TECHNION
Israel Institute of Technology
FOCUS
Number 3, 2015
www.focus.technion.ac.il

Breathe Easy

Lung model to study particle inhalation and deposition

The acinus-on-chip developed at Technion

Our lungs represent a prodigious organ for exchange with an intricate network of airways connecting a vast airspace, from the trachea down to the individual alveoli (less than 1 mm big). With each breath, we potentially inhale millions of particles into our lungs. Understanding the basic mechanisms governing the transport of inhaled particles in the deep alveolated regions called acini, is important both in health risk assessment (occupational and environmental exposure, for example) and inhalation therapy (such as delivering vaccines or antibiotics).

To date, however, no diagnostic tool or imaging modality exists to measure *in vivo* the dynamics of airborne particles and their trajectories in the pulmonary acini of our lungs. It follows that much of our understanding of what precisely goes on down in the depths of the lung has mostly relied on computer-based simulations.

▶▶▶ Continued on page 7

LEADING INNOVATION

She has impressed judges and won round audiences with her promising green energy technology, and now she has caused walls to fall: Meet Technion PhD student Shani Elitzur from the Faculty of Aerospace Engineering, winner of the first Falling Walls Lab contest held in Israel.

Elitzur's research, under the supervision of Prof. Alon Gany and Dr Valery Rosenband, deals with the production and storage of hydrogen and electric energy based on an aluminum-water reaction at room temperature and its application in fuel cells.

▶▶▶ Continued on page 4

THE SCIENCE OF BEING FLEXIBLE

President Obama met it. President Hollande examined it. The Snake Robot has been on show at any number of exhibitions and conferences. And now the general Technion public comes face to face with another bio-inspired hyper-redundant robot.

▶▶▶ Continued on page 6

In this issue...

FROM THE PRESIDENT

(l-r) French Minister of Economy, Industry and Digital Affairs, Emmanuel Macron and Technion President Prof. Peretz Lavie

We start the 2015-2016 Academic Year with a slew of new programs and developments.

We launch revolutionary new study programs in medicine and architecture with this year's intake. Architecture and medicine alike are both disciplines – a way of thinking, and professions – a way of doing. Therefore, measures were taken to separate the dual aspects of the curricula in these two fields.

We believe that the upgraded content of the medical program will educate a new generation of physicians with a broad knowledge of modern technology and basic sciences, capable of research and able to meet the challenges posed by modern medicine.

As of this year, students of architecture study a six-year course leading to a professionally accredited Master's of Architecture and Town Planning degree and become eligible to practice as architects; they may also graduate after four years of study, with the non-professional BSc degree of Bachelor of Architectural Sciences. This is common practice in schools of architecture outside of Israel and allows deeper development of both architectural knowledge and better preparation for architectural know-how.

Further to our exceptional commitment to STEM (science, technology, engineering, and mathematics) education in Israel, the Department of Education in Science and Technology officially became a Faculty on June 28, 2015. Its flagship "Views" program provides Technion alumni and current students with an additional BSc degree in STEM education, tuition free.

Construction of the new undergraduate dorms is making swift progress, and we expect to complete the provision of 500 beds to our students by 2017. Other developments, part of the 30-year Strategic Master Plan for the campus known as TechCity 21, are underway. While TechCity 21 includes proposals for doubling the built space on campus, it also calls for a much better integration into the urban fabric and surrounding natural environment. Above all, the plan is promoting a hybrid "forest city" image for the Technion of 2045.

I am proud to share with you a remarkable achievement: Technion ranks eighth among the elite top ten institutions – led by Stanford University – with the highest number of Nobel prizewinners since 2000. The *Times Higher Education* analysis notes that it takes a great deal of academic freedom, a drive for creativity, world-class research infrastructure, and serious investment for a university to attract and retain the kind of scholars that will go on to win Nobel prizes. Our position – tied with MIT – is especially meaningful because we lack the budget to recruit promising international scientists and our success stories tend to be homegrown.

Beyond our noted scientific prowess is the steadfast recognition that technological innovation is the key to a competitive and growing economy. I was delighted to sign an agreement with École Polytechnique to promote relations between their accelerator program, L'X, and Technion's T-Factor. After laying the foundations of our partnership in 2013, we will now pool our resources and experience to positively impact the economies of both countries. Participants in each accelerator will have privileged access to the other, providing participants at T-Factor with the chance to spend up to six weeks at L'X, and vice versa. The signing took place at Technion in the presence of the French Minister of Economy, Industry and Digital Affairs, Emmanuel Macron, during his prestigious state visit to Israel.

