Committee for the Evaluation of Material Science and Engineering Study Programs

Technion - Israel Institute of Technology

Faculty of Material Science Engineering

Evaluation Report

October 2014

Contents

Chapter 1- Background

The Council for Higher Education (CHE) decided to evaluate the study programs in the field of Material Engineering during the academic year of 2014.

Following the decision of the CHE, the Minister of Education, who serves ex officio as Chairperson of the CHE, appointed a Committee consisting of:

- Prof. Enrique J. Lavernia – College of Engineering, University of California, Davis, California, USA: Committee Chair
- Prof. David N. Seidman – Materials Science and Engineering, Northwestern University, Evanston, Illinois USA
- Prof. Dr. Reiner Kirchheim – institute für Materialphysik, Gottingen University, Germany
- Prof. Ronald Gibala – Materials Science and Engineering, University of Michigan, Michigan, USA
- Prof. Doron Aurbach – Department of Chemistry, Bar-Ilan University, Israel

Ms. Daniella Sandler- Coordinator of the Committee on behalf of the CHE.

Within the framework of its activity, the Evaluation Committee was requested to:[1]

1. Examine the self-evaluation reports, submitted by the institutions that provide study programs in Material Engineering, and to conduct on-site visits at those institutions.
2. Submit to the CHE an individual report on each of the evaluated academic units and study programs, including the Committee's findings and recommendations.
3. Submit to the CHE a general report regarding the examined field of study within the Israeli system of higher education including recommendations for standards in the evaluated field of study.

The entire process was conducted in accordance with the CHE's Guidelines for Self-Evaluation of July 2012.

[1] The Committee's letter of appointment is attached as **Appendix 1**.

Chapter 2-Committee Procedures

The Committee held its first meetings on 25, 4, 2014, during which it discussed fundamental issues concerning higher education in Israel, the quality assessment activity, as well as Material Engineering Study programs in Israel.

In 27, 4, 2014- 1, 5, 2014, the Committee held its visits of evaluation, and visited the Azrieli College of Engineering, the Technion and Ben Gurion University. During the visits, the Committee met with various stakeholders at the institutions, including management, faculty, staff, and students.

This report deals with the Department of Material Science Engineering at the Technion. The Committee's visit to the Technion took place on 29, 4, 2014.

The schedule of the visit is attached as **Appendix 2**.

The Committee thanks the management of the Technion and the Department of Material Science & Engineering for their self-evaluation report and for their hospitality towards the committee during its visit at the institution.

Chapter 3: Evaluation of _Material Science & Engineering Study Program at the Technion

This Report relates to the situation current at the time of the visit to the institution, and does not take account of any subsequent changes. The Report records the conclusions reached by the Evaluation Committee based on the documentation provided by the institution, information gained through interviews, discussion and observation as well as other information available to the Committee.

1. Executive Summary

Since its foundation in 1924, the Technion has played a vital role in the rapid development of Israel's high technology sector, an important ingredient in the nation's social and global well-being. Just as important, perhaps, are the multiple generations of men and women whose success in all areas of society provides evidence to the Technion's reputation as a bastion of excellence in science and technology.

The MSE Department at the Technion was founded in 1953 and has grown significantly in size and prestige from its origins as a small metallurgy program. To date, the MSE Dept. consists of 18 world class faculty members, several of whom are world class scientists (which includes a 2011 Nobel Prize winner, Prof. Dan Shechtman, for his discovery of quasi-crystalline matter), and encompasses impressive research and teaching in diverse areas, such as nanotechnology, surface science, fracture, computational materials, corrosion and microelectronics. The research infrastructure is impressive, although the Executive Committee notes the need to develop and implement a financial model that will allow maintaining and updating expensive research infrastructure, which is especially vital for materials research.

The teaching programs of the MSE Dept. emphasize basic sciences, grounded in chemistry and physics. The MSE Dept. currently offers a 9-semester program, which leads to the award of double degrees, a B.A in Physics and a B.Sc. in Materials Engineering and a parallel Chemistry-Materials Engineering double degree. Moreover, plans for a Biology-Materials Engineering program was approved and will be implemented in October 2014. The Executive Committee provides comments and recommendations regarding a new Materials Engineering program, currently under discussion.

It is the view of the Evaluation Committee that the Technion, and by default the MSE Dept., greatly benefits from visionary and proactive administrators, dedicated faculty, intellectually rigorous teaching programs, state-of-the-art infrastructure, and highly skilled academic and research staff. The recommendations made in this report, which encompass all areas of academic performance, including: mission, faculty, study programs, infrastructure, and research reflect the dual challenge faced

by the MSE Dept. at the Technion. First, how to increase the quality of an already excellent department; second, how to establish a financial structure that can sustain an increasingly successful MSE Department.

