



# FACULTY OF MECHANICAL ENGINEERING TECHNION

## EVALUATION REPORT

COMMITTEE FOR THE EVALUATION OF MECHANICAL ENGINEERING STUDY  
PROGRAMS IN ISRAEL

JUNE 25, 2018

## Section 1: Background and Procedures

- 1.1 In the academic year 2017-18 the Council for Higher Education [CHE] put in place arrangements for the evaluation of study programs in the field of Mechanical Engineering [ME] in Israel.
- 1.2 The Higher Education Institutions [HEIs] participating in the evaluation process were:
- Afeka Academic College of Engineering
  - Ariel University
  - Ben-Gurion University
  - Ort Braude Academic College of Engineering
  - Shamoon Academic College of Engineering
  - Technion – Israel Institute of Technology
  - Tel Aviv University
- 1.3 To undertake the evaluation, the Vice Chair of the CHE appointed a Committee consisting of:<sup>1</sup>
- |                                       |  |
|---------------------------------------|--|
| • Prof. David Norris, Committee Chair | ETH Zurich, Switzerland  |
| • Prof. Leslie Banks-Sills            | Tel Aviv University, Israel                                    |
| • Prof. Patricia Brackin              | Rose-Hulman Institute of Technology, USA (ABET representative) |
| • Prof. David Clarke                  | Harvard, USA   |
| • Prof. Kon-Well Wang                 | University of Michigan, USA                                    |
| • Prof. William Wepfer                | Georgia Tech, USA  |
- Ms. Maria Levinson-Or served as the Coordinator of the Committee on behalf of the CHE.
- 1.4 The evaluation process was conducted in accordance with the CHE's Guidelines for Self-Evaluation (June 2017). Within this framework the evaluation committee was required to:
- examine the self-evaluation reports submitted by the institutions that provide study programs in ME
  - conduct on-site visits at those institutions participating in the evaluation process
  - submit to the CHE an individual report on each of the academic units and study programs participating in the evaluation
  - set out the Committee's findings and recommendations for each study program
  - submit to the CHE a general report regarding the evaluated field of study within the Israeli system of higher education including recommendations for standards in the evaluated field of study

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<sup>1</sup>The committee's letter of appointment is attached as **Appendix 1**.

- 1.5 The evaluation committee examined only the evidence provided by each participating institution — considering this alongside the distinctive mission set out by each institution in terms of its own aims and objectives. This material was further elaborated and explained in discussions with senior management, lecturers, students and alumnae during the course of each one-day visit to each of the institutions.<sup>2</sup>
- 1.6 This report deals with the Faculty of Mechanical Engineering School at the **Technion – Israel Institute of Technology**. The Committee's visit to the Technion took place on June 17<sup>th</sup>, 2018. The schedule of the visit is attached as **Appendix 2**.
- 1.7 The Committee thanks the management of the Technion and the Faculty of Mechanical Engineering for their self-evaluation information and their hospitality towards the Committee during its visit.
- 1.8 N.B. this report will use Faculty, with a capitalized first letter to refer to the Faculty of Mechanical Engineering and will use faculty with the first letter not capitalized to denote professors and lecturers collectively. This report will use Committee, with a capitalized first letter to refer to the international evaluation committee conducting this review.

## Section 2: Executive Summary

While the Committee identified specific areas that could be improved, the overall program either met or exceeded the expected threshold level of performance in all evaluated categories. Hiring efforts should proceed without delay to maintain or slightly increase the size of the faculty as colleagues retire over the next few years.

## Section 3: Observations

### 3.1 Introduction

The Technion is a leading educational institution in Israel with a strong international reputation. The Faculty of Mechanical Engineering is the oldest ME program in the country and typically provides leadership to the discipline in Israel. The program educates ~780 undergraduate and ~290 graduate students. It is well integrated in the Technion and well supported by the senior leadership. The Committee is confident that the Technion can sustain and enhance the ME program.

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<sup>2</sup>Prof. Leslie Banks-Sills did not participate in the visit to Tel-Aviv University or in the panel's discussions concerning the evaluation of this institution.