Join us in a year of scientific inspiration and technological innovation!

FOCUS

Technion FOCUS is published by the Division of Public Affairs and Resource Development
Technion – Israel Institute of Technology
Haifa 3200004, Israel

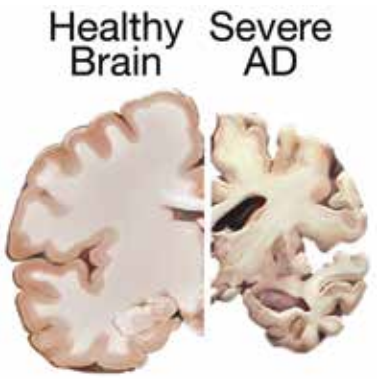
Tel: 972-4-829-2578
focus@tx.technion.ac.il
www.focus.technion.ac.il
www.youtube.com/Technion
www.technionlive.technion.ac.il
http://pard.technion.ac.il

VP External Relations and Resource Development: Prof. Boaz Golany
Director, Public Affairs and Resource Development Division: Danny Shapiro
Head, Department of Public Affairs: Yvette Gershon
Editor: Amanda Jaffe-Katz
Contributors: Barbara Frank, Kevin Hattori, Georgina Johnson, Itzhar Vardi
Design: CastroNawy
Photo Coordinator: Hilda Favel
Photography: Yoav Bachar, Tsafrir Ozer, Adrian Schröder, Tal Segev, Shitzu Photography, Shlomo Shoham, Sharon Tzur, Nitzan Zohar, and others

Completing the Circle
In June 2015, Haifa Municipality inaugurated a plaza in Central Carmel named for the late Prof. Josef Singer, former president of Technion. Singer was internationally recognized in the field of aerospace engineering and he received the Israel Prize in 2000. The dedication ceremony was attended by Singer's family and colleagues, and dignitaries including Mayor of Haifa Yona Yahav and Technion President Prof. Peretz Lavie.

Promising Results: Alzheimer's Drug Trial

Avraham Pharmaceuticals Ltd. announced in July 2015 successful second interim results in a Phase 2b clinical trial for the evaluation of the safety and efficacy of ladostigil, a unique, multifunctional drug for the treatment of mild cognitive impairment (MCI). MCI is a syndrome defined as an intermediate stage between the expected cognitive decline of normal aging and the more pronounced decline of dementia. The primary goal of the current clinical trial is to determine whether ladostigil can delay or prevent the onset of Alzheimer's disease (AD). After two years of treatment, both biological markers and behavioral measures indicate positive trends of the ladostigil-treated group in comparison to the placebo-treated group.



©National Institute on Aging/National Institutes of Health

"We are looking forward to the final results when they become available in Q3 2016, following three years of treatment," says Prof. Moussa B.H. Youdim of Technion's Rappaport Faculty of Medicine. "We are thinking of the patient because ladostigil is the first AD drug that slows down the atrophy of the AD brain as shown by functional MRI analysis."

Ladostigil was designed by Youdim and Prof. Marta Weinstock-Rosin of the Hebrew University of Jerusalem. The drug was exclusively licensed to Avraham Pharmaceuticals by Yissum Research Development Company Ltd. and by the Technion Research and Development Foundation Ltd.

KEEP YOUR HAIR ON!

Technion student team tackles baldness at its roots

By Amanda Jaffe-Katz

Hair loss affects roughly 1.5 billion people worldwide, and some 95 percent of hair thinning in men is attributed to male pattern baldness, also known as androgenetic alopecia. The trigger for this condition is believed to be a derivative of testosterone called dihydrotestosterone (DHT). There is a multi-billion dollar market for male pattern baldness treatments, yet currently available topical solutions have unpleasant side effects or are effective for only a minority of patients. Few available products are based on scientific solutions to the problem.

"Our solution aims to target the real, scientific cause of the problem," states Alexey Tomsov, captain of the Technion team competing at the 2015 international iGEM synthetic biology competition. "We aim to show convincing evidence of DHT breakdown, providing a promising platform for treatment of male pattern baldness."

Prototype comb

"We have created a system in which two different engineered bacteria are combined in a custom-made comb, manufactured with a 3-D printer, that work together to break down DHT, treating the problem at its root," explains Tomsov.

