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HELLENIC REPUBLIC  
**H . Q . A . A .**  
HELLENIC QUALITY ASSURANCE AGENCY  
FOR HIGHER EDUCATION

## **EXTERNAL EVALUATION REPORT**

DEPARTMENT OF CHEMICAL ENGINEERING

ARISTOTLE UNIVERSITY OF THESSALONIKI

November 2013

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### **External Evaluation Committee**

The Committee responsible for the External Evaluation of the Chemical Engineering Department of the Aristotle University of Thessaloniki consisted of the following five (5) expert evaluators drawn from the Registry constituted by the HQAA in accordance with Law 3374/2005 :

1. Professor Manos Mavrikakis (Coordinator)  
(Title) (Name and Surname)  
University of Wisconsin-Madison, USA  
(Institution of origin)
  
2. Professor Spiros Agathos  
(Title) (Name and Surname)  
Catholic University of Louvain, Belgium  
(Institution of origin)
  
3. Professor Christos Georgakis  
(Title) (Name and Surname)  
Tufts University, USA  
(Institution of origin)
  
4. Professor Themis Matsoukas  
(Title) (Name and Surname)  
Pennsylvania State University, USA  
(Institution of origin)
  
5. Professor Kyriakos Papadopoulos  
(Title) (Name and Surname)  
Tulane University, USA  
(Institution of origin)

## **Introduction**

### I. The External Evaluation Procedure

The committee was on site at the Aristotle University of Thessaloniki (AUTH) November 25-27, 2013.

On Nov. 25<sup>th</sup>, the External Evaluation Committee (EEC) met with the Vice-Rector of AUTH and Chair of the University's Unit of Quality Control (MODIP), Prof. D. Lialiou, the Chair of the Department of Chemical Engineering (ChE), Prof. M. Liakopoulou-Kyriakidou, the Chair of the departmental Internal Evaluation Committee (IEC), Professor A. Salifoglou, as well as other members of the Committee, heads of the Department's divisions, the head of the Vice-Rectorate secretariat, Ms. A. Tzaneraki and the head of the Department secretariat, Ms. C. Besta. After a general presentation of the University by the Vice-Rector, there were presentations of the Department's structure and missions by the Department Chair and of the internal evaluation process by Prof. A. Salifoglou.

On Nov. 26<sup>th</sup>, the committee attended presentations by Prof. M. Assael on the undergraduate program, by Profs. R. Tzimou and V. Zaspalis on the interdepartmental postgraduate programs, by Ms. E. Tsatse, a third-year undergraduate student, on exchange schemes for the mobility of students and faculty members. Further presentations to the EEC were made by Prof. M. Stoukides on research activities of the Department and on its doctoral research program, and by Prof. A. Lemonidou on the research projects. The committee also met separately and had discussions with groups of (a) undergraduate students, (b) M.Sc.-level postgraduate students, (c) Ph.D.-level postgraduate students (doctoral candidates), (d) postdoctoral researchers, (e) technical and support staff members, and (f) administrative staff members. These meetings were followed by similar separate interviews with groups of (a) lecturers, (b) assistant professors, (c) associate professors and (d) full professors of the Department. The committee was gratified that a large majority of departmental faculty members and staff were there for the presentations, and participated in the group discussions.

On Nov. 27<sup>th</sup>, the committee attended presentations by Prof. M. Mitrakas on the ChE Department's outreach activities and collaborations with various stakeholders and by Prof. S. Paras on the undergraduate program's internship requirement. Next, the EEC visited a number of teaching and research laboratories, areas housing major new instrumentation, the departmental library and meeting / teleconference room, computing center and clusters. At the end of the visit, the committee met again with Vice-Rector D. Lialiou at the University Rectorate, and ~~upon its return to the Department~~, it had an interview with the President of the Center for Research and Technology-Hellas (CERTH), Professor A. Konstantopoulos, also a member of the Department's faculty. The committee's last interaction with the Department was a debriefing final session with the Department Chair in the presence of division heads and other faculty members.

Prior to and during its visit, the committee was provided with copies of the IEC reports, the departmental Study Guide (Οδηγός Σπουδών), lists of courses, copies of all presentations, as well as data on grants, instrumentation, research and other expenditures. Short CVs of faculty members and data on their publication output during the period under evaluation (2009-2013), and the algorithm used for funds allocation from the AUTH to the Department were also provided.

On Nov. 28<sup>th</sup> the EEC met at the Divani Acropolis Hotel, to discuss and start the preparation of the report. Tasks were assigned to individual committee members. The committee was briefly visited by Professor Constantinos Memos, ADIP Council member.

On Nov. 29<sup>th</sup> the EEC met again at the Divani Acropolis Hotel to integrate the thoughts of the individual members into the preliminary report. After departure from Athens, a preliminary report was drafted by the Committee Chair, and reviewed by the EEC members so as to reach the final report.

## II. The Internal Evaluation Procedure

The IEC report of 2009-13 (dated November 2013) as well as the Yearly Update Reports (Απογραφικές Εκθέσεις) of 2009-10, 2010-11, 2011-12 and 2012-13 were based on extensive data provided by the departmental faculty and staff, and external bibliographic databases such as ISI's Web of Science and Scopus. Extensive up-to-date documentation was provided on undergraduate and postgraduate curricula, teaching and research activities for each departmental faculty member (including course evaluations), administrative services, facilities, and plans for improvement. All powerpoint presentations were made available to the EEC. An additional report (dated 2008), specifically addressing the Department's thoughts on its future strategic development, was also given to the committee.

The IEC report and accompanying material was thorough, up-to-date and clearly demonstrated a strong commitment by the Department to the evaluation processes. The availability of both quantitative metrics and qualitative conclusions based on strengths, weaknesses, opportunities and threats (SWOT) pointed to the same direction. Based on the above it is clear that the objectives of the internal evaluation process were fully met.

