



## Donald E. Troxel, 1934 - 2011

Professor Emeritus Donald E. Troxel passed away Jan. 18, 2011, following a protracted illness.

Don Troxel, born March 11, 1934, in Trenton, New Jersey, received the BS degree in electrical engineering from Rutgers University in 1956. He followed with studies in electrical engineering at the Massachusetts Institute of Technology earning the SM and PhD degrees in 1960 and 1962 respectively. Don remained at MIT, first as a Ford Foundation Postdoctoral Fellow and then joining the EECS Department as Assistant Professor in 1964, reaching full Professor in the Department in 1985. He retired as Professor Emeritus in July, 2004.

Troxel's early research interests were concerned with tactile communications and sensory aids for the blind. Since 1968 his principal research interests focused on digital systems design and image processing, including bandwidth compression, enhancement and graphic arts applications. Troxel was principal investigator with both the Research Laboratory of Electronics, RLE, and with the Microsystems Technology Laboratories, MTL. His teaching activities centered on electronics and digital systems laboratories. Prof. Troxel was noted for teaching 6.111, Introductory Digital Systems Laboratory, for nearly twenty years.

## Jerome Lettvin, 1920 - 2011

Jerome Lettvin, Professor Emeritus of electrical and bio-engineering and communications physiology, and principal investigator with the MIT Research Laboratory of Electronics, died on April 23 in Hingham, Massachusetts. He was 91.

As noted in the MIT News Office, April 29 obituary, Lettvin came to MIT in 1951 under Jerry Wiesner, then-director of the Research Laboratory of Electronics and later MIT president. Along with Lettvin, Wiesner also hired Walter Pitts and Warren McCulloch, creating what would become a prolific team of neurophysiology researchers.

Lettvin is most noted for publication in 1959 of the paper "What the frog's eye tells the frog's brain." The paper became one of the most cited papers in the Science Citation Index. Lettvin and his team, including mathematician (and lifelong associate) Walter Pitts, Humberto Maturana, Warren McCulloch and Oliver Selfridge, demonstrated how specific neurons respond to specific features of a visual stimulus. Early skepticism on this new explanation gave way to a profound and lasting impact on the fields of neuroscience, physiology and cognition.

In addition to his work on vision, Lettvin carried out many important studies of the neurophysiology of the spinal cord and information processing in nerve cell axons. Though he is best known for his work in neurology and physiology, he also published on philosophy, politics and poetry. Lettvin was one of the early directors of the Concourse Program, a freshman learning community that bridges the humanities and the sciences by exploring connections between disciplines such as literature and physics, or history and mathematics.



Jerome Lettvin, left, with Walter Pitts.

## Bootstrapping technology entrepreneurship in Africa & Sri Lanka Healing through innovative technology in India

EECS students apply intelligence and passion to areas of opportunity and need

### EECS International

The Department of Electrical Engineering and Computer Science continues to build its international presence, engaging—and in some cases collaborating—to support major academic and research centers worldwide. EECS students are encouraged to take advantage of international opportunities—just as they are encouraged to take part in the UROP Program. The options for EECS students include VI-A International and the MISTI (MIT International Science and Technology Initiatives). In 2011, over 100 EECS students took advantage of both summer and IAP opportunities through these programs working and/or studying in Europe, Latin America and Asia.

In addition, other programs have sprouted over the past ten or more years, allowing hands-on experience to teach and live in communities abroad—often resulting in significant benefit to these communities. Two such programs—one created within the EECS/CSAIL community and another (nonprofit) created by former EECS students as a response to need—are highlighted in the next two articles in this newsletter. AITI (Accelerating Information Technology Innovation) was formed in 2000 by two EECS undergraduate students interested in building technology education in their native African country. IIH (Innovators in Health) a nonprofit organization was started by three recent EECS graduates in response to the inaugural Yunus Challenge to Alleviate Poverty in 2007.

### From mobile apps to global apps, AITI takes hold in Africa

In 2006, EECS graduate student Michael Gordon was well on his way to earning his PhD in computer science under Professor Saman Amarasinghe. But he felt the need to add another dimension to his learning and energy.