"We engineered *Bacillus subtilis*, a bacterium found naturally on the scalp, to secrete 3∝-hydroxysteroid dehydrogenase, an enzyme which reduces DHT to a non-steroidically active compound, using NADPH and NADH – common cofactors used for a variety of biological processes. Cofactors are non-protein molecules which are essential for the activity of some enzymes. In addition, we genetically engineered *E. coli* to overproduce NADPH, enabling the enzymatic reaction to take place. The two strains can be combined easily and cleanly with the help of our comb, providing a user-friendly tool," he continues.

> **"We have created a system in which two different engineered bacteria are combined in a custom-made comb."**

The team also conducted a survey in order to estimate public openness towards the idea of using a genetically engineered bacterial product. Almost 80 percent of respondents indicated that balding men would be willing to use such a product.

Technion's 2015 iGEM team comprises 10 students from a variety of disciplines: biotechnology, chemical engineering, mechanical engineering, biochemical engineering, and electrical engineering.

In addition, the team is doing community outreach to educate about synthetic biology and the issue of baldness. They are mentoring one of the first Israeli iGEM high school teams – youth from different schools, all participating in the Technion's Future Scientists Program. This and another high school team from Israel are competing this year, along with the student teams from Technion and Ben-Gurion University of the Negev.

Technion sent the first Israeli team to the 2012 iGEM competition. This year, a national mini-jamboree was held at Technion, at which all four teams from Israel could practice to become "pitch perfect" before setting off for Massachusetts at the end of September for the international competition, known as the Giant Jamboree, where some 280 teams participated. There, they had to bring a set of deliverables that included a 20-minute talk, following which the referees could pose questions.

According to Prof. Roee Amit of the Faculty of Biotechnology and Food Engineering, who supervises the Technion team, iGEM "has evolved into the most exciting, innovative and dynamic experiment in scientific education from high school through to the postgraduate level."

Technion iGEM and Technion High School teams

Breaking News! *The Technion iGEM team won gold medals in several categories and was designated "Best New Application." According to the iGEM organizers, "It is the novelty of ideas and approach in investigating a question that may never have previously been examined that qualifies a project in the New Application track." In addition, the newbie Technion High School team won a silver medal in the Best Model category. Technion iGEM captain Tomsov reports that the team was honored to have represented Technion and Israel so well.*

Members of the Israeli delegation in Baku (l-r) Prof. Zeev Gross, head coach Dr Izana Nigel-Etinger, Itai Zvieli, Roni Arenzon, Nadav Genossar, Ron Solan, and Schulich Faculty of Chemistry PhD student, Jenya Vestfrid.

Chemistry = Bronze^3

The Israeli delegation, coached at Technion, brings home three bronze medals from the 47th International Chemistry Olympiad (IChO) which took place in Baku, Azerbaijan. The IChO is the oldest international science competition for high school students.

"The material they were tested on was at a very high level, much higher than what is being taught in Israeli high schools," remarked Prof. Zeev Gross, incumbent of the Reba May Blum and Robert D. Blum Jr. Academic Chair in the Schulich Faculty of Chemistry. "We are extremely proud of the team's accomplishments and are so pleased that three of its members attained bronze medals."

"This was a very special experience for me," said Nadav Genossar. "We met students from all over the world. We studied and trained a lot for this competition, to reach the high level of knowledge required. I participated in the IChO competition last year as well, and this year I won a bronze medal!"

From SpinPop *to* SpinBrush

By Shlomo Maital

As a retired Technion professor, with silver hair and lots of stories, I get to meet and greet many visitors. I recently had lunch with one of the most interesting ones – an American entrepreneur named John Osher. Here is his story.

Osher grew up in Ohio; he took seven years to finish college. He worked as a plumber, carpenter, and cabdriver. He was an entrepreneur from age 5, he tells me. He started and sold a vintage clothing store, and an earring outlet, while still in college. *Harvard Business Review* Prof. William Sahlman, who wrote a lengthy case about Osher, says, "He's a street-smart guy and he has this observational power. He hated having to manage employees, so he built a big company with very few employees."

Dr. John's was Osher's third major venture built from the ground up and ending in a lucrative exit. He produced the uniquely American (and 'insanely popular') SpinPop battery-powered lollipop, which later led to SpinBrush. SpinPop is a lollipop that spins in your mouth (using a tiny battery-powered motor), enhancing the flavor, and creating a new market category of "interactive candy." In developing the product, Osher focused laser-like on cost, setting cost targets and determining that if they were not met, the product would not be produced.

I teach: "Don't fall in love too soon with your product," I told Osher.

Osher answered, "NEVER!" (Never fall in love with your product.). Easy to say, hard to do.