2. Organizational Structure and infrastructure

Observation and Findings:

The Evaluation Committee met with the senior management of the Technion, including the president, Prof. Peretz Lavie. The leadership of the president and his senior team impressed the Evaluation Committee. He has a very good perspective about future plans, international relationships, promoting high level research and teaching. It seems that the leaders of the Technion have all the necessary cleverness, diligence and experience to push this excellent institute further. The senior management of the Technion seems to appreciate the Faculty of materials science & engineering as a leading one in both research and teaching. The president is well aware of the special needs of this faculty in terms of space, major equipment, high maintenance costs, and the need to recruit to the faculty the best young scientists in the field of materials science.

The faculty of materials science and engineering seems to have very good management. The Dean and his team are highly experienced. It seems that the faculty has a very effective administrative staff. The administrative staff is also very dedicated and provides very good service to both the faculty members and the students.

It is the opinion of the Evaluation Committee that the Technion as a top academic institution benefits from a very good and effective administration. It seems that from the organizational point of view, both the entire institute and the faculty therein, are in very good hands. In general, the faculty is supported with reasonable infrastructure for its daily and current duties in terms of research and teaching. In terms of teaching, there are enough lecture rooms and auditoriums. There are teaching laboratories in a reasonable shape, possessing the necessary pieces of equipment. The computers and networking services for the students appear adequate. There is a reasonable availability of computerized work stations, in which students can sit calmly, search for any needed information and do homework. All the faculty members have research labs that provide them the means needed to

conduct a first rate research work. The faculty possesses a central facility of major analytical equipment such as high-resolution electron microscopes, XRD machines, scanning probe microscopes and spectrometers. There is a trained laboratory scientist (holding a Ph.D.) who is in charge of the faculty's analytical central facility.

The Evaluation Committee notes that despite the adequate infrastructure described above it is evident that the faculty suffers from a lack of space. The department should expand both its research and teaching laboratories. There appears to be sufficient empty land around the two buildings of the faculty, making it possible to construct a third building close by; an additional building will solve all the space needs of the faculty. There is a need to renovate some of the teaching and research laboratories. The major equipment, on which the research in the faculty depends, requires substantial and expensive maintenance. Usually after a decade of operation, equipment such as electron microscopes has to be replaced. Also, the faculty may need to recruit more research staff to properly support the research laboratories and major analytical equipment. Hence, the faculty should have adequate financial resources to meet all the above needs. The Dean and the senior academic staff should continuously press the senior management of the Technion to put the Faculty in a central place on the endowments map of the institute. Fortunately, the president understands well the above needs and challenges. The fact that the faculty is ranked at the Technion as a top one in terms of research and teaching achievements and the number one in terms of third party funding per capita, should help to convince the management to invest the additional resources needed. The Dean and the senior faculty should make this a very high strategic priority.

Recommendations:

Long Term (1-3 years):

1. Renovate some of the teaching and research laboratories.
2. Be aware of the need to replace equipment, such as electron microscopes that need to be replaced.
3. Consider recruiting more research staff to properly support the research laboratories and major analytical equipment

3. Mission and Goals

Observation and Findings:

The Department of Materials Science and Engineering (MSE) at the Technion successfully educates engineers and professionals in three areas: Materials Engineering & Physics, Materials Engineering & Chemistry, and more recently Materials Engineering & Biology. It is the view of the Evaluation Committee that the MSE Department is a strategic department for the Technion as a whole, and moreover, that there is broad and deep support for the MSE Department amongst the administration. The Evaluation Committee was pleased to see that the MSE Department figures prominently in the Technion's strategic future plans, Globalization, for example, as well as in other new Technion initiatives described by President Prof. Peretz Lavie.

The MSE Department's academic philosophy starts with the assumption that a teaching environment centered on fundamental scientific issues provides students with a broad and excellent set of skills. The department is actively engaged in an effort to ensure that all undergraduate students succeed and is addressing the issue of dropout rates. The Evaluation Committee would like to acknowledge an excellent example of this proactive strategy, which is illustrated by the implementation of the 65/27 program that is maintaining an academic average of 65 for 27 credits during an undergraduate course of study. Similar to the high quality undergraduates in the MSE Department, the graduate students were impressive, although the MSE Department needs to increase enrollments. They are aware of this challenge and working on developing strategies.

