HOW YOUR CODE AFFECTS ME

IS THE ALGORITHMIC WORLD SAFE FOR HUMANS?
Michigan Engineering's human-powered submarine barrels down the testing basin during a test run in the Aaron Friedman Marine Hydrodynamics Lab. Designed for competition by a team of naval architecture and marine engineering students, the sub can reach a top speed of about six miles per hour with its pedal-powered propulsion system.

PHOTO: Joseph Xu
40 | PUNCH A HOLE IN THE SKY
On the fly with aerospace engineering professor Eli Asbún

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Is there water on Europa?

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A2 drives autonomy

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Riding, wrenching and coding

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It’s a big step
FOCAL POINT
THE CULTURE. THE CULTURE. THE CULTURE.

CULTURE IS KEY
Why Michigan Engineering is focusing on getting it right

When it comes to the most important aspects of a successful engineering school, the culture may not be the first to come to mind. Yet Michigan Engineering is making it a major focus.

From early in the strategic planning process, College leaders knew it would benefit the organization if there was a shared sense of purpose and action, backed by behaviors that reflected its values.

“When we outlined the vision, mission and values for the College, we did so with the knowledge that nothing was broken, but that there was an opportunity to be intentional about who we already are, and what our legacy will be,” said Alec Gallimore, the Robert J. Vlasic Dean of Engineering. “The results were a reflection of our community, which is why it has resonated so strongly with our students, faculty, staff and alumni.”

This laid the groundwork for the Michigan Engineering 2020 Strategic Plan, in which “culture” was one of the three pillars of focus, alongside “research” and “education.” The work within that pillar emphasizes the College’s values, and how those impact the achievement of its goals. [See page 18]

“The values directly support our vision of being the preeminent college of engineering serving the common good,” said Gallimore, who is also the Richard F. and Eleanor A. Towner Professor, an Arthur F. Thurnau Professor, and a professor of aerospace engineering. “To be preeminent, you must lead, and in order to lead, you must be willing to take risks and be creative, transparent and collaborative. In other words, to achieve our vision, we must live our values.”

In an organization as complex and large as ours, if we really want to accomplish new things and stay true to our mission, then we have to make sure our core values are imbued in our culture,” said Michael Wellman, the Lynn A. Conway Collegiate Professor of Computer Science and Engineering, associate dean for academic affairs and co-leader of the culture pillar.

“We need to make sure our actual day-to-day practice is consistent with and supports our values.”

The College tapped faculty and staff leadership for input. It also worked with its Leadership Advisory Board (LAB), a group of academic, corporate and government leaders, to draw from their experiences.

“For things to be sustainable, and culture is a sustainable advantage, it is important for an organization to ask, ‘Are we still where we need to be?’” said Crystal Ashby (BA LSA ’83), a seasoned executive, lawyer and a member of the LAB. “While something may not be broken, it can always be improved upon. You might affirm, ‘Yes, that is who we still are’ or find that new innovations and different perspectives should be considered.”

As a large enterprise, Michigan Engineering needs to continually reinforce the shared understanding about the fundamentals. “Culture is both foundational and a pillar,” said Ashby. “It’s foundational because its strength is a key component of the College’s brand and underpins everything that gets done. But if you don’t constantly cultivate it, it won’t stay at the forefront of the way you think, interact with and treat each other internally and externally.”

The LAB has helped the planners think holistically about how communications, rituals and career development paths reflect and reinforce the organization’s values. The College has come to understand that culture must permeate all aspects of an organization’s processes. It is a natural fit with strategy, according to Deborah Mero, executive director of resource planning and management at the College.

“We need to make sure our actual day-to-day practice is consistent with and supports our values,” said Gallimore, who is also the Richard F. and Eleanor A. Towner Professor, an Arthur F. Thurnau Professor, and a professor of aerospace engineering. “To be preeminent, you must lead, and in order to lead, you must be willing to take risks and be creative, transparent and collaborative. In other words, to achieve our vision, we must live our values.”
Over-hyping engineers?

The Michigan Engineer has always seemed to be a bit of a hype machine. I get that. The University needs to promote itself so that alumni will feel a desire to support it with donations. For something like the past year, I have felt that the hype has gone into a kind of jingoistic overdrive. The key individuals in the articles often have endowed chairs in their departments so whenever their name comes up in an article, it’s their name plus an extended honorific describing their endowment. It’s not simply Alec D. Gallimore, it’s Alec D. Gallimore the Robert J. and Eleanor Vlasic Dean of Engineering or Alec D. Gallimore the Arthur F. Thurnau and Richard F. Thurnau Professor of Engineering. Is that how the Arthur F. Thurnau and Richard F. and Eleanor A. Towmer Professor of Engineering? Is that how he answers the phone?

The article on the Parker solar probe had a breathless tone to it with the standout phrase “making history all of the way” while constantly referencing the dangers of operating near the sun. The article about the use of nanoparticles to kill bacteria describes the researchers as “stepping into the chasm” with constant battlefield metaphors throughout the article.

I am an electrical engineer who earned his BSEE degree at Michigan in 1980. Yes, I am impressed by the science but I can seriously do without the portrayals of individuals and actions on a mythic scale. It’s science. It’s what they love doing. It’s their life. It’s also an engineering problem to be solved. If they do something extraordinary, they will get recognition from the rest of the scientific community. Charles Piotter (BSEE EE ’80)

When a faculty member with an endowed chair or other named title is featured in The Michigan Engineer, they have been the recipient of support from an external partner or the College because of their expertise and leadership. That support, which funds research, faculty work and students, is critical to our mission, and the named title is included to recognize a generous donor or a distinguished former faculty member. – Editor

Go hard or go home

As a United Launch Alliance employee and a Michigan Engineering alumnus, I’m so excited to launch this spacecraft and help begin its journey to the sun! Mitchell Drew

United Launch Alliance manufactures the Delta IV Heavy rocket used to launch the Parker Solar Probe. – Editor

Faster 3D printing

A response to our Random Access item on faster 3D printing

Great work by Prof. Okwudire and his students that not only improves 3D printing, but many precision manufacturing machines. Galip Ulusoy

Mapping the Gaps

A response to our “Mapping the Gaps” story on how mentoring affects outcomes for diverse students in engineering education

This is applicable for all disciplines, but especially so for engineering! Richard H. Stacey

I’m only in my first semester here, yet having a black woman as a professor – especially in the engineering department – has been amazing. @jandosema,

Intergalactic rhymes

A response to our Q&A article featuring Nobel laureate and Michigan Engineer Sam Ting’s dark matter research

The author writes, “Reading the article in the 2018 spring edition ‘What is Dark Matter?’, I could not resist sending the magazine a poem I recently composed on the subject. Technical it is not, but perhaps some might enjoy.”

We’re told dark matter is a critical key
In unraveling a major mystery
Without its presence planets might flee
What happened to Isaac’s gravity?

Yes, we can really believe
Cards pulled from cosmologists’ sleeves?
Better we wait watching them grieve
Discovering it’s all pure make believe.

Then for certain they would realize,
Discovering it's all pure make believe.
Better we wait watching them grieve
Discovering it’s all pure make believe.

What happened to Isaac’s gravity?
Without its presence planets might flee
What happened to Isaac’s gravity?
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Better we wait watching them grieve
Discovering it’s all pure make believe.
Better we wait watching them grieve
Discovering it’s all pure make believe.

Let’s hope astronomers’ minds get weary
Observation somewhat blurry
They cite existence with esoteric sway
Yet said scholarly must have their play

And the company plans to expand its presence in Michigan.

We're told dark matter is a critical key
In unraveling a major mystery
Without its presence planets might flee
What happened to Isaac’s gravity?

Better we wait watching them grieve
Discovering it’s all pure make believe.
Better we wait watching them grieve
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We can’t! It’s dark I say
Yet said scholarly must have their play
With computers whirring right and day
They cite existence with esoteric sway.

Yet, can we really believe
Cards pulled from cosmologists’ sleeves?
Better we wait watching them grieve
Discovering it’s all pure make believe.

For decades scientists extolled
Words explicit and controlled
Knowledge arcane and bold
Stars exist in a vacuum, cold.

Now persistent loquacious chatter
Save space consists of different spatter
Once presume as an empty shell
It’s managed to acquire ubiquitous Dark Matter.

Observation somewhat blurry
They cite existence with esoteric sway
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Michael Wellman (left), responding to a question on distribution of wealth during the Isaac Asimov Memorial Debate with top artificial intelligence experts in the country. Wellman, the Lynn A. Conway Collegiate Professor of Computer Science & Engineering and associate dean for academic affairs, participated in the panel assembled by Director of the Hayden Planetarium Neil deGrasse Tyson (right). The discussion explored Asimov’s famous Three Laws of Robotics and challenged whether these early safeguards are enough in our emerging AI-reliant world.

Although construction on the new Ford Motor Company Robotics Building has just begun, you can get a sneak peek of what it will look like inside with a 3D virtual tour. Stroll through the glass atrium and check out the fourth floor, which will be home to more than 100 Ford employees in a unique collaboration with the College. When complete, the building will house the McNeil Walking Robotics Laboratory, high-bay garage space for autonomous vehicles, a three-story flying lab, maker space and shops for student robotics teams and a rehabilitation robotics lab where researchers will work with amputees and people with paralysis.

Go to robotics.umich.edu/building-cad

A nanoparticle that lights up in the absence of oxygen could be a new weapon in the fight against cancer. That’s because cancerous cells in the body contain far less oxygen than healthy ones.

The U-M research team that developed the particle believes it could help detect cancer by sniffing out telltale oxygen deficiencies. The particle could detect the spread of cancerous cells or provide surgeons with a way to identify the boundaries of a tumor more precisely.

While there are plenty of oxygen-sniffing phosphors out there, organic phosphors that can be used in the body are a much newer development. The team combined the phosphor with an organic polymer and a polystyrene core to get precisely the properties they needed in a 200-nanometer package.

“The challenge was to get the right-size particle that was biocompatible, water soluble and nontoxic,” said Jinsang Kim, a professor of materials science and engineering who led the work.

The nanoparticles could also be useful in industrial oxygen detection, monitoring oxygen-starved ocean dead zones, and, of course, for creating a cool-looking glow-in-the-dark block M.

