

# Flexing Their Muscles

*Building a successful business partnership*

What do you get when you pair a passionate and intelligent engineering professor at the University of Maryland with two ambitious and hard working recent engineering graduates? FlexEL. This company develops a novel, high-capacity, rechargeable thin film battery. IEEE Fellow Dr. Martin Peckerar, professor of microelectronic engineering at the University of Maryland's A. James Clark School of Engineering and the brains that helped launch the company, tells us how it all started.

Before becoming a professor at the University of Maryland, Peckerar worked for 20 years at the Naval Research Laboratory (NRL), the corporate research laboratory for the Navy and Marine Corps that conducts a broad program of scientific research, technology, and advanced development. "At NRL, we were the first to show how self-assembled monomer thin films could be used in ultra-high resolution imaging," Peckerar informs. "We built prototypes and developed many of the processes used in the UV cameras flying on-board the SOHO solar observatory. I was part of the Department of Defense Advanced Lithography program. In that capacity, Dave Nagel, now at George Washington University, and I invented the high-brightness plasma light source for x-ray and EUV lithography."

At the University of Maryland, Peckerar continued much of the work he

was doing for the government. "I was teaming with Prof. Neil Goldsman of our department on a project to make ad hoc distributed networks. Peckerar explains these networks are sensor systems composed of many "small" modules densely distributed through the environment that each have low-level local computational capability and can RF telecommunicate with one another. Their local "intelligence" lets them work in a "quiescent mode" for long periods of time, looking for some "wake-up" signal, he adds. This could be the sound of an intruder or the presence of toxic gas. According to Peckerar, the "aroused" system could do some threat assessment and pass its findings on to a base station, relaying signals through other nodes.

"Clearly, such a system must run unattended for long periods of time and it must be capable of sustaining 'burst mode' power dissipation," he says. "You can't run power lines to these nodes—they're too small and too dense. Clearly, power supply is the critical issue in getting these systems to work." So Peckerar, Goldsman, and three graduate students at the University of Maryland, Dr. Yves Ngu—now at IBM Burlington, Mahsa Dornajafi, and Dr. Zeynep Dilli—now a post-doc—invented a thin-film battery to do the job. Peckerar says this battery could sustain a charge for months while dispensing low levels of power

(microwatts) and allowing for tens of thousands of power bursts (tens of milliwatts for milliseconds). The cell is thin and flexible and resembles "electric duct tape." Antennas and other hybrid components can be printed on or directly attached to the battery surface. The cells are rechargeable. Peckerar explains that because the cells can be recharged at relatively low voltage (1.2 V), they are candidates for RF recharging or recharge through energy-scavenging devices like mechanical energy scavengers.

Peckerar and his team recognized this type of battery could have broad application. Peckerar says they could be used to monitor the health of major architectural structures such as bridges, buildings, and air-frames and can be used in the type of "pervasive computing" you see in the old *Star Trek* series ("Computer – set a course for Altair 5...").

As a result, the state of Maryland has become very interested in the product, and Peckerar says the state has allowed them to start FlexEL, LLC, a company to manufacture the cells for sale to the emerging networked sensor field. "While it wasn't our original goal, we have found that we can make our cells very thin—so thin that we now think we can exceed the volumetric storage capacity of lithium ion cells," he says. "That is our next frontier."

Zeynep Dilli, one the entrepreneurs of FlexEL, earned her bachelor's of science in electrical and electronics engineering from Bilkent University, one of the leading research-focused institutions in Ankara, Turkey. She came to the University of Maryland, College Park for her graduate studies where she earned her master's and doctorate degrees. She presently works as a



Dr. Martin Peckerar



**As FlexEI partners, Mahsa Dornajafi and Zeynep Dilli both recognize the challenges of starting a new business.**

post-doctoral researcher at the University of Maryland where she focuses on novel energy sources, energy harvesting, and modeling electromagnetic effects on integrated circuits.

Dilli says there are great challenges in starting a new business. “Coming from a purely academic background, there is another world out there on the business side of things, with its own language and concerns and critical items and approach,” she says. According to Dilli, the Venture Accelerator Program at the University of Maryland, which helps University of Maryland inventors turn their research into a successful venture creation through coaching and support, helped them launch their company.