The mission of the MSE Department is stated as follows:

"The mission of the Department of Materials Science & Engineering is to serve as the national center of teaching and research in materials science and engineering, by educating world class scientists and engineers and conducting cutting edge research in specific fields of materials science and engineering"

The Evaluation Committee finds that this mission statement is self-consistent and accurately reflects the education and research endeavors in the MSE Department at the Technion. However, the Executive Committee sees an opportunity for the MSE Department to play a leadership role in current and future materials-related activities throughout the Technion. A Technion-wide leadership role in materials science and engineering will provide the department with a platform to participate in current and planned interdisciplinary research. As such, the Evaluation Committee would like to make the following recommendations.

Recommendations:

Short Term (0-1 year):

1. The MSE Department should revise the mission statement to reflect a leadership role in materials research throughout the Technion.
2. The MSE Department should establish and implement a methodology to periodically assess the mission statement with all relevant constituencies: faculty, students, alumni and industry.

Long Term (1-3 years):

1. The MSE Department should convene an Advisory Committee and include members from national and international peer institutions, alumni, industry and government.
2. The MSE Department should implement regular reviews of the mission statement and engage all constituencies in the process.

4. Study Programs

Observation and findings:

In excellent agreement with its mission and strategy, the department has succeeded in covering a very broad spectrum of materials science from physics to chemistry including its basic engineering mission.

The department takes care of the rapidly changing discipline of materials science by hiring new faculty of novel and advanced fields and asking them to offer courses in their fields while allowing them within the first year to prepare for teaching and to set-up their own research.

In some cases we understood from students that prerequisites for offering some courses, which require the attendance of undergraduate student are not given. The large number of courses offered is mostly due to both existing dual programs; but 13 of the listed 51 courses marked with the superscript (e) require a lecturer to teach them and some of the 13 have not been offered within 4 years.

The high failure rate of students after the first year by not attaining the necessary credit points in the fields of mathematics and physics requires a detailed analysis. However, this is a general problem worldwide and is not a specific problem of the department. Nevertheless, the question of how much mathematics and physics is needed for undergraduates and who is teaching the corresponding courses should be addressed.

Regarding the breadth of research it might be helpful for MS- and namely PhD-students being informed about the various fields of the department by attending presentations of the corresponding faculty within department seminars.

Recommendations:

Short Term (0-1 year):

1. Offer courses not taught within more than three years with a higher frequency without increasing the teaching load by for instance combining course of similar content.
2. Offer seminars starting during the second year of the graduate program describing the ongoing research within the department. It is important to maintain close contact with the undergraduate students in the early stages of their studies, in order to develop from the beginning a high level of morale.
3. Evaluate the content of courses in physics and mathematics within the undergraduate program regarding the requirements for the graduate program of the department.

Long Term (1-3 years):

1. Regarding the proposed additional program in materials engineering the department may consider establishing four programs of study: 1. materials science and physics; 2. materials science and chemistry; 3. materials science and biology; and 4. materials science and engineering.

The committee is aware of the fact that a new program will require approval by the CHE. In this context the CHE should consider an accelerated procedure to deal with this modified program. It is modified with respect of the existing program as for the first two in the upper list no changes are required regarding the curriculum and for the third program approval has been obtained regarding the new program called materials engineering and biology. The proposed new program, materials science and engineering, does not require major changes in the courses presently being taught in the department. However, the most important aspect of the new program should be that the knowledge of classical materials, such as steel and aluminum alloys will be maintained in this department and taught to interested students. As these materials at present and in the future will be the materials produced and applied most, there will be a never ending need for knowing their properties. In addition, with the new and advanced techniques, such as atom-probe tomography, analytical transmission electron microscopy, and first-principles computer simulations we will gain a deeper and atomistic insight into their properties. In summary: (i) more students could be attracted for the new program considering the intellectually demanding new approach of fundamental research of classical materials; (ii) concerns mentioned by students and alumni about a loss of basic sciences need to be overcome as well as (iii) concerns of some of the faculty that

physics and chemistry research and teaching may overshadow the engineering mission of the department despite its relevance for science and technology, and Israeli industry.