Although construction on the new Ford Motor Company Robotics Building has just begun, you can get a sneak peek of...
**COULD MICROPOLASTICS SAVE LIVES?**

When the immune system goes nuts, it can be a killer. One example of this is when inflammation in the lungs leads to so much fluid production that a person can drown. Lola Eniola-Adefeso, a professor of chemical engineering, and her students discovered the potential of an unconventional treatment. They’d been trying to design polystyrene microparticles for drug delivery, but immune cells kept spotting the particles and escorting them away. In tests with mice, they realized that these particles could actually distract the immune system, reducing the severity of inflammation in the lungs of the mice. If the particles work safely in humans, they could help prevent organ damage or death when the body suddenly attacks itself.

**PRINTABLE MEDICINE**

Instead of counting out pills, pharmacists may one day be able to print ultra-precise, customized doses of drugs right at the pharmacy. That’s the goal of a new technique that U-M researchers have successfully used to print multiple medications onto a variety of surfaces including dissolvable strips and microneedle patches.

Developed by a team that includes Max Shtein, professor of materials science and engineering, the process could make life easier for patients who now must take multiple pills every day—all those meds could be printed onto a single dose. Medications printed with the process also dissolve more easily than pills, which could enable the use of drugs that today are shelved because they don’t dissolve well enough in pill form.

**FOUR REASONS WE’RE UPGRADING THE WORLD’S MOST INTENSE LASER**

At 20 septillion (2×10²²) watts per centimeter squared, U-M’s HERCULES laser can still cram the most power into the smallest space, but it lost ground in the overall power department to newer competitors. A $2 million upgrade funded by the National Science Foundation will double or even triple its current power of 390 trillion watts, bringing it closer to the most powerful lasers today. Here’s what that could mean for science:

1. **TABLETOP ACCELERATORS**
   Laser light can power the acceleration of particles and produce other high-energy beams such as X-rays in just a few square yards or less. These can be used for medical treatments, fundamental physics research and identifying nuclear contraband in shipping containers.

2. **X-RAYS THAT DIFFERENTIATE AMONG SOFT TISSUES**
   High-energy X-ray beams emitted by laser accelerators could enable advanced imaging that would be cheaper and offer faster results than an MRI.

3. **SOLVING ASTROPHYSICAL MYSTERIES**
   HERCULES-induced strong magnetic fields on microscopic scales could break apart and reconnect the field lines around black holes, shedding light on how powerful, seconds-long bursts of gamma rays occur in space.

4. **CHECKING QUANTUM ELECTRODYNAMICS**
   Quantum electrodynamics—the quantum description of light and its interactions with matter—needs more testing in extreme situations, such as the very strong electric fields that occur in neutron stars. HERCULES could simulate these electric fields.

**BLOOMBERG: NIGHT VISION IS A SELF-DRIVING BLINDSPOT**

“The Uber accident really draws attention to one of the areas in which we have the greatest number of pedestrian fatalities, which we’re hoping self-driving cars can fix. Until now, a lot of the research has been focused on using daytime vision driving as the benchmark. This accident highlighted how maybe we need to expand how we think about that.”

— Matthew Johnson-Roberson, associate professor of naval architecture and marine engineering who works on autonomous vehicle technology.

**WAIRED: THE LAB THAT MAKES ROBOTS WALK THROUGH FIRE AND RIDE SEGWAYS**

“By bit, researchers like Lensyl Glitzy are getting Cassie to move faster, or better tackle uneven terrain, or climb steps. That will undoubtedly help build a world where bipeds move more confidently among us, whether that be walking through fire or, sadly, stealing our Segways.”

— Conclusion of an article about Cassie Blue, newest biologically inspired robot in the lab of Josy Gitzel, director of the Robotics Institute, the Elmer G. Gilbert Distinguished University Professor of Engineering and the Jerry W. and Karol A. Levin Professor of Engineering in electrical and computer engineering.

**SCIENTIFIC AMERICAN: THE ORIGIN OF MARS’ METHANE**

“Nearly 95 percent of all the methane in the Earth’s atmosphere originated from current and past biology. So, it is natural to ask whether methane on Mars is also of biologic origin.”

— Sushil Atreya, professor of climate and space sciences and engineering, on the ExoMars Mission’s Trace Gas Analyzer, which aims to determine why methane, a possible sign of life, is being released on Mars.

**NEW ATLAS: A PILL TO DIAGNOSE BREAST CANCER**

“We overdiagnose $4 billion per year on the diagnosis and treatment of cancers that women would never die from. If we go to molecular imaging, we can see which tumors need to be treated.”

— Greg Thurber, assistant professor of chemical engineering and biomedical engineering, on his new pill that makes breast tumors glow under infrared light.
The Galileo spacecraft, which orbited Jupiter from 1995 until 2003, seems to have run into a water plume over the moon Europa in 1997. This incident went unnoticed for two decades until it was unearthed by a team from U-M, UCLA and the University of Iowa. Xianzhe Jia, an associate professor of climate and space sciences and engineering at U-M and first author of the paper in Nature Astronomy, explains how they did it.

Jupiter’s moon, Europa, is one of the best places in our solar system to search for extraterrrestrial life because it is believed to harbor a global ocean beneath its ice cover. Compelling evidence for that subsurface ocean came from the magnetic field measurements acquired by NASA’s Galileo spacecraft during flybys of the moon. We recently reanalyzed data from Galileo and suggest that in 1997, the spacecraft passed through a water plume rising a few hundred kilometers above Europa’s surface. Indeed, we found that during a three-minute interval when the spacecraft encountered an obstacle; a plume provides a plausible explanation based on what has been learned at another icy satellite of Saturn, Enceladus, where active water jets erupt from the surface and modify the magnetic field and the ambient plasma.

The detection of a plume during a flyby not only provides additional evidence for the contemporary presence of liquid water on Europa, but also has major implications for future missions to Europa to assess its habitability, such as NASA’s Europa Clipper mission and the European Space Agency’s Jupiter Icy Moons Explorer (JUICE) mission. With all the evidence of plumes presently available, there appears to be a considerable probability for future spacecraft to fly through plumes over Europa. In that case, a spacecraft will be able to directly sample plume materials originating from the subsurface ocean. The measurements obtained by the modern instrumentation onboard those missions will provide a wealth of information for scientists to assess whether or not Europa’s ocean has conditions suitable for life.

To test the plume hypothesis, we turned to numerical simulations by the Center for Space Environment Modeling at U-M, we systematically explored the plume interaction with the incident Jovian plasma in three dimensions (Figure 2) and compared simulated magnetic and plasma parameters with the Galileo data. A model that incorporated a plume with characteristics inferred from Hubble images reproduced the anomalous changes in the magnetic field and plasma wave measurements with high fidelity. The satisfactory quantitative agreement between the model and data led to the conclusion that Galileo passed through a plume during its close flyby of Europa in 1997. The detection of a plume during a flyby not only provides additional evidence for the contemporary presence of liquid water on Europa, but also has major implications for future missions to Europa to assess its habitability, such as NASA’s Europa Clipper mission and the European Space Agency’s Jupiter Icy Moons Explorer (JUICE) mission. With all the evidence of plumes presently available, there appears to be a considerable probability for future spacecraft to fly through plumes over Europa. In that case, a spacecraft will be able to directly sample plume materials originating from the subsurface ocean. The measurements obtained by the modern instrumentation onboard those missions will provide a wealth of information for scientists to assess whether or not Europa’s ocean has conditions suitable for life.

Figure 1: An artistic illustration of Galileo’s orbit through the inferred plume viewed from the direction from which the wind is blowing (left) and from outside Europa’s orbit looking toward Jupiter.

Figure 2: Plume flow surfaces with the colors illustrating the bends of the magnetic field caused by the slowing down of Jupiter’s magnetized wind as it encounters Europa’s atmosphere. In panel (A) where there is no plume present, the magnetic field bends towards the viewer above Europa’s equator and bends away from the viewer below the equator. In panel (B), the bends illustrated in panel (A) are still present but additional bends, evident from changes of color, develop in a small region around the plume.
Changing of the Chairs

With nearly two centuries of combined professional experience and over 1,000 published papers, these newest chairs are leaders in their fields and share Michigan Engineering’s mission for creative thinking and research-driven innovation.

**AERO**

Anthony Waas, professor emeritus of mechanical engineering and professor emeritus of aerospace engineering, has been named the Richard A. Aull Department Chair of Aerospace Engineering.

**CLaSP**

Tuija Pulkkinen, vice president for research and innovation at Aalto University in Espoo, Finland, has been named the new chair of the Climate and Space Sciences and Engineering Department.

**ECE**

Mingyan Liu, professor of electrical engineering and computer science, has been named the new chair of Electrical and Computer Engineering.

**IOE**

Brian Denton, professor of industrial and operations engineering and professor of urology, has been named the new chair of the Industrial and Operations Engineering Department.

**ISD**

Diann Brei, professor of mechanical engineering, professor of integrative systems + design, co-director of General Motors/U-M Multi-functional Vehicle Systems Collaborative Lab, has been named the new chair of the Integrative Systems + Design Division.

**ME**

Ellen Arruda, Maria Comninou Collegiate Professor of Mechanical Engineering, professor of biomaterials science and engineering, and co-director of the Exercise & Sport Science Initiative, has been named the Tina Manganello/BorgWarner Department Chair of Mechanical Engineering.

**NERS**

Todd Allen, Grainger Institute for Engineering Professor in the engineering physics department at the University of Wisconsin-Madison, has been named the Graian F. and Gladys H. Krull Department Chair of Nuclear Engineering and Radiological Sciences.

**TOTAL CHAIR STATS**

- ~1,000 COLLECTIVE NUMBER OF PAPERS PUBLISHED
- 23 COLLECTIVE NUMBER OF DEGREES EARNED
- ~180 COMBINED YEARS OF EXPERIENCE
- 54% MALE
- 46% FEMALE
- 25% EXTERNAL
- 75% INTERNAL

**CHANGING OF THE CHAIRS**

With nearly two centuries of combined professional experience and over 1,000 published papers, these newest chairs are leaders in their fields and share Michigan Engineering’s mission for creative thinking and research-driven innovation.

**INCOMING CHAIR STATS**

- ~1,000 COLLECTIVE NUMBER OF PAPERS PUBLISHED
- 23 COLLECTIVE NUMBER OF DEGREES EARNED
- ~180 COMBINED YEARS OF EXPERIENCE

**THAT’S HOW ALEX HALDERMAN ALTERED THE OUTCOME OF A MOCK ELECTION IN TISHMAN HALL THIS WINTER – AND HE CAUTIONS THAT SOMETHING SIMILAR COULD REALLY HAPPEN IN A CLOSE ELECTION.**

In the November midterms, millions of Americans across 18 states will cast ballots on the same type of voting machines he purchased online from an Ohio electronics recycling company.

