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HELLENIC REPUBLIC  
**H.Q.A.**  
 HELLENIC QUALITY ASSURANCE AND  
 ACCREDITATION AGENCY

## EXTERNAL EVALUATION REPORT

School of Civil Engineering  
 National Technical University of Athens (NTUA)  
 Greece

November 2013



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### **External Evaluation Committee**

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

**1. Prof. Ted Stathopoulos (Coordinator)**

Department of Building, Civil and Environmental Engineering, Concordia University, Montreal, CANADA

**2. Prof. Filip C. Filippou**

Department of Civil and Environmental Engineering, University of California, Berkeley, USA

**3. Prof. Athanassios Papagiannakis**

Department of Civil and Environmental Engineering, University of Texas at San Antonio, USA

**4. Prof. Spyros G. Pavlostathis**

School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, USA

**5. Prof. Stavros Savidis**

Department of Civil Engineering, Faculty of Planning Building Environment, Technische Universität Berlin, GERMANY

## ***Introduction***

### ***I. External Evaluation Procedure***

The external evaluation committee (EEC) was invited by HQAA to visit Athens from the 11<sup>th</sup> to the 16<sup>th</sup> of November 2013 to carry out the external evaluation of the School of Civil Engineering of the National Technical University of Athens (NTUA).

In the first day of the visit the EEC met with a member of HQAA to discuss the evaluation process. It then met with the Chair of the School of Civil Engineering and the heads of the Divisions of Structural Engineering, Water Resources and Environment, Transportation Engineering and Infrastructure, Geotechnical Engineering, and Project Planning and Management. After the presentation of the School by the Chair, the division heads presented the educational and research programs of their divisions. The final presentation addressed the entire undergraduate program of the School.

The second day of the visit involved presentations of the 15 School laboratories. At the end of each presentation, there was a discussion on related topics and some general questions affecting all laboratories. During the presentations several faculty members were present and responded to questions by the EEC.

The third day of the visit started with a presentation about the program of practical training followed by an overview of the two post-graduate study programs with subsequent detailed presentations of each program. After completion of the presentations, the EEC met separately with the junior and senior faculty members of the School, with instructors and technical staff, with undergraduate students, with post-graduate and doctoral students, with recent alumni of the School, and with administrative staff. The program of the day ended with a meeting with the Rector of NTUA followed by a concluding meeting with the Chair of the School.

The external evaluation committee (EEC) was not able to visit the site of the School of Civil Engineering due to circumstances beyond its control stemming from the strike of administrative and technical support staff and the resulting closure of the NTUA campus.

The EEC was impressed by the exemplary level of cooperation of the Chair and all members of the School they met during the visit.

### ***List of reports, documents and other data examined by the Committee***

There were a number of documents submitted to the EEC prior to the visit:

1. course catalogue and program of study for the academic year 2011-12;
2. internal self-evaluation department report for the academic year 2009-10;
3. publication list of the department faculty for the period 2006-2010.

During the visit the EEC was exposed to the following information:

1. presentation of the School of Civil Engineering;
2. presentations of the five divisions;
3. presentation of the undergraduate curriculum;
4. presentation of the PC laboratories;
5. presentation of 14 laboratories;
6. presentation of the practical training program;
7. presentation of the post graduate programs.

Additional materials were available for several courses on-site and on-line for the review of

EEC. Samples of diploma theses and project reports were also made available.

## **II. The Internal Evaluation Procedure**

The members of the EEC found the self-evaluation report of the School to be an accurate reflection of the state of the School for the academic year 2009-2010. Updates of the School activities during the last three years were presented during the EEC visit.

The objectives of the internal evaluation process were met by the School.

## **A. Curriculum**

### Undergraduate Program

The goals of the undergraduate NTUA Civil Engineering curriculum are to produce graduates that have a high level of civil engineering technical knowledge and can benefit society through technology transfer. The curriculum goals and the means for achieving them are defined and updated by the Undergraduate Study Committee with student input and approved by the Assembly General of the School of Civil Engineering. The EEC believes that the undergraduate program, as currently structured, generally meets its stated goals. However, there appears to be no industry input in defining and updating these goals, and revising the curriculum. Therefore, the EEC recommends that representatives of the industry participate in the evaluation of the educational goals of the School.