After SpinPop's success, Osher simply walked up and down the aisles of Wal-Mart, and looked for product ideas that could build on the cheap-battery technology of SpinPop. He came up with 100 of them. Then he narrowed them down, to an inexpensive electric toothbrush, to become SpinBrush. Here was his plan: Produce an electric toothbrush that would have battery life of at least three months, and cost only $1.49 to manufacture! Sell it retail at $5.00.

> "All you need is imagination, experience, objectivity, pragmatism, leadership, drive, energy, hard work, and persistence."

I told him that what he did fits two of our models in our book, *Cracking the Creativity Code*. First, zoom in, zoom out. Zoom in on SpinPop and what you learned from it; Zoom out to find ideas that can leverage it. Then Zoom in again, to implement the idea. Second, Price Cost Value. Start with high value (electric toothbrushes that create value, because people are willing to pay $50 for a Braun, for example). Make it at very, very low cost. Then charge a reasonable price, to share the value between profit margin (for the company, price minus cost) and client margin (for the buyer, value minus price). (You get, say, a $50 electric toothbrush for $5 – that's value!).

Osher is very modest, quiet-spoken, and very, very wealthy – he sold SpinBrush to Procter & Gamble for nearly half a billion dollars. He achieved this with soaring

John Osher, entrepreneur, speaking at Technion.

head in the clouds imagination (Lollipops that spin? Give me a break!) and hard-nosed, hard-headed, feet-on-the-ground pragmatism.

Anyone can do this. All you need is imagination, experience, objectivity, pragmatism, leadership, drive, energy, hard work, and persistence.
Thanks, John, for showing the way.

Prof. Emeritus Shlomo Maital is Senior Research Fellow at S. Neaman Institute.

LEADING INNOVATION

▶▶▶ ... continued from page 1

By Amanda Jaffe-Katz

"The innovative technology was developed and patented at the Fine Rocket Propulsion Center," explains Elitzur. "Among the many applications that can make use of this energy are electric vehicles, emergency generators, autonomous systems in the air or sea, and as auxiliary power in commercial aircraft."

PhD student Shani Elitzur

"We have demonstrated this technology in a remote-controlled model car and boat that we constructed," Elitzur continues. "Fueling by five grams of activated aluminum enabled the vehicles to operate for a duration of 40 minutes. A full-size electric car could drive for a range of 500 km with only 50 kg aluminum powder and 50 kg water."

At the September 2015 event, held at Technion under the auspices of the Technion Center for Computer Engineering and the Bronica Center for Entrepreneurship, and in conjunction with the Hebrew University of Jerusalem, 21 Israeli contenders – selected from 40 proposals – were given three minutes each to pitch their inventions. The distinguished panel of judges picked Elitzur to compete in the international Falling Walls Finale in Berlin. At the November contest, she will be one of 100 young finalists from across the globe, all winners of their national heats, who will take the opportunity to communicate their outstanding ideas, research projects, and initiatives.

> "A full-size electric car could drive for a range of 500 km with only 50 kg aluminum powder and 50 kg water."

The Falling Walls Conference is an annual global gathering of forward-thinking individuals organized by the Falling Walls Foundation. Each year, 20 of the world's leading scientists are invited to Berlin to present their current breakthrough research.

For her presentation "Clean Energy in Commercial Aircraft," Elitzur reaped First Prize and was voted Audience Favorite at the Challenge 2015 student competition. Held in conjunction with the third EcoMotion Conference in Tel Aviv–Jaffa in April, Challenge 2015 sought ideas to reduce the use of fossil fuels in transportation.

Elitzur was also recently selected as a Rieger Foundation-Jewish National Fund Fellow in Environmental Studies for the 2015-2016 school year. The Rieger Foundation prioritizes scientific and engineering research in the areas of water resources, pollution prevention, and clean and sustainable energy.

INNOVATION NATIONS

What is special in Israel's DNA, and can Israel learn anything from other societies?

Given Imaging's PillCam®

By Amanda Jaffe-Katz

What makes Israel so successful at launching start-ups, and how does Technion provide the necessary milieu for this culture of innovation to thrive? Does national culture make a difference? All these issues and more are addressed by the doyenne of innovation management, Prof. Miriam Erez of the Davidson Faculty of Industrial Engineering and Management.

Erez, an Israel Prize winner, is also the founding chair of the Knowledge Center for Innovation at Technion. Here, she conducts much of the applied work in cooperation with industry. "And not just the high-tech companies for which Israel is famous, but there is plenty scope and requests for innovation in the non-high-tech sector also," explains Erez.