Halderman, a U-M professor of computer science and engineering, worked with The New York Times editorial department in March to stage a mock election as a way to demonstrate how vulnerable many of these machines are. Voters were simply told they were participating in an experiment. Ballots asked: Which is the greatest university, U-M or Ohio State?

After more than 200 votes, the winner was announced. According to the machines, Ohio State eked out a victory. But the paper trail told a different story: U-M won by a wide margin.

Halderman and President Trump alike are both calling for paper ballots, which can be tallied by computer but also spot-checked by hand as a sure-fire way to guard against vote hacking.

"Our election infrastructure is far too vulnerable to hacking and sabotage," Halderman said. "States and the federal government need to act before it’s too late."
THE JOB MARKET FOR A STARTING ENGINEER

WHAT ARE COMPANIES LOOKING FOR?

Many Michigan Engineering alumni are involved with talent acquisition, helping their companies to recruit engineering grads for the workforce. We asked one of them — David Liaw (BSE EE ’08, MSE ’10, PhD ’14), the university relationship manager for Northrop Grumman Corporation’s southern California region — for his insights about today’s job landscape.

How does the market look for today’s grads?

With unemployment at such an incredible low point, the job market is amazing for students. They are getting multiple offers, and they can often find one that fits what they’re looking for — whether it’s culture, size, type of work, location or salary. That’s a shift we’ve seen over the last 10 years since the recession. And STEM talent is heavily desired and heavily needed.

What type of skills are needed to get hired?

The best students are the ones who work across disciplines. Because we work in areas like artificial intelligence, cyber-security, machine learning and big data, we need people from a broad range of backgrounds, from mechanical and aerospace to computer science, you name it. So not just looking at your field of study, but people who are able to work with other areas on multidisciplinary team projects. And not just engineering, but also students in business, schools of information and more.

WHAT TYPE OF CANDIDATE REALLY STANDS OUT?

The people who stand out are the ones who can work with others — they respect other people’s ideas, they can think critically about their own ideas and other people’s ideas and they know how to listen.

What are companies looking for?

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Many Michigan Engineering alumni are involved with talent acquisition, helping their companies to recruit engineering grads for the workforce. They are getting multiple offers, and they can often find one that fits what they’re looking for — whether it’s culture, size, type of work, location or salary. That’s a shift we’ve seen over the last 10 years since the recession. And STEM talent is heavily desired and heavily needed.

What type of skills are needed to get hired?

The best students are the ones who work across disciplines. Because we work in areas like artificial intelligence, cyber-security, machine learning and big data, we need people from a broad range of backgrounds, from mechanical and aerospace to computer science, you name it. So not just looking at your field of study, but people who are able to work with other areas on multidisciplinary team projects. And not just engineering, but also students in business, schools of information and more.

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Michigan Engineering strives to anticipate the global, technological and educational changes ahead, and position our institution to lead the evolution of 21st-century engineering research and education for the benefit of the common good.

We will use a startup investment model to spur innovative and collaborative research to solve grand challenges. Three funding approaches will be piloted, providing early-stage investment, mid-level investment modeled after “angel” investors and high-level strategic funding through a venture capital model.

We will ensure that every Michigan Engineering student benefits from an educational experience that is among the finest in the world. We will introduce academic innovations consistent with preeminent engineering education, including new pedagogical and technological delivery methods, beyond-the-degree experiences and access to learning for students and professionals around the globe.

We will align our promotion process, incentives and career development with our core values to foster a culture of daring, leadership and inclusivity. Three initiatives we will undertake include articulating the tenure-track criteria, incentivizing faculty and staff for activities that are creative or daring, and creating culture-building activities and practices to increase understanding and adoption of our vision, mission and values.

See more about the vision, mission and values that will enable our strategic plan:

strategicvision.engin.umich.edu
A TALLER TOMORROW

The sun sets on South University Avenue as Six11, the area’s latest luxury student apartment high-rise, takes shape near the corner of East University and South University. Now complete, the 14-story Six11 houses 91 fully furnished apartments along with ground floor retail tenants. Amenities include a penthouse lounge, granite countertops, 50-inch Sony HD flat-screen TVs, walk-in closets and a three-story parking garage.

PHOTO: Kevin D. Larkin
BUILT BY HUMANS. RULED BY COMPUTERS.
The great and terrible consequences of an algorithmic world.

Story by: Gabe Cherry
Photos by: Joseph Xu
Brian Russell is a regular blue-collar guy. stocky with a shaved head, black-tinted glasses and a tightly trimmed van dyke, he pulls down steady hours at his job installing security systems. Every night, he drives his old green Jeep home to a freshly planted subdivision of modest ranch houses outside the squarly-clean West Michigan town of Zeeland. Trucks mean past on the freeway out back and the dewy-sweet smell of cut grass follows him to the door. His dog, Mischief, his fiancée and their two boys greet him at the door. All seems right with the world. But this world – the one we can see and touch and smell – is no longer the only one that matters. Another domain, built by humans but ruled by computers, has taken shape in the past few decades: that of algorithmic decision-making. This new world is often invisible but never idle. It likely determines whether you’ll get a mortgage and how much you’ll pay for it, whether you’re considered for job opportunities, how much you pay for car insurance, how likely you are to commit a crime or mistreat your children, how often the police patrol your neighborhood. It even influences the level of prestige conferred by a U-M degree, thanks to the now-ubiquitous, algorithm-based U.S. News & World Report college rankings.

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Generally, these algorithms keep a low profile. But occasionally, they collide spectacularly with humans. That’s what happened to Russell. In 2014, a computer system called MiDAS plucked his file out of the Michigan Unemployment Insurance Agency database and calculated, without any human review, that he had defrauded the unemployment system and owed the state of Michigan approximately $22,000 in restitution, penalties and interest — the result of a supposed $4,300 unemployment claim.

Russell simply couldn’t afford the five-figure hit to his income. For the next two years, he made ends meet the best he knew how — he cancelled family trips, cut back on medical care for his diabetes, worked odd jobs. For a time, he lived in a friend’s basement. While Russell struggled in the aftermath of the fraud determination, MiDAS kept rolling. An algorithm-based administration and fraud collection system implemented by the state of Michigan, it ran without human intervention for nearly two years between 2013 and 2015. During that time, it accused about 50,000 Michiganians of unemployment fraud. A 2017 review by the state found that more than 90 percent of those accusations were false. Russell still doesn’t know why MiDAS accused him of fraud. He collected unemployment on and off a few years back when he was working as a journeyman electrician. Like generations of electricians before him, his union filed for unemployment on his behalf when he was between jobs. He can’t see the system, can’t touch it, can’t talk to it, can’t ask it why it has taken his money. The Michigan Unemployment Insurance Agency hasn’t shared any information with him.

“How do you beat something you can’t see?” Russell said. “It’s like swinging in the dark. What are the laws that apply to a computer system? And what about us humans?”

That’s a question that, increasingly, is troubling the architects of the algorithmic world. They’ve dedicated their careers to data, certain that it would make life more fair, equitable and efficient. In some cases, it has. But as algorithmic decision-making has become more and more powerful, some researchers have become increasingly concerned that it’s not living up to their vision.

A growing number of people, like Russell, have been harmed by an algorithmic system gone off the rails. Algorithm-based financial systems were found to have helped spark the 2008 housing crisis. Residents of neighborhoods targeted by predictive policing systems feel besieged by an unending wave of police scrutiny. The U.S. News & World Report college ranking system has been criticized as distorting academic priorities and raising the cost of an education.

In many cases, the researchers who helped create the algorithmic world have turned their attention to rebuilding it in a form that’s fairer, safer and more sophisticated. At times, their work takes on an ironic David-and-Goliath quality as they work to hem in the massive entity they helped create.

H.V. Jagdish, the Bernard A. Galler Collegiate Professor of Electrical Engineering and Computer Science at U-M, has been tapped to lead the Center for Responsible Information Technology, a U-M think tank that’s now in development. It will aim to help technologists use algorithmic systems and other IT advances in a socially responsible way.

In the early days of any new technology, you want raw creativity and bold ideas; you want to make technical progress as quickly as possible. As the technology matures and has a greater reach, you have to take into account its impacts on society,” said Jagdish. “In the early days of the industrial revolution, for example, there was tremendous pollution, but over time the need to control pollution became well recognized. Therefore, there has been a lot of technical work to maximize the benefits and minimize the harms of industrialization. “I expect that with algorithms and data science and artificial intelligence it’s going to be the same,” he said. “A lot of smart people are starting to think about this and over the next several years, we’ll adopt best practices that have as little harm as possible for the good they can do.”

Changing the world — any world — is a series of small steps. And researchers are just beginning what could be a decades-long journey.

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Some engineers are working to make sure that the data that goes into decision-making systems is better parsed and more thoroughly understood. Others are working to help non-engineers gain a better understanding of the algorithmic tools that shape their lives. And still others have assumed the role of cyber-vigilante, testing algorithms in the wild to ensure that they’re helping humans, not harming them.
One of those engineers is Danai Koutra, a U-M computer science and engineering assistant professor who is working to build a deeper understanding of the data that goes into algorithmic decision-making tools. From an engineering standpoint, she says, it’s easy to find a simple correlation and use it, without looking deeper to see why that correlation exists or how the data behind it might be flawed.

“People are flawed. We make biased decisions,” Koutra said. “And now we’re asking algorithms to be better than we are, based on data that we produce. That’s an interesting ask.”

MiDAS, for example, relied on a single, simple correlation: discrepancies between the data reported by claimants like Russell and data reported by their former employers. If an employer and employer reported different amounts of income, for example, or different reasons why an employee left a job, it was flagged as possible fraud. But typically, it was assumed that the employer was the one who reported incorrectly with the intention of defrauding the system. An automated quarantine was sent to the employer — often at a years-old address — and if the agency didn’t receive it back within 10 days, MiDAS made an automatic determination that the employee had committed fraud.

Koutra is working to develop systems that handle data in a more nuanced way, partnering with Jagadish on GeoAlign, a project that aims to clean up the algorithmic world’s geographic data. Present in some 80 percent of algorithmic datasets, geographic data is a key component in the measurement of everything from credit scores to crime rates. Comparing how two different variables — say, home ownership and crime rate — shake out over a given geographic area is endlessly useful.