The undergraduate curriculum consists of 46 core courses. There are 4 areas of specialization, namely Structural Engineering, Water Resources and Environment, Transportation Engineering and Infrastructure, and Geotechnical Engineering. Each area has a number of required courses and several general elective courses. The program delivery is conventional, involving classroom lectures, laboratory exercises and classroom recitations/problem solving. Depending on the area of specialization, a total of 67 to 68 courses are required for completing the Diploma in Civil Engineering. The program typically involves 9 semesters of course work and one semester dedicated to an extensive diploma thesis. The student load is 13.6 courses per year and requires 26 to 33 contact hours per week. The undergraduate curriculum has significant technical depth. However, it requires a larger number of courses and lecture hours per week than similar programs abroad. Therefore, the EEC recommends reducing the number of courses required for graduation. Furthermore, it recommends reducing and refocusing the number of elective courses, while ensuring that the breath of each area of specialization is not compromised. This may be possible by offering certain elective courses in alternate semesters or by cross-listing some graduate/undergraduate elective courses and will result in higher efficiency.

Another problem is that although the curriculum describes a sequence of courses, there is no mechanism for ensuring that the courses are followed in a pedagogical sequence. Therefore, the EEC recommends establishing mechanisms for ensuring that a logical sequence of courses is followed throughout the curriculum. Such mechanisms may have the form of either prerequisites or by required advising through the program of study (e.g., at the end of 4th and 8th semesters).

Student comments suggest that the content of some courses is mostly theoretical. There is a general wish for a better balance between theory and applications. Furthermore, some topics, such as construction management, construction law and computerized drawing need to be emphasized. The EEC recommends that the undergraduate curriculum enhance the exposure of concepts for construction management and construction law, if possible within existing courses. In terms of course delivery, a format that incorporates more practical exercises and problem solving during the regular lecture period is preferable.

Over the past several years, the Civil Engineering School has expended considerable effort in coordinating student internships. Students that participated in these internships spoke very favorably of their expanding education and future employment opportunities. Student funding for these internships was provided from the Greek government through a rather bureaucratic mechanism that imposed an undue burden on the faculty coordinating them. Furthermore, this funding will lapse in 2014. Clearly, this funding is not sustainable. Therefore, the EEC recommends that practical training in the form of internships should be encouraged and organized in a way that gives participating students elective course credit.

A mechanism for sustaining these internships with industry funding is essential.

The quality of the undergraduate diploma theses is outstanding and the effort the students and their supervisors put into compiling them is commendable. However, they seem to be focused in narrow technical areas and typically do not involve team work. Therefore, the EEC recommends developing a capstone design course, separate from the undergraduate thesis, with input and review by faculty and professional engineers from industry. Such projects should be inter-disciplinary, include concepts of construction management and be carried out by student teams. This course should be offered in lieu of an elective course.

#### Graduate Programs

The graduate curriculum encompasses 2 post-graduate interdisciplinary programs and a PhD program. The inter-disciplinary programs are in the area of Water Resources Science and Technology and Analysis and Design of Structures. It is noted that faculty members of the School of Civil Engineering contribute to other interdisciplinary post-graduate programs offered by different NTUA Schools. The two post-graduate programs seem to be very competitive with an acceptance rate in the order of 25%, and enroll a large number of graduate students. The post-graduate program in Water Resources Science and Technology has three tracks, namely hydrology/water resources, water quality, and management of coastal areas. The post-graduate program in the Analysis and Design of Structures has two tracks, namely structural analysis and structural design. A version of this program is offered in English to attract foreign students.

Both post-graduate programs offer a large number of graduate courses. This increases the faculty effort and cost making them more vulnerable under budgetary reductions. Therefore, the EEC recommends better streamlining of course offerings within each program by defining a common core of required courses and rationalizing the need for the elective courses by, for example cross-listing some of these courses with undergraduate elective courses.

The curriculum of these programs is formulated by internal faculty committees without a formal evaluation mechanism. Therefore, the EEC recommends establishing a routine internal evaluation process with input from faculty, students and alumni.

Another issue is the fact that no tuition fees are levied for these post-graduate programs as done by similar graduate programs in Greece thus compromising their sustainability. Therefore, the EEC recommends the development of a tuition fee structure comparable to that of similar post-graduate programs in Greek academic institutions.