## ***A. Curriculum***

### **A1. APPROACH**

#### **UNDERGRADUATE PROGRAM**

The goals and objectives of the Curriculum are to prepare students to become Chemical Engineers. The Department defines a Chemical Engineer as one who can apply the principles of physics, chemistry, mathematics, engineering science and economics to processes that involve physical and chemical transformations, energy and material flows, including design and optimization with respect to technical, economic and social criteria. The educational program aims to prepare graduates for employment in a number of areas such as: research; development, design and optimization of processes; construction of plants; overseeing and managing plant operation; providing technical support; and technical sales.

The curriculum is designed as a 5-year program based on courses that are generally accepted in other Greek, European and North American programs. The courses include classroom-based instruction and laboratory work. Students have the opportunity to spend two months working in industry. The program culminates in the capstone design course and a Diploma thesis that is completed in the 5<sup>th</sup> year.

The curriculum is based on 56 courses of which 46 are required of all students and 10 are electives. The required courses cover the established core of chemical engineering and include material and energy balances, thermodynamics, transport phenomena, reactor design, and capstone design. The curriculum includes several laboratory courses (7 required) that cover inorganic and organic chemistry, physical chemistry, analytical chemistry, and unit operations. The elective courses cover a broad spectrum of areas that include selected advanced topics in chemical engineering and specialized topics in three focus areas, energy, food science, and materials.

The faculty members regularly monitor the curriculum through a standing committee and faculty meetings. Most recently, the curriculum was revised and the new one will be implemented in 2014/15.

#### MULTIDISCIPLINARY POSTGRADUATE PROGRAMS

The ChE Department does not offer its own postgraduate program, but participates in two interdepartmental multidisciplinary postgraduate programs: Art Conservation, and Advanced Materials. The ChE Department contributes faculty members who advise degree candidates in these areas.

#### DOCTORAL (PhD) PROGRAM

Currently, the Department does not offer any courses for the PhD program. However, because EU regulations need to be met, the Department is currently working towards establishing such a curriculum.

### **A2. IMPLEMENTATION**

#### UNDERGRADUATE PROGRAM

The curriculum is structured in a logical order. The first two years are mostly devoted to Mathematics and basic sciences, years 3 and 4 cover mostly chemical engineering topics, and year 5 is devoted to elective topics, capstone design, and to the completion of the thesis. As a 5-year program, the curriculum has ample room to cover a large number of technical topics, both core material as well as electives. The faculty members are well qualified to teach the courses of the program. The number of faculty members is sufficient to carry out the educational mission, which consists of approximately 55 courses each year. The student-to-faculty ratio is about 19 and is considered adequate.

The focus areas and advanced topics that are offered as electives cover a broad section of technologies that are likely to be critical in the next 10 years.

The ChE Department publishes a student guide with the recommended course schedule for students in each year. However, there is no formal structure of prerequisites that would prevent unprepared students from taking upper-level courses, or bypass a course that is perceived as “difficult” until later semesters, even if the course happens to cover important material for other courses. This practice is contrary to all international norms. It is an anachronistic peculiarity, not only of this department, but of the Greek higher-education system as a whole and it must be addressed, in view of being eventually abolished.

The ChE Department has begun the implementation of student advising, which is a positive development, and the faculty members who are assigned advising duties are dedicated. However, not all faculty members are assigned to advise students. The EEC is concerned that this uneven distribution of service duties between faculty members who advise students and those who do not, does not reflect well on the entire Department and should be corrected.

An established formal program for industrial internships provides an excellent opportunity for students to receive experience in engineering practice. Approximately 60% of the graduating class participate, a success rate that is considered high, given the financial constraints that prevent students from accepting positions far from home. The EEC also notes the involvement of the ChE Department with mobility schemes such as IASTE, BEST, and ESN, which open up international opportunities for the students of the program. The EEC was truly impressed by the intensity and enthusiasm of the students who volunteer their effort and leadership skills to run the local chapters for these programs.

### **A3. RECOMMENDATIONS**

#### **UNDERGRADUATE PROGRAM**

1. The ChE Department should establish a series of prerequisites to ensure that students who take upper level courses have the background to be successful.
2. The ChE program offers several electives but all of them are taught in Chemical Engineering. The EEC recommends that students be allowed to take electives outside chemical engineering, both in engineering as well as in related science fields. This will increase the choices for students, decrease the teaching loads for the members of the ChE faculty, and, most importantly, it will expose students to the interdisciplinary nature of all modern technological problems.
3. The ChE Department should continue to review the program and adjust the curriculum to modern needs. The recent curriculum revision (to take place in Fall 2014) resulted in a reorganization of the basic science courses but has left the core unchanged. There are several changes going on in chemical engineering education, most notably at the interface between chemical engineering and life sciences that must become more prominent in the curriculum. Safety in chemical processes is another topic of growing importance. The EEC was pleased to see that safety topics already exist in an elective course and recommends that it becomes a required one. There is a large number of topics that are offered in two-course sequences (e.g., reactor design, control, computers), whose restructuring can provide room for more modern topics.

**DOCTORAL PROGRAM**

The Department is encouraged to move aggressively towards meeting EU requirements for coursework and other credit-offering activities at the PhD level.

**B. Teaching****B1. APPROACH**

The educational mission of the Chemical Engineering Department of the ATh (Aristotle University of Thessaloniki) is to produce chemical engineers at the levels of Πτυχίον (Diploma), (interdisciplinary) Masters, and PhD. Whereas the program's structure and content are similar to those of typical chemical engineering departments in North America and Europe, they nevertheless have a distinct character that also reflects the history of the Department and the needs of Greek industry and R&D that employs chemical engineering graduates. A continuously changing Greek and global environment with regard to the industrial and societal needs for chemical engineers should continuously guide the Department's evolving educational mission.