5. Human Resources / Faculty

5a. Faculty

Observation and findings:

The faculty of the Department of Materials Science and Engineering (MSE) at the Technion – Israel Institute of Technology has 18 full-time members, with a distribution consisting of nine professors, six associate professors, and three assistant professors. This number of faculty members is small compared to highly ranked MSE departments in the USA, where typical numbers are as low as 20 and as high as 40 or more. Some of the teaching is also done by a small complement of adjunct faculty. Of the nine professors, five are retiring soon, and plans and the process are in place for their replacement in research areas that are in part reasonably direct replacement of existing expertise and in part new or evolving areas in MSE. Almost all faculty members are actively involved in research and teaching, but with wide distributions in the individual amounts of research activity and teaching involvement. The wide distribution of publication rates and citation counts suggests that appropriate evaluation of faculty research relative to their peers elsewhere should involve careful benchmarking of individual faculty output relative to measures within their specific areas and sub-areas of MSE. The average teaching load of three courses per year is consistent with the expected high level of research output at the institution. In general, students and alumni speak very favorably about their educational and research experience within the department and their interactions with the faculty.

The morale of the faculty appears to be high, although the comparatively slow rate of faculty promotion in the department compared to other Technion departments seems to have a negative impact. There appears to be only a modest amount of collaborative research done by MSE faculty with materials researchers in other departments at the Technion. The self-evaluation report did not discuss the nature and extent of the materials community of researchers in other departments at the Technion, but it probably involves another three to five times the 18 faculty members in MSE. There are opportunities to synergistically enhance the total materials research output in the MSE department and the institution as a whole by better definition and integration of the materials community through new

interdisciplinary interactive research programs. The existing energy program represents an excellent example and start in this direction.

Recommendations:

Short Term (0-1 year):

1. The department and the institution should benchmark the research output of faculty members relative to their specific areas and sub-areas of the field of MSE. The number of publications by faculty should be continuously assessed paying particular attention to the balance between number of publications and their quality.
2. The department should speed up the rate at which faculty are brought up for promotions, consistent, of course, with appropriate evaluation of faculty achievement.

Long Term (1-3 years):

1. The institution should allow growth of the MSE department to above 20 faculty members for the department to remain competitive with its international counterparts.
2. The institution, with substantial input from the MSE department, should nurture the formation of a more interactive materials research community through establishment of interdisciplinary research programs and centers that are primarily initiated through collaborative research efforts established by the Technion faculty.

5b: Technical staff:

Observation and findings:

The technical staff in the MSE department consists mainly of Ph.D. level researchers with Technion educational backgrounds, often complemented by several assistants who handle many day-to-day teaching activities. The research microscopy staff scientist and the facilities manager for undergraduate laboratory courses are excellent and appear to have their respective responsibilities well under control. The major issue with regard to the adequacy of technical staff involves the increasingly wide breadth of characterization techniques that are expensive and necessary (and becoming commonplace at most advanced research departments) for modern materials research – techniques such as, but not limited to, surface science, advanced x-ray diffraction techniques, ion beam technologies, atom probe

systems. As the materials community at the Technion grows, more Ph.D. level staff scientists will be required for proper maintenance of the instrumentation.

Recommendation:

Short Term (0-1 year):

1. The MSE department must take the lead in determining and defining the additional Ph.D. level staff needed to maintain the Technion at the forefront of advanced materials research. The institution must supply the funds to support these positions.

6. Students

Observation and findings:

The Evaluation Committee spoke with undergraduate students, 1st through 4th years, and MSc. and Ph.D. students, and alumni, in the absence of any faculty members of the Department of Materials Science and Engineering. Overall the Evaluation Committee found all of the students and alumni to be articulate and not bashful about expressing clearly their ideas and opinions. All of the students spoke in fluent English with the exception of one student. The Evaluation Committee was unanimously impressed by the energy level and engagement of the students and alumni. They all stated that they were happy that they had chosen the field of materials science and engineering as a career path.

The 1st and 2nd year undergraduate students discussed extensively the teaching of both mathematics and physics and they all mentioned the failure rate being high in both these subjects, and the fact that it wasn't uncommon to have to repeat one or more of these courses a second time because of failing grades. The Evaluation Committee was unable to find precise values of course failures in the self-evaluation report. Additionally, the Evaluation Committee was informed that the mathematics courses are taught by pure, as opposed to applied, mathematicians. Similar uniform complaints were raised about the teaching of physics, which indicates a very strong need for what appears to be a serious educational problem. The Evaluation Committee did not receive any complaints about the teaching of the chemistry courses.

The third and fourth year undergraduate students addressed a problem that can be characterized as one of. This is an important issue because one wants the undergraduate students to *esprit de corps* feel that they are in the minds and hearts

of the faculty at a very early stage in their academic studies. This is an issue that needs to be addressed by the faculty of the Department of Materials Science and Engineering starting immediately in the first and second years of undergraduate studies.