The Doctoral curriculum is offered across all Civil Engineering technical areas. Graduates of the School's post-graduate programs are not required to take additional courses, while other candidates are expected to complete 4 to 6 courses prior to beginning their doctoral dissertation. The typical length of the doctoral program is 5 years. However, this often depends on the level of financial support students receive from projects and grants during the period of their study. No formal external evaluation of the Doctoral program is evident. The depth and quality of the courses supporting the post-graduate programs is excellent and the quality of faculty supervision and doctoral theses is high and well integrated with the research programs undertaken by the faculty. However, the average number of 11 doctoral degrees per year over the period 2008-2013 is lower than expected when compared to faculty size and the overall research productivity of the School. This is caused by the large percentage of doctoral students without funding support that results in the lengthening of the time to graduation and, in some cases, withdrawal from the program. Therefore, the EEC recommends that the School devise methods for funding all active full-time doctoral students through the research programs of the supervising faculty.



## ***B. Teaching***

The School is proud of its teaching, the number and quality of courses, and the commitment and excellence of instructors. Similarly, the students are generally happy with their program of study despite the heavy demand of 26-33 contact hours of lectures, labs, and tutorials per week, and are convinced that they receive a high quality education.

The School admits 118 students each year through entrance examinations, but the number increases significantly with transfer students and student admitted in special categories resulting in over 180 (up to 271) student admissions each year. As a result, the required courses have an average enrollment of over 250 students with a student to faculty ratio of about 37. Both, the large course enrollment and the relatively high faculty to student ratio exceed those for a school of Civil Engineering of comparable size at the international level. There are also a large number of inactive students making the development of productivity metrics and the rational allocation of teaching resources difficult. The problem is further exacerbated by the number of times that the students are allowed to repeat a particular course until they pass the corresponding exam. Therefore, the EEC recommends that the School address the problem of inactive students, of college transfers, and of the number of course repetitions.

The faculty performance is assessed with course evaluations at the end of each semester. However, this practice appears not to be uniformly applied and the number of students participating is low reducing the value of the data. The students do not seem to appreciate the value of this process, because the effect of their feedback remains uncertain. Therefore, the EEC recommends that the School conduct teaching evaluations for every course and ensure that the students understand their importance in improving the quality of teaching. Furthermore, the student participation rate for each course evaluation should be included with the results.

Teaching quality is generally satisfactory, as corroborated by the students interviewed. However, the school does not provide resources for improving the faculty teaching effectiveness. Therefore, the EEC recommends that the School address the issue of faculty development to enhance their teaching skills and methods of course delivery.

Most courses have multiple faculty members as instructors. This is understandable for required courses of large enrollment with multiple sections. However, this practice carries over to several single section courses. Despite the assignment of a course coordinator, the presence of multiple instructors may result in inconsistency of teaching styles and methods of examination and grading and cause confusion and frustration to the students. Therefore, the EEC recommends that the School establish a clear correspondence between faculty and course sections and request a consistent student evaluation system from the course coordinator. The EEC further recommends that the School consider on-line delivery methods for large enrollment courses. This may alleviate the impact of cuts to faculty and staff without compromising the quality of instruction and the breadth of available courses.

Faculty use both traditional blackboard and digital computer presentations to deliver the course material. In general, the teaching methods seem to be effective and the students are appreciative of the faculty efforts. Course material, such as the schedule, the lectures, the examples and the homework assignments, is posted for many courses on-line at mycourses.ntua.gr. A few instructors also select the electronic submission of homework assignments to ensure proper delivery. However, the availability of course material including examples and past examination problems is not consistent for all courses, a typical complaint of students. Some students also complained about the lack of correspondence between lectures and reference material, and the lack of correspondence

between course material and examination problems. Finally, the students mentioned that the teaching style of many courses encourages memorization instead of fostering critical thinking. Therefore, the EEC recommends that the School continue the development of teaching resources on-line, while ensuring that the above mentioned student input is considered. Furthermore, the School should ensure frequent performance feedback to the students.