"It was a personal journey. I was doing computer science research in Saman Amarsinghe's group. It was traditional research, parallel programming languages and compilers. I was looking for more direct and human impact...

but still wanted to continue with my PhD research. My officemate and I brainstormed about how we could have more of an impact. We looked at some of the technology changes that were happening in the developing world and noticed that mobile phones were just beginning to penetrate. Then, I became involved in a few interventions involving mobile phones in developing countries: healthcare applications, mobile commerce, and Internet access initiatives.

Having attempted interventions in India and the Philippines, I came to appreciate the difficulties. The technological aspects were appropriate, but we had difficulties with deployment, training, sustainability, language, and existing stakeholders. This experience motivated me to start thinking about how one can stimulate homegrown technology innovation. Locals know the conditions best. They know the problems and opportunities. We just need to arm them with the appropriate technology and entrepreneurial skills to create businesses that address local and regional needs."

— Michael Gordon, PhD, 2010

Gordon's budding ideas found a perfect vehicle in an existing program at MIT, the MIT African Internet Technology Initiative (AITI). AITI began long before Gordon knew about it—in 2000, when two EECS undergraduates, Paul Njoroge and Martin Mbaya, on their graduation returned to their native Kenya with a fellow alum and a graduate student in Linguistics, to conduct a six-week course on Java and Linux for 45 undergraduates at Nairobi's Strathmore University. Over the next six years, the program continued to send MIT students (mostly undergraduates) to African universities and high schools to teach basic programming, Internet technologies, and operating systems.

In 2007 Michael was selected as an AITI instructor at Strathmore University in Kenya. Michael notes about his immediate approach to this assignment, "I added a mobile app development curriculum. And, I got students over there to start thinking about mobile phones as little connected computers, little devices for which they could develop applications. We taught the students that with



# AITI, Accelerating Information Technology Innovation

## AITI, continued

minimal capital there are opportunities for entrepreneurship in the mobile phone market right in their own communities.”

Five years later, Michael Gordon, now Postdoctoral Associate under Prof. Amarasinghe, is the director of AITI (known since 2008 as Accelerating Information Technology Innovation). Michael took control of the program in 2007, and has introduced curricular and structural changes, added new partner universities, and engaged new corporate sponsors. Michael has overseen the expansion of AITI and is now organizing a permanent home for AITI in MIT's International Science and Technology Initiative (MISTI).

In the four years as director of the program, Gordon's goal of stimulating entrepreneurship predicated on Internet and mobile technology at universities in developing countries faced many challenges. “Students at some of the African partner universities had learned computer programming on paper because of various systemic issues. Entrepreneurship was not encouraged; students wanted the safe job with a corporation; networks to foster entrepreneurship did not exist.”

AITI's success in 2007 as one of the first programs teaching mobile application development in Africa caught the attention of Google. They expressed interest in offering support. Buoyed by a subsequent \$30k grant from Google, Gordon trained another group of 4 teaching assistants at MIT, taking them to Kenya where they delivered a mobile application incubator course. Plied with presentations about what the students were doing and ultimately with enthusiastic elevator pitches and business plans from the students, the Google team, as Gordon describes it, “... was blown away by what the students were doing. This was in 2009 when that kind of stuff wasn't really happening in East Africa.”

Yet another and larger round of funding from Google as well as MIT funding through MISTI, the Deans of Undergraduate and Graduate Education, and EECs Professor and MIT President Emeritus Paul Gray enabled Gordon to run two programs in 2010 in Kenya and Rwanda. In both locations, the AITI courses culminated in startup showcases, similar to the MIT \$100k competition; the exposure from the showcase resulted in a team becoming one of the first mobile services startups in Rwanda.