The issue of elective course offerings was discussed with the M.Sc. and Ph.D. students. It was stated that certain elective courses of interest were offered infrequently. An examination of the list of graduate courses in materials science indicates a list of 51 courses (Table 8 on page 23 in the SER), with five courses to be offered in the near future, and thirteen courses for which an instructor is being sought. The Evaluation Committee would like to strongly recommend that a detailed study be performed of this long list of courses with the aim of consolidating the list, which is excessive.

Recommendations:

Short Term (0-1 year):

1. Applied mathematicians as opposed to pure mathematicians should teach the mathematics courses because they have a better understanding of the needs of students who become engineers working in industry, students working in research laboratories, and students becoming academicians at universities or research institutes. This is a problem that needs to be addressed by the dean of undergraduate studies.
2. The quality of the teaching of the physics courses also needs to be seriously and vigorously addressed by the dean of undergraduate studies.
3. The problem of the *esprit de corps* of the undergraduate students needs to be examined immediately, commencing with first year students, with the goal of involving them in the minds and hearts of the faculty.
4. The list of 51 graduate courses, Table 8 on page 23 in the SER, needs to be reexamined in detail with the aim of consolidation, so that the M.Sc. and Ph.D. students are satisfied with the courses offered by the Department of Materials Science and Engineering. The committee thinks that a number of the courses can be consolidated with the aim of offering their subject matter more frequently; for example, combine *Dielectric Materials* with *Ferroelectric Materials,* combine *Polymer Blends, Polymer Surfaces*, and *Polymeric Materials* into one course, combine *Structure and Compositions of Interfaces* and *Structure of Interfaces,* etc.

Long Term (1-3 years):

1. Applied mathematicians, as opposed to pure mathematicians, should teach the mathematics courses because they have a better understanding of the needs of students who will become engineers working in industry, students working in research laboratories, and students becoming academicians at universities or

research institutes. This is a problem that needs to be seriously and vigorously addressed by the dean of undergraduate studies, Prof. Yachin Cohen.
2. The quality of the teaching of the physics courses also needs to be seriously and vigorously addressed by the dean of undergraduate studies, Prof. Yachin Cohen.
3. The problem of the *esprit de corps* of the undergraduate students needs to be continuously addressed, commencing with first year students, with the goal of involving them in the minds and hearts of the faculty. This should ideally increase the retention rate of undergraduate students to 100%.
4. The list of 51 graduate courses, Table 8 on page 23, needs to be reexamined with the aim of serious consolidation, so that the M.Sc. and Ph.D. students are satisfied with the courses offered by the department of materials science and engineering.

7. Teaching

Observation and findings:

In the SER, Table 22 on page 61 demonstrates that women are very well represented in the undergraduate program, which is most uncommon in departments of materials science and engineering and is certainly to be commended.

A problem of major concern is the dropout rate in the Materials-Physics undergraduate program (Table 24 on page 63). For example, in 2013 out of the 89 total students in this program nine (10.1%) dropped out, of which four were expelled and five changed departments. This is a significant problem that needs to be addressed as quickly as possible, so that the dropout rate can be reduced significantly.

The materials/chemistry program, Table 23 on page 61, has a total dropout rate, in 2013, of seven, which is 4% of the 174 students in this program. This dropout rate is significantly better than for the materials/physics program, but nevertheless it needs to be addressed.

Recommendations:

Short Term (0-1 year):

1. The dropout rate in the materials/physics program is unacceptably high and needs to be addressed immediately. In 2013 it was 10.1% out of the 89 students registered for this program.
2. The dropout rate in materials/chemistry program is smaller than in the materials/physics program, but nevertheless it needs to be addressed; in 2013 it was seven students (4%).

Until the next cycle of evaluation:

1. For the next cycle the Department of Materials Science and Engineering needs to demonstrate that it has solved the above two problems.

8. Learning Outcomes

Please see reference to this subject in Section number 9- the Self Evaluation section

9. Research

Observation and findings:

The amount of research funding per capita of the Materials Science and Engineering department is number one among all of the departments of the Technion, and is certainly competitive with the best MSE departments in the world. Among the various projects currently funded in the department the two ERC project are worth noting, not only because this is a highly competitive program, but also because it is prestigious and involves an important international collaboration component.

The research funding is a strong indicator of the high quality of the research done at the department, because evaluation of the corresponding proposals is conducted in most cases by peer reviewing based on the scientific quality of the application.
The number of publications and citations represents another metric that is widely used as an indicator of research impact, although the numbers are highly discipline dependent, and hence proper analysis should be done with utmost care. As another most used indication for success in research reveal a broad distribution due to differences of the expected numbers in the various fields of the faculty and the distribution of expected performance. Accordingly, the department should pursue a benchmarking study to assess faculty productivity and set expectations that are appropriate for the individual sub-field in materials science and engineering. Such a methodology can be used as an effective tool to motivate senior faculty as well as to provide junior faculty with clear path towards success in academe.