The available computer facilities appear to work well. The students have access to 30 personal computers in the PC lab of the School and can access the computer facilities through remote desktop connection with secure SSL. Several software packages are installed on the School server for student use. Some of the computer equipment and software appear outdated. The computer facilities appear limited relative to the number of enrolled students. The number of students using the remote desktop connections (50) also appears small relative to the enrollment of required courses. Therefore, the EEC recommends that the School increase efforts for the wider availability of modern hardware and software tools to the students, as well as encourage the incorporation of computer methods in course material.

Several courses involve laboratory experiments and demonstrations that are very much appreciated by the students. The continuation of these activities is in jeopardy with the sudden reduction in technical staff threatening the quality of courses with a significant experimental component. Therefore, the EEC recommends that the School assign high priority to the support of teaching activities by the technical laboratory staff.

Some courses are currently taught to as few as 5 students. Therefore, the EEC recommends that this number be raised (perhaps to a minimum of 10) to address current cuts in teaching staff. The School should consider reducing the frequency of small enrollment courses to every other year, if possible.

The presentation of course material is enhanced with technical field trips which are well organized and very much appreciated by the students. Therefore, the EEC recommends that the School continue these activities with vigor.

The students have access to an elective course on practical training which is well organized and brings students in contact with professional practice and future employment opportunities. Therefore, the EEC recommends that the School continue supporting the development of this course and undertake efforts to make it available to a larger number of students.

The undergraduate study concludes with a diploma thesis. The EEC had the opportunity to view a selection of such theses and found the quality of the work very good. Students working on their diploma thesis and students working on research projects and doctoral theses mentioned they do not have adequate access to bibliographic resources in the library. The EEC believes that the school's efforts to provide electronic access are laudable, but access to bibliographic information electronically should be ensured for all students working on the diploma thesis. Whether real or perceived, the EEC recommends that the School address this issue.

There are some student exchange opportunities with European institutions. However, the reciprocity of participation is impeded by language barriers for the foreign students. Such barriers would be minimized if the exchange focuses on the diploma thesis preparation which can be in English. Therefore, the EEC recommends that the School encourage students to use the diploma thesis as the opportunity for enriching their educational experience through collaboration with foreign faculty and researchers.

### ***C. Research***

The School has five Divisions, 14 technical laboratories with presently 62 faculty members who are pursuing research in the general area of Civil Engineering, grouped under the themes represented by the five Divisions. Overall, the School aims at high quality, high impact research, both fundamental and applied. It is noteworthy that the size of the faculty dropped from 76 in the academic year 2009-2010 to 67 in the year 2012-13 and to its current size this year while the total number of students has remained practically unchanged.

The School promotes research through: a) collaboration among faculty members; b) research collaborations with other Institutions and organizations in Greece and abroad; c) collaborations with industry and governmental organizations; d) faculty participation in national and international funding programs; e) a limited number of graduate student exchanges; and f) organization of national and international conferences. Research is primarily promoted by actively pursuing competitive funding from National and EU sources. Industrial and other private support, as well as support for providing specialized services to various national organizations, industry, and local authorities, contribute a significant fraction of the total research funds. In the EEC's opinion the number of national and international collaborations developed by the School of Civil Engineering is impressive.

In the period 2010-2013 the School has been involved in 160 research projects with a total budget of 32.4 M Euros. In the EEC's opinion the quality and the number of research projects when compared to that of many Civil Engineering Departments abroad is excellent.

The research infrastructure consists of state-of-the-art facilities, established primarily through the initiatives of faculty members with specialized equipment from both national and European funding sources. Many research areas and their respective laboratory infrastructure are unique in Greece, and some also in Europe. Many of the laboratories are accredited by European and International accreditation agencies, another indication of the quality and importance of research conducted in the School. However, equipment maintenance and technical support will become a major concern after the anticipated reductions in technical staff. A source of major concern is that a significant number of doctoral candidates are not financially supported. Therefore, the EEC recommends that additional funds for doctoral student scholarships, as well as for post-doctoral fellowships be secured.

The School meets its research objectives with an excellent record of research output as evidenced by: a) the large number of publications in peer-reviewed journals; b) the number of books published by the faculty, several of them in foreign languages; c) the number of book chapters; d) the participation in conferences (invited talks, keynote and plenary lectures); e) the invitation of faculty members to act as guest editors for special issues; and f) several international awards. The impact of the research results and achievements of the faculty members at the national and international level are noteworthy. According to the School Chair's presentation, for the period 2010-2013, there are 13.6 publications with 258 and 156 citations per faculty member according to Google Scholar and SCOPUS, respectively. The output of several faculty members reaches national and international standards of excellence. However, the reported average number of completed doctoral theses is only 11 per year.