Erez regularly presents her ideas to delegations from China and other developing economies, who seek the recipe for Israel's secret sauce that earned it the moniker Start-up Nation. Her empirical research takes a closer look at the relationship between three main concepts: culture, creativity, and innovation.

"First," asks Erez, "what do we mean by creativity? It can be measured in several ways, and it is useful to consider three criteria when assessing someone's creativity on a standardized creativity test."

"There is a lay assumption that people in some cultures are more creative than in other cultures."

These measures are fluency – referring to the ability to provide many different ideas for a new product or a new service; originality – a measure of the novelty of the idea for a new product or a new service; and flexibility – the provision of solutions from different categories.

"What we are seeking when we are looking for true creativity is a break away from what we call 'functional fixedness.' This means the ability to draw a solution from one area and apply it to another," Erez explains. A good example of this is Given Imaging's camera-in-a-pill, invented by Technion alumnus Dr Gabriel Iddan, that is drawn from the camera element of a guided missile and reapplied to medical diagnostics of the digestive track. "Some people are born with this ability, but one can also train for it," Erez says.

Creativity, then, is the generation of novel ideas that are both useful and appropriate. This is distinct from originality, which may spawn ideas that may not be useful. Appropriateness and novelty are competing forces.

Creativity is also a core component of innovation, along with its counterpart: implementation.

"There is a lay assumption that people in some cultures are more creative than in other cultures," says Erez. Yet, an examination of individuals from different cultures revealed no significant differences on creative ability tests. What does make a difference, according to her findings, is the cultural context. Working with one or more other persons activates the cultural norms and influences the level of creativity and innovation.

"Israel has a very high tolerance for ambiguity, which gives rise to a need to explore by yourself. This is good for creativity."

In cross-cultural research conducted with her graduate student Rikki Nouri, and international colleagues Lee and Chiu in 2014, Erez uncovered further dimensions to the meaning of creativity across cultures. Whereas Israelis may primarily offer the definition of breakthrough, Chinese, for example, will suggest harmony and usefulness as important criteria.

Other ways to consider national culture is to invoke terms such as Individualism vs. Collectivism; Uniqueness vs. Conformity; Equality vs. Inequality; Uncertainty Avoidance vs. Tolerance for Ambiguity, and so on. On the measure of Collectivism, for instance, Israel is characterized by a moderate level, China by a high level, and the USA and Germany by low levels, namely, they are highly individualistic.

Power distance is a measure of equality versus inequality in the workplace. Low-power-distance cultures like Israel place a stronger emphasis on novelty, while other cultures (high in power distance) place a stronger emphasis on usefulness. In high power distance cultures, such as Korea, India, and China, working under a supervisor inhibits creativity, whereas in individualistic cultures, such as the USA, the presence of peers reduces creativity.

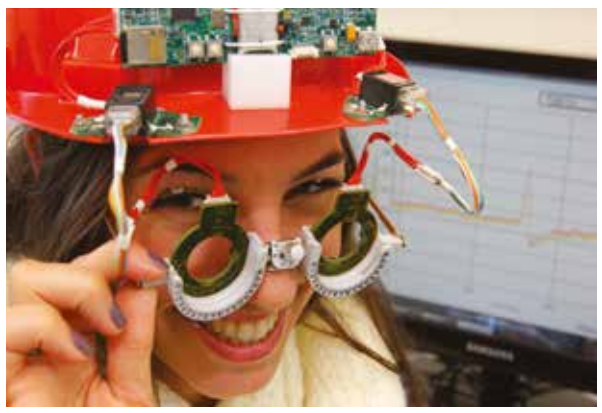
The World Economic Forum's annual Global Competitiveness Report evaluates 144 of the world's economies on various measures of innovation. In the 2013-14 report, Israel was ranked the third most innovative country in the world. This compares to China, which was ranked 32.

A typology of cultural values across 62 countries, developed by the GLOBE study, in which Erez served as the Israeli co-investigator (House et al, 2004), places Israel very low in emphasis on rules and regulations, rituals, and extensive documentation. "Israel has a very high tolerance for ambiguity, which gives rise to a need to explore by yourself," explains Erez. "This is good for creativity."

A question that remains to be addressed, concludes Erez, is, "Can you create subcultures within national cultures?" Two specific areas that call for this are a subculture in Israel that activates a culture that supports implementation, enabling a scaling-up of start-ups, and, conversely, a subculture in China that activates more and original ideas.

Prof. Miriam Erez, founding chair of the Knowledge Center for Innovation.