Currently, the ChE Department prepares the students for industries varying from petroleum, petrochemical and chemical industries, all the way to materials and the food industries. While there is a long list of elective courses offered by the ChE faculty, currently students are not allowed to take electives outside the Department, which can limit their pursuit of important directions such as pharmaceuticals. If this policy is changed, it will also strengthen the existing departmental directions, e.g., ChE students concentrating in Food Engineering would become much more competitive if they took courses and participated in activities in the Division of Food Science & Technology of the School of Agriculture. Here it should be noted that the areas of Pharmaceutical or Food Science and Engineering are just two examples and that there are benefits to be gained by allowing and encouraging the students to pursue electives in several other departments that offer courses complementary to chemical engineering.

**B2. IMPLEMENTATION**

To understand in more depth the quality of education offered to the ChE students, during its visit, the EEC met for half-hour periods, separately with undergraduate and graduate students, and heard their assessments and suggestions regarding the Department and the University. Additionally, one committee member met two more times with undergraduate students, and held further discussions with them. The EEC saw syllabi, quizzes and final exams of several undergraduate courses, and checked representative top, average and poor performances of students. Furthermore, the EEC conducted surprise visits to four class lectures and two required laboratory classes.

The undergraduate program is designed for five years, though the average time for graduation is around seven. This is clearly due to the unique characteristic of Greek Universities that allows students to postpone or repeat the taking of final exams, and all of this without penalty. The EEC feels that this is most detrimental to the educational process, a true waste of the most precious time of the young minds, as well as a waste of the talent and effort of the faculty. In congruence to normal practice in mainstream higher institutions in North America and Europe, there should be a limit of how many times a student can postpone or fail a course before he or she is placed on probation, leading to expulsion from the program.

The laboratory instruction offered to the ChE students of the AUTH is exceptional. The EEC was impressed by the laboratory facilities, the maintenance of the equipment, and the dedication of the faculty who teach labs. Specifically, in its visits and examination of in-progress Chemistry laboratories, the EEC also discerned a spontaneously expressed enthusiasm by the freshmen and sophomores. The educational experience the AUTH students have in these courses could be considered excellent by any international standard. As an example among several indices of excellence, we may mention that in the last five years, almost no first-year student has missed any of the scheduled lab sessions in any given year.

A point of concern may be found in lecture-based courses, especially those of the first three years. Some such courses are offered by more-than-one professors, e.g., one faculty member teaching the “theory” part of the course, and a different professor teaching problems and applications of the “theory.” Such practices, when not coordinated well, may be detrimental to the educational process, and for that, the Department should spare no effort in ensuring the excellent coordination between the two instructors involved.

Generally, lab and lecture-based courses use state-of-the-art computers and computer programs, and ChE students have adequate access to licenced computer programs that are necessary for such courses. However, the EEC detected one exception and retrenchment in this area, which is compounded by the fact that it affects the first-year students, which may be discouraging to the students at the very beginning of their undergraduate experience. The specific example relates to the freshman course “Technical Drawing” (Τεχνικό Σχεδίο). Until 2012, this was a computer-based course that used the program “Solid Works,” and was receiving raving reviews by the ChE students who are now upperclassmen. In 2013, the ChE Department due to lack of human resources, was forced to retain this course in the curriculum even as a non-computerized “hand-drawing” design course. Based on the feedback from upperclassmen, and on our own assessment of this change, we recommend that the previous version of this course be reinstated. If, for lack of human resources or infrastructure, this is not possible, our suggestion is to eliminate this course altogether.

Since a five-year ChE program should impart knowledge that is included in Masters courses of North American and European universities, ChE core-courses should be restructured so as to include postgraduate material. This may not be happening in all core-course sequences like Transport Phenomena, Thermodynamics, and Reactor Design. Our recommendation is that the faculty re-examine the material taught, as reflected by the exams given throughout the semester, to ensure that key postgraduate-level material is indeed taught and examined, otherwise the program may not claim that its undergraduate students are taught postgraduate core-ChE material.

The students interviewed by the EEC expressed the wish to have, at an early stage of their undergraduate experience, more exposure to industry, for example via field trips to industry or by inviting practicing chemical engineers to visit the Department and talk to the students about the “real world” chemical engineering practice. While students of peer institutions of North America and Europe may be similarly exposed to limited opportunities in this area, the ChE Department at the AUTH should use local resources and connections to increase early exposure of its undergraduates to industry.

A formal presentation was given to the committee by a third-year student, who apprised the EEC of opportunities and participation that AUTH chemical engineering students have in studies and internships outside Greece. It is clear that ChE students can and are encouraged to compete for a variety of such opportunities, like IAESTE, BEST, ERASMUS etc. One side observation the EEC made through this presentation is that

within the student body of the ChE Department there is a fledgling student leadership, which organizes structured activities for the professional advancement of the students. This is very encouraging, other departments and schools should follow its example and promote professional activities by students.

Regarding the quality of education the ChE Department can provide to its students, a serious concern for the committee is the excessive number of students admitted and allowed to enrol yearly. It can easily be argued that the numbers of students who have been enrolling in years past were significantly higher than the needs of the Greek industry that employs chemical engineers. It is troubling and puzzling that this number, which was already illogically high, has recently been increased by the Ministry of Education. With non-proportionally increasing resources, this can only be detrimental to the education the ChE faculty can offer to its students. In view of the fact that chemical engineers must learn to make logical decisions when they design processes and plants, if the country's educational leadership makes the decision to train numbers of engineers several times higher than those the country's industry needs, this by itself may be educationally a very bad lesson of decision making.

The postgraduate education offered by the ChE Department leads to interdisciplinary Masters and to Doctoral degrees. On average, the quality of the produced degrees can be considered good. There are a few cases of excellence, as reflected by the success of holders of AUTH ChE Doctorates in obtaining grants and being offered research and teaching positions by universities and research institutes in Europe and elsewhere. Such cases should be used as models, and should constitute a key graduate-education mission of the Department. To this effect, the postgraduate program should also be updated along the lines of doctoral programs in globally leading institutions, including the European standards set by the Bologna Convention.