In spite of significant efforts by faculty to maintain and improve their research output and productivity, external factors, such as legal, administrative, and financial hurdles, are the main obstacles for the School to maintain its current breadth, depth and quality of research.

In view of these observations, the EEC has identified several areas in need of improvement.

Given the emergence of new global challenges (e.g., climate, resilient infrastructure, energy, sustainability, new materials, civil systems etc.), in which the new generation of Civil Engineers will play a significant role, the School should consider prioritizing its research areas to take advantage of new funding opportunities.

Collaboration and cooperation between the School laboratories as well as with other groups within and outside NTUA is imperative for a number of reasons: best use of the School know-how and expertise; strengthening the School's capabilities, and pooling of resources available for the collective benefit.

In view of recent, as well as anticipated budget reductions, the unique capabilities of the School's laboratories need to be promoted for providing specialized research services to industry.

Junior faculty members should be mentored by successful senior faculty and assisted in developing contacts with funding agencies and industrial sponsors, and in the preparation of research proposals.

The administrative support and services, in particular those related to procurement and processing of project expenditures, should be re-organized and drastically improved.

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

The EEC believes that the support services are generally adequate. However, in view of the current and anticipated drastic cuts, this adequacy is under serious threat. Therefore, the EEC recommends that changes be implemented so as to allow the gradual restructuring of all administrative support services.

At present, the bureaucracy is high and causes delays even for simple matters such as minor purchase orders or travel expense reimbursements, which appear to be lengthy, cumbersome and require extensive paperwork even for travel necessary by the applicant's existing research grants. Electronic handling and simplified approaches may be the key to address this problem. The School should have a fully computerized record-keeping system of all transactions. Therefore, the EEC recommends that the process of electronic services at all levels be completed and expanded.

The EEC also found that awards for undergraduate student theses, fellowships and financial support for doctoral students range from limited to non-existing, thus they are inadequate. It is, therefore, recommended that this be rectified.

There is an inadequate system of staff evaluations and feedback provision to the members of support staff. This is potentially demoralizing. Therefore, the EEC recommends that the School address this issue.

Building infrastructure is good and most laboratories are well developed and possess adequate equipment and instrumentation. However, there are problems that need to be addressed systematically. For instance, most buildings lack proper security due to guard shortage; some buildings were built prior to 1981 and need to be assessed seismically; there are potential health risks due to questionable quality of the drinking water on campus. Buildings are covered with graffiti projecting a negative image. Therefore, the EEC recommends that a building operation committee be formed to address and prioritize the issues of building safety, security of people and equipment, organization of lab status and services including possible centralization of functions such as that provided by the machine shop.

Financial needs for the lab accreditation / certification have not been secured, thus there is a threat that these labs will lose their status. Likewise, concerns were expressed about the equipment maintenance and the services provided by the machine shop. The EEC was sympathetic to these concerns and recommends that the issue be addressed.

Students participate in several on campus and off-campus activities including technical visits, field trips and the like. The EEC was pleased to see that a good social and cultural interaction takes place enriching student life beyond academia.

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

In principle, the EEC agrees with the School goals to keep providing high quality civil engineering education, generate original civil engineering knowledge and technology, as well as transfer this knowledge to the society. However, in order to maintain the high ranking in Europe and in the world that the School of Civil Engineering of NTUA enjoys at present, a pragmatic and flexible strategic plan must be developed. This plan should rectify current bureaucratic inefficiencies in order to respond to the present and likely future reductions of positions and budgets. The plan should also streamline the present course offerings by reducing the total number of courses required for the degrees and the number of contact hours of instruction for students.

Therefore, the EEC recommends that this plan be followed in the long term by the development of a strategy to incorporate emerging opportunities of high research and educational value for the systematic development of the School research and educational programs, as well as for the hiring and professional development of faculty and staff.

