locations.

The School must revamp the curriculum and address the overlap of the courses and repetitive content in some courses. This could be achieved through the formation of a task force with participation of members from the young faculty as well as senior undergraduate and graduate students who have recently taken these courses. They could also recruit the help of graduates who are currently faculty members in universities in foreign countries and have experience from modern curricula.

It appears that a dialog among the three Chemical Engineering Programs in Greece has started and the School's administration should maintain and promote these interactions.

The competitiveness of the graduate students in the national and international market will benefit from the use of English in courses and in the preparation of the Diploma/Master thesis. While this might require legal action, the School should permit and accept the use of English in thesis writing immediately. The undergraduate students have agreed that more use of English is highly desirable and they would welcome the permission to write their thesis in English. Many countries, including Turkey and France that have strong national language identity, have accepted the use of English in related academic affairs, giving their graduates a significant advantage over Greek students in the international academic and industrial arena.

The scientific quality and output of a large number of the faculty members and scientific staff is low, especially with respect to the name recognition that the School enjoys around the world. The School should implement incentives and reward mechanisms that will promote productivity and quality. A measure of the success of these plans would be a more uniform distribution in the metrics of academic performance.

The School should seek and heed the advice of successful alumni from the academic and industrial sector abroad. An Advisory Board should be appointed, consisting of prominent academics and industrial researchers, to provide feedback on the School's strategic plan.

The scientific inbreeding in the School appears to be a major inhibiting factor. The School should take measures to proactively stop growth based on inbreeding. There are many high quality candidates from other departments in the country and abroad that could and should be recruited. The current effort for more interactions between Chemical Engineering programs in the country could be used to promote the cross fertilization in hiring of graduate students and young faculty. Many successful departments in the USA and in Europe have explicitly included the avoidance of inbreeding in their mission statements. A long stay in other institutions in the country or abroad is the only career path that can lead to hiring in the alma mater institution.

The School should promote a culture and environment for the independent academic growth of the young faculty.

The existence of the Sector system is historical and does not serve well the needs of students and young faculty. The School should develop and implement a plan that enables efficient horizontal integration of the four Sectors.

The large graduate program must be drastically revamped and revitalized. The School should appoint an Advisory Board that can guide these efforts. The inclusion of members from European institutions in the Advisory Board will be essential to help the graduate program and its graduates become competitive in the European Community, where graduate students are competing for fellowships, participate in European summer and winter schools, and ultimately become employed.

The appointments of new members of the Staff should be done based on a School-wide strategic plan. If these members simply diffuse into the existing laboratories, the current inbreeding will proliferate and perpetuate a situation that lies at the center of some of the problems that the School faces.

There is inefficient allocation of space within the School. The School should evaluate how the space is used within each sub-group relative to its scientific output and relative to its use for externally funded research. Such space allocation should take into account the current and future needs of young faculty.

While the School is working to formulate a plan for improving its educational and research outcomes, the effectiveness of any such plans will depend on the quality of management at the School and institutional levels.

The success of the School plans will also depend on the introduction of the English language in many upper classs undergraduate courses and in the Diploma thesis. The successful implementation of this plan will require the support of the Institution (NTUA).

The School should use its upcoming 100-year anniversary (1917-2017) as an opportunity to showcase its contributions to the Greek society and the world. A Committee consisting of faculty and prominent alumni should be formed immediately to organize events that engage both the students and the society at large and elevate the national and international image of the School.

Proposals for action by the Greek State

The implementation of School's strategic plan is subject to important constraints imposed by Greek State laws and regulations. The Greek State must review these laws and regulations and make the necessary changes. The committee deems imperative and recommends that the State:

1. Limits the number of students admitted yearly to the School. The recommendations of the School regarding student enrollment levels should be taken seriously.

2. Supports the School's educational and research missions by providing funding for maintenance and improvements of the School's instructional and research facilities, and for research initiatives.

3. Develops effective procedures that will ensure the availability of high-quality instructional and research facilities to faculty, staff and students in perpetuity.

The Members of the Committee

Name and Surname Signature

1. _____
2. _____
3. _____
4. _____
5. _____