### **B3. RESULTS**

Overall, the education offered to undergraduates in the Department of Chemical Engineering at the AUTH is considered to be comparable to that offered by other well-qualified international ChE programs. There are, however, several areas which can benefit from improvements in order to pursue ChE-education excellence, and these have been explained in Section B2 and summarized in Section B4.

The total number of undergraduate students is 890 and the number of faculty members 35. Thus the nominal ratio of students to faculty members is 25.4. Since the number of the teaching staff is 46 the ratio of students to teaching staff is 19.35.

There are 2 computer laboratories (each with 30 PC's), which are also used as study areas for students and for internet literature search. There are 6 classrooms with capacity of 162, 156, 82, 126, 90 and 48 persons each.

All the students are linked to the Department's research through their Diploma thesis. In the period 2009-2013, 340 students have gotten their Diploma, and 62 their Doctorate.

The Department has instituted an evaluation scheme for all courses based on student feedback. On an out-of-100 scale, the average numerical evaluation of the instructors for the mandatory courses, based on student questionnaires is 68.3% and for the elective courses is 86.6%. The average numerical scores for the mandatory courses were 3.4 out of 5, and for the elective courses 3.9 out of 5. It is not clear, however, how the Department uses this information and in particular what it plans to do about courses that receive low evaluations.

Based on the data presented to the EEC by the Department, 8,7% of the students are graduating within 5 years, 28.5% within 6 years, 22.% within 7 years, 15.5% within 8 years and 12% within 9 years.

#### **B4. SUMMARY AND RECOMMENDATIONS**

1. Students at the AUTH receive a solid chemical engineering education.
2. The growing variety of industries that employ chemical engineers, both in Greece and globally, requires a continuous revisiting and adaptation of the educational mission of the Department as well as the structure to accomplish such mission.
3. Allowing undergraduate students to fulfill their electives requirements by taking courses outside the ChE Department, besides broadening the students' choices, would render the students more competitive in the job market, at the same time better addressing the needs of society and industry.
4. A mechanism should be established to prevent students from indefinitely repeating or postponing courses beyond the prescribed time.
5. When two instructors are involved in teaching "theory" and "exercises" sections for the same course, then every effort should be made to coordinate the two parts.
6. In several cases of two consecutive courses in a given subject, the material taught is more than what is taught in a single undergraduate course given abroad but by no means does it cover the corresponding Masters level course.
7. The ChE Department should increase the exposure of students to the local industry in their early undergraduate years.
8. The number of admitted students must be decreased drastically so that the number of graduates meets the needs of the Greek job market.
9. The ChE faculty should articulate a plan for evaluating courses based on student feedback and for taking teaching evaluations into serious consideration in the evaluation of faculty members of all ranks, including promotion cases.

## **C. Research**

### **C1. APPROACH**

Research in the Department is performed at four levels: (1) undergraduate, through the compulsory execution of the required diploma thesis by each student during their last year of studies; (2) PhD students conducting research for their doctoral thesis; (3) at the Masters' equivalent level via a couple of inter-departmental graduate programs (ΔΙΕΠΙΣΤΗΜΟΝΙΚΟ ΜΕΤΑΠΤΥΧΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΣΠΟΥΔΩΝ); (4) at the postdoctoral (μετα-διδασκατορικό) level. The total number of PhD students in the Department varies over the last 5 years (period of the present evaluation) between a maximum of 115 and a minimum of 69. The majority of them work in the "Chemistry Sector", which is the largest sector in the department, in terms of number of faculty members.

The main objective in research is to generate new knowledge and, at the same time, to train students in performing original research. Dissemination of generated knowledge is pursued by publications in peer-reviewed journals, book chapters, and other archival literature (e.g.: conference proceedings, etc.). Faculty members present their work at national and international conferences, whereby direct exchange of ideas with peer researchers can be accomplished.

### **C2. IMPLEMENTATION**

A reasonable fraction of the faculty members is very active with writing competitive grants in response to calls for proposals by both EU and National funding agencies. In addition, direct contracts with industry provide an avenue for more applied research.

Research infrastructure appears to be well established; no major shortcoming, in terms of instruments needed for the faculty members to pursue their research of interest, appears to exist. Recent acquisition of major equipment, such as a powerful NMR facility, demonstrates that the Department can make the equipment purchases needed. Computational facilities needed for modeling focused research appear to be available and plentiful, with the IT personnel required to support computer clusters also available. At the present time, the department has 3 experienced technical personnel, which is capable of building and maintaining equipment for research laboratories, as needed. This personnel is mainly for maintaining educational labs, but they do spend a fraction of their time in research support as well.

Research is facilitated by the existence of a departmental library, which provides access to hard copies of a collection of journals, books, and proceedings volumes, among others. In addition, access to electronic journal subscriptions is essential to advancing the frontiers of knowledge. Because of the financial crisis Greece has been experiencing over the last few years, there have been problems with accessing these journals for extensive periods of time. However, the situation has improved lately and access to this essential information for performing state-of-the-art research is returning back to normal.

Assessment of research results is performed through the internal evaluation procedure, which appears to be well established and performed on a regular basis. The faculty has committees in place which are responsible for the assessment of research and for documenting that assessment. To their credit, the document they produced for the

evaluation period was very thorough and detailed, and demonstrated a high level of commitment to this important task.

Research is supported mainly by competitive Greek state grants and European Union grants, whereas a smaller fraction of research projects is sponsored by industry. Indirect research support is also provided by motivated postgraduate students who are not paid by any research grants, but they yet work on their PhDs because they like research and hope that by getting a PhD, they are increasing their chances of qualifying for a job in an admittedly difficult job market.

