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WHAT'S THE MOON MADE OF?

Technion researchers provide answers
45 years after Man conquered the Moon

Scientists believe that the Moon was formed mostly from material that came with a giant impactor that struck the proto-Earth.

Given that most of its material came from another body in the Solar System, it was expected that the composition of the Moon should also be very different from that of the Earth. Yet, analysis of Moon samples obtained by the Apollo missions showed otherwise – in terms of composition, the Earth and Moon are almost twins.

With their distinct dissimilarity from that of other bodies in the Solar System, it seems odd that the composition of the Moon is so similar to that of the Earth. This inconsistency challenges the giant impact scenario. Breakthrough research, conducted by Prof. Hagai Perets of the Faculty of Physics and colleagues, and published in *Nature* in April 2015, is able to reconcile this perceived contradiction that has puzzled astrophysicists for some 30 years.

"According to the 'giant impact' paradigm," explains Perets, "the Moon was formed following a collision between a small Mars-like planet, known as Theia, and the proto-Earth.

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SWEET SUCCESS

Over the past few decades, the number of people with diabetes mellitus has more than doubled globally, making it a crucial public health challenge worldwide, with pre-diabetes increasingly observed among children, adolescents, and younger adults. To date, there is no cure for Type 2 diabetes mellitus (T2DM), so treatment aims at keeping blood glucose levels as normal as possible and controlling symptoms to prevent health problems developing later in life.

A generous and far-sighted gift made last year has enabled the establishment of The Rina and Avner Schneur Center for Type 2 Diabetes Research. The Center brings together Prof. Shulamit Levenberg, a leading researcher from the Faculty of Biomedical Engineering, with Prof. Eddy Karnieli, an eminent clinician from the Rappaport Faculty of Medicine, to seek a cure for T2DM.

Levenberg explains, "The Center was established to find new technologies to cure Type 2 diabetes. Research is

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AND THEN THERE WAS NANO

(The Smallest Bible in the World)

Technion's Nano Bible, created at the Russell Berrie Nanotechnology Institute, is on show at the Israel Museum's iconic Shrine of the Book.

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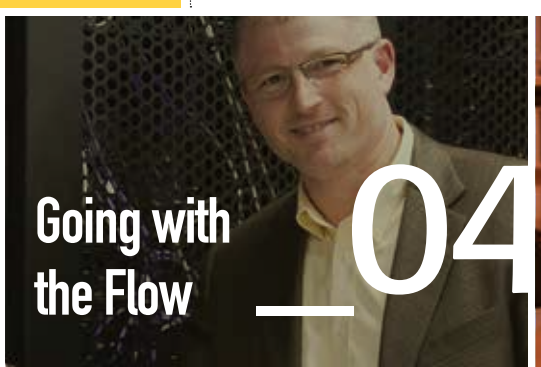
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FROM THE PRESIDENT

(l-r) Technion President Prof. Peretz Lavie presents Dean Kamen with an honorary doctorate.

So far, 2015 is proving to be a landmark year for Technion in many respects, locally, nationally, and internationally. It is 90 years since Technion's official Opening Ceremony in February 1925, celebrated on Tu B'Shvat (New Year for Trees), when our institution was known as "Technikum." The great Zionist leader, Menachem Ussishkin, who presided over the ceremony, opened with the following words: "Basic research and applied research are the two sides of the same coin. The Technikum will do both".

Indeed, since that time, we have been doing both, as well as educating more than one hundred thousand of the brightest scientific minds who have built the country as engineers, scientists, architects, and medical frontrunners.

This year, we celebrated Tu B'shvat by awarding an honorary doctorate to entrepreneur and inventor Dean Kamen – one of the world's great innovators and creator of the global robotics organization, FIRST. This year, FIRST Israel is celebrating its 10th anniversary and the Technion is very proud to have adopted this as its flagship pre-university program.

This year also marks 50 years of diplomatic – and scientific – relations with Germany. Technion celebrated this significant landmark in March with a Green Photonics symposium, organized jointly by the Russell Berrie Nanotechnology Institute, the German Technion Society, and TU Berlin. A significant portion of the conference addressed innovative technologies based on advanced use of photons, paying tribute to the UN International Year of Light.

Technion's own champion of light, Mordechai (Moti) Segev, the Robert J. Shillman Distinguished Chair, was elected in April to the prestigious U.S. National Academy of Sciences. There he joins three other Distinguished Technion Professors: Jacob Ziv, Avram Hershko, and Aaron Ciechanover.

Three Technion alumni were among the 14 "trailblazing Israelis who made the world a better, safer, more interesting and more advanced place," who lit torches on Independence Day. We are gratified that Gavriel Iddan, inventor of the PillCam, Alice Miller, who pioneered the right of women to have full representation in all sectors, and Rafi Mehoudar, who brought drip irrigation to its current global prevalence, were all educated here at Technion.

This year, the Israel Museum in Jerusalem is also celebrating its 50th anniversary. The exhibition, "And Then There Was Nano – The Smallest Bible in the World" brings the Technion Nano Bible to the Shrine of the Book. This exhibition is a fascinating confluence of history, culture, and cutting-edge science — where the Land of the Bible meets the Start-Up Nation.

Every year, the Technion campus is abuzz with new developments, and each spring with a symphony of colors as flowers bloom. One new addition to our landscape, particularly close to my heart, is the recent installation of an inspiring sculpture, *Triangularity,* created and donated by David Bakalar. This sculpture depicts three figures of Man that interact with a coded double helix. As one walks around the sculpture, Man is portrayed in on and off mode: a full silhouette from one angle; from another, he assumes the negative form.

And so clearly is Technion open to complex, multiple interpretations, living in harmony with Nature and simultaneously pushing its boundaries to the very limit and beyond. I welcome you to explore its many facets in this issue of *FOCUS.*

SWEET SUCCESS

▶▶▶ …continued from page 1

done in biomedical engineering in collaboration with the medical faculty. We are combining cell and tissue engineering technologies to control blood glucose levels."