But geographic data is notoriously messy, largely because different agencies measure it in different ways. How do you compare home ownership and crime rate, for example, if home ownership is measured by ZIP code and crime is measured by county?

Mathematically, it might be tempting to assume that crime is evenly distributed across the country and simply take the county map into ZIP codes, attributing a given percentage of the county’s to each ZIP code based on its geographic size. But in reality, crime tends to cluster in certain areas. So that approach would almost certainly lead to a faulty algorithm and potentially life-changing consequences for the people affected by it.

GeoAlign takes a more sophisticated approach. It uses what’s called a “warping algorithm” to find other variables in the dataset that correlate with the ones being studied and are available on a finer geographic level. It then uses those additional data points to infer the geographic distribution of the data that’s being studied.

It might find, for example, that crime is closely correlated with the number of tax-delinquent properties in a given area — and that the latter piece of information is available on an address-by-address level. The system crunches the variables to determine exactly how closely they hew to one another, coming up with a weighted formula that can more accurately port geographic data from one unit of measurement to another.

GeoAlign shows that honing the data behind automated decision-making systems isn’t simple. But as algorithms work their way into more and more areas of our lives, we don’t have the luxury of time to test out new ideas. When an algorithm recommends the wrong movie, it’s laughable. When it declares someone ineligible for medical coverage or saddles you with a massive debt? Not so much.

“It goes back to understanding what your data is representing,” she said. “Data is never perfect, but if you understand how it’s skewed than you can build the math to account for that. As powerful as data is, it’s up to us to interpret it.”
Led by Kevin Gray (center), Michigan Law’s Unemployment Insurance Clinic provides assistance to claimants who have been accused of fraud by the MiDAS system, including Brian Russell.

The MiDAS system is still running today, though the state has made modifications and implemented human oversight that it says has solved the problem. Meanwhile, Michigan Law’s Unemployment Insurance Clinic continues to review automated fraud determinations.

"If I get my money back, that would be great. I meet other people around town who have gotten settlements," he said. "But I try not to get my hopes up.

I suspect things will get worse before they get better because we keep moving toward more complex machine learning that’s harder and harder to interpret. There’s a lot of snake oil out there, and you run the risk of something awful getting entrenched.

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A NUTRITIONAL LABEL FOR ALGORITHMS

U-M professor H.V. Jagadish’s labelling system for algorithmic systems evaluates their safety and effectiveness. It breaks down algorithms according to five key attributes:

**RECIPE:** Lists the factors that the algorithm considers, along with the weight given to each factor by its designer. This provides an easily understandable window into the designer’s intentions.

**INGREDIENTS:** Lists the same factors, but instead of showing the weight given to each factor by the designer, it shows the actual correlation of each factor to the algorithm’s final output. Put another way, the Recipe widget shows intentions while the Ingredients widget shows results.

**STABILITY:** Determines whether slight changes in the data going into an algorithm can lead to wild and unpredictable swings in the results coming out. The stability score is determined by feeding a ranking algorithm, for example, a range of hypothetical items and plotting the results on a line graph. A steeply sloping line indicates more differentiation between ranks and a stable graph. A flat line indicates that rankings are too close together and could be influenced by noise in the data or very small changes in the algorithm.

**FAIRNESS:** Evaluates whether the results of an algorithm show statistical parity with a given attribute. Using the MiDAS example, it could determine whether females or data from a specific race or gender are handled by the algorithm differently than another.

**DIVERSITY:** Related to fairness, shows a graphical distribution of every group within the overall population in a range of categories, and the diversity of the algorithm’s results, providing a broader view of how different demographic groups are handled by the algorithm.
RIPPLE EFFECT

What’s happening in Detroit, with the help of the Michigan Engineering Zone, may help solve Michigan’s economic manpower problem.

STORY BY: JIM LYNCH
PHOTOS BY: JOSEPH XU
A lot of the young men here are frustrated with a lot of things. There is a lot of frustration that drives (crime). A lot of broken relationships. Disappointment, dreams that have gone bad."

Small wins like this are visible around Osborn in recent years if you take the time to look. And it might be worth a long look. What’s happening in schools across Detroit through the national FIRST Robotics program has implications for individual neighborhoods, the city, the auto industry and Michigan’s economy as a whole. U-M’s Michigan Engineering Zone, an incubator for Detroit schools’ robotics programs known as the MEZ, is a small link between them.

Michigan has embraced the FIRST Robotics phenomenon like no other state, with 200 more high school teams than the next closest state, California. Often overlooked pockets of Detroit, like Osborn, may be the greatest source of untapped potential Michigan has to offer. Schools in those areas often turn to the MEZ, located along Woodward Avenue, to get robotics teams up and running.

 Detroit and state officials want this rising interest in robotics to continue. Both have enjoyed an economic resurgence in recent years that runs the risk of short-circuiting without more workers trained in math and science.

Despite the exploding popularity here, however, Detroit public schools historically struggle to match the performance of other districts in robotics. A resource gap exists for areas that fall outside the state’s greatest source of untapped potential Michigan has to offer. Schools in those areas often turn to the MEZ, located along Woodward Avenue, to get robotics teams up and running.

Osborn is just one example. Detroit currently has 19 high schools participating in FIRST Robotics at the MEZ. Each has kids willingly diving into the nerk-work of robot building at U-M’s facility in a way that, in previous generations, might have been reserved for sports teams or school plays. And FIRST Robotics rewards that effort with a similar kind of spectacle – electrifying competitions that surreptitiously encourage interest in math and science.

SHOWTIME

It’s 5 p.m., a mid-April Thursday afternoon in Saginaw. Close your eyes and you might be at a concert, a professional wrestling match, maybe a college basketball game. Open them and it still might take a while to realize you’re not.

Saginaw Valley State’s Ryder Center is rocking right now with the noise of thousands of students, parents, teachers all poised to watch a video game come to life. Opening ceremonies for FIRST’s Michigan state championship are underway and things are … frenzied.

If you’re just showing up now, you’ll be lucky to park within a half-mile of the action. Herds of school buses have staked out spaces closest to the facility. This is a three-day event and, for many, a family affair, evidenced by the RVs and campers popping up in a sea of vehicles.

The arena stands are packed with people, grouped together by the T-shirt colors of the schools they’re backing. Masons crisscross the aisles while, overhead, four massive screens provide video feeds of action on the floor.

FIRST Robotics touts its events as “the excitement of sports, the rigor of science.” The fun and spectacle of it all is a Trojan horse. By the time students realize they’re learning, they’re already hooked.

Dean Kamen, inventor of the Segway and co-founder of FIRST, once identified the problem he hoped to circumvent through robotics: large groups of children, particularly girls and minorities who, by the age of 12, focused on future in one of only two fields. “All of their role models come from those two fields . . .” Kamen told CNN in 2006. “So it seemed to me that we have to go into all of these communities across the country and really energize these kids to develop a passion to spend a lot of their time developing skill sets that . . . will prepare them for the good jobs, the exciting jobs, the high-paying jobs . . .”

Amidst the noise on the floor in Saginaw, Dennis Martin moves through the crowds with two other Osborn High School teens, all in their yellow MEZ T-shirts. He’s Trim 099’s only senior and, perhaps, the kind of kid Kamen had in mind.

Earlier in his high school years, Dennis will tell you, he was a quarterback. It’s clear he sometimes wishes he still was, but grades and life intervened. He’s here now and, today, he’ll be driving the Osborn Knight Riders’ robot, Kitt 1, as one of the MEZ T-shirt warriors.

It’s like a sport and, for people who give all their time and effort to it building these big things, it’s like a blood sport,” he jokes ahead of the team’s first match. “These guys are aggressive. And aggressive neds are scary.”

Humor is a big part of Dennis’s infectious personality, something...
he uses to pump up his younger teammates. Had things turned out differently, he might be running a huddle on a Friday night. On this day, robotics provides the playing field and it’s giving him a glimpse at opportunities he might not otherwise have seen.

“This is … nah, it’s not the same (as football). This is, like, 100 percent mental, nothing physical. So you’ve got to be locked in up here,” Dennis said, pointing to his head. “And you have to know the technicalities of the rules. If you don’t know the rules, then it’s game over every time.”

Dennis is extremely hard not to like and root for. But today, he’s two months from graduation and remains unsure of what he’ll do after. Looking around the facilities at Saginaw Valley State, he says: “Something like this wouldn’t be bad.”

THE LEARNING LAB

Rewind a bit. It’s 6 p.m., a late-March Tuesday night in Detroit’s Midtown. A few blocks south of here, early Red Wings fans are crowding the bars ahead of a matchup with the defending Stanley Cup champs from Pittsburgh. Nayah Daniel, however, is caught up with a practical problem.

The 18-year-old sits cross-legged on the floor beneath a workbench in the MEZ. She’s puzzling over how best to improve the lifting ability of Cass Tech’s robot, which clamps wheels on opposite sides of a box to roll it upward.

She doesn’t puzzle long.

“The problem we had at our last competition was with the wheels gripping the boxes,” Nayah says from behind a pair of safety glasses. “So, we’re tripling the number of wheels to have more stability.”

Around her, every inch of the MEZ’s 5,200 square feet of first-floor space is alive with activity. More than a half-dozen local high school robotics teams are here tonight ahead of district FIRST competitions that get underway in Livonia and Troy in less than 48 hours.

When Michigan Engineering opened it in 2010, the MEZ hosted a dozen teams total. This year 19 high schools are using the facility. Students get the run of the place with access to workbenches, tools, supplies and, most importantly, mentors. Roughly 2,000 kids have been part of this since it started.

Nayah is Cass Tech’s latest success story born out of a partnership with the MEZ. She’s graduating in June, headed to the University of Michigan with scholarship assistance to study naval architecture – an interest, she’ll tell you, that came from her love of action movies.

Nearby is Wayne Lester, a Cass Tech grad, MEZ mentor and example of what could lie ahead for the kids here. Several weeks from now, he’ll leave U-M with a master’s degree in space systems engineering, heading off to a job with Lockheed Martin in Washington, D.C.

By comparison to Cass’ decade-old team, Osborn’s program is just getting started – technically in only its third year. An earlier robotics team at the high school dissolved. But Rockpointe Community Church of Sterling Heights has stepped in as a sponsor and, with the help of the MEZ, has the program flourishing in a short time.