Research is led by a total of 35 faculty members: 33 from Chemical Engineering plus two recent additions from the General Department of AUTH, both Physics Professors, as a result of AUTH re-organization. Of these, 14 are Full Professors, 7 Associate Professors, 9 Assistant Professors, and 5 Lecturers.

On average, each PhD thesis produces 2-3 scientific papers in scientific journals. The average duration for a PhD is ~6 years. We note in passing that an increasing fraction of PhD theses is written in English, which is an internationally recommended practice. The EEC sensed that there is an interest in increasing the research output, but, at the same time, not at the expense of quality. "Slicing" as a means of producing more papers was not detected.

### **C3. RESULTS**

The EEC attended two presentations by the faculty with emphasis on research efforts in the Department, without, however, getting into the detailed research activities of individual faculty members, except through a non-exhaustive visit with research laboratories, which took place on the third day of the evaluation visit. The following comments describe our assessment of research activity of this department:

- A good fraction of the recent research activity is performed in collaboration with international institutions. Contrary to that, the collaboration among faculty members of the ChE Department in AUTH is only modest.
- The scientific output of the ChE faculty is varied both in terms of quantity and quality. There are areas of immediately recognizable excellence, such as heterogeneous catalysis, polymer reaction engineering, physical and inorganic chemistry, characterized by publications in high impact journals in those areas, but also other research areas with modest level of research activity characterized by publications in low to modest quality journals in those scientific areas.
- Over the 2008-2013 period, the entire faculty published a total of 846 publications in peer reviewed journals. This translates to an average of ~4 publications per faculty per year. Some of these publications were published in high impact journals of their field (e.g.: Angewandte Chemie), and some in more modest reputation journals.
- In terms of actual impact of these publications, they collectively gathered ~17000 citations over 4 years, which translates into an average citation rate per faculty member of 128/year. This is modest by international standards. Yet, the EEC notes

that this average represents a very substantial improvement compared to the previous five year period, where the average citation rate per faculty was only 51/year. The faculty suggested that this increase is due to the special circumstances generated by the existence of Greek State funding programs (ΘΑΛΗΣ, ΠΕΝΕΔ), which, in turn, led to an increased number of publications and citations. We note in passing that the annual production of PhDs varies between 21 and 6 over the last 6 years.

- Research is funded by: (1) EU, (2) Greek State, (3) industry. Funds from EU and the Greek state represented the majority of funding over the last 5 years, with ~3 million euros each. However, funding from the Greek state is characterized by a serious lack of continuity, which severely undermines the sustainability of cutting-edge research efforts. Funding by the EU has become increasingly more competitive and difficult to secure. The data provided by the Department suggest that over an 8-year period, there was a total of 8 million euros raised in research funding, which translates to a modest ~30k euros/yr/faculty member.
- The majority of this funding is attracted to research related to: (1) energy and the environment, (2) biotechnology, (3) materials and nano-science, and (4) more basic research, in decreasing magnitude. EU funding came mainly from various branches of FP7 and involved extensive collaborations with other European labs, both academic and industrial. Substantial amount of funding for more applied research in the area of water treatment and characterization, including quality of therapeutic water baths (ιαματικά λουτρά), and air pollution and its abatement is remarkable.
- Unfortunately, the Intellectual Property infrastructure in Greek Universities is nearly non-existent, which makes patent filing and long-term support impractical. More IP opportunities might exist for faculty members of the Department affiliated with the CERTH (EKETA) center. There are currently four faculty members of the ChE Department, who are also members of the EKETA. Despite these difficulties, the EEC noted the early stages of fund raising for a startup company based on findings and ideas by members of the ChE faculty.

Areas of excellence have been recognized with important and competitive awards, including an advanced ERC grant and a Descartes Prize.

#### **C4. RECOMMENDATIONS**

Although good work is being done in specific sub-fields of Chemical Engineering in the department, overall, there is clearly significant room for improvement at the level of attracting research funding, and producing high quality and significant quantity of research publications. What follows represents a non-exhaustive list of examples, where things could be improved substantially:

1. The EEC wants to recommend strongly that the Greek authorities do not interfere with the decision as to how many undergraduate students the department will admit on an annual basis. Current practice requests a suggestion by the faculty, and then the Ministry doubles the numbers requested or even exceeds those. This is a completely irresponsible practice that needs to be terminated immediately. Large numbers of incoming students, not only dilute the quality of the education offered to

the best of them, but also distract faculty's energy, which needs to be focussed on research. Limiting the number of students to the level suggested by the department will release time and energy for faculty members to pursue grant applications, do research, attract high quality postgraduate and postdoctoral students, increase the quantity and quality of research output, and the commensurate impact. In turn, enhanced impact will increase the academic reputation of the department.

2. The AUTH has to consider increasing the overhead rate to match at least the European standards, and perhaps move towards the US ones, while keeping competitiveness in mind. The collected income has to be allotted more equitably towards the departments generating this overhead. This extra income can be used to offset the expected loss of revenue by ΤΣΜΕΔΕ and to provide more research fellowships for postgraduate students and PhD candidates. Having full time postgraduate students and postdocs can only enhance the research output of the department, which will inevitably lead to enhanced research pre-eminence.
3. The Department should make a conscientious effort to limit inbreeding in the faculty ranks. No new faculty hire at any level should be made among PhD graduates of AUTH, unless the candidate has been away from the department at other prominent research institutions for an extensive period and until the candidate has established a research profile that is independent of AUTH. That approach would warrantee that new ideas and techniques are brought into the department on a frequent basis.
4. A more systematic effort needs to be undertaken so that the department reaches out successfully to a broader spectrum of European industry. Focussing on the clearly smaller Greek industry is rather limiting.
5. Given the current age distribution of the faculty and the clear excellence imbalance favouring the highest ranks (with the notable exception of some very promising new hires at the lower professorial ranks), the EEC feels that the department badly needs to pursue some senior hires in the very immediate future. To be successful with attracting senior people from abroad the necessary resources need to become available for start-up packages. Recent excellent hires (e.g.: at the Associate Professor level) might be faced with retention issues soon, if resources do not become available immediately for these people to build their labs and to start producing the high quality research they are capable of (as they have demonstrated in the past at the foreign institutions they came from).
6. The Department has started working towards identifying core areas of research excellence, so that they invest in those areas in terms of future faculty hiring. More work needs to be done in that direction very soon. It is impractical to hope that every single research area currently represented in the departmental research portfolio will become a core of excellence. Focusing on 3-4 areas is imperative. This process needs to take into account the goal of differentiating between this and the other two ChE departments in Greece. In that regard, minimum overlap is desired, and the principle of complementarity should be observed.