The first symposium on T2DM research held under the auspices of the center took place on May 3, 2015. International keynote speakers included Prof. James Shapiro of the University of Alberta, Canada, who delivered a lecture on islet transplantation technologies. "We can achieve the same results today with cell treatment that could previously be achieved only by whole pancreas transplant," he reported.

Harvard Medical School Prof. Rohit Kulkarni, spoke about the use of induced pluripotent stem cells in the treatment of this huge problem of diabetes. He noted that mature cells can be reprogrammed to become pluripotent, and referred to the 2012 Nobel Prize won by John Gurdon and Shinya Yamanaka for the discovery that mature cells can be converted to stem cells.

Prof. Derek LeRoith, who recently joined Technion's Rappaport Faculty of Medicine, discussed the triangle of obesity, diabetes, and cancer. He presented research that throws light on cancer deaths associated with obesity, and the aggressive effect of insulin on tumor growth. Specifically, he described how obesity and T2DM affect breast cancer development and metastases.

(l-r) Prof. James Shapiro (Alberta, Canada), Prof. Derek LeRoith and Prof. Shulamit Levenberg (Technion), Prof. Rohit Kulkarni (Harvard, USA) and Prof. Eddy Karnieli (Technion).

Co-chair Prof. Eddy Karnieli, in his closing remarks, commented that the recent addition of LeRoith to the faculty is empowering diabetes research in Israel's north. He summarized that the symposium focused on the diverse areas of basic science, translational medicine, and peripheral factors such as transporters. "At our next meeting, I am looking forward to bringing new data collected at the Schneur Center," he said.

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TECHNION. *together.*

The Board of Governors June 2015 events mark the dedication of the **Joel S. and Jeri J. Rothman Apartment** and the **Florette and Henri Avram Dormitory Building** in the **Zielony Graduate Student Village.**

Shabbat Science highlights Technion Space Research, presented by both new and senior scientists. **Gary Goldberg** of Canada will moderate this illuminating session.

Dr Qanta Ahmed, a Muslim women's rights advocate, staunch supporter of Israel, and outspoken critic of radical Islam is interviewed by Technion president and fellow sleep researcher, Prof. Peretz Lavie.

An exclusive screening of the documentary episode "The Secret Handshake" is followed by a panel discussion with the two featured Nobel Laureates, **Prof. Michael Levitt** and Technion alumnus **Prof. Arieh Warshel,** moderated by Uri Rosenwaks, director and producer of the series *The Nobelists*. The screening is courtesy of YES Doco, The Gesher Multicultural Film Fund, and The Avi Chai Foundation.

The distinguished laureates also unveil their signatures at the Schulich Faculty of Chemistry's Wall of Fame, followed by an awards ceremony that recognizes Technion research innovation and academic excellence.

Prof. Shamay Assif, of the Faculty of Architecture and Town Planning and head of the **Philip and Ethel Klutznick Center for Urban and Regional Studies,** presents "Technion 21C" – the master plan for the Technion campus.

A salute will be made to Bernard M. Gordon and the **Bernard M. Gordon Center for Systems Engineering.** A Memorandum of Understanding between the University of Waterloo and the Technion will be signed for the establishment of a **Collaborative Quantum Communications Satellite Project.**

Finally, a special event at the Israel Museum in Jerusalem includes a private visit to the exhibition And Then There Was Nano – The Smallest Bible in the World (see story on page 8).

AWARDS TO PUBLIC FIGURES AND TECHNION SUPPORTERS:

Honorary Doctors
Sandy Hittman, USA
Prof. Michael Levitt, USA/Israel
Prof. Krzysztof Matyjaszewski, USA
Joel S. Rothman, USA
Prof. Arieh Warshel, USA/Israel
Sanford I. Weill, USA
Prof. Charles Weissmann, Switzerland

Honorary Fellows
Dr Qanta Ahmed, USA/UK
Harry J.F. Bloomfield, Q.C., Canada
Rebecca Boukhris, Israel/France
Dr Amit Goffer, Israel
Robert Hanisee, USA
Avi Kerbs, Israel
Sonia Marschak, USA
Allen Prince, USA

Prof. Anat Rafaeli, head, engages with Technion International students.

Happy Campers – and Other Dissatisfied Customers

By Amanda Jaffe-Katz

"Customers may always feel they are right," says Prof. Anat Rafaeli of the Davidson Faculty of Industrial Engineering and Management, "but they are certainly not always happy. In part, this is because constraints of time and organizational policies limit what employees can do, which is frustrating for customers, and too often creates a classic 'shoot the messenger' response."

Rafaeli, the Yigal Allon Chair of People at Work, studies expressions of emotion in organizations. Despite general perceptions, she says, emotions play an integral role in modern workplaces. And organizational requirements regarding emotions are the focus of Rafaeli's research. Some three decades ago, she introduced the concept known today to all researchers in her area as Emotional Labor. It refers to the labor of displaying emotions expected and needed for the promotion of organizational goals.

Emotional Labor is often required in jobs with customer-service interactions. Examples are flight attendants and nurses, who must show friendliness and empathy respectively; less obvious examples are police officers and interrogators who must be firm with suspects, and empathetic with victims and witnesses. Rafaeli's research shows that training and experience help employees to regulate their expression of organizationally required emotions.

"Note the distinction," Rafaeli counsels, "expressed emotions are not necessarily felt emotions. We have research on the dissonance between what employees feel and what they must display, and the implications of such dissonance."

An assumption in customer service is that customers must be satisfied, and, further, that if employees are nice, customers will surely be satisfied. This does not always work, and indeed customers are often frustrated and angry.

"The moment of truth is when employee meets customer," Rafaeli continues. "Wait time is the best predictor of customer anger."

Yet, the research shows that customer anger causes employee "depletion." This means that employees who encounter angry customers make more mistakes, experience greater burnout, become more fatigued, and furthermore, these effects are carried over into subsequent customer interactions. A worldwide feature of call-center staff, whose average turnover time is a mere 12 to 14 months, is the sentiment that, "everyone is hostile to me."