With a new classroom dedicated to robotics on the way, Osborn is now a MEZ graduate program – no longer needing its on-site facilities but still receiving financial support and technical assistance when needed.

Not every Detroit school has a partner like Rockpointe. Thomas Reisner, while in his first year overseeing Osborn’s team, has three decades teaching in the school district and a unique understanding of the hurdles it faces.

“Years ago, all of the vocational tech programs were taken out of the local high schools and moved to the vo-tech centers …,” he said.
A multi-tiered approach to home-growing and recruiting workers with skill-sets for the new economy. He has also been a staunch supporter of FIRST Robotics as means of setting students on a path to get those skills. "FIRST is something that is opportununit, first and foremost, to learn about science, technology, engineering, and math," Snyder said. "That's their first exposure to hands-on engineering, and it's working."

Jacobian Drumh (BS EECS ’17) is proof. A few years ago in the time, he was wrapping up his senior year at Detroit's Finney High School. Twelve months back, he was walking at U-M's commencement ceremony with a degree in computer science and engineering. Today, he's finishing up his sixth month with Ford in the automaker's college graduate program. After taking a rotation on the F-150 assembly line, he's now working with the connected vehicles and services team.

It all started when Jacobson's teacher used a trip to the MEZ to lure him onto Finney's robotics team. "From that day on, I was hooked," he said. "I started off with me realizing that I can be an engineer—that I do have these critical thinking skills that can be developed."

THE INNER ENGINEER

First round matches are about to get underway, so freshman Donald Lew is leading Osborn's team and Kitt Jr. to the arena. Today, the encourage consists of just three students since half are unable to attend the opening for various reasons. Reiner and Rockpointe mentors Mike Aubrey, Ken Lames and Thomas Parnessa are doing along for support. Ja'mon Miller brings up the rear. Both Reiner and Dennis will tell you that 17-year-old sophomore Ja'ron has a gift for robotics. "He can be the foundation of our program for the next two years," Reiner said. "He's our technician. He handles everything." While other teens may struggle to muster enthusiasm for science, that's never been a problem for Ja'ron. In recent years, he's also discovered an aptitude for math. It's evidence that the homegrown talent Michigan needs is here. Yes school and community leaders say kids aren't likely to seek our engineering unless they're shown what it is.

"Once I got into FIRST, I just knew engineering had to be my thing—like I have to be an engineer," he said. "My inspiration is Elon Musk. Elon Musk is the best, if you didn't know. Him and Neil deGrasse Tyson, of course. They are the coolest people in science. But I want to grow up and be able to revolutionize the tech industry or the engineering field." Ja'ron is the kind of kid that gives hope to Quincy Carter back in Osborn. "That's their first exposure to hands-on engineering, and it's working," Snyder said. "FIRST is something that is an opportunity, first and foremost, to learn about science, technology, engineering, and math," Snyder said. "That's their first exposure to hands-on engineering, and it's working."
"It’s our role to serve and inspire the broader community to benefit the common good. Through the MEZ, we instill knowledge of the types of STEM careers that are available and the self-confidence for students to realize these goals are within their reach."

DETROIT TAKES THE FLOOR

If you don’t know what you’re watching, a FIRST Robotics match can be just … bewildering. Each match has six teams involved, with three schools teaming up per side. The objectives and rules of the game change every year. Fortunately, Reiner is in the stands offering a tutorial as the game gets underway.

This year’s competition had students construct robots to move and lift boxes in what looks like a giant Mario video game. Boxes, or ‘power cubes,’ can be placed up high atop a scale or on lower areas called switches. Teams compete to keep the scale and switches tilted in their direction for as much of the two-and-a-half minute match as possible.

Each match starts off with 15 seconds where robots must operate autonomously. And in the final 30 seconds, robots can earn points by climbing the scale.

When their first match gets underway, the Knight Riders have trouble immediately. Kitt Jr. moves into the playing space for the autonomous sequence, but quickly comes to a halt. It sits frozen in place for 15 seconds—a penalty for not having autonomous capability—while other robots scuttle around hoisting cubes onto the scale and placing others into the switches with surprising precision and speed, and Kitt Jr. just doesn’t seem to have

Osborn’s robot gets moving again at the 30-second mark and the robot drops in first box into the neutral switch receptor. Standing behind the plexiglass enclosing the game area, Dennis tries to send his robot to the further switch, but is caught behind a teammate robot and forced to wait as more seconds tick by.

At 45 seconds gone, the robot can move again and Dennis sends it to the far end of the game area. He manages to pick up and place a second cube into one of the switches, but half the game has slipped by at this point.

A third cube goes into the far switch and Dennis moves towards a fourth with just 45 seconds left. An opponent sitting a dozen feet away sees what he’s up to and moves quickly to block, wedging in robot between Kitt Jr. and the switch. It leaves Osborn’s team with nowhere to go as the clock shows just 40 seconds left.

In the stands, Reiner watches, arms folded and narrating with the even teacher’s tone he always uses. If this match ended right now, it would be a slight disappointment. But he’s waiting for something.

"If you don’t know what you’re watching, a FIRST Robotics match can be just … bewildering," he says. "But he’s waiting for something.

Fast-forward again. It’s 8:45 p.m., May 9, in Detroit. A different part of the arena. It pulls in front of the scale, next to a teammate robot from State University.

"The annual end-of-year banquet for MEZ teams and their families is winding down at the Michigan Science Center, but there’s time for one more photo op. As is tradition, the MEZ’s graduating seniors come onstage to tell the audience of nearly 300 where each is headed next.

Several will go north to places like Michigan State or even further north to Michigan Tech. Some, like Nayah seated at a rear table, will go to Ann Arbor. Others are headed out of state.

Near the end of the line, Dennis steps up and takes his turn. In April, he’d been unsure of what lay ahead— if college was in his future or not. Tonight, it seems, he knows more than he did then.

"My name is Dennis . . .,” he says with his characteristic smile. “I come, preventing them from dreaming beyond what they already know."

Experiences with the MEZ and First Robotics brought ideas—hopes of getting into computer marketing and data harvesting—and that alone put him ahead of many peers. Some are forced into adult roles early, caring for older or younger family members. Others are called to contribute to the household income, preventing them from dreaming beyond what they already know.

They don’t think they have options . . .,” he said. "Don’t get 40 and frustrated. Because I’ve seen so many that wind up frustrated when people realize ‘Man, I missed these opportunities.’"

OFF THEY GO

For now, though, that matters little. After their first match, the Knight Riders are ranked among the top quarter of teams here. In just six months, Team 6099 has arrived.

Back in the pit area, ahead of the second match, there are visitors—finally some familiar faces in an ocean of strangers. The MEZ’s Julian Patz and Ayana Davis are there. There are hugs, and a recounting of the context that just took place. The Knight Riders have a cheering section of their own for the rest of the day.

A VIOLENT SHOVE

Gauze and bandages cover the right arm, knuckles to elbow, courtesy of the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky.

A dress on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky. A dressing on the left side of his chest hints the bullet that passed through 72 hours ago. Another round clipped the tip of Dennis’ right pinky.
PUTTING THE AI IN AVIATION
Persuading a field to face its future

Story by Kate McAllister
Photos by Levi Hutmacher
somewhere, in a parallel universe, there is an Ella Atkins who happily does her research on autonomy in aerial vehicles, licenses software to aircraft companies and generally makes airspace a safer place.

In our universe, aerospace hasn’t been ready for her. Just doing her research has been a struggle. But she’s not one to succumb to prevailing winds.

“She is strong-willed in a good way,” said Ed Durfee, a professor of computer science and engineering at U-M, recalling Atkins as a PhD student. “She had direction, she had purpose, she had strong opinions as to how to do things, and she was very good at digging deeper into her rationale. She was very often able to convince us that her idea was worth pursuing.”

From graduate school on, the aerospace engineering professor has had to keep making her case both in academia and in government. There are changes coming to aerospace whether we like it or not, both in the form of increasingly autonomous airplanes and in the proliferation of unmanned aerial vehicles. Done right, autonomy has the potential to raise the already high standard of safety in the skies, she believes.

Still, she thinks about it sometimes, the status she would have had if she had spent her time pursuing the incentives of academia. But in this one, she’d have to throw every ounce of her weight just to nudge aerospace in the right direction.

TAKEOFF

Like many aerospace engineers, Atkins became interested in planes as a kid. Living near military practice airspace, she saw more than just the run-of-the-mill airliners. She earned her bachelor’s and master’s degrees in aeronautics and astronautics engineering from the Massachusetts Institute of Technology and moved to California, taking a job in industry.

After six years of learning about airplanes, she decided it was time to learn how to fly one, taking lessons from instructor Cindy Rice.

“We flew everywhere, ranging from Palm Springs for dinner to Long Beach – a crowded airport to various places in the desert to just practice landings,” said Atkins.

At the time, she carried a hard copy of the Federal Aviation Administration (FAA) rulebook FAR/AIM (Federal Aviation Regulations and Aeronautical Information Manual).

“I thought it was like the dictionary. You just look stuff up,” she said. She didn’t yet understand that the world around the FAA was changing, and these rules wouldn’t be able to keep up.

She did, however, recognize her own limitations. As a single pilot in a single-engine aircraft, she had a lot to think about if something went wrong: where to go, how to keep the aircraft from stalling on the way, how to land in spite of the problem. She became interested in how software could help in these situations.

By this time, in the early 1990s, commercial aircraft had been transitioning from hydraulic controls to electronic fly-by-wire systems. While you’d need a full-on robot to handle hydraulic controls, a computer was already sending the electrical signals on the newer planes. It would just need to be smarter. She wanted to design autonomy that could handle problems as well as ordinary flights.

And she wasn’t happy as a workaday engineer, clocking off at 5 p.m. and leaving the puzzles behind. She wanted to keep thinking and talking about them, and she wanted to be around others who felt the same. So, she applied for a PhD in computer science.

As one of U-M’s early efforts in this, President Mark Schlissel introduced a new honor in 2017: the President’s Award for National and State Leadership. Atkins was one of two inaugural recipients. “Professor Atkins has more than a decade of engagement with aerospace committees and posts at the national level, including NASA’s Jet Propulsion Lab and the National Research Council,” Schlissel said.