## ***D. All Other Services***

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

### **D1. APPROACH**

#### University services to students

The Department is conscious of the need for adequate administrative and support services to the students, faculty members and research personnel. The Department also understands the importance of web-based services for its above constituencies, including easy student access to library and scientific publications through the internet, and class accessibility on-line through the availability of syllabi and notes via the Eudoxus network plus electronic learning via the e-Class platform.

It is recognized that laboratory and classroom facilities must satisfy requirements for teaching effectiveness, safety and handicap access. It is also recognized that properly equipped and maintained laboratories for student and faculty research are of crucial importance. The available space is more than adequate and the quality of the instrumentation and technical support is very good.

The importance of student academic advising is recognized, as is the need to facilitate student involvement in research; students and faculty members recognize the importance of such engagement for a rewarding student experience and for student academic and professional networking. Available pathways towards this target include the required Practical Exercise, mainly in industry but also in the public sector, plus a variety of exchange schemes and internships (IAESTE, BEST, Erasmus) whose offerings are well-organized, as stated above.

Overall, it appears that the Department and the University at large have a genuine interest in the welfare of their students, and the affordability of their education.

#### University services to the Department

The above-mentioned University infrastructure demonstrates that AUTH is committed to providing services that contribute strongly to the Department's function and effectiveness.

#### Services within the Department

As seen from the Department's communal facilities, including its library, meeting and teleconferencing room and teaching labs, the ChE Dept. is committed to provide good computational, teaching and research infrastructure services for students, staff and faculty.

### **D2. IMPLEMENTATION**

#### University services to students

The committee was impressed by the services offered by the University to the students. These include: very good library services and resources available during the working week student

housing and free food (board) services for those who qualify; medical insurance; and discounted public transportation.

Adequate administrative infrastructure is in place. The Department has excellent access to web support, and computer stations are available to students at the library (with new books purchased each year, and access to electronic journals). Computer stations are plentiful and up-to-date; computers are renewed regularly. Extensive internet support is available on campus and for students, faculty and staff on and off campus through VPN.

Students have access to academic advisors on an ad hoc basis for course and curriculum counselling. There seemed to be overall limited guidance related to internships, mobility, or for future professional placement. Nonetheless, the Department's efforts to offer consistent opportunities of internships are appreciated as a sign of the School's willingness to maintain and enhance the links between itself, its students and the greater economy sectors.

The Department has well organized outreach to the community, the local schools and the industrial sector.

### **D3. RESULTS**

The committee did not have an opportunity to evaluate central administrative services first-hand. However, in the presentations and documents received, it was clear that the Liaison Office (Γραφείο Διασυνδέσεως) and Research Committee at the AUTH level appear to function well.

Generally, and within structural constraints, the committee felt that the services provided to the students by the University and the Department are of good quality, and this was broadly acknowledged by most local constituencies (students and faculty members).

The functionality of the Department's administrative services and infrastructure is concluded from the internal self-evaluation, discussions with faculty members and students, and actual visits to the Department's facilities. The University's Administration seems committed to supporting the Department's needs and growth, within the constraints created by the other priorities within the AUTH. Web infrastructure is excellent, allowing each student unlimited internet access, including the scientific literature online and access to internet-based course delivery modalities such as e-Class.

Support technical staff positions appear limited while administrative staff positions appear exaggerated and should be re-thought, for optimal use of human resources. Grant management services are provided by the University through the Research Committee; however, several faculty members expressed concern that the University Research Committee frequently did not facilitate the preparation of proposals.

The lack of filling positions that will be left vacant through retirements, especially at higher ranks, and the increase in the number of incoming students limits the capacity to train students with limited resources. At the Department's building on the main campus, facilities appear adequate and equipment seem at a good level with some recent acquisitions being

exceptional and clearly unique in the University and even in Greece. The EEC noted a well-founded concern for safety of the older building compared to that of the newer buildings.

Excellent programs in certain laboratories have served and continue to serve the local economy and other stakeholders (e.g. analysis of water and wastewater). Profit generation from some of these services has contributed to the sustainability of these programs.

Students have access to academic advisors for course and curriculum counselling. However, regular meetings with advisors are typically not required, potentially contributing to the above-mentioned widespread problem of students taking courses that should constitute prerequisites subsequent to the course itself, thus unduly extending the time required for the completion of their degree. Despite the Department's clear commitment to the concept of student internships, there seemed to be overall limited formal guidance in this area or in future professional placement. Luckily the weaknesses in this area are partially addressed by the above-mentioned emerging student leadership and self-organization. Still, despite the promotion of opportunities for student internships through the IAESTE, BEST and, especially, Erasmus program, student participation appeared limited.

Students appear reluctant to utilize elected student representative bodies in order to voice their grievances regarding academic issues.

Outreach to the community, the local schools and industry was well organized but mechanisms should be in place for their continuous and regular offering.