"This means that companies expend resources in recruitment and training, and that customers are more likely to encounter new, inexperienced employees. The solutions of extrinsic rewards, such as salary or perks, are not very helpful when it comes to the frustration and burnout of handling angry customers," Rafaeli explains.

> "The solutions of extrinsic rewards, such as salary or perks, are not very helpful when it comes to the frustration and burnout of handling angry customers."

Rafaeli believes that rather than manage the employee, management should reduce the reasons that cause customer anger, such as waiting, and think about managing the customer. "Providing the customer with more information can be very helpful," she says. "In research we did in a hospital emergency room, information about why waits are long made people feel less frustrated and less angry with the hospital staff, be it nurse, administrator, or doctor."

"Technion has a great graduate program in Behavioral Sciences and Management," claims Rafaeli, "and 80 percent of my recent work has been done with these students." This includes the above work on customer anger. And recent research, with Yakir Rosenfeld and Daniel Altman, examines emotion in a large-scale organizational social network, in an international high-tech company.

Rafaeli is now working on a new interdisciplinary project through the Jacobs-Technion Cornell Institute, funded by AOL, where she will extend this research. The long-term goal is to develop "virtual frontline agents" – replacing people with technology – so service will be summoned through chats, Twitter, and other social media. The design of the interaction between customers and such virtual agents is a lot of work, and Rafaeli is joining forces with colleagues from the Faculties of Computer Science and Electrical Engineering toward this goal.

Technion International HQ

Aside from her research and teaching, Prof. Anat Rafaeli heads Technion International (TI) – the center for all international initiatives held at the Haifa campus. She sees it as a tremendous opportunity for Technion to position itself in the global education arena. "We get lots of requests and offer a variety of programs for students from all over the world. This is the beauty of the operation but also the challenge. The Technion culture needs to adapt," she says. "Our focus is not research but also not just teaching. There is something else here, namely, cultivating international relations that are student-centered."

TI's first program was a BSc in Civil Engineering, taught in English, with the third cohort graduating in August 2015. That same month, Chinese students from Guangdong Province – as a prelude to establishing the Guangdong-Technion Institute of Technology (GTIT) – will commence a new undergraduate program, also taught in English, in Chemical Engineering with a minor in Environmental Technologies. "The Li Ka Shing Foundation initiative for Guangdong would not have been possible without the proven successful infrastructure of TI," says Rafaeli.

> "The Li Ka Shing Foundation initiative for Guangdong would not have been possible without the proven successful infrastructure of TI."

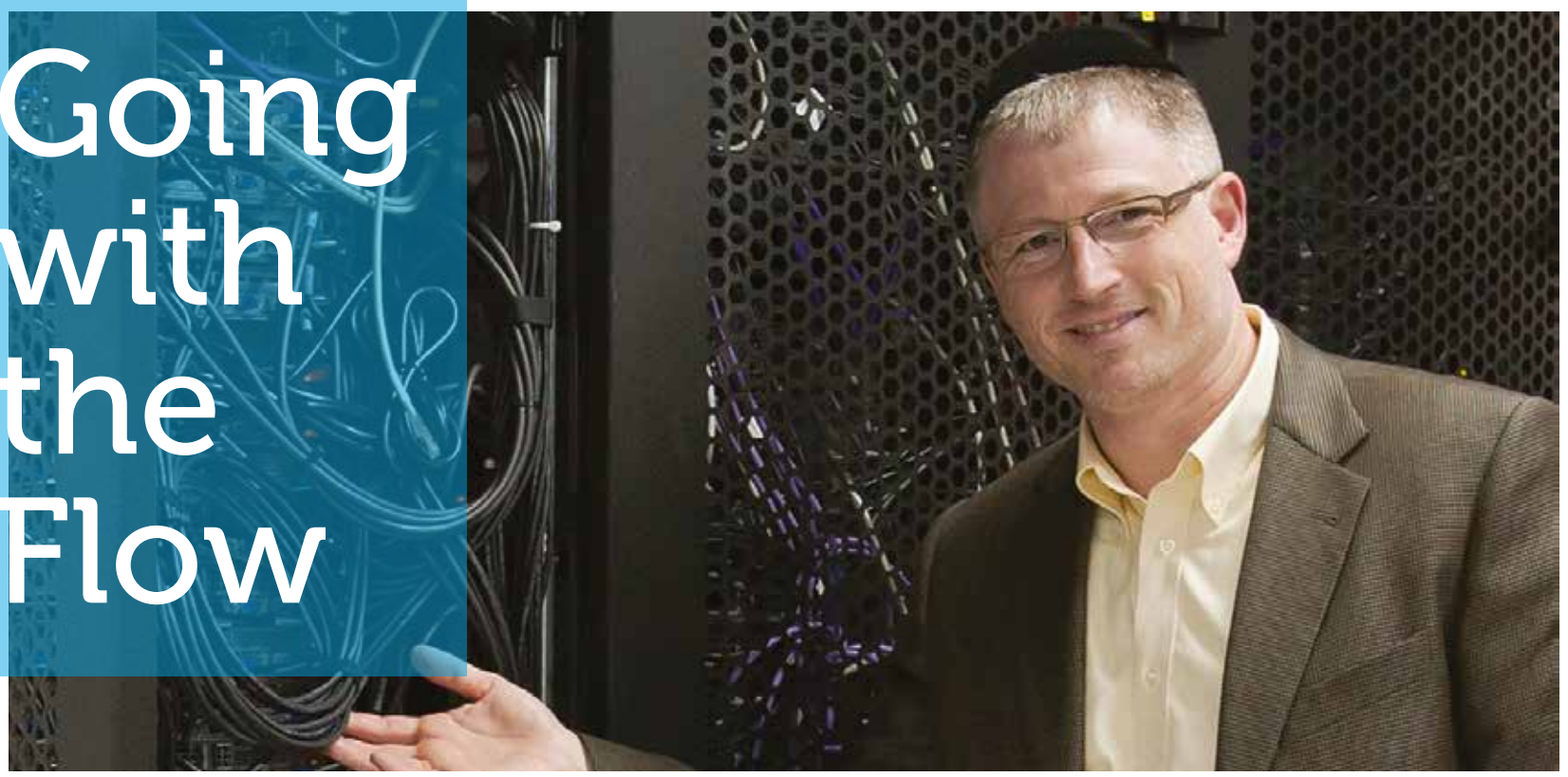
A third TI program is a first year in Russian, during which students also study Hebrew. "Graduates of this introductory year must satisfy two requirements: an adequate knowledge of Hebrew and the ability to be accepted into a regular Technion program from their second year," Rafaeli explains.