“If I were to pick one piece of advice for new entrepreneurs, it would be, ‘Do not overlook or underestimate the business aspects,’” Dilli says. “Get all the advice you can, run the numbers, have a well-thought out business plan, think through the little things like bank accounts and employees and supply chains and location. Really consider partnering with someone experienced in that side of it.” She says the company benefited massively when FlexEI’s CEO, Dr. Robert Proctor, joined them, because of his past entrepreneurship experience. “It takes time to get the business side settled down and running on smooth rails,

but in the next step it really frees you to focus on your research much more effectively,” she says.

And that leads the way to the fulfilling part of owning a business. “The greatest reward is like an expansion of those moments an engineer lives for—the moment when you throw the switch or run the code and see the thing you designed and built do whatever you designed or built to do,” Dilli says. “The product gets better, the company functions more and more smoothly, and it is all something you worked for, put a

part of yourself in.”

Mahsa Dornajafi, one of FlexEI’s partners, grew up in Shiraz, Iran, and moved to the United States, where she earned her bachelor of science in electrical and computer engineering from the University of Missouri. She is currently working toward her master’s degree in electrical engineering with a focus on

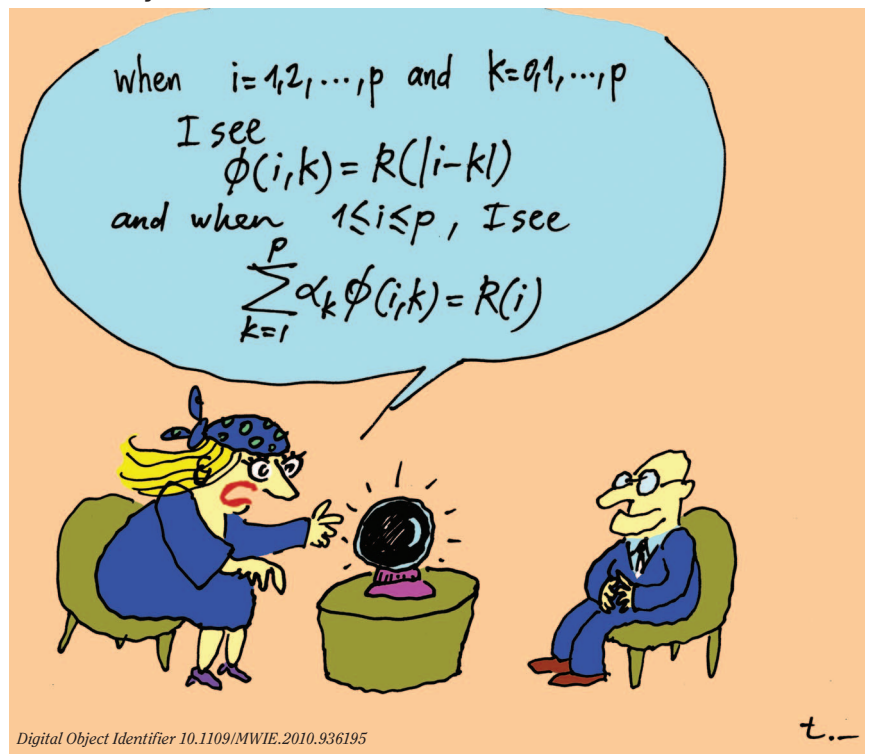
microelectronics. Dornajafi says one project she was working on for her master’s thesis focused on flexible thin film batteries’ fabrication and characteristics. So when FlexEI was created, she was so motivated and excited to have part-ownership in the company because she knew how much she enjoyed working in the field through her master’s thesis project work.

“Of course, being part of a new-established company was very challenging for me too,” Dornajafi says. “We had to work really hard, days and nights so we could achieve our goals. Sometimes, I had to spend weekends making batteries and doing experiments. What is more challenging for me is splitting my time between courses and school and the company since I am still in school. The only thing that makes a company grow is hard work and patience and these are needed even more for a new company,” she adds. “But it is also more joyful when you see that you are getting close to a product line and the company is worth more every day.”

—Nancy Salim



### Fun with Tayfun



Digital Object Identifier 10.1109/MWIE.2010.936195

t...