THE ACCELERATOR



PhD student Adi Hanuka demonstrates the Eyelid Motion Monitor.

Regular followers of *FOCUS* will surely remember Adi Hanuka, the *cum laude* electrical engineering (EE) student who attended the Clinton Global Initiative University in 2013. Let us revisit Hanuka, now in the Jacobs Graduate School, to review her current research and further international achievements.

Hanuka is a direct-track PhD student, supervised by Prof. Levi Schächter, the Gerard Swope Chair in Electrical Engineering. Her research focuses on optical medical accelerators, with the goal of increasing the effectiveness of radiation doses to tumors and reducing the dose to healthy surrounding tissue.

"Radiation from existing devices damages healthy tissue."

"Existing devices operate on energy from big and expensive accelerators, and worse yet, this radiation damages healthy tissue," explains Hanuka. "Our vision is to develop a compact accelerator that would be relatively inexpensive and which could be employed also in small clinics, with a capacity for direct targeted radiation to the tumor site."

To this end, she also performs experimental work in collaboration with the National Accelerator Laboratory at Stanford University (SLAC).

Hanuka mentors undergraduate EE students Alon Berger and Maor Itzhak, whose project is a real-time prototype system for monitoring eyelid motion. The Eyelid Motion Monitor (EMM) comprises a tiny magnet located on the upper eyelid, a specially designed hardware system for real-time signal acquisition, and a dedicated computer software for analyzing real-time and off-line modes.

"Eyelid motion provides us with meaningful information about the health status of a patient," clarifies Hanuka. "It may indicate, for example, neurological conditions such as Parkinson's disease and autoimmune diseases such as Graves' disease. At the request of Dr Daniel Briscoe, Chairman of the Department of Ophthalmology at Emek Medical Center, we developed a device that can be installed on standard refraction glasses used in eye tests."

"Eyelid motion provides us with meaningful information about the health status of a patient."

With approval from the ethics committee, EMM has now entered clinical trials.

The EMM project, conducted at the High Speed Digital Systems Laboratory (HS-DSL), qualified for the Top 20 teams at the 2014 international Texas Instruments Innovation Challenge (TIIC): Europe Analog Design Contest. This challenge is an initiative to encourage system-level design within universities.

Hanuka studied within the framework of the Technion Excellence Program, and she is a graduate of the first cohort of the EE-EMET Program. The latter is an excellence program in the areas of electronics, computers, and communication run by the EE Faculty.

She also co-founded the *BeChen* Program (Hebrew acronym for 'Girls meet at EE'), together with Prof. Lihi Zelnik-Manor. *BeChen* is a social-academic initiative, which brings together female EE students in order to strengthen their sense of belonging and increase their confidence when progressing on to advanced studies or turning to work in the industry.

Hanuka recently received the prestigious fellowship from the Ariane de Rothschild Women Doctoral Program funded by the Rothschild-Caesarea Foundation.

In July 2015, Hanuka represented Israel at the Lindau Nobel Laureate Meeting, a globally recognized forum for the transfer of knowledge between Nobel laureates and young scientists, held annually in Germany. Some 70 Nobel laureates – among them Profs. Dan Shechtman, Aaron Ciechanover and Ada Yonath – attended this year's conference, which focuses on interdisciplinary research.

"After meeting so many inspiring people at Lindau, my perspective on the world has been permanently altered," reports Hanuka. "I have never been so excited about science, my research and my future. I have been humbled by the Laureates and my fellow Young Scientists and can genuinely say that the Nobel Laureate Meeting has been 100 percent life-changing!"

© Adrian Schröder/Lindau Nobel Laureate Meetings

PhD student Adi Hanuka (2nd from left) engages with other young scientists at the 65th Lindau Nobel Laureate Meeting in a lively discussion with Nobel Laureate Robert Woodrow Wilson (Physics, 1978), who discovered cosmic radiation. July 2015.

THE SCIENCE OF BEING FLEXIBLE

►►► … continued from page 1

By Amanda Jaffe-Katz

Oded Salomon, long-time lab engineer at the Faculty of Mechanical Engineering and currently Chief Engineer of the Danciger Teaching Laboratories, recently presented his research on another hyper-redundant robot.

This time it is a robotic arm, carried out for his MSc degree under the supervision of Prof. Alon Wolf.

"Hyper-redundant robots – or HRR, for short," explains Salomon, "have a very large number of degrees of freedom, many more than are basically required, which enable them to handle more constraints, such as those present in highly convoluted volumes. HRR are extremely versatile, like their biological counterparts: snakes, elephant trunks, and worms. These animal 'role models' can all access crevices as well as manipulate objects."