TI also offers a variety of short-term programs, which span periods of two weeks to one year and include students on research internships and "Study Abroad." A new development is customized study tours for students from a specific university.

Finally, Rafaeli helps develop opportunities for international graduate students and postdoctoral research visitors in collaboration with the Jacobs Graduate School and the VP for Academic Affairs. "There is both supply and demand for international people of this caliber," she says, "and since the focus is research, language is less of a constraint. These efforts are also essential for our development of the Guangdong faculty."

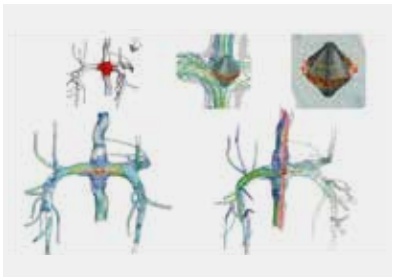
"In five years, we hope for a rise of 30 percent in the number of international postdocs and a 20 percent increase in undergraduate and graduate students," Rafaeli concludes.

Going with the Flow



Prof. Steven Frankel, Faculty of Mechanical Engineering

By Gail Lichtman



Images from the computational surgerical implantation and high-fidelity blood flow simulation of the chronic pump in a patient-specific Fontan circulation showing blood vessel and pump geometry together with complex flow patterns, structures and particle tracks.

Prof. Steven Frankel, the Rosenblatt Chair in Mechanical Engineering, joined the Technion in June 2013 with an impressive résumé of 20 years of research work in the field of computational fluid dynamics (CFD) at Purdue University. Since then, he has set up Technion's new CFDLAB and is engaged in several significant projects.

"My research concerns computational simulation of fluid flows," explains Frankel. "These flows can be liquid or gas or multiphase liquid and gas combinations. My work involves developing and applying computational models for fluid flows, focusing on turbulence."

The CFDLAB specializes in using high-performance computing to simulate complex flows in a variety of application areas. "Our work has implications for air flow over aircraft wings, combustion inside engines, and blood flow through blood vessels, blood pumps, stents, and so on," Frankel continues.

"Our work has implications for air flow over aircraft wings, combustion inside engines, and blood flow through blood vessels, pumps, and stents."

Many of these types of simulations require large-scale computations using high performance parallel computers. The new CFDLAB, which opened in January 2015, has a parallel computer with 1,024 processors and is one of the largest computers for any one faculty member at Technion. It is Frankel's pride and joy.

With his current staff of six assistants, two postdoctoral, two doctoral and two masters' students, he has been able to successfully carry out a virtual simulation of surgical implementation of a new heart blood pump he helped develop along with a pediatric cardiac surgeon at Riley Children's Hospital, Dr. Mark Rodefeld, while still in Indiana.

"Generally speaking, congenital heart defects are the number one birth defect. Ten out of every 1,000 babies born have congenital heart disease," Frankel notes. "For the last 25 years, the condition has been treatable. However, these children, and young adults face continuous medical problems."

In a normal heart, the left ventricle pumps blood to the body while the right ventricle pumps blood to the lungs. Babies born with the above condition have a single working ventricle, and require serious open heart surgery.

"These babies need a procedure that bypasses the right ventricle and sends the blood directly to the lungs," Frankel notes. "We use the existing ventricle to pump blood to the body. Generally, these babies have three open heart surgeries during their first few years of life. Despite these surgeries, they have problems for the rest of their lives. Some of these babies even need heart transplants later on."

Most existing heart pumps are designed for adults, and are for the left side of the heart since most heart attacks occur on that side. They pump blood at a higher pressure, with a normal mercury level of 120 mm. In addition, they spin at 50,000 RPM.

"Children with congenital heart problems need a device for the right side of the heart with less pressure," Frankel states. "We designed a metal pump that provides only a few mm of mercury and has a very gentle spin – 3,000 RPM. It is like the gentle cycle spin on the washing machine."

"We are able to use real patient-specific cases for our simulation."

"We designed a high-fidelity simulation tool which captures flow features and is capable of handling complicated geometry such as patient anatomy," he says. "We are able to use real patient-specific cases for our simulation, in which we directly connected the pulmonary arteries to the lungs which forms a T-junction. Our pump, which spins in the center of the junction, acts like a traffic rotary, directing the flow of blood and giving a boost to the blood flowing to the lungs."

Frankel stresses that what he is doing in the lab is developing the software to study complex flow patterns in the human body. The actual physical development of the pump prototype will be carried out by outside engineers.

Frankel's second project, developed entirely at Technion, uses the same software as the blood pump but simulates air flow around helicopter blades.

"A helicopter is a complicated device from an aerodynamic point of view," he states. "The rotary blades spin and create lift. It is important to be able to predict air flow in order to be able to fly and maneuver. We are currently simulating helicopters in hover in a project with the Israeli Ministry of Defense and the U.S. Army and are developing capabilities for future helicopter design. The next generation of helicopters may have co-axial rotors. Instead of one set of blades, they will have two, one on top of the other. Two rotors will provide a more powerful lift and more stable flight."

Frankel and team have simulated five-blade co-axial rotors. "This is a relatively new capability and the work on it is being done here at Technion," he says proudly.

Frankel had never been to Israel until March 2012, when he came for a professional conference at the Dead Sea. "By the end of the trip, I saw that I could succeed in Israel both professionally and personally. I also realized that it was time to make aliyah before the children got too old to adjust."