#### **D4. RECOMMENDATIONS**

The University should implement a more thorough and safer process for disposing hazardous wastes generated by the research and educational activities of the department.

It was brought up to the attention of the committee that the recent central power failures have caused several problems in the operation of critical equipment such as high-end instruments. The department has decided to install their own power generator in order to be able to remediate this frequently occurring situation, and thus, the committee feels that this request deserves a high priority attention.

There is urgent need for safe laboratory space for student training.

The Department needs at least one dedicated staff member to handle grant management and other fiscal operations. Continuous efforts need to be in place to assure good understanding between faculty members and CERTH (EKETA). This will give added opportunities for funding and also for training of undergraduate and postgraduate students in CERTH's superb facilities. Job placement services for students are limited. Regularly organized meetings with representatives from industry, government, institutes, foundations etc. would assist students in networking with potential employers. Faculty members' engagement in assisting students with choices for the performance of the Practical Exercise and with internship opportunities is crucial, especially in the current economic climate.

The Department should continue and enhance the effort of encouraging students to take

advantage of Erasmus, IAESTE and BEST mobility opportunities.

Regularly scheduled advising sessions will assist students to design their plan of coursework in proper order, to avoid placement in courses without listed prerequisites. This issue can also be addressed with an electronic registration-based system to assure that students will not register without relevant prerequisites.

The EEC strongly recommends the development of an organized mentoring system for junior faculty on issues related to professional growth and development, teaching and scholarly activity.

The EEC strongly recommends the development of a retention, promotion and tenure institutional policy which will provide guidance to faculty members on related issues. A number of programs and laboratories have excelled in providing much needed services and outreach to numerous stakeholders, and these need to be adequately recognized and honoured by the Department as well as the University. Recognition and reward of excellence will promote visibility and encourage opportunities for the Department to build on existing areas of strength. The Department's initiatives are mainly oriented towards maintaining active outreach programs to the community, the local schools and industry. These appear to be both extensive and well organized, but they should be more oriented beyond Macedonia and Greece towards SouthEast Europe and esp. the Balkans.

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

#### **E1. Overall view**

The strategic planning of the ChE Department is one of the most important tasks needed for the most effective development of the Department in the near and medium term future. The Department initiated this activity in 1991. A report was put together in 1992, 1999, 2005 and 2008. The committee was given the report of 2008 in which there were brief summaries of the previous reports. The EEC will discuss here the information provided in that report and will make recommendations for the next strategic planning activity of the Department.

The EEC will also list the major limiting factors that will affect the future development of the Department.

#### **E2. Analysis and comments of the past strategic planning activities.**

The past strategic planning reports are addressing the following main attributes of the Department:

- Number of Faculty Members (Μελη ΔΕΠ)
- Space available
- Departmental priorities
- Proposed new Faculty positions

The following points can be made about the contents of the strategic plan, which was briefly presented orally during the visit:

1. In the distribution of the total number of faculty members, the Chemistry Section is the largest one, often double the size of the next largest. In the May 2005 report the Chemistry section had 15 members while the other three sections had 6, 7, and 7 faculty members.
2. The total amount of space available (8,418 m<sup>2</sup>) is plentiful. Many ChE Departments abroad would be very envious of such ample space availability.
3. The new faculty positions planned are properly chosen. The areas of Biomedical Engineering and Biotechnology, Materials, and Food Engineering and Technology are of current interest. However the justifications provided for these new areas is not at the desired detail, as it will be explained below.

Concerning the above brief summary of the past strategic planning efforts of the department the following comments are appropriate:

- a) Most of the suggested new positions are presented with an implicit assumption of a continuous expansion of the size and the budget of the Department, a “positive sum game”, one might say. In the present environment, the Greek University finds itself in a shrinking funding environment from the Greek government. Consequently, the Department should adopt a “zero-sum-game” in its planning.
- b) The support provided in most of the planned new faculty positions is mostly based on teaching needs for the undergraduate students. Instead, the selection and justification of such new positions should be based in a much broader prospective of the needs for the country as well as the local region’s technological and developmental future.

### **E3. Recommendations for the next strategic plan**

The present EEC recommends that the department undertake a strategic planning task as soon as possible. This should be undertaken in a much greater depth than in the past and in the framework of the “zero sum game”. A non-technical external facilitator might be helpful for this task. Alternatively one might solicit the help a senior faculty member of another ChE Department. Yet, another approach implemented internationally, would entail the establishment of an external advisory board consisting of a limited number of ChE faculty members from abroad, which would meet with the Department’s faculty every 1 or 2 years, on a regular basis. The issues that should be examined are well known to the department but are listed here for completeness and reinforcement:

- a) Assuming that the total number of faculty remains constant, if not reduced because of National financial constraints, over the next 10 years and accounting for the expected retirements, what is the total number of faculty slots that will need to be filled in the Department year-by-year over the next 10 years? This simple calculation should be done for the overall department and not section-by-section as positions might need to be shifted, temporarily or permanently, between sections. This number of slots to be filled should not be related to the research specialty. Research specialties can change over time, depending on problems to be solved and international trends in research activities. Number of slots should be derived by a simple “body count”.
- b) With the numeric results of the activity described in item (a) above as background, the Department should enter into a discussion with itself about the future personality and character of the Department. This should be done in the context of Greece and of Southeastern Europe. Namely, what will make the AUTH ChE Department unique and different, let alone excellent among its peers? The synthesis of the proper mission statement will require the need to benchmark the present position of the AUTH ChE Department among its peers in the Southeastern part of Europe.
- c) To facilitate the synthesis of the future personality of the department issues like the

following should be initially addressed:

- a. If there is an interest in continuing activities in food engineering, as one might guess, a study should be conducted on the sub-areas the AUTH ChE Department should be competitively involved in view of the substantial high quality activity already existing in the School of Agriculture, in the same University. Collaborative links need to also be planned and established.
- b. Furthermore in the areas of Materials, Energy as well as in Biological or Biomedical Engineering a similar discussion should be initiated in selecting the areas in which the ChE Department at AUTH should focus its attention.
- d) Parallel to the planning discussions of the above obvious areas, the department should also ponder and select one or two additional areas of potential future value that might substantially distinguish the ChE Department at AUTH from the other similar departments in Southeastern Europe. However, such a selection should not be lightly motivated by the ideas of one or two faculty members, but with a rather extensive consultative and deliberate process with the appropriate stakeholders that will benefit from such novel but exceedingly risky ventures.