The width of the distribution of research subjects goes along with the mentioned breadth of teaching leading to synergy in both primary duties of the department

being research and teaching. Thus the mission of the department as expressed in its new name is fulfilled.

The excellent research facilities available at the department have to be kept in operation and renewed over the years, in order to maintain it as one of the prerequisites of excellent research.

Recommendations:

Short and long term (0-3 years):

1. With respect to number of publications and quality of related journals, it will be helpful for a further increase of the national and international visibility and high reputation of the department by defining bench marks for maintaining and increasing the performance of the faculty. These bench marks have to take into account the large differences existing in the various disciplines of materials science, i.e., physics-, chemistry-, biology- and engineering-based fields. As a helpful measure of excellence the bench marks may be also used to accelerate promotion of faculty besides other measures like the performance in teaching and administration.

Until the next cycle of evaluation:

1. There is always room for improvement; but for the evaluated department it could already be considered to be a great success, if it keeps its present high level of research.

10. Self-Evaluation Process

Observation and findings:

The self-evaluation report of the Department of Materials Science and Engineering of the Technion–Israel Institute of Technology follows a logical and comprehensive process of assessment and evaluation of all activities of the department. The process is a very good one that offers substantive information for regular periodic review of most of the department's activities. As such, the self-evaluation document has been a valuable resource in the conduct of this review.

The self-review report also demonstrates modest progress toward the development of a department-level process for continuous quality improvement of the undergraduate program based on assessment and evaluation of learning outcomes. The report contains a program-level statement of a general learning outcome that is

intended to be applied to undergraduates and MSc students. A process for measuring learning outcomes that includes use of homework problems and mid-term and final exams in courses and evaluation of oral presentations and written reports of students in laboratory courses is outlined. The process includes comprehensive faculty-wide evaluation of student reports and posters for senior projects. A substantive five-year summary of the undergraduate and MSc student grades is also included in the self-evaluation report and demonstrates that virtually all students do well enough to pass their courses and graduate, often with distinction. However, there is little evidence that the self-evaluation process is as yet robust enough to be effective at the department level. For example, only three course descriptions out of nearly twenty undergraduate courses contained learning objectives as part of the overall course syllabus, and no evidence was presented concerning evaluation of student achievement of these outcomes or that the course outcomes were used as input to evaluate achievement of the general program-level general learning outcome. Discussion with Technion administration heads at the summation exit meeting disclosed that plans at the institution level for assessment and evaluation processes that more fully incorporate substantial definition and use of learning outcomes in courses and program improvement processes are in progress

Recommendations:

Short term (0-1 years):

1. The department should require that all course syllabi contain a full complement of specific learning objectives that are measured, assessed, and evaluated by the faculty member in charge.

Long term (1-3 years):

1. The department should develop a process that incorporates achieved course-level learning outcomes into the evaluation of the department-level outcome (or possibly outcomes) and that can demonstrate evidence of continuous quality improvement of the undergraduate and MSc program. At the same time, the administration of the Institute should hasten its current efforts and plans to more effectively incorporate use of learning outcomes in the broader education process at the Technion.

Chapter 4: Summary of Recommendations and Timetable

Short term:

1. The MSE Department should revise the mission statement to reflect a leadership role in materials research throughout the Technion.
2. The MSE Department should establish and implement a methodology to periodically assess the mission statement with all relevant constituencies: faculty, students, alumni and industry.
3. Offer courses not taught within more than three years with a higher frequency without increasing the teaching load by for instance combining course of similar content.
4. Offer seminars starting during the second year of the graduate program describing the ongoing research within the department. It is important to maintain close contact with the graduate students in the early stages of their studies, in order to develop from the beginning a high level of morale, i.e., *esprit de corps.*
5. Evaluate the content of courses in physics and mathematics within the undergraduate program regarding the requirements for the graduate program of the department.
6. The department and the institution should benchmark the research output of faculty members relative to their specific areas and sub-areas of the field of MSE. The number of publications by faculty should be continuously assessed paying particular attention to the balance between number of publications and their quality.
7. The department should speed up the rate at which faculty are brought up for promotions, consistent of course with appropriate evaluation of faculty achievement. Applied mathematicians as opposed to pure mathematicians should teach the mathematics courses because they have a better understanding of the needs of students who become engineers working in industry, students working in research laboratories, and students becoming academicians at universities or research institutes. This is a problem that needs to be addressed by the dean of undergraduate studies.
8. The quality of the teaching of the physics courses also needs to be seriously and vigorously addressed by the dean of undergraduate studies.
9. The problem of the *esprit de corps* of the undergraduate students needs to be examined immediately, commencing with first year students, with the goal of involving them in the minds and hearts of the faculty.
10. The list of 51 graduate courses, Table 8 on page 23 in the SER, needs to be reexamined with the aim of serious consolidation, so that the M.Sc. and Ph.D. students are satisfied with the courses offered by the department of materials science and engineering. The committee thinks that a number of the courses can be consolidated with the aim of offering their subject matter more frequently; for example, combine *Dielectric Materials* with *Ferroelectric Materials*, combine *Polymer Blends*, *Polymer Surfaces*, and *Polymeric Materials*