"I was fortunate enough to have multiple job opportunities from several universities in Israel, some much closer to Beit Shemesh, where we live, but I chose Technion despite the longer commute and I am very pleased I did. I have learned that life can be challenging and good at the same time," Frankel concludes.

Prof. Steven Frankel is planning the first Israel national conference on CFD (www.cfdimpact.org) to take place June 30, 2015, with a high-profile speaker from abroad.

IN A HEART BEAT

By Gail Lichtman

Even though she has only had her appointment as an assistant professor in the Faculty of Biomedical Engineering since March 2014, and is not much older than the students she teaches and supervises, Dr Yael Yaniv already has achieved two breakthroughs and won six grants for her research in understanding and monitoring heart activity.

As head of the Bioelectric and Bioenergetics Systems Laboratory, Yaniv, who received all three degrees from the Technion, concentrates on how changing amounts of energy produced by heart cells affect electrical activity in the heart. "I am looking at the internal mechanisms that affect electrical activity and induce abnormalities in heart function," she states.

"Heart disease remains the number one killer in Western societies," continues Yaniv, who did her postdoctorate and worked as a researcher for seven years at the National Institutes of Health (NIH). "Unfortunately, once heart disease is diagnosed, there is no cure. You can only try to manage the condition. My quest is for early detection. I believe that if we are able to detect heart problems at an earlier stage, drug treatments could be more effective. We could decrease deterioration and may even be able to repair damage."

"Once heart disease is diagnosed, there is no cure. You can only try to manage the condition. My quest is for early detection."

"The device will give physicians the ability to have 24/7 monitoring of at-risk populations."

Yaniv's first breakthrough is the development of a mobile device for early detection of arrhythmia that enables affordable, easy-to-use, real-time monitoring from a distance.

Cardiac arrhythmia (also known as irregular heartbeat) occurs when the electrical impulses that coordinate heart beats do not work properly, causing the heart to beat either too fast, too slowly or irregularly. Although many arrhythmias are not life threatening, some can cause serious impairment of cardiac function and even stroke – one of the most common causes of death in Western countries.

"It is known that normally the heart rate is not constant," she relates. "When a person's heart rate variability becomes constant, then we know that this is a signal that arrhythmia will occur shortly afterwards."

Today, to measure a patient's heart rate over time, the patient must be hospitalized and hooked up to an EKG for 24 hours. The data generated are then sent to a technician and processed. It takes a long time to get results and is very expensive.

The device that Yaniv has built can be worn on the patient's wrist and enables monitoring the patient from anywhere – home, work, or even remote areas. Data are fed to a chip for analysis. The results are available within a few minutes and sent to a mobile device or an iPad. Yaniv has developed an App for both patients and their physicians. Both will get an alert that arrhythmia is about to occur in approximately the next five minutes. The patient can then rest in order to try to prevent arrhythmia.

"The device will give physicians the ability to have 24/7 monitoring of at-risk populations," Yaniv explains.

Until now, the device was tested on computer and animal models. Yaniv is now working on an ethics protocol to enable testing on human beings, in conjunction with Rambam Health Care Campus in Haifa. This protocol will take from six months to a year to develop.

Human heart rate is controlled by two signals – one from the brain and the other from an internal mechanism in the heart's natural pacemaker. Yaniv, along with the six students who work in her lab, has had a major breakthrough in understanding the molecular mechanisms in the heart's pacemaker that controls variability in the heart rate in vivo.

"I found that calcium and phosphate signal levels, regulated by an internal mechanism in the heart's pacemaker, control the amount of variability of the heartrate," she explains. "If there is too little calcium and phosphate, then there is a lot of variability leading to arrhythmia and a very slow heart rate. If there is too much calcium and phosphate – this can increase heart rate."

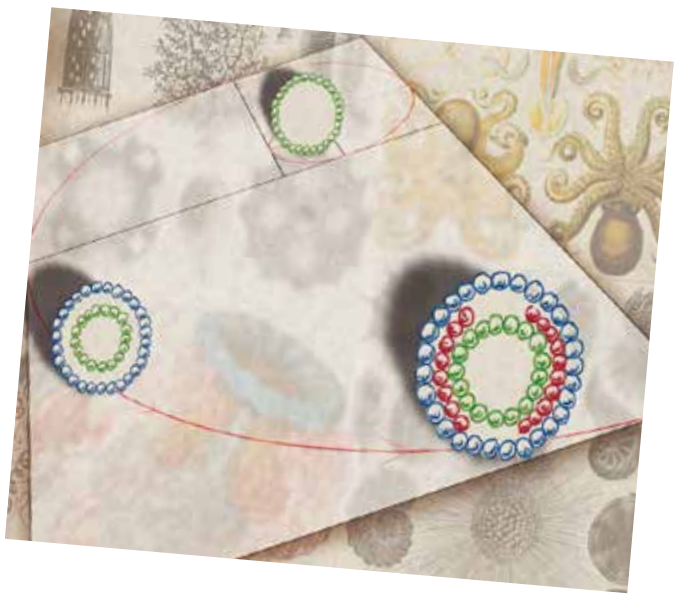
Student Sofia Segal *(l)* and Prof. Yael Yaniv in the lab with instruments to measure the heart rate

"In the future, I want to see how beat-to-beat changes in these signal levels relate to arrhythmia. We are looking for ways to better read changes in the pacemaker in vivo and then try to control these changes through signal processing and FDA-approved drug interventions. For example, the NIH has developed a virus which can increase calcium and phosphate signal levels when injected into the heart's pacemaker."

Yaniv's work has not gone unnoticed. She received many awards and her lab now has a waiting list of students wanting to work with her.

"For me, my appointment in Biomedical Engineering has been a real homecoming," she concludes.

Prof. Yael Yaniv received grants from the Mallat Family Research Fund and the Karbeling Biomedical Engineering Research Fund, and significant support from Steve and Ilene Berger's gift for a mobile health lab.



What Turns Genes On?