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

### **CONCLUSIONS**

Overall, it is the EEC's view that the School functions well in spite of several existing resource constraints and limitations. The Chair, as well as the majority of faculty and staff, is admirable for their commitment and dedication. There is a climate of on-going cooperation and collegiality that is conducive to a stimulating academic life as testified by the students interviewed by EEC. However, the frequent disruptions of the School operation present great challenges to the continued excellence of the educational and research programs. The EEC sympathizes with this situation and hopes that the NTUA administration will make every effort to prudently address the issue with the best interest of students, faculty and staff in mind.

Specific recommendations to address current quality related concerns have been made in this report. The major recommendations are summarized below.

### **GENERAL RECOMMENDATION**

Develop a long term strategic plan to incorporate emerging opportunities of high research and educational value for the systematic development of the School research and educational programs, as well as for the hiring and professional development of faculty and staff.

### **CURRICULUM RECOMMENDATIONS**

1. Involve representatives of industry in the evaluation of the educational goals of the School.
2. Reduce the number of courses required for graduation. Reduce and refocus the number of elective courses, while ensuring that the breath of each area of specialization is not compromised.
3. Establish mechanisms for ensuring that a logical sequence of courses is followed throughout the curriculum.
4. Enhance the exposure of concepts for construction management and construction law in the undergraduate curriculum, if possible within existing courses.
5. Encourage practical training in the form of internships organized in a way that gives participating students elective course credit. A mechanism for sustaining these internships with industry funding is essential.
6. Develop an inter-disciplinary capstone design course, separate from the undergraduate thesis, with input and review by faculty and professional engineers from industry. This course should be offered in lieu of an elective course.
7. Streamline the course offerings within the post-graduate programs by defining a common core of required courses and rationalizing the need for the elective courses.
8. Establish a routine internal evaluation process of the post-graduate programs with input from faculty, students and alumni.
9. Develop a tuition fee structure comparable to that of similar post-graduate programs in Greek academic institutions.

### **TEACHING RECOMMENDATIONS**

1. Address the problem of inactive students, of college transfers, and of the number of course repetitions.
2. Conduct teaching evaluations for every course and ensure that the students understand their importance. Include the student participation rate to the course evaluation with the results.
3. Establish a clear correspondence between faculty and course sections and request a consistent student evaluation system from the course coordinator.
4. Consider on-line delivery methods for large enrollment courses.
5. Ensure frequent performance feedback to the students.
6. Offer more modern hardware and software tools to the students, and enhance the development of teaching resources on-line. Enhance the incorporation of computer methods in course material.
7. Assign high priority to the support of teaching activities by the technical laboratory staff.
8. Reduce the frequency of small enrollment courses and raise the minimum number of students required for a course to be offered.
9. Encourage students to make use of exchange programs, particularly for diploma thesis preparation.

### **RESEARCH RECOMMENDATIONS**

1. Evaluate the areas of research emphasis for addressing emerging global and national societal needs.
2. Devise methods for funding all active full-time doctoral students through the research programs of the supervising faculty.
3. Enhance cooperation among the School laboratories as well as with laboratories within NTUA and beyond for reducing costs and technical support requirements.
4. Promote the unique capabilities of laboratory equipment and infrastructure for providing specialized research services to industry.
5. Improve the administrative services for procurement and processing of research expenditures.

### **FACULTY DEVELOPMENT RECOMMENDATIONS**

1. Encourage, mentor and assist junior faculty members in establishing contacts with funding agencies and industrial sponsors, and in the preparation of research proposals.
2. Develop a mechanism for assisting faculty members, particularly junior, with their teaching skills and methods of instruction.

### **SUPPORT SERVICES RECOMMENDATIONS**

1. Implement the gradual restructuring of administrative support services.
2. Expand and complete the process of electronic services for registration with fully computerized academic student folios, student registration and record keeping.

3. Prioritize the implementation of awards for undergraduate theses and expand the funding base for doctoral student support.
4. Perform staff evaluations on a regular basis with prompt feedback to the individuals. Develop a mechanism for routinely evaluating the performance of technical and administrative personnel.
5. Provide and maintain proper access to scientific and technical journals as well as library material.
6. Establish a building operation committee to address and prioritize the issues of building safety, security of people and equipment, organization of lab status and services including possible centralization of functions such as that provided by the machine shop.