The ideal design, according to Salomon, is the elephant's trunk. The design that he came up with for the 80 cm long robotic arm is modular, has a segmented backbone, high rigidity, low self-weight and 16 degrees of freedom. Salomon designed and tested it at Wolf's Biorobotics and Biomechanics Lab, where he served as lab engineer for seven years. Salomon and Wolf published a scientific paper in *ASME Journal of Mechanisms and Robotics,* and patented the design in 2012.

Salomon discussed the novel design of a modular robotic arm, composed of two concentric structures: a passive backbone and an exoskeleton, which carries self-weight as well as external loads. This robotic arm could serve in many applications, by extending the reachability and maneuverability of the operator. In this manner, the HRR enables the operator to bypass obstacles and apply forces on a target that may not be in a direct line of vision.

"Our design is capable of bending 180°," says Salomon. "It may be of service to first responders and in search-and-rescue missions. It can drill underground, and has potential for scouting out terrorist tunnels."

Oded Salomon and the hyper-redundant robot

The multiple degrees of freedom that afford the HRR its wide range of capabilities also constitute its major challenges, Salomon cautioned. These are apparent in mechanism design, control, path planning, and obstacle avoidance.

The HRR was also presented at the 25th CIRP Design Conference, a global forum for leading researchers and engineers engaged in the field of mechanical innovative design, hosted by the Faculty of Mechanical Engineering in March 2015.

Salomon reported that the Chief Scientist of the Ministry of Economy has awarded funding to develop the next generation of the robot.

Breathe Easy

▶▶▶ … continued from page 1

(l-r) PhD student Rami Fishler and Prof. Josué Sznitman hold their patented in vitro *breathing model.*

Technion researchers, led by principal investigator Prof. Josué Sznitman of the Faculty of Biomedical Engineering, designed an *in vitro* platform for studying the dynamics of inhaled particles and ensuing deposition patterns inside pulmonary acini. Using microfluidic technology, they have constructed a true-scale pulmonary acinar model that allows – for the first time – direct time-resolved observation of airborne particle trajectories and mapping detailed deposition locations of aerosols.

The research paper describing this work, titled "Particle dynamics and deposition in true-scale pulmonary acinar models," was published online on September 11, 2015, in Nature Publishing Group's *Scientific Reports*.

The acinus-on-chip platform consists of an anatomically inspired, multi-generation network of bifurcating airway ducts lined with alveolar cavities, where the walls are periodically deformed in a physiologically realistic "breathing" fashion.

"This artificial-breathing 'guinea pig' not only has the potential to serve as a screening tool… such *in vitro* methods may also provide alternatives to animal testing."

"This artificial-breathing 'guinea pig' not only has the potential to serve as a screening tool to quantify the fate of inhaled particles inside the lung depths, such *in vitro* methods may also provide viable alternatives in the future to traditional, but controversial, animal testing," says Sznitman.

The interdisciplinary research involved colleagues at the Faculty of Biomedical Engineering and the Faculty of Civil and Environmental Engineering, the Technion Center of Excellence in Environmental Health and Exposure Science (TCEEH), the Micro-Nano Fabrication Unit, and was supported by the Russell Berrie Nanotechnology Institute at Technion.

In February 2015, Sznitman and his doctoral student Rami Fishler patented the device. In June 2015, Sznitman received the "Young Investigator Award" for a researcher aged less than 40 from the International Society of Aerosols in Medicine (ISAM).

A Breath of Fresh Air

Street-savvy app for air quality data gets personal with the weather

BizTEC Entrepreneurship Challenge

Air quality can change dramatically in a matter of hours. For individuals with certain health sensitivities, this can be critical. Start-up company BreezoMeter delivers the first real-time air quality data platform at street resolution: their mission is to improve the health and quality of life for billions of people worldwide, by providing accurate air quality data for consumers and businesses in a format as simple, intuitive, and actionable as weather data.

The company was cofounded by three Technion alumni – CEO Ran Korber (BSc in Environmental Engineering), CMO Ziv Lautman (BSc in Environmental Engineering, *summa cum laude*), and CTO Emil Fisher (BSc in Software Engineering). Their revolutionary app taps open-source big data to gather air quality and weather measurements, process the data, and send the usable location-based map of air-pollution levels straight to your smartphone, for free.

Armed with these important facts, users can make informed choices about where they live and plan their daily outdoor activities, receiving real-time air-pollution notifications together with personalized health recommendations.