An animal mystery solved reveals that the past is not done with us

While the animals you find in the zoo all seem completely different, one of the first stages during the early development of each and every one of them is to determine which cells are going to be on the inside of the animal, which on the outside, and which in the middle layer. Since the 19th century, biologists have been puzzling over which of these layers came first in animal evolution. Prof. Itai Yanai of Technion's Faculty of Biology and his colleagues now provide compelling evidence that the layer called the endoderm evolved first, followed by the ectoderm and finally the mesoderm layer.

> "Evolutionary analyses can reveal what in the cell is easily changeable, and what is not."

This work from the Yanai lab, led by Dr Tamar Hashimshony, was made possible by the CEL-Seq method, which was pioneered by the lab in 2012. This method shows the level of expression of each gene in any given single cell. Yanai's team discovered that the genes expressed in the different germ layers come on at different times during the development of a worm embryo.

From these results, published in the March 12, 2015, issue of *Nature*, it is apparent that the internal layer of animals was likely the first to evolve hundreds of million years ago and that this event continues to constrain the present process of development. Yanai and colleagues argue that the endoderm layer dates back to ancient single-celled organisms that banded together to form the first multicellular animals. A fraction of the cells in these early animals continued to maintain their ancestral feeding function, giving rise to the modern endoderm germ layer, and freeing up the other cells to evolve into new layers in the animal.

Understanding how evolution has altered cells in the past can also reveal what is easily changeable and what is not changeable in a cell, according to Yanai. "If a cell goes into a disease state, for instance, we might know more about what we could do to reverse this state and what might be more difficult to reprogram in the cell," he added.

With the help of an analogy, Yanai explains that one way to envision the power of CEL-Seq is to consider a single human cell and the 20,000 genes it contains as a room with 20,000 light switches. "Each room can have a different mood, because we can turn on or turn off those switches in many different ways. This is why cells with the same genes can have many, many different types of behavior," he explained. "With this method, we can take a given cell and know the position of every switch – whether it's on or off – and from this infer what functions are going on."

"This is a transformative technology that can be applied to many biological problems," says Hashimshony, who is working to decipher the gene expression of each and every cell in the developing embryo of the tiny worm.

Currently a Fellow at the Radcliffe Institute of Advanced Study at Harvard University, Yanai is using the method to study the development of tumors in zebrafish. "For the last 10 years my lab and I have been working on development and evolution, all seen through the eyes of gene expression," he said, "and we've realized that cancer is actually a natural extension of this work since here you also have cells developing and evolving."

Prof. Itai Yanai is a recipient of the 2015 Henry Taub Prize for Academic Excellence. Dr Tamar Hashimshony received the Excellence in Research Award from the Technion Faculty of Biology.

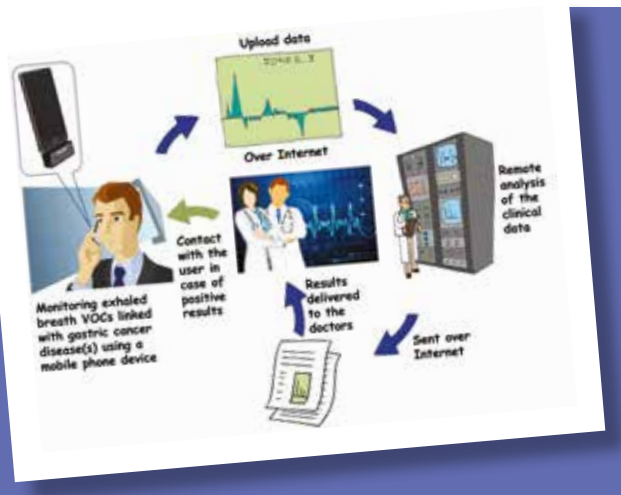


Illustration of the SNIFFPHONE concept for remote screening and monitoring of gastric diseases, through exhaled breath testing.

Dr Smartphone

Screening for early detection of a disease can reveal individuals among the general population with increased likelihood of the disease, who could benefit from further medical evaluation. The ideal screening test is high-accuracy, low-cost, noninvasive, easily repeatable, effortlessly operated by a layperson and makes minimal impact on the individual's daily activities.

Prof. Hossam Haick, of the Wolfson Faculty of Chemical Engineering and the Russell Berrie Nanotechnology Institute, is heading an R&D consortium to develop a product that, when coupled with a smartphone, will be able to screen the user's breath for early detection of life-threatening diseases.

The current group, supported by a recent €6 m. grant from the European Commission's Horizon 2020 program, will expand the "electronic nose" breathalyzer technology that Haick has been developing since he joined Technion in 2006.

> "Early diagnosis can save lives, particularly in life-threatening diseases such as cancer."

The SNIFFPHONE consortium includes Siemens; universities and research institutes from Germany, Austria, Finland, Ireland, and Latvia; and Technion spin-off company NanoVation-GS Israel. NanoVation is headed by Dr Gregory Shuster and Sagi Gliksman, both graduates of Haick's lab, and Haick serves as Chief Scientific Officer.

The product will work by integrating micro- and nanotechnologies into an autonomous smart system that can be attached to a mobile phone and analyze disease markers from exhaled breath. The data are then transferred wirelessly to a remote information-processing system for analysis. Statistical pattern recognition methods are applied and a clinical report, including the diagnosis results, is returned to the designated receiver: medical practitioner and/or the user, depending on ethical approval.

"The SNIFFPHONE is a winning solution. It will be smaller and cheaper than current disease detection solutions, consume little power, and most importantly, it will enable immediate and early diagnosis that is both accurate and noninvasive," says Haick. "Early diagnosis can save lives, particularly in life-threatening diseases such as cancer."

Prof. Hossam Haick has received numerous prestigious honors for his electronic nose research, including, most recently, the 2014 Halevy Award for Innovative Applied Engineering.

On the Horizon

Horizon 2020 is the biggest EU Research and Innovation program ever, with nearly €80 b. of funding available until 2020. The goal is to ensure that Europe produces world-class science, removes barriers to innovation, and makes it easier for the public and private sectors to work together in delivering innovation.