### 3.2 Management and Administration

Technion's Senior Executive Vice President and his team strongly support the Faculty of Mechanical Engineering. Technion is aggressively pursuing emerging research areas within a global context. The Faculty is generally supportive of this strategy as seen by their recent hires at the "periphery" of ME. While Technion leadership would like the Faculty to move more rapidly in this direction, the Dean must carefully manage natural generational and sub-disciplinary differences in opinion within the faculty.

ME faculty participate in Technion-wide interdisciplinary areas, including *Energy, Nano, Space, Water, Autonomous Systems, Transportation, and Integrated Cancer Treatment*, along with their research centers and corresponding graduate programs. The Committee recommends that the faculty increase their interactions with campus-wide centers, which can lead to additional resources from the administration.

The Committee was unable to discern the true extent of departmental decision-making and budget autonomy. However, the program has a well-established committee structure and all faculty appear to be fully integrated into the academic decision-making process.

The program is committed to diversity. For example, they have placed four female postdocs at prestigious US institutions with plans to recruit them afterwards as Technion faculty. Furthermore, this year's freshman class consists of 25% women, and the program has funding for underprivileged students.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### 3.3 Vision

The program has recently experienced a large influx of new hires (18 people in 6 years). Because many of these new colleagues perform research outside the traditional areas of ME, the faculty are now discussing how upcoming hires should balance needs in core versus emerging areas. This has led to a natural pause in faculty recruiting while a common vision is developed. However, the program must hire ~2 faculty per year simply to keep pace with retirements. Thus, the Committee urges the Faculty to continue to move forward in their hiring. For this, they have targeted four research areas. But they also plan to be flexible due to the small pool of Technion-caliber candidates available.

More generally, the Faculty has a plan, driven by Technion's self-evaluation process and the recent establishment of an Industrial Advisory Board. However, it does not have a formal strategic planning document.

In this area of evaluation, the Committee determined that the Technion meets the acceptable threshold level of performance.

### 3.4 QA & Self-Evaluation Process

The Technion carries out a self-evaluation of its Faculties every 7 to 9 years. The last evaluation of ME was in 2016. Hence, for this Committee, they submitted their self-study, the evaluation report from the International Review Panel (IRP),<sup>3</sup> and a recently prepared update to the self-study report of 2016.

In response to the recommendations of the IRP from 2016, various meetings were held, including a faculty retreat, a faculty meeting, and a meeting between the President, Senior Management, and the ME faculty. The Dean also reported to the Technion Senate. Hence, it appears that the report was taken seriously.

Some support for renewing laboratories has been provided. The Mechatronics Lab and the Control Lab (shared with Aerospace Engineering) were upgraded. Labs have been added to a few theoretical courses. This will continue. The Faculty should consider the use of learning outcomes in their courses.

An Industrial Advisory Board was established to provide input with representatives from start-ups, industry, government, IDF, and investors. A Curriculum Committee was set up to thoroughly examine the program. The faculty is now actively debating whether to make small changes or bold moves in their study program. These discussions are healthy for the future of the Faculty.

All of these activities, which resulted from Technion's self-evaluation process, convinced the present Committee that CHE does not need to re-evaluate the internal Technion QA process. Rather, CHE can simply monitor their reports.

In this area of evaluation, the Committee determined that the Technion exceeds the expected threshold level of performance.

### 3.5 Study program

The program is of very high quality at both the undergraduate and graduate level. Some of the program's online teaching is being used by students at other institutions in Israel. Furthermore, the MSc research is often considered by the faculty as a mini-PhD program.

In response to the 2016 IRP report, the Faculty is undergoing an extensive self-examination of its curriculum. While this process is not yet complete, it is clear that serious consideration is being given to reducing the number of specialization tracks, allowing students to take courses from more than one track, and possibly reducing the number of electives. Although the Faculty has not completely adopted the IRP recommendation to emphasize "capstone" design-and-build projects, they have introduced and implemented three types of final-year projects: (i) design and build projects, (ii) design projects, and (iii)

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<sup>3</sup>The members of their external evaluation panel were: Adnan Akay of Bilkent University and Carnegie Mellon University, Tamar Flash of Weizmann Institute of Science, Jayathi Murthy of UCLA, and Robert McMeeking (Chair) of UCSB.

research-based project. The new format also requires a mandatory presentation of the final results. The importance of the project has also been stressed by increasing the credits from (2+2) to (3+3). The final projects are excellent.