into one course, combine *Structure and Compositions of Interfaces* and *Structure of Interfaces,* etc.

11. The dropout rate in the materials/physics program is unacceptably high and needs to be addressed immediately. In 2013 it was 10.1% out of the 89 students registered for this program.
12. The dropout rate in materials/chemistry program is smaller than in the materials/physics program, but nevertheless it needs to be addressed; in 2013 it was seven students (4%).
13. With respect to number of publications and quality of related journals, it will be helpful for a further increase of the national and international visibility and high reputation of the department by defining bench marks for maintaining and increasing the performance of the faculty. These bench marks have to take into account the large differences existing in the various disciplines of materials science, i.e. physics-, chemistry-, biology- and engineering-based fields. As a helpful measure of excellence the bench marks may be also used to accelerate promotion of faculty besides other measures like the performance in teaching and administration.
14. The department should require that all course syllabi contain a full complement of specific learning objectives that are measured, assessed, and evaluated by the faculty member in charge.

Long term:

1. Renovate some of the teaching and research laboratories.
2. Be aware of the need to replace equipment, such as electron optical instrumentation.
3. Consider recruiting more research staff to support properly the research laboratories and major analytical equipment
4. The MSE Department should convene an Advisory Committee and include members from national and international peer institutions, alumni, industry and government.
5. The MSE Department should implement regular reviews of the mission statement and engage all constituencies in the process.
6. Regarding the proposed additional program in materials engineering the department may consider establishing and strengthening four programs of study: (1) materials science and physics; (2) materials science and chemistry; (3) materials science and biology; and (4) materials science and engineering.
7. The institution should allow growth of the MSE department to above 20 faculty members for the department to remain competitive with its international counterparts.
8. The institution, with substantial input from the MSE department, should nurture the formation of a more interactive materials research community

through establishment of interdisciplinary research programs and centers that are primarily initiated through collaborative research efforts established by the Technion faculty.

9. The MSE department must take the lead in determining and defining the additional Ph.D. level staff needed to maintain the Technion at the forefront of advanced materials research. The institution must supply the funds to support these positions.
10. Applied mathematicians, as opposed to pure mathematicians, should teach the mathematics courses because they have a better understanding of the needs of students who will become engineers working in industry, students working in research laboratories, and students becoming academicians at universities or research institutes. This is a problem that needs to be seriously and vigorously addressed by the dean of undergraduate studies.
11. The quality of the teaching of the physics courses also needs to be seriously and vigorously addressed by the dean of undergraduate studies.
12. The problem of the *esprit de corps* of the undergraduate students needs to be continuously addressed, commencing with first-year students, with the goal of involving them in the minds and hearts of the faculty. This should ideally increase the retention rate of undergraduate students to 100%.
13. There is always room for improvement, but for the evaluated department it could already be considered to be a great success, if it maintains its present high level of research.
14. The department should develop a process that incorporates achieved course-level learning outcomes into the evaluation of the department-level outcome (or possibly outcomes) and that can demonstrate evidence of continuous quality improvement of the undergraduate and MSc program. At the same time, the administration of the Institute should hasten its current efforts and plans to more effectively incorporate use of learning outcomes in the broader education process at the Technion.