The Future and Emerging Technologies (FET) Open Call had its first cut-off date on 30 September 2014. Of the 643 proposals submitted, only 24 Research and Innovation Actions and four Coordination and Support Actions were selected. Two projects involve Technion researchers.

Prof. Roee Amit of the Faculty of Biotechnology and Food Engineering is the coordinator of "MRG-Grammar," a project to leverage Synthetic Biology with cutting-edge DNA synthesis technologies and high-throughput analysis.

Prof. Alexander Leshansky of the Wolfson Faculty of Chemical Engineering is a partner in "Microflusa," a project that proposes using microfluidic technology to enable an increased production of complex building blocks mimicking molecular structures in the field of colloidal science.

Learning by Doing: STEM Education

By Gail Lichtman

Ofer Danino *(r)* teaches Robophysics® to pre-university "Technion Buds."

In 2011, on his 50th birthday, Technion electrical engineering graduate and Israeli entrepreneur Ofer Danino gave himself an unusual present. He used his own money to set up an innovative, three-year pilot project in STEM (science, technology, engineering, and mathematics) education: designed to be flexible enough to engage students from grade six through university, yet challenging, low-cost, hands-on, and most of all – fun.

"I had a vision to develop a strategic plan for interdisciplinary STEM education," explains Danino. "The idea is the basis for my master's thesis in education in electrical engineering." This he is now completing, supervised by Dr Ari Gero, in the Department of Education in Science and Technology.

"STEM education lags about 30 years behind what is going on in the field," he continues. "There is often no connection between the future needs of Israeli high tech and what students are learning. I worked on a plan to develop a systematic vision of how to build future scientists and engineers equipped for the high-tech environment of the 21st century."

Danino developed a core of experimental programs called Robophysics®, in which students learn by doing. Using robots, they cover physics, math, and grasp systems engineering. "This is project-based hands-on learning," he states.

Pilot programs were conducted in schools as well as with Technion undergraduates in physics. Later, Danino introduced it to two Technion programs that prepare high school students for university studies in STEM: Madaanei Atid (Future Scientists) and Nitzanei HaTechnion (Technion Buds), for the Druse sector. Danino is proud to report that "Bud" Isam Kias has been accepted to the prestigious dual BSc degree in electrical engineering and physics.

> "Every smartphone can become a personal laboratory."

"I wanted to give the students a taste of engineering design under uncertain conditions," Danino relates. "They operate in teams of four like in a start-up. Each group consists of a team leader, software engineer, hardware engineer, and a scientist/physicist."

"All the projects help the students to understand STEM concepts and provide them with the tools to deal with real-life problems," Danino says. "They have to develop a hypothesis and test it. If successful, they must show that the experiment is replicable. They learn the correct terminology, and integrate formulas and materials into building the robots. If they were to learn the same material in an abstract manner through frontal learning, they probably would not internalize it. Here they do."

Experimenting with a smartphone as a sensor in the Robophysics platform spurred the idea of developing a full suite of scientific laboratory equipment based on sophisticated, yet inexpensive and broadly accessible, smartphones and tablets. "Every smartphone can become a personal laboratory, and the cloud communications and database will create unlimited learning and research communities," Danino envisions. Thus, the concept of the STEM Lab, a cross-faculty endeavor was born, inspired in part by such programs as the MIT Media Lab.

"Once teachers have the smartphone/tablet/cloud platform, they too can develop and be up-to-date with the technology," Danino says, with reference to the scarcity of STEM teachers who can both inspire and keep up with fast-changing technology. "This project is a long-term investment. The students of today will be Israel's technological leaders of tomorrow in both industry and academia," Danino concludes.

Ofer Danino received the 2015 Kaplan Prize for Excellent Graduate Students in Education.

WHAT'S THE MOON MADE OF?

▶▶▶ …continued from page 1

2016 INTERNATIONAL SPACE UNIVERSITY COMES TO TECHNION

"Some of the debris from the collision fell back to Earth, some was scattered far into space, and the rest went into orbit around the Earth. This orbiting debris later coagulated to form a single object: our Moon."

In a suite of computational simulations of planetary growth, Perets and postdoctoral researcher Dr Alessandra Mastrobuono-Battisti, in collaboration with Dr Sean Raymond of Université Bordeaux, tracked the feeding zones of growing planets. They found that different planets formed in the same simulation have distinct compositions, but the compositions of giant impactors are statistically more similar to the planets with which they collide.

(l-r) Dr Alessandra Mastrobuono-Battisti and Prof. Hagai Perets at the Faculty of Physics' telescope facility

Prior studies have traditionally focused only on the compositions of the final planets, whereas Perets and collaborators have considered not only the planets, but also the composition of the impactors on these planets. Consequently, they discovered that in many cases, the planets and

> "The Earth and the Moon might not be twins born of the same body, but they did grow up together in the same neighborhood."

the bodies that collide with them share a very similar composition, even though they formed independently. The similarity between the Moon and Earth stems from the similarity between Theia and Earth. The researchers conclude that the similarity in composition between the Earth and Moon could be a natural consequence of a late giant impact.

"Earth and Theia appear to have shared much more similar environments during their growth than just any two unrelated bodies," explains Mastrobuono-Battisti. "In other words, Theia and Earth were formed in the same region, and have therefore collected similar material. They eventually collided, and the material ejected, mostly from Theia, ultimately formed the Moon."

"The Earth and the Moon might not be twins born of the same body," summarizes Perets, "but they did grow up together in the same neighborhood."

Prof. Hagai Perets joined Technion as a Deloro Fellow in 2012.

Any Way the Wind Blows...

By Amanda Jaffe-Katz

The Wind Group of Engineers without Borders – Technion (EWB) is rightly quite pleased with itself. They have successfully built a wind turbine for green energy production from scratch. The group's current head, final-year environmental engineering student Loic Le Goueff, says that the turbine was tested atop the Borowitz building of the Faculty of Civil and Environmental Engineering over two years, without any failures. "We impressed ourselves that it worked without a hitch during that time," he says.