The resulting support, \$150k from Google and enough money from other sources to run three additional programs in 2011 including Sri Lanka as well as four African



2007 AITI Kenya Class Photo at the Strathmore University in Nairobi. Michael Gordon is pictured front left center.

countries (Ghana, Nigeria, Kenya and Rwanda), became the strongest measure yet of AITI's success. With the growth of the entrepreneurial element in the program, Gordon was able to recruit and train 18 student instructors from Sloan and MIT CSAIL with an entrepreneurial spirit and a desire to make an impact on the world. He notes: “The model seems to have proved that as long as you train instructors here and send them over there with some context—they take the structure and run with it. The instructors take ownership of the course and do incredible things.”

Over his four years of involvement with AITI, Gordon is pleased that the MIT students who apply and are selected as instructors are successfully affected—often aiming for far more diverse careers when they graduate. “It's a great experience for students from here—especially for undergraduates. There's a world of difference when they return. They come out of their shells, more outgoing and assertive because it is a dynamic and demanding environment. There is a lot of mentorship and public speaking and pitching.” Typically one Sloan MBA, one CS graduate student and two undergrads in either management or computer science form a team at one location. As for qualities required for AITI instructors, Gordon notes, “As long as they have programming or entrepreneurship experience, they are outgoing and can organize, they will adapt very well on site.”

Gordon has also been developing ways to find good students in Africa—opening the programs up to multiple universities in each country and asking instructors and professors at these universities to send their best students. He notes, however, “There are systemic issues with a scientific education in Africa and I don't see us as an organization going in and making a huge impact

teaching basic skills. We're a small organization. What we can do is make a huge impact with top students who already have skills. We push them towards entrepreneurship and make them leaders and examples. Then they can affect change—a trickle down effect.” So, the selection process of students and universities with which AITI partners has been refined through better recruitment practices and selective scholarship support.

Gordon also notes that things are changing in Africa. There is a greater sense of opportunity. He says, “There's a lot of developing industry, a lot of low hanging fruit, and there's a lot of money to be made because there's a mobile phone in just about everybody's hands and they don't have a mature ecosystem of mobile services as in the U.S.” A lot of multinational organizations such as Google look at Africa and see opportunity and market growth.

2011 also provided great inroads to establishing AITI in Sri Lanka, effectively a part of the huge Indian market. Gordon notes that although some of the top Sri Lankan universities produce students who can program, there is no curricular inclusion of entrepreneurship and innovation—particularly problem solving. “In Sri Lanka there does not exist a culture of risk-tolerant innovation among the students; furthermore, entrepreneurial support structures fostering startups are nascent.”

## The right connections in Sri Lanka

With the goal of raising entrepreneurial instincts, Gordon says that, “AITI offered one of the first incubator courses in Sri Lanka with tremendous outcomes. We had their biggest newspaper putting out articles on the course as it was unfolding. We had the three largest mobile operators intimately involved in the course, bidding to incubate the startups. As a result three startups were funded from the course.” Besides the recognition of the MIT name, Gordon credits his advisor, Saman Amarasinghe (who hails from Sri Lanka). “He was always supportive of what I did, but once he saw what I had done, he gave contacts and helped build the model to be effective in Sri Lanka. In fact, the first year was so successful in large part because he called up influential business leaders to reach out for help and publicity. I appreciate the freedom that one gets at MIT when an advisor provides the flexibility to innovate.”

Gordon has learned through his experience and computer science training to think in terms of scalability and sustainability while building local teaching skills. Local

instructors are attached to AITI courses to participate in the instruction. After experiencing positive outcomes, local instructors see the benefit of teaching incubator style courses, and can continue without direct support from MIT AITI.



Students working on their startup pitches during AITI's 2011 Sri Lanka program at the University of Moratuwa.

Ultimately Gordon seeks to help establish regional entrepreneurship centers. Funding is brought in—from the World Bank, for example. Gordon has sat in on a number of boards as this process plays out. Kenya, the inaugural location for AITI, will no longer be part of the program—a kind of planned graduation. Since the first AITI mobile training in 2007 at Strathmore University, the Kenyan university now offers its own two-year Master's course in mobile-application entrepreneurship. Also Strathmore is opening its own entrepreneurship lab, for which Gordon sits on the board. Gordon reported for the MIT News Office in late 2011: “We're done in Kenya. They have enough local talent and resources to offer these incubator-type classes without direct intervention. That's a huge outcome in my opinion.”