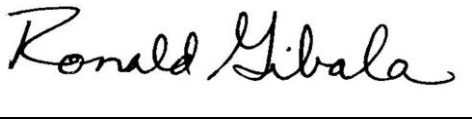
Signed by:

_____

Prof. Enrique J. Lavernia-Chair

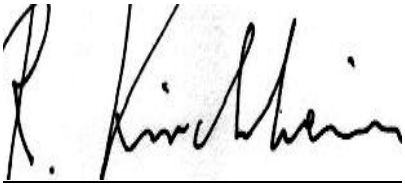
_____

Prof. Doron Aurbach



_____

Prof. Ronald Gibala



_____

Prof. Dr. Reiner Kirchheim

S

_____

Prof. David N. Seidman

Appendix 1: Letter of Appointment

March 2014

Prof. Enrique J. Lavernia,
College of Engineering,
University of California, Davis
USA

Dear Professor Lavernia,

The Israeli Council for Higher Education (CHE) strives to ensure the continuing excellence and quality of Israeli higher education through a systematic evaluation process. By engaging upon this mission, the CHE seeks: to enhance and ensure the quality of academic studies, to provide the public with information regarding the quality of study programs in institutions of higher education throughout Israel, and to ensure the continued integration of the Israeli system of higher education in the international academic arena.

As part of this important endeavor we reach out to world renowned academicians to help us meet the challenges that confront the Israeli higher education. This process establishes a structure for an ongoing consultative process around the globe on common academic dilemmas and prospects.

I therefore deeply appreciate your willingness to join us in this crucial enterprise.

It is with great pleasure that I hereby appoint you to serve as the Chair of the Council for Higher Education's Committee for the Evaluation of the study programs in **Material Engineering**. In addition to yourself, the composition of the Committee will be as follows: Prof. Ronald Gibala, Prof. Reiner Kirchheim, Prof. Doron Aurbach, and Prof. David Seidman.

Ms. Daniella Sandler will be the coordinator of the committee.

Details regarding the operation of the committee and its mandate are provided in the enclosed appendix.

I wish you much success in your role as the Chair of this most important committee.

Sincerely,

Prof. Hagit Messer-Yaron
Deputy Chairperson,
The Council for Higher Education (CHE)

Enclosures: Appendix to the Appointment Letter of Evaluation Committees

cc: Ms. Michal Neumann, Deputy Director-General for QA, CHE
Ms. Daniella Sandler, Committee Coordinator

Appendix 2: Site Visit Schedule

Department of Materials Science & Engineering
Schedule of site visit
Technion (Update 22.04.2014)

Tuesday, April 29th 2014

Time	Subject	Participants
09:00-9:45	Opening session with the heads of the institution and the senior staff member appointed to deal with quality assessment	**Technion's Administration**: **President**: Prof. Peretz Lavie **Senior Executive Vice President**: Prof. Moshe Sidi **Deputy Senior Vice President**: Prof. Daniel Rittel **Dean of Undergraduate Studies**: Prof. Yachin Cohen **Dean of the Graduate School:** Prof. Ben-Zion Levi
9:45-10:45	Meeting with the academic and administrative head of the Department of Materials Science & Engineering	Prof. Wayne Kaplan (Dean)
10:45-11:15	Meeting with Heads of the Undergraduate & Graduate committees	Prof. Dov Sherman (Head of the Undergraduate committee) Prof. Shlomo Berger (Head of the Graduate committee)
11:15-12:00	Meeting with senior academic staff	All faculty
12:00-13:00	Lunch (in the same room)	Closed-door working meeting of the committee
13:00-13:30	Meeting with Adjunct academic staff	2-3 participants: Dr. Ziv Atzmon, Dr, Shuki Yeshuron Dr. Maxim Levit
13:30–14:30	Meeting with BSc students**	Representatives (7-9)
14:30-15:00	Tour of facilities: classrooms, library, offices	Dean (Wayne Kaplan)
15:00-15:45	Meeting with MSc students**	Stas Obuhovsky, Moran Gross, Ruth Moshe, Oshri Blank, Lotem Buchbinder.

15:45-16:30	Meeting with PhD students**	Dor Amram, Pini Shechter, Hen Dotan, Sivan Fadida, Sasha Pachouck.
16:30-17:15	Meeting with Alumni**	Hila Meltzman, Yaron Kauffmann, Osnat Landau, Shelomo Mahari, Hagit Geler.
17:15-17:35	Closed-door working meeting of the committee	
17:35-18:00	Summation meeting with head of department	Dean (Wayne Kaplan)
18:00-18:15	Summation meeting with heads of institution	**Technion's Administration**: **Senior Executive Vice President**: Prof. Moshe Sidi **Deputy Senior Vice President**: Prof. Daniel Rittel **Dean of Undergraduate Studies**: Prof. Yachin Cohen **Dean of the Graduate School:** Prof. Ben-Zion Levi **Dean**: Wayne Kaplan

* The heads of the institution and academic unit or their representatives will not attend these meetings.
** The visit will be conducted in English with the exception of students who may speak in Hebrew and anyone else who feels unable to converse in English.