For Atkins, this engagement was not merely dutiful. It was necessary. She wanted to realize the potential to improve flight safety through autonomy, and she has had to fight on two fronts: regulation and education. In another parallel universe, she might be winning. But in this one, she’s had to throw every ounce of her weight just to nudge aerospace in the right direction.
A year into her studies, Atkins received news that Rice had died, caught by a waterspout off the coast of San Diego while flying a cargo run. “I realized that even somebody who tended to make the right decisions when they flew could get into situations that they couldn’t escape,” said Atkins.

Atkins’ predecessor under Durfee and Shin, David Mauliner, had designed a generic architecture for real-time intelligent control. Her mission was to improve its ability to handle unexpected situations and apply it to aircraft. “A big chunk of the work Ella did was designing for what happens when the system has too much to do, it needs to slow the world down. When a pilot needs time to think about how to land missing one engine, or with some of the wing flaps not working, he or she can slow the world down by circling. Or if the world can’t be slowed down, as in a case when an aircraft has no functioning engine, the computer has to apply it to aircraft.”

Atkins called for a tougher test, and Marshall put his body into it, “Hey, it’s not going to work! In fact, autonomy needs more computational power, sensors and actuators,” said Durfee.

Here, her piloting experience merged well with the needs of real-time systems. “If the system has too much to do, it needs to slow the world down. When a pilot needs time to think about how to land missing one engine, or with some of the wing flaps not working, he or she can slow the world down by circling. Or if the world can’t be slowed down, as in a case when an aircraft has no functioning engine, the computer has to apply it to aircraft.”

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They are installing software for Cesnik’s X-HALE (Experimental High Altitude Long Endurance) unmanned aerial vehicle.

fly wherever they want to.

of the dangers can pull a drone out of their backpack or car trunk and

as you aren’t near an airport. Now people without skill or appreciation

pass a multiple choice test, there are no restrictions to stop you as long

in the last decade. Sometimes her certifications came through quickly,

Then Atkins’ program manager at DARPA got in touch, and the waiver

isn’t quite as irrefutable as I had originally thought,’” said Atkins.

she hadn’t been a member of a public institution, she wouldn’t have been

professional. And the FAA has different rules for professionals. In fact, if

“We have some in our lab that can carry a 15 pound movie camera.

“She developed an accelerated computing course for freshmen, but it mostly serves computer science majors. She has succeeded in adding flight software systems as a technical elective, and she is still pressing to make it a requirement.

It is an enclosed space – four stories high, and with about half of

It’s rigged with lights for more spectacular night flights.

"And perhaps this is also true more broadly. Full autonomy will

"But if there isn’t enough room for autonomy in aerospace, Atkins

helped to shepherd the project toward approval.

And so she disappeared for a few hours, emerged with the draft,

the group made some revisions, and that was that.

ROOM FOR AUTONOMY

Atkins is a firm believer in computer programming as a core

room for autonomous engineering. When she arrived at the

University of Maryland, they were ready for her. They knew they

were hiring a computer science PhD, and they expected her to start

computer science courses. And she did: she developed an aerospace

comparing course for freshmen as well as a flight software course for

juniors. Both are still requirements.

things were different at Michigan. Part of the problem, Atkins later

realized, was the generic first-year engineering curriculum at Michigan.

A freshman aerospace computing course was impossible, and with only

three years’ worth of flexibility, the department was locked into its

required courses.

She tasked the computer pilot.

(is your computer pilot going to do in different situations?) and

relatable being the behavior of adaptive and nondeterministic systems

instigated and followed through to maturity," said Atkins. "The people

where new research for increasingly autonomous systems should be

accepted their invitations.

The first report, on NASA’s aviation safety research, was released in

2010. The big problem? NASA technologies were running into the

biggest problem? NASA technologists were running into the

accepted their invitations.

Ashton-Miller had this to say of Atkins: “Her integrity and characteristic

frankness were vital as the committee debated not only safety, but also legal

and regulatory issues for the individual and University.

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frankness were vital as the committee debated not only safety, but also legal

and regulatory issues for the individual and University.

Atkins works with researchers in the lab of Darco Cesnik, a professor of aeronautic engineering.

They are installing software for Cesnik’s X-HALE (Experimental High Altitude Long Endurance) unmanned aerial vehicle.

The regulatory trouble was that Atkins is not a lobbyist. She’s a professional. And the FAA has different rules for professionals. In fact, if she hadn’t been a member of a public institution, she wouldn’t have been allowed to fly at all.

“This was the first time that I really stepped back and said, “Maybe this book, this dictionary that I have used since I was first learning to fly planes, isn’t quite as irrefutable as I had originally thought,” said Atkins.

Still she applied for a waiver and waited. Fall turned to winter, and

shepherd the project toward approval.

& Distinguished Research Scientist in mechanical engineering, helped to

champion M-Air in part to provide a safe place for students to test out

their ideas. James Ashton-Miller, Associate Vice President for Research Policy

and Compliance and also the Albert Schuette Collegiate Research Professor

& Distinguished Research Scientist in mechanical engineering, helped to

shepherd the project toward approval.

"Facing a relentless series of regulatory and institutional challenges, it would be easy to become resentful. Yet Atkins resists it all with humor (some wry), empathy for why the status quo is what it is and gratitude, even, for the challenge of bringing ideas to a table that didn’t always have a place for her. She has an easy smile and enjoys the

whimsey that her students bring to the lab, such as the “Disco Machine.” This large octocopter is fitted with bumpers of white plastic tubing for safety – and inside the tubing, her students are adding a string of lights for more spectacular night flights.

It helps that the students who do learn from her recognize that
devolving increasingly autonomous systems is critical to the future of

aviation.

“Professor Atkins’ work builds an essential bridge between
computer science and engineering and aviation,” said Pedro E. Donato

(ISC Robotics ‘16, PhD ‘17), now a Regulation Specialist in the

engineering division of the Brazilian National Civil Aviation

Agency. “This bridge between different research fields is fundamental

considering that a modern airplane has millions of lines of code. I
thank Professor Atkins for expanding my horizons beyond more
classical aerospace areas such as flight dynamics, structures and

controls.”

Swee Balachandran (MSE AERO ‘13, PhD ‘16), now an engineer

at NASA’s Langley Research Center, added: “She was instilled in us the idea that

algorithms and software architectures can help oversee the execution of complex aerospace systems and provide real-time decisions to make them safer.

But if there isn’t enough room for autonomy in aerospace, Atkins has found that there is plenty of room for aerospace in robotics. She helped develop Michigan’s robotics program from the beginning, directing graduate studies from the first admissions in 2014. And perhaps this is also true more broadly. Full autonomy will probably come to small UASs long before it reaches passenger jets. It is the robots operating in airspace that are pushing the boundaries in aerospace. And Atkins, as ever, is on the front lines.
Here’s how southeast Michigan is leading the way.

1. American Center for Mobility
2. Ann Arbor Connected Vehicle Test Environment
3. Center for Connected and Automated Transportation
4. U-M Transportation Research Institute
5. Mcity, with TechLab and the Mcity Driverless Shuttle
6. U-M Robotics Institute
7. U-M Ford Center for Autonomous Vehicles
8. Toyota Research Institute – Ann Arbor
9. Next Generation Transportation Systems Program
10. May Mobility

Michigan’s New Motor City. That’s what The New York Times called Ann Arbor last year. The city is home to some central pieces of an expanding autonomous vehicle R&D ecosystem that rival Detroit’s storied leadership in advancing the automobile.

Established firms and startups alike have set up shop in southeast Michigan, lured by a mix of singular testing sites, forward-looking state policies and proximity to an entrenched supply chain, university resources and a burgeoning venture capital scene and workforce.

Some examples: Toyota has opened an autonomous driving research institute here. Waymo, Google’s self-driving vehicle arm, has offices in Ann Arbor and Detroit. French firm NAVYA, builder of all-electric, fully autonomous shuttles, opened its first U.S. production plant in Saline in 2017. Ann Arbor-based Michigan Engineering startup May Mobility raised $11.5 million in seed funding in 2018 and partnered with supplier Magna to release its first fleet of low-speed autonomous shuttles. And Ford has put $15 million toward the Ford Motor Company Robotics Building, slated to open on North Campus in early 2020. Ford engineers will occupy that building’s fourth floor. “The list goes on.”

EDUCATION AND WORKFORCE DEVELOPMENT

When Uber moved into autonomy research a few ago, it poached 40 people from Carnegie Mellon’s robotics center – four faculty members and 36 researchers and technicians. The company took some heat in the headlines for “gutting” the lab. But where else can you get that kind of workforce today?

In 2015, the state of Michigan’s Connected and Autonomous Vehicle Task Force surveyed 50 employers in southeast Michigan about the autonomous vehicle workforce. Their most common need was for “connected systems engineers” – a specialty that includes software engineering, systems engineering and electrical engineering, and pays roughly $90,000 a year.

“Industry still needs people who have deep expertise in a single field, but the need for people with knowledge in multiple fields is more urgent,” said Huu Peng, director of Mcity and the Roger L. McCarthey Professor of Mechanical Engineering. “They need expertise in traditional fields such as dynamics, control or signal processing and coding, as well as in the relatively new fields of artificial intelligence, big data and cybersecurity.”

Across the globe, companies are looking to hire thousands of this new kind of engineer: “We have a glut of end customers – multiple OEMs with assembly plants and R&D centers. Ninety-two of the top 100 global auto suppliers have a presence in Michigan. So you can develop and test in other places if you like, but the truth is if you want it on a vehicle or mass produced, it’s got to touch Michigan at some point.”

More and more efforts are situating here from the start. U-M and Michigan Engineering are helping to draw them here, through institutional partnerships and faculty-led research projects. And they’re not just about technology. Their work touches on the full life cycle of this industry’s transformation – from training the necessary workforce to putting the vehicles out in the world in a way that makes a positive difference. Here are some of the ways they’re doing that.
SENSORS: Lidar, radar and cameras work together to take in an autonomous vehicle’s environment in 360 degrees and to pinpoint its location. While today’s cameras and radar are robust and cost-effective, lidar sensors aren’t there yet. They range in price from $7,000 to $70,000 and in some cases, they’re lasting in the hundreds-of-miles range—far from the auto-grade 100,000 miles or the lifetime of a car. U-M researchers have a possible solution. Ryan Eustice, professor of naval architecture and marine engineering and senior vice president of automated driving at the Toyota Research Institute—Ann Arbor, used video game technology to turn pre-recorded maps into 3D visualizations that make it possible for an autonomous vehicle to rely on inexpensive cameras rather than lidar technology to pinpoint location.