The Faculty began an international undergraduate program about two years ago that is taught in English. This is outside the normal undergraduate program and has attracted ~30 international students, mostly from China.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### 3.6 Teaching and Learning

The faculty are motivated and interested in teaching. They have developed an environment that encourages good teaching. New faculty and assistants are required to attend a two-day teaching workshop. Student surveys are conducted to evaluate each course. If faculty are having problems they can consult the Center for the Promotion of Teaching. The faculty also sought additional ways to help undergraduate students succeed in their studies (*e.g.* helping with Reserve duty and looking for funds to support final projects).

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### 3.7 Faculty

The Faculty of ME contains a strong group of academics with excellent achievements and potential. The program has recently recruited in diverse areas, as discussed above. Despite their aggressive hiring, the overall faculty size has decreased. The Committee agrees with the Faculty that its size can increase to 42-45. The initiatives of expanding classes in English and hiring non-Hebrew speakers will help enhance the program's recruiting competitiveness. The ability to offer specific candidates (junior or senior) a salary boost would also help.

The ME program has an informal mentoring system for un-tenured and non-full-professor faculty. This includes meetings with the Dean. However, this system and the detailed guidelines for promotion and tenure are perhaps insufficient. Due to its large size, the Faculty should consider a more structured mentoring program and better communicate promotion and tenure guidelines to the faculty. At the same time, the Faculty should carefully consider academic performance assessments, including both quality and impact. This is especially important now that many faculty have diverse backgrounds, which can lead to different measures of scholarship compared to traditional ME.

The faculty appeared very supportive of new hires. Faculty are consulted and have a voice in some of the program directions. The Technion also provides good resources to encourage faculty research and graduate-student mentoring, *e.g.*, providing significant internal funds to support graduate students.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### **3.8 Research**

From the recently hired faculty, two have received ERC starting grants, two have received the Alon fellowship, and two the Krill award. Over the past 5 years, 11 new research laboratories have been established (\$8.4 million).

The level of research in the Faculty is very good to excellent. Areas of research include: (1) thermal sciences and fluid mechanics, (2) solid mechanics and micro-systems, (3) robotics, control, and dynamics, (4) manufacturing, design, and CAD, (5) biomechanics, and (6) optical engineering. The faculty bring in over \$4 million annually in research funds. The faculty have a high international presence including collaborations and contributions to international programs.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### **3.9 Students**

Students are admitted into the program based on a combination of factors. Technion routinely has entering class averages above their minimum desired value. The ME program has very high admission credentials (3<sup>rd</sup> highest in engineering). The faculty report that the quality of the students is excellent.

Although we did not speak with students or alumni, they obtain good jobs in industry and a significant portion go on to graduate school. Technion's efforts to attract students to graduate studies and then monitor their progression for potential hiring after they complete a post-doc is commendable.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

### **3.10 Infrastructure**

The Faculty infrastructure is excellent with the recent completion and occupancy of their new building. The faculty spoke highly of the teaching labs and of the study space for students. No issues were identified regarding infrastructure, although it was not clear how the Faculty allocated resources for materiel and consumables for the undergraduate projects.

In this area of evaluation, the Committee determined that the Technion clearly meets the expected threshold level of performance.

## Section 4: Recommendations

### Essential recommendations:

- Future self-evaluation reports from the Technion's QA internal process should be monitored by CHE, without requiring a second evaluation from a separate international committee.