Another aspect of the project – and one that epitomizes what EWB-Technion is all about – is interaction with communities and education towards sustainability. The group chose to give their turbine to the AFAK School that serves special needs pupils among the Arab communities of Jerusalem. It was previously designated a "green school" that showcases environmental projects.

In summer 2014, the group erected a turbine on AFAK's roof.

Part of the yearlong preparation process involved the development of educational modules on topics relevant to renewable energies. The group was able, via its Arabic-speaking members, to explain wind power and electricity to the children, using models, a competition, and hands-on games.

At their last meeting at the school in March 2015, they finally connected all the cables and, reports Le Goueff, "we were thrilled to see it work for the first time." The turbine provides power to an aquaponic system for the creation of agricultural produce and fish growing, making the symbiotic fish-plant system completely self-sufficient.

The Wind Group is completing the construction of another turbine of a new and improved design, now at the balancing stage in the EWB workshops on campus. It will be tested on the roof of Borowitz and used for cellphone charging. In addition, the group is working on a Live Lab, where one can see the actual turbine spinning and monitor it over time, using an electronic monitoring system that checks what the turbine really does.

This system involves electricity, wood, metal, and plastic. "None of the team members really has any experience working with these materials," Le Goueff explains. "There is always a phase of study, where we explore how other people have done it. For example, we rely heavily on the work booklet published by international wind guru, Hugh Piggott."

Le Goueff states that one of the challenges is to provide a more comprehensive set of guidelines to give future generations of the Wind Group. To this end, they are excited at the possibility of engaging directly with Piggott whom they have found to be available and approachable.

Inbal Haas, another team member, is studying for her PhD in transportation engineering. "It is a constant challenge; we find ourselves working from one problem to the next," she says. "Mostly, these involve technical issues. For example, regarding the turbine blades: that's one we haven't yet solved. It's very satisfying when we finally figure it out."

"There is a characteristic 'disconnect' between what one learns at Technion and what we actually need in terms of skills. It really helps to have students from different faculties involved because they think in different ways," Le Goueff says.

Le Goueff is from Luxembourg. He initially enrolled in the English-speaking program in civil engineering at Technion International. After his first year, he switched to regular Technion studies.

He found like-minded people in EWB, a special group who are prepared to go the extra mile to make a difference. "We share a common vision that generates a very good atmosphere," he says. "It is relaxed, but at the same time the team members all invest their energy to the success of the project."

> "It really helps to have students from different faculties involved because they think in different ways."

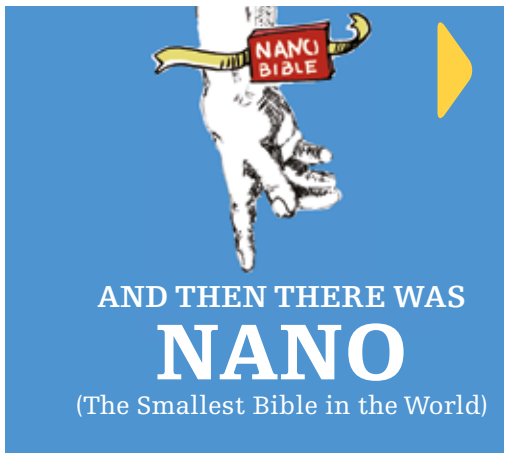
The current members of the group have democratically decided that the emphasis of the coming project will be in response to an energy need. This is in contrast to the turbine located at the school, where the main outcome is the educational aspect.

Members of Engineers without Borders–Technion Wind Group erecting the turbine.

They are now choosing a community with whom they can work wisely and who, in turn, wants to take responsibility for the project.

The Wind Group cherishes the legacy of wind energy pioneer Hanan Einav-Levy (1979-2012), a PhD student at the Faculty of Aerospace Engineering, who charismatically led the EWB Wind Group for a year and a half.

An exhibition currently at the Elyachar Central Library showcases all the active groups of EWB-Technion.



The Nano Bible is a gold-plated silicon chip the size of a pinhead on which the entire Hebrew Bible is engraved. The text, consisting of over 1.2 million letters, is produced by means of a focused ion beam. The beam dislodges gold atoms from the plating and creates letters, similar to the way the earliest inscriptions were carved in stone. To read the text it is necessary to use a microscope capable of 10,000-fold magnification or higher.

This technological marvel demonstrates the wonders of present day miniaturization. Dense information storage is not unique to human culture: The blueprints of all organisms are stored by nature at even higher densities in long DNA molecules and transmitted in this form over generations.

At the April 19 launch of the exhibition, Museum Director James Snyder noted that the Shrine of the Book opened its doors a few weeks before the rest of the Israel Museum, on April 20, 1965. "Here are housed the oldest recorded versions of the Hebrew Biblical text," he said, "which represents a cultural narrative to the museum overall." And here, he continued, "the Hebrew Bible is stretched to its technological limits."

> "We chose the Bible because the written word is the most refined method of storing an idea. In my opinion, script is the DNA of civilization."—Prof. Uri Sivan

Curator Adolfo Roitman pointed out that the Nano Bible is just one of the ways that the Bible has been produced over 3,000 years. "It is symbolic that the opening of this exhibition coincides with the week of Israel's Independence Day," he said.

Technion Prof. Uri Sivan, who conceived the idea together with Dr Ohad Zohar as an educational project, said that the challenge was the volume required to store information. Sivan quoted Richard Feynman, whom he calls the Prophet of Nano, "There is plenty of room at the bottom," he said.

"We chose the Bible because the written word is the most refined method of storing an idea. In my opinion, script is the DNA of civilization. We wanted to preserve the idea of text inscribed with a hammer and chisel in stone, and thus the Nano Bible represents a modern version of the ancient scriptures."

"And Then There Was Nano – The Smallest Bible in the World" is part of the 50 year celebrations of the Israel Museum and the Shrine of the Book. The exhibition, slated to run through December 31, 2016, was made possible through the generosity of the Dorot Foundation, the Russell Berrie Foundation, and Joan and Arnold Seidel and family.