PERCEPTION SOFTWARE: In order for autonomous vehicles to understand what their sensors take in, researchers are turning to a combination of classical computer vision and the younger field of deep learning. Where traditional computer vision relies on models that focus on edges and other defining features that humans find meaningful, deep learning takes what some call a “brute force” approach. It involves feeding the system an immense set of annotated images that it can learn from.

“As the moment there are publicly available datasets to test deep learning systems and they have several thousand images—all annotated by a human. People go in and draw boxes around all the people and cars and sidewalks and stop signs, for example. But we need millions of these images to train these algorithms well,” said Ram Vasudevan, assistant professor of mechanical engineering and co-leader of the U-M/Ford Center for Autonomous Vehicles.

He and his colleague and co-leader Matthew Johnson-Roberson, associate professor of naval architecture and marine engineering, are working to streamline the process. Video games come to the rescue again. Grand Theft Auto, it turns out, looks enough like the real world to train a system. They were able to develop automated image annotation algorithms and then, overnight, extract and mark up 10 million scenes, which they used to improve the accuracy of their system.

The team has also developed an algorithm that can find a pedestrian in a scene and zoom in on their hands, which can be used to make predictions about what they’ll do next.

CONNECTIVITY: To be as safe as possible, autonomous vehicles should talk to each other and to the infrastructure around them. Dedicated Short Range Communications, or DSRC, lets vehicles send messages about their location, direction, speed and more at the rate of 10 per second, and at a distance of up to 1,500 feet. DSRC isn’t restricted to line-of-sight, like a camera or lidar. The technology has undergone testing for more than a decade, and it’s ready for market, even on human-driven vehicles. It’s being piloted on a grand scale around Ann Arbor right now. A federal government mandate, which has stalled, would advance adoption, says Jim Sayer, director of UMTRI.

“Every year that we wait to put connected vehicle technology in place, we’re losing tens of thousands of lives,” Sayer said. “And I don’t believe you can have highly automated vehicles without connectivity.” Some automakers are moving ahead with plans to install DSRC ahead of any mandates.

Beyond reducing crashes, connectivity could curb traffic jams and lead to dramatic improvements in energy efficiency. Gabor Orosz, an associate professor of mechanical engineering, has shown that the smoother transitions a connected, automated vehicle makes between braking and accelerating can boost energy efficiency by as much as 19 percent.
PATH-PLANNING: How will autonomous vehicles decide how to get where they’re going—now and where to turn, but when to change lanes, when to brake hard and when to speed up? Prior mapping will be central to navigation. Prior mapping involves loading the vehicle with detailed surveys so it knows where to expect traffic signals and trees, for example, reducing the need for on-the-fly perception. Not only does this tell the car where it is in the world, it opens space for prior mapping approaches that let vehicles localize themselves, with centimeter precision, even when the road is covered in snow.

Human-like behavior, and he’s commercializing it through his startup, May Mobility.

SOCIETAL ASPECTS

Moving society to new-generation mobility systems—and making sure the shift doesn’t lead to unintended consequences—will require new laws, city designs, business models, cybersecurity measures, and also public acceptance. Across U-M, scholars are delving into these broader aspects. On the law front, driverless cars will likely shift faults for accidents from drivers to auto manufacturers, raising new liability questions. They will also collect more data than we’ve used to, leading to privacy issues. In a step toward exploring these quandaries, the U-M Law School and editor of the project’s new Journal of Law and Mobility.

Through the Center for Connected and Automated Transportation, a five-year, $135-million, U.S. Department of Transportation-funded effort, UMTRI is studying the shift holistically as well.

“Connected and automated vehicles will have a disruptive impact on our transportation system,” said Henry Liu, professor of civil and environmental engineering, who leads the center. “While these technologies will continue their steady advance toward public roadway systems, there are a variety of open questions and issues on technology development, policy and planning, and system design and operations that require answers and resolution.”

One of the biggest opportunities driverless cars will bring is wheels for those who don’t have access to reliable transportation—the elderly, disabled and economically disadvantaged. “We need to think about accessibility,” said Carrie Morton, deputy director of Mcity. “How do we take this unique moment in time when we’re re-envisioning transportation from the ground up to make sure we design it to move all society forward, and that means thinking about socioeconomic mobility, access to healthcare, to grocery stores—all of these things.”

Mcity is doing that, through collaborations across campus. But sometimes a driverless car won’t be the answer. “It’s not all about connected and autonomous vehicles,” said UMTRI Director Sorey. “They’re one tool. The goal really needs to be improving mobility and that can mean reducing the need to move. Rather than dragging an elderly person to a doctor, why not take the service to them in other ways?”

ABLY-STAGE TESTING

Rain and snow can cloud driverless car perception systems just like they cloud your vision. So Ford Motor Company turned to the Mcity Test Facility to test the shuttle’s performance in winter weather. That’s an example of the kind of work that’s possible in this first-of-its-kind proving ground. At the test facility, industry and faculty researchers can put their vehicles through potentially dangerous situations that self-driving cars must master before they can take the place of human drivers. The 32-acre site, with more than 16 acres of roads and traffic infrastructure is a safe place to test robots and other autonomous public roads, which is legal in Michigan.

Mcity, a campus-wide, public-private initiative, opened the test facility in 2015, and since that time the public-private partnership has grown to more than 60 industry partners, and the capabilities of the test facility have expanded. “We’ve added infrastructure connectivity, the ability to use augmented reality displays in testing environment and the ability to monitor Mcity’s traffic in real time,” said Mcity Director Peng. The state-of-the-art Michigan Traffic Lab, the traffic control center for Mcity, can monitor and control all infrastructure. The traffic lab also enables augmented reality testing at Mcity. That combines the real-world environment with simulated connected vehicles to serve as realistic background traffic. It’s a good way to fine-tune control parameters before they can take the place of human drivers. Otherwise, you haven’t taught it.”

“WE’re not focusing on the technology with the shuttle, but on understanding consumer acceptance,” said Morton, Mcity deputy director. “We’re testing the shuttle in downtown Detroit, and how do people react? Are other vehicles impatient?”

And through the “living laboratory” of the Ann Arbor Connected Vehicle Test Environment, thousands of vehicles across the city are communicating with one another and infrastructure like road signs, traffic lights and crosswalks. ACVTE, as it’s called, is run by UMTRI, in collaboration with Mcity, the city of Ann Arbor, the U.S. Department of Transportation and the Michigan Economic Development Corporation. It was born out of Safety Pilot, which in 2012, was the largest connected vehicle deployment in the world.

PRODUCT DEVELOPMENT

Technological innovation means prototype to product can take the next steps at the American Center for Mobility. ACM’s more-than-500-acre campus hosts a 2.4-mile highway-speed loop, multi-decker bridges, a tunnel, a 6-by-6 lane intersection and a full-scale boulevard designed with the Michigan Department of Transportation’s help.

“It is the real world,” said John Maddox, former ACM president and CEO. “For the verification and validation aspects we’re focusing on, that’s what you need. If you want to operate your vehicle on a highway, you have to test it on a highway. Otherwise, you haven’t taught it.”

Validation and verification involve ensuring that a design meets its specifications in real-world conditions and for intended customers. Individual companies can set up their own scenarios or participate in events like “Plug Fest,” where ACM invites manufacturers to connect to other products and test interoperability and security.

ACM, at Willow Run in Ypsilanti, is less than 10 miles from Mcity and the facilities complement each other. “Their proximity is a clear example of our leadership in this area,” Maddox said. “There’s no other place like this in the world.”

While Mcity focuses on the earlier-stage testing, some product development happens there as well. At TechLab, students work with startups to improve their products. The last cohort included CARMERA, of New York and Seattle, which provides real-time 3D maps for autonomous vehicles, and Zendrive, of San Francisco, which uses smartphones sensors to identify driving behaviors and provide insights and coaching to help you drive more safely.

DEPLOYMENT

Two autonomous shuttle systems with ties to U-M are now on the road. Faculty startup May Mobility began Phase 1 of the Mcity Driverless Shuttle research project in 2015, and since that time the public-private partnership has grown to more than 60 industry partners, raising new liability questions. They have expanded.

“We’ve added infrastructure connectivity, the ability to use augmented reality displays in testing environment and the ability to monitor Mcity’s traffic in real time,” said Mcity Director Peng. The state-of-the-art Michigan Traffic Lab, the traffic control center for Mcity, can monitor and control all infrastructure. The traffic lab also enables augmented reality testing at Mcity. That combines the real-world environment with simulated connected vehicles to serve as realistic background traffic. It’s a good way to fine-tune control parameters before involving a lot of real vehicles, said Professor Liu, who leads the lab.
VICTORS FOR ENGINEERING 110,000 TONS OF NICKELS

VICTORS STEP UP MICHIGAN ENGINEERS ARE STEPPING FORWARD TO TRANSFORM THE COLLEGE – AND THE WORLD – IN OUR $1 BILLION RESOURCE-GENERATION EFFORT

THANK YOU!

We’d like to thank all contributors to the College of Engineering during the Victors for Michigan Campaign. So far, the campaign has raised more than $600 million in philanthropic support and more than $600 million in strategic resources and has resulted in growing the College’s endowment to $500 million.

Because of you, we can pursue our dreams for Michigan Engineering: To improve the quality of life by developing intellectually curious and socially conscious minds. To provide scientific and technological leadership to the world. To create collaborative solutions to societal problems. And to promote an inclusive and innovative community of service for the common good.

We will continue to keep you updated through the remainder of the campaign and into the future, and we appreciate your interest and support.

YOU HELPED RAISE $1 BILLION

WE’RE AMAZED AND GRATEFUL.

GRATITUDE FOR OUR VOLUNTEERS

The success of the Victors for Michigan campaign at Michigan Engineering is due in significant part to the leadership and support of the following campaign volunteers.

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(BSE IE ’56)
Timothy A. Howes
(BSE AERO ’85)
Arthur J. Marks
(BSE IE ’67)
Kenneth R. Pelowski
(BSE IE ’81)
Mary L. Petrowich
(BSE IE ’85)
Carlos R. Quintanilla

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Alan Steenbergen
(BSE CompL ’94)
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Bruce Watson
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10,000 TONS OF NICKELS
HOW VOLUNTEERS ENABLED THE CAMPAIGN VISION

Is raising $1 billion really possible? The achievement is so audacious that it’s fair to ask whose idea it was in the first place.