### Important recommendations:

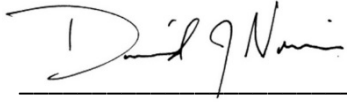
- The Faculty should continue to move forward in their hiring to maintain or slightly increase the size of their faculty.
- The Technion should consider further mechanisms to enhance hiring competitiveness to encourage the best talent on an international level to come to their programs.
- The Faculty's Curriculum Committee should complete its current process regarding potential changes to their study program.
- The Faculty should add a more structured faculty mentoring program.

### Desirable recommendations:

- The Faculty should consider the use of learning outcomes in their courses.
- The Faculty should consider enhancing connection to its alumni.
- The Faculty should consider expanding use of English in the undergraduate program.



Signed By:



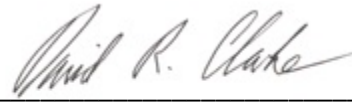
Prof. David Norris  
Committee Chair



Prof. Leslie Banks-Sills



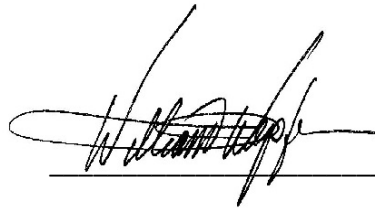
Prof. Patricia (Patsy) Brackin



Prof. David Clarke



Prof. Kon-Well Wang



Prof. William Wepfer

## Appendix 1: Letter of Appointment



January 2018

Prof. David Norris  
Department of Mechanical and Process Engineering  
ETH Zurich  
Switzerland

Dear Professor,

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 by accepting our invitation to participate in our international evaluation committees. 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 chair of the Council for Higher Education's Committee for the Evaluation of the study programs in **Mechanical Engineering**. In addition to yourself, the composition of the Committee will be as follows: Prof. Leslie Banks Sills, prof. Patricia Brackin, prof. David Clarke, prof. Kon-Well Wang and prof. William Wepfer.

Ms. Maria Levinson-Or 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 chair of this most important committee.

Sincerely,

Prof. Ido Perlamn   
Vice Chair,  
The Council for Higher Education (CHE)

*Enclosures:* Appendix to the Appointment Letter of Evaluation Committees

cc: Dr. Varda Ben-Shaul, Deputy Director-General for QA, CHE  
Ms. Maria Levinson-Or, Committee Coordinator

## Appendix 2: Visit Schedule

<u>Mechanical Engineering - Schedule of site visit</u> <u>Technion</u> Sunday , June 17 ,2018 Dan and Betty Kahn Building , Room 316		
09:00-10:00	Opening session with the head of the institution	Prof. Adam Shwartz, Senior Executive Vice President Prof. Hagit Attiya, Executive VP for Academic Affairs  Prof. Wayne Kaplan, Executive VP for Research  Prof. Boaz Golany, VP for External Relations and Resource Development  Prof. Emer. Zalman J. Palmor, Executive Vice President & Director General Prof. Alon Hoffman, Deputy Senior Vice President Prof. Orit Hazzan, Dean of Undergraduate Studies Prof. Dan Givoli, Dean of the Graduate School
10:00-11:30	Meeting with the Dean and Vice Dean of the Mechanical Engineering Faculty	Prof. Yoram Halevi , Dean  Prof. Oleg Gendelman, Vice Dean for Graduate Studies Assoc. Prof. Dan Mordehai, Vice Dean for teaching Assoc. Prof. Sefi Givli, Vice Dean for undergraduate Studies
11:30-12:45	Meeting with the Track Coordinators	Prof. Izhak Bucher, Head of the Curriculum committee  <b>Track Coordinators:</b>  Asst. Prof. Gal Shmuel - Material Mechanics and Microsystems (MEMS) Prof. Michael Shapiro - Energy Assoc. Elon Rimon - Revadim (Robotics, control, dynamic system, Mechatronics) Assoc. Prof. Reuven Katz - Design, Manufacturing and CAD/CAM Assoc. Prof. Carmel Rotschild – Optical Engineering Asst. Prof. Shelly Tzlil - Biomechanics  Assoc. prof. Nitai Drimer – Marine Engineering  <u>Honors Program:</u> Assoc. Prof. Dan Mordehai –“Brakim”  Asst. prof. Shmuel Osovski – “Reamim”