With the above preliminary work completed, the strategic plan should consider and conclude which areas should receive diminishing or minimal support and attention in the future in order to make resources available for the development of the most prominent of the new ideas. A plan is not a strategic plan but a list of wishes, if it does not propose which research and teaching areas will have to be reduced or eliminated to make room for the new ones. This is not an easy task but, nevertheless, a necessary one.

#### **E4. Inhibiting Factors**

The factors that inhibit the development of the Department are several. They are divided in *universal inhibiting factors* that affect all Departments, Schools and Universities in Greece and *particular inhibiting factors* that inhibit the present department.

##### **Universal Inhibiting Factors:**

There is a multitude of factors universally inhibiting the development of Greek Universities:

- The legal framework that governs the University is extraordinarily limiting its future development. If we are serious as a country in trying to have universities that can be competitive in the regional and world scene we must change the legal framework into something similar to the one used for the research Centers and Institutes.
- The micro-management of the Greek Universities by the Ministry has to stop. The number of entering students should not be determined for political reasons but only by the present and expected future need of the job market. This way the quality of the students will improve substantially and the number of jobless graduates will be reduced drastically. With the reduction in the number of undergraduate students, the faculty will have more time and energy to strengthen the present research output. Most importantly, each Greek University should take its autonomy seriously and decide, with its own internal organic constitutional chart, how it will best use its freedom from the tight control of the Ministry, to develop towards excellence.

##### **Particular Inhibiting Factors**

- The mentality of the Department is limited mostly into the Greek sphere of interest, with the only exception the notable but, for the large size of the faculty, limited

number of European research projects. Noting the fact that the physical distance to Sofia is shorter than the one to Athens, the educational, research and service activities of the Department, should have a Southeastern European focus of interest if not an Eastern Mediterranean one.

- Limited collaborations between faculty from different sectors as well as with other departments and schools in the AUTH and other Universities. In today's world, where research challenges are in the interfaces between fields, collaboration with other fields is a necessity and not a luxury. Some international collaborations do exist and are commendable, however they need to be more numerous and by almost all the faculty members.

## ***F. Final Conclusions and recommendations of the EEC***

The EEC wants to commend the department for the following:

1. Remarkable productivity by several faculty members, despite the current financially adverse conditions
2. Promising recent hires with the potential of moving the department forward
3. Continuously improving interaction among sectors of the Department
4. Largely positive experience of students on their interaction with the Department
5. The program produces a fair number of very good undergraduate students
6. Notable outreach and interactions with industry
7. Initial progress with strategic planning towards identifying key research areas for future growth
8. Impressive major instrumentation (e.g.: NMR, LC-MS)
9. Commitment to students' internships and mobility
10. Availability of a wide variety of elective courses
11. Genuine commitment to the evaluation process
12. Technical support staff has a positive contribution to the educational mission of the department.

### **RECOMMENDATIONS**

In addition to other recommendations listed in individual sections of this report, the EEC feels that the following suggestions, if implemented, will help the Department to evolve in a very positive way in the future:

1. Senior hires of the highest quality are urgently needed, particularly in classical and more emerging Chemical Engineering areas of research. Currently, there is an imbalance in the numbers of faculty, strongly favoring Chemistry. This imbalance is not in line with international standards and needs to be addressed with new hires with expertise in key/emerging Chemical Engineering areas of research
2. International practice suggests that chemistry and math courses in a ChE curriculum are taken from Chemistry and Math Departments in a given University. This scheme may need to be considered in AUTH as well, so that more faculty lines in the ChE department may be freed up for Chemical

Engineering focused new hires.

3. Necessary start-up funds should become available by the University and the Greek State to attract and retain high quality faculty.
4. Criteria for promotion should be strictly merit-based. Time of service to the Department should not be a dominant factor for promoting an otherwise unproductive faculty member.
5. AUTh should continue its funding of sabbatical opportunities, which allow faculty members to pursue experiences at centers of research excellence abroad.
6. An award system (not necessarily involving monetary rewards) needs to be established for recognizing hard-working and internationally visible faculty members.
7. Number of admitted undergraduate students should be decreased according to the projections by faculty.
8. The faculty members should invest more energy in strategic planning.
9. Team spirit in the Department needs to be strengthened.
10. Senior faculty should engage in active mentoring, coaching, and support of junior faculty.
11. Serious restructuring of human resources (non-ΔΕΠ, technical, administrative and support staff) is needed to maximize efficiency.
12. The Department should undertake a wide-ranging benchmarking study of the curriculum, research productivity standards, human resources with international peer institutions.
13. Academic inbreeding at the faculty hiring level is a serious handicap and should be avoided at all costs. No new faculty member should be hired, if they got their PhD from this Department, unless they demonstrated a strong track-record of independent research at other internationally recognized institutions, during an extensive period after they got their PhD.
14. All PhD candidates should be supported through full-time fellowships/grants
15. The Department should continue to explore avenues for cross-departmental contact, including possibilities for new undergraduate electives from other disciplines (e.g.: biology, chemistry, etc.)
16. Establish strong interactions with the Food Science program in the School of Agriculture of AUTh.
17. At the National level, the flow and deciphering of information between the National Contact Point and research committee at Universities, about calls for proposals, should become more efficient.
18. University should hire cleaning personnel.

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