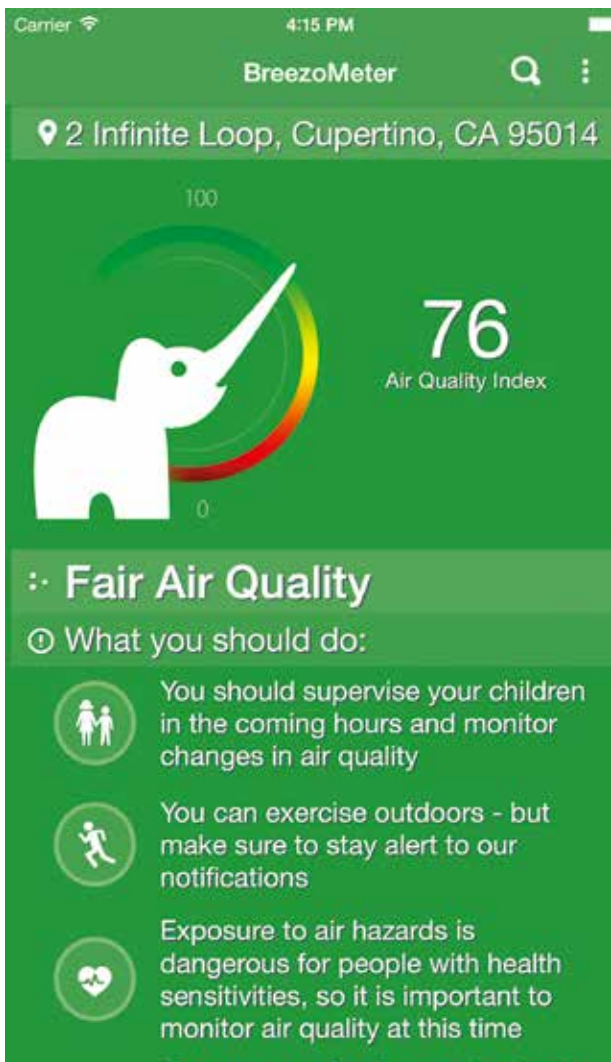
BreezoMeter uses a unique and cutting-edge algorithm that understands how air pollution disperses through time and space in real time.

BreezoMeter started its activity at Technion in the context of BizTEC, the National Entrepreneurship Challenge. The team proceeded to win the competition in 2013 and the accolades have been raining down on them ever since.

In 2014, BreezoMeter won the Start-up Open and was named the most promising start-up company by Global Entrepreneurship Week. They were among six finalists to be honored by the United Nations Economic Commission for Europe's Ideas for Change start-up competition in Geneva.

In May 2015, the team met with President Barack Obama as part of an Emerging Global Entrepreneurship event at the White House. And in September 2015, BreezoMeter's booth attracted a lot of attention at DLD Tel Aviv Innovation Festival – all the more so, perhaps, as the well-attended event took place during a sandstorm.

The company raised $1.8 m. in mid-2015.



EXHIBITION
CURATED BY ANAT HAR-GIL

A DOG'S LIFE AT TECHNION

Students raise seeing-eye puppies

A new outdoor exhibition on campus displays scenes from the lives of student volunteers and their Labrador puppies, who are destined to become guide dogs for the blind.

The dogs only begin their advanced training after they reach one-and-a-half years old; until then, they require loving foster homes in which they are exposed to a compassionate social environment. Some dogs are fostered by Technion student volunteers, who receive eight-week-old puppies and raise them until their advanced training. The puppies accompany the students wherever they go, including classes, jobs, and on public transport.

At the end of this period, the dogs leave their foster homes and go through a regimen in which they learn how to guide blind people, enabling them to integrate fully into society and providing them with greater confidence in their daily lives.

The volunteers who raise these puppies invest a lot of time and emotional involvement, but the outcome is worth every effort.

TECHNOBRAIN
— CHALLENGE —

The "Gumpool 2015" race took place in a 72-square-meter pool built in the heart of the Technion campus, for the June event. Dr. Bob's TechnoBrain competition, sponsored by Robert J. Shillman, is held in memory of its founder, Neev-ya Durban. This year's creative engineering challenge was held in the spirit of green energy. Elastic-band-powered boats, designed and built in advance by the competing teams, had to travel a distance of eight meters, anchor by means of a magnet, and fire a jet of water into a funnel from a distance of three meters – all this is in the shortest time possible and with the fewest rubber bands.