As it continues to mature, AITI in 2012 will see further changes, including the addition of programs in West Africa and Southeast Asia. The other change for 2012 will result as Google increases its annual contribution—enough that AITI can hire a coordinator. Michael Gordon is eager to see the program come under permanent coordination—as he transitions into an advisory role. He looks back, “I wouldn't say we were pioneers; but we were bootstrapping technology entrepreneurship where there is a lot of potential.”

<http://aiti.mit.edu/>



## Innovators in Health

enabling data-driven healthcare delivery and co-founded by three EECS graduates

Manish Bhardwaj, CEO and co-founder of the nonprofit Innovators in Health (IIH), <http://www.innovatorsinhealth.org/>, has lived in many locations around the globe, including his native India, and in Singapore, Indonesia, Austria and the U.S. On completing his SM degree in Electrical Engineering in 2001, he joined and became vice president of Engim, Inc., a private venture-backed wireless semiconductor startup. Manish returned to EECS in 2005 for his PhD, which he earned in 2009.

What moved Manish to found and lead a non-profit? The project started in response to the inaugural Yunus Challenge to Alleviate Poverty, an initiative of MIT's Jameel Poverty Action Lab (J-PAL), Public Service Center, D-Lab and International Development Initiative (IDI). The challenge was to improve adherence to tuberculosis (TB) medication. Manish describes this stage: "It turned out that the Buddhist chaplain at MIT, and now Director of the Dalai Lama Center for Ethics and Transformative Values, the Venerable Tenzin Priyadarshi, was working on TB in the Indian state of Bihar. So, we got a group together with Ven. Priyadarshi's foundation (Prajnopaya Foundation, based at MIT) and started work." This was in 2007 when the group responded to the Yunus Challenge, winning the IDEAS Competition in May. Manish, who was new at the time to public service, had teamed with fellow EECS graduate students Bill Thies ('09) and Goutam Reddy ('05), both of whom had previous public service experience.

On another level, Manish describes the motivation for becoming involved. "It was hard to grasp that 50 years after drugs for TB were invented, about 2 million people were still dying of the disease. It seemed to make no sense. Having been part of a start-up (between my SM and PhD), knowing that we had a strong community partner (Prajnopaya), a very supportive staff at the Public Service Center and MIT D-Lab, and most crucially, a strong team at MIT, gave us confidence that we could make a contribution."

Innovators In Health, as noted on its website, develops technology to electronically record, authenticate, wirelessly relay, and analyze delivery of medication, with the goal of lowering costs and improving cure rates, thus helping programs scale.

From their initial 'debate in a room in Cambridge' approach, the team's intervention design has evolved to an iterative, community-driven one. Manish notes, "The first iteration was a detailed plan based on copious theoretical data and some limited community interaction." Then this thinking was rolled out in 'fully-baked form' in the target areas. "We did this in 2008 with poor results," he admits. The next attempt in 2010, was undertaken first with the team living in communities, spending 2-3 months walking around their target villages, conducting more than 200 long-form interviews with residents, patients, private and public healthcare providers. "What we learned," Manish relates, "led to Aahan - a TB control program that we now run jointly with our partners."



A health worker in New Delhi, India scans a patient's fingerprint to prove that tuberculosis medications have been administered on schedule.

In the past year and a half, one of IIH's most successful interventions has been mobilizing the government's female community health workers (called "ASHA") to deliver TB drugs. Manish describes a process that has been challenging but promising. "From afar, literature and conversations (crucially, not people from the community) indicated that the ASHA were a lost cause. But detailed conversations with the ASHA themselves and the broader community painted a more complex picture. ASHA were not active in the TB program because of inadequate training, motivation and delays in compensation. Despite these barriers, about 10-15% ASHA displayed great dedication and skill, and were trusted by their communities more than any other healthcare agent. In concert with the public health system, we retrained the ASHA, and now have periodic meetings to understand their difficulties in the field, recognize and reward their efforts, and advocate for higher and timely wages on their behalf. As a result, this past year, 32 ASHA workers delivered drugs to about 150 patients, an order of magnitude improvement."