The story actually goes back seven years to a restaurant patio on Lake Tahoe. With the Victors for Michigan campaign coming down the pike at the University, leadership at the College of Engineering assembled a group of alumni and other volunteers to begin planning.

“We were about one day into the meeting,” said Bob Brown (BSE IE ’67), a member of that campaign committee. “The College explained what we’d done in the past, raising something like $300 million. The staff from the College gave the rationale of raising the goal to $450 or $500 million.”

The conversation grew from there, and the group didn’t pull any punches in its critique. “We talked about how we’re a really good university, but not quite at the top,” recalled Art Marks (BSE IE ’67), another committee member.

After some time, the group asked the College staff to leave so they could talk over the right goal to set.

“We figured that the only schools that compare to Michigan are Stanford, MIT and Harvard,” Brown said. “Ye Michigan has a first-class teaching hospital, medical school, nursing school, all those types of things. So the seven or eight of us decided the goal was way too small. We said you’ve got to make it $1 billion.”

“We got back with the staff and announced our suggestion,” Marks said. “We were greeted with a certain degree of shock.” But the committee made its case: Be collaborative and find ways to innovate across campus.

“And I think that’s pretty much what happened,” Brown said.

TEAMING UP

In addition to setting a more ambitious fundraising goal, the campaign volunteers were also ambitious about pioneering new models of fundraising. For one, they helped to develop the concept of combining traditional fundraising with strategic resources to help meet the goal. While more than $400M has been raised through traditional fundraising from individual donors and foundations, more than $600M years is MCubed, a seed fund for researchers to form teams across the University. MCubed was the inspiration for several bold new funding models being introduced at the College that help momentum to continue to build.

This project also received support from individual donors, including a gift from the Ronald D. and Regina C. Mellon Foundation.

The addition and renovation to the George Granger Brown Memorial Laboratories, the longtime home of Mechanical Engineering, was the first example of attracting strategic resources. A federal NIST grant and $50M capital outlay from the state of Michigan provided significant support for the G.G. Brown project. With features like the ultra-low vibration chambers and tissue culture rooms in the new world-class Center of Excellence in Nano Mechanical Science and Engineering, the changes expanded the scope of the department to nanoscience.

Campaign committee donors also provided essential support, including Mike Korybalski (BSE ME ’69, MSE ’73, MBA ’80), Mary Petrovich (BSE OE ’85), and Norm Harbert (BSE IE ’56). Tim Manganello (BSE ME ’72, MSE Dearborn ’75, PDM Dearborn ’81), former head of BorgWarner, was instrumental in facilitating a gift from that corporation.

ACROSS DISCIPLINES

As one of those original committee members in Tahoe, Art Marks says the committee recognized early on that collaboration across the University would be important to raising $1 billion. As a result of this emphasis, numerous examples of cross-campus innovations have been launched to facilitate groundbreaking research.

An example of a novel funding model that has thrived in recent years is MCubed, a seed fund for researchers to form teams across the University. MCubed was the inspiration for several bold new funding models being introduced at the College that help momentum to continue to build.

It illustrates the bold and creative collaboration that the campaign engendered. The building will bring together a variety of disciplines to push Michigan Engineering’s work in robotics. Robots will soon drive, walk, fly and help rehabilitate or enhance human function thanks to the facility.

Ford provided significant funding for the facility, and when the building is completed in 2020, Ford researchers will occupy the fourth floor in a unique arrangement for both Ford and Michigan Engineering. The gift initiated a new venture for Ford, and represents an entirely new model for the University of Michigan to partner with industry.

The key is how they bring researchers from across disciplines to collaborate with engineers – ranging from medicine to public health and social work.

“I think MCubed is a brilliant idea,” said Marks, who has backed an MeCabed project. To him, it is one of many small ways that university research is catching on about how problems are actually solved in the world.

“One thing that’s obvious to those outside the university is that a lot of innovation happens across disciplines. Engineering and medicine is a well-known example,” he said. “It’s that fundamental understanding by the campaign leaders – many of whom have business experience – that led the College to stretch its goals.

Marks, who is chair of the dean’s Leadership Advisory Board, has pushed to structure the group in ways that more directly tap this sort of expertise from alumni and other volunteers.

“It’s not just show and tell for the board,” he said. “We’re matching up their experience and talents. It has been a good sounding board for a list of what the dean is trying to do. We don’t tell him what to do, but we are very independently minded and so we do tell him what we think.”

Marks also provided scholarship support, one of the main priorities of the campaign. He is one of several donors to influence the direction of the campaign through support for students. Others include Larry Leinweber’s software scholarship program, aimed at retaining talent to stay and thrive in the state of Michigan; and a gift by Ditson Dell (BSE EE ’65, PhD ’69) to fund a directorship for the Center for Entrepreneurship that will influence student opportunities for years to come.

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Drone startup SkySpecs has become something of a Cinderella story. Originally founded by Danny Ellis (BS AERO ’10, MSE ’13) and Tom Brady (BS AERO ’11, MSE ’13) as a senior project, the Ann Arbor–based company closed on a Series B funding round of $8 million in early 2018. The first and only company to offer automated inspection of wind turbine blades, SkySpecs is the fastest-growing inspection service in the wind energy sector. The pair officially launched SkySpecs in 2012 with support from TechArb, the University of Michigan’s student venture accelerator. But Ellis says the team’s turning point came in 2015 when they decided to stop building their drones in-house.

“We were trying to be the best at everything, and therefore, we ultimately became mediocre at everything,” Ellis said.

The following year, the resources saved from that decision allowed the co-founders to set a new goal: to achieve completely automated inspection of wind turbine blades, SkySpecs is the fastest-growing inspection service in the wind energy sector. In 2015, they launched their inspection drone live at the world’s largest wind conference in Germany. Ellis says the team’s turning point came in 2015 when they decided to stop building their drones in-house.

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Levi Weintraub (MS BSE ’06) has lived on two wheels for close to two years now, putting his incredibly accomplished tech career on hold for an epic trans-African journey that’s stoking his passion for travel and educating a cohort of aspiring African tech professionals.

Weintraub’s wanderlust first hit him in May of 2016. He was working at Google, where he landed by way of Intel, Apple, Microsoft and Palm. But something about his comfortable Bay-area life just didn’t seem right. He’d always had a passion for two things: teaching and motorcycling. And he decided to combine them on an epic cycling trip that would take him the length of Africa, over 7,500 miles.

This wasn’t his first ride – he’d ridden motorcycles with his dad in his hometown of South Haven, Michigan, and nine years ago, the two rode the length of the Americas, from Alaska to the southern tip of South America. It wasn’t enough.

“As soon as I got to Patagonia, I knew I’d do Africa next,” he said. “I love motorcycling because it forces you to be in the moment. When it’s hot, you’re hot, when it’s cold, you’re cold, when it rains, you get wet. You lean into turns. And you’re wedded to this machine that’s dramatically less reliable than a car. That forces you to learn about it and care for it.”

But ultimately, it was Weintraub’s passion for teaching that pushed him to hit the road. He had earned a reputation as a teacher and consensus builder at Google, and he wanted to apply those skills in Africa, though he wasn’t sure exactly how. He set out from Cape Town, riding north toward Tangier.

It all came together at a hamburger stand in Dar Es Salaam, Tanzania, where Weintraub met a fellow motorcyclist who was trying to build a tech mentoring program. Weintraub didn’t hesitate. He spent the next four months teaching coding and entrepreneurship to a group of students fresh out of high school.

As it turned out, he learned as much from the students as they did from him. He learned how to bridge cultural gaps and how to sort out the infinite logistical challenges that come with running a program in Tanzania. But most of all, he learned about himself.

“Travelling in Africa is a constant lesson that the things we take for granted are actually culturally instilled,” he said. “Our perspectives are shaped on a deep level by where we grew up, and by meeting people with different experiences, you learn about yourself.”

He isn’t sure when his trip will end, but when it does, he plans to go to graduate school and eventually become a university professor. In the meantime, he’s back on the bike, planning to travel to Tangier and then across the Strait of Gibraltar into Spain. Coding and motorcycling might seem like wildly different pursuits, but Weintraub believes that they have a lot in common.

“Riding, wrenching and coding are about planning before you act so you don’t get yourself into a situation you can’t get out of,” he explains. “You learn how something works, and once you know, you can go on a really amazing journey. That’s the joy of engineering and the joy of travelling.”

ALUMNI NOTES

Have a story you’d like us to consider for the next issue’s Alumni Notes? Let us know by sending an email to MichiganEngines@umich.edu with “Alumni Notes” in the subject line.

BRAIN HACKS

Before the days of computer aided design and spreadsheets, determining properties like the volume of a ship hull or the shape of a propeller required age-old instruments that were expensive, fragile, cumbersome – and often quite beautiful. Many of them were invented in the early 19th century and used until the end of the 20th.

Emeritus Professor of naval architecture and marine engineering Bob Beck recently gave us a tour of the newly renovated Aaron Friedman Marine Hydrodynamics Laboratory in West Hall on Central Campus, where several of U-M’s old instruments are on display. Most were made by the German company Kempf and Remmers, the same firm that made the Tow Tank’s carriage.

Finely machined and housed in wooden boxes that are themselves works of art, these old-school instruments can’t match a CAD program for speed, but they certainly outdo it in beauty. One of them is pictured here. Can you guess what it was used for?

a. Measuring hull resistance
b. Designing propellers
c. Measuring wind speed
d. Generating onboard electricity

Answer B:
It’s a set of wake wheels, used to measure the velocity of water flowing into a propeller at various distances from its center. One four-pronged wheel at a time is fitted onto a spindle that’s attached to a hull’s propeller shaft during testing in the model basin. A magnetic pickup inside the spindle measures the speed of the wheel’s rotation, which can then be used to calculate the velocity of the water flowing past.

PHOTOS: Robert Coelius
Movers and Shakers

After graduating at the spring 2018 Michigan Engineering commencement, Kevin Stephens (center) and Raymond Smith-Bald (right) celebrate in front of the Crisler Center with their Omega Psi Phi fraternity brothers. Their “church” is a tradition of the historically African American fraternity and its members, used to celebrate the achievements of their fellow brothers.
THIS IS NOT A DRONE
Inside the universe of ELLA ATKINS, aerospace engineering professor
PAGE 40