IIH co-founder Bill Thies has led a team at Microsoft Research India and IIH to develop uPrint, a biometric tech-

nology. uPrint establishes, with a high degree of confidence, that patients received their drugs from providers by linking to a database to identify and authenticate the user. Each provider is equipped with a unit including a fingerprint reader attached to a processing device running custom software. Patients and providers register their prints to establish the meeting. Despite the expense of the reader devices, single providers can serve on the order of a hundred patients a year.

IIH co-founder Goutam Reddy started Abiogenix, Inc. to commercialize the uBox, a technology developed by an IIH and Prajnopaya team led by Reddy. The uBox enables patients to take medication themselves, alleviating the need for patients to travel to providers.

All of the IIH interventions are targeted towards TB, but have implications for other diseases. For example, strategies for improved adherence apply in the more challenging context of HIV/AIDS as well. They also apply to mental health, where patients may stop taking medication. In terms of geography, one of the states in India where IIH works is Bihar, which has a population of 103 million. "So," Manish notes, "it'll keep us busy for a while!" And, in terms of transference, he notes, "People working in other regions may find some of the principles underlying our interventions useful, though the specifics would have to be tailored, perhaps significantly, to incorporate local culture and dynamics."

IIH is very much an MIT alumni-instigated entity with significant roots in EECS. Three of IIH's four co-founders are EECS alumni, including Bill Thies, Goutam Reddy and Manish Bhardwaj. The organization includes two full-time staff in a biometrics program in Delhi, supervised by Bill Thies. The program in Bihar has 10 full-time staff and all full-time staff are local. At least 18 students at MIT have made substantial contributions to Innovators In Health from its start in January 2007. Of these, eight are from EECS (5 PhD, 2 MEng, one senior).

"EECS has played a big role directly," Manish says. "It has also played an intangible role. The faculty, staff and our fellow EECS and MIT alumni/ae have contributed to an education that ranks among the best in the world. The mere act of standing as one with our patients sends a powerful message. It says that the poor and illiterate patient in a village is equally worthy of the attention of society's best institutions. To borrow a favorite phrase of mine, "much is asked of those to whom much is given." I think the gift of an MIT education probably asks for a lifetime of public service."

[www.eecs.mit.edu](http://www.eecs.mit.edu)



Manish Bhardwaj (seated left) with a resident of the Keota village, Bihar, as part of a survey on health-seeking behavior.

With entrepreneurship so strongly established at MIT, Manish talks about nonprofits and the meaning of choosing public service as a career. "First, the number of graduates choosing public service as a career remains small, perhaps even zero in many years. This is not because people don't want to serve, but because it is difficult to find appropriate opportunities and examples of others who have done so.

"Second, there is a significant gap between a student initiative and a viable organization, profit or non-profit. The ecosystem at MIT for non-profit ventures is in its formative stages, compared with a highly mature environment for for-profit entrepreneurial ventures. Students don't see a clear path to making that jump. The development community is aware of this gap and working to fix it.

"Third, there is a healthy debate about whether the promise of technological interventions and social entrepreneurship has been oversold. We need to have that debate at MIT, since as engineers and entrepreneurs, we have an unquestioned faith in technology and free markets and, to put it bluntly, the profit motive. We have invited Kentaro Toyama (Bill's former boss), who will give a talk at MIT in March 2012 to ignite that debate. The point is not whether technology and for-profits have a role in development - they absolutely do - but whether they are always appropriate.

"So, we need several things in place if we want to see lasting change by university initiatives or student groups. We need to question some orthodoxies and we need more people picking service as a career, with support systems at MIT to make that easier. With all this, and a lot of luck and hard work, we have a shot at real change."