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COMPUTATIONAL
THINKING

The Value of an SCS Education



the LINK

Computer Science at CMU underpins divergent fields and endeavors in today's world, all of which link SCS to profound advances in art, culture, nature, the sciences and beyond.

BRINGING DOWN THE HOUSE

CMU ALUMNUS IAN CLARK BLENDS FASHION, STORYTELLING IN DESIGN WORK

While on vacation in Australia in 2018, **Ian Clark** knew it was time for a change.

He was working in real estate but had more creative ambitions — and anxieties about embracing them. Around the same time, the late rapper Nipsey Hussle released his “No Pressure” mixtape, and for Ian, the music’s message plus being on the beaches of Australia made him realize that he could build the life he wanted. He just needed to leap.

“I’d always wanted to come out with a clothing line, but I was scared because I thought there wasn’t enough money or people wouldn’t like it,” Clark said. “And once I heard ‘No Pressure,’ I knew. I thought, ‘Let’s just go for it.’”

Clark returned to his Los Angeles home and founded House of Orange, a design firm focused on fashion and creative storytelling. He earned his master’s degree in human-computer interaction at Carnegie Mellon’s School of Computer Science in 2023. Even though it didn’t involve fashion or marketing, his capstone project — cybersecurity work for Cisco — had definite applications to House of Orange. Working with and around other designers tackling different challenges, for example, taught him that in the design process, finding the right solution takes time.

“YOU’RE GOING TO FAIL A TON, BUT THAT’S GOOD BECAUSE YOU LEARN THE WRONG WAY TO GO AND YOU PIVOT. I THINK ONCE YOU HAVE THAT MENTALITY, YOU CAN DO ANYTHING.”

— IAN CLARK (SCS 2023)

“I used to think that Steve Jobs and those types of people would just walk into a room and a design automatically happened, like they had a magic wand,” said Clark. “But when you learn the design process, it’s never like that. It’s mostly iteration. You’re going to fail a ton, but that’s good because you learn the wrong way to go and you pivot. I think once you have that mentality, you can do anything.”

A year later and back in Los Angeles, Clark was nurturing House of Orange with the design skills he honed at CMU and his business hit the international stage. Indiana Pacers point guard Tyrese Haliburton wore a House of Orange sweatshirt during a press conference for the Pacers playoff series against the New York Knicks, and photos of it went viral. The black “Don’t Choke” hoodie featured a picture of Pacers legend Reggie Miller making a choking gesture at filmmaker Spike Lee, a courtside fixture at Knicks games.

Clark says it would have been easy to try to replicate this moment and create more viral pieces of clothing. But he looked to one of his inspirations, the late Virgil Abloh, creator of Off-White and artistic director for Louis Vuitton’s

menswear collection, and decided to build a lasting fashion brand. He knew he had to stay true to his creative decision-making and not chase trends. The only item available with the Don’t Choke design is still the hoodie, which is sold out.

“I’m definitely excited this all happened with the hoodie, but it doesn’t change how I’ve designed,” said Clark. “I designed from my opinion, and people like it or they don’t. I think that’s the purest way to design anything because it’s from a place seated in yourself.”

Clark’s fashion brand focuses on streetwear, and he gravitated toward this style because of his love for basketball — and his family.

“Basketball and streetwear fashion are connected, and that’s always been a part of me,” he said. “I also have older brothers and my mom was very fashionable, so I saw how they dressed and it had a big impact on me. I’ve always been into clothing.”

For Clark, though, House of Orange goes beyond fashion. It’s a full-service creative and marketing agency where he can explore and integrate what he’s learned about design into any product. ■

the LINK

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Publisher

Martial Hebert

Editor

Kevin O'Connell

Contributing Writers

Sheri Hall, Niki Kapsambelis, Tricia Miller Klapheke, Mallory Lindahl, Kevin O'Connell, Chris Quirk, Amy Whipple, Marylee Williams

Design and Illustration

Susie Hernishin

Photography and Images

Carnegie Mellon University, CREATE Lab, Kevin Lorenzi, Elan Mizrahi, Nate Smallwood, StuCo, Alexander Waibel, ZGF Architects

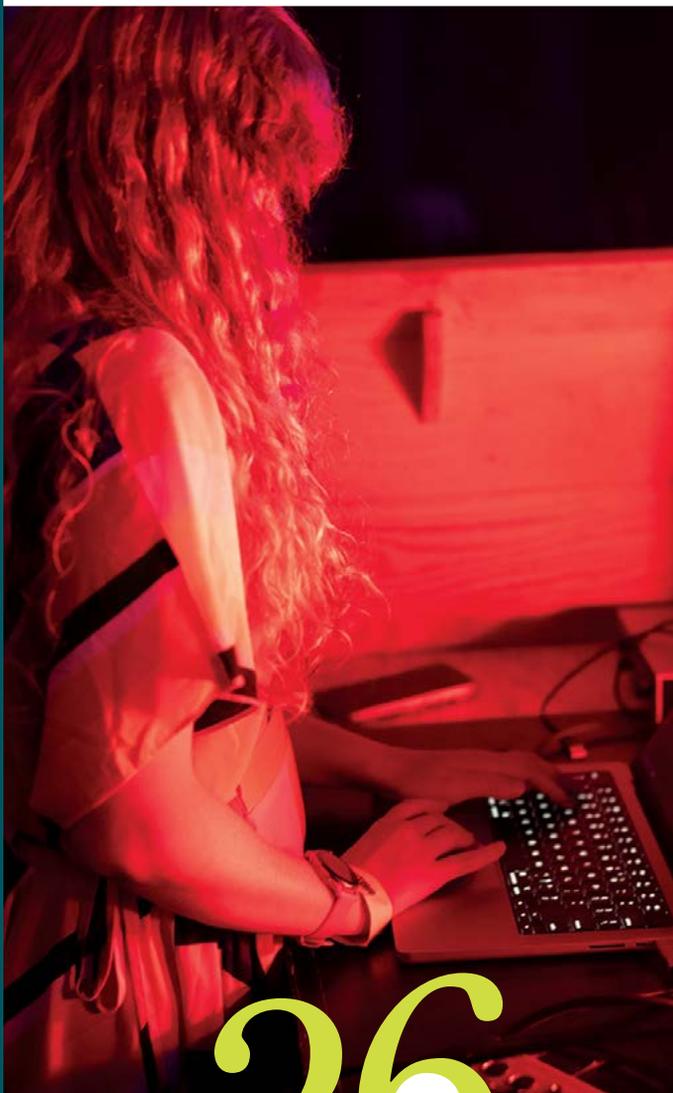
Office of the Dean
Gates Center for Computer Science
Carnegie Mellon University
4902 Forbes Avenue
Pittsburgh, PA 15213
cs.cmu.edu

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magazine@cs.cmu.edu



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WIDEN

an Clark (SCS 2023) founded the fashion company House of Orange prior to earning his master's degree in human-computer interaction. Since then, his designs have achieved worldwide attention. While Clark's journey into the field of fashion may seem unexpected for a graduate of the School of Computer Science, his example highlights the breadth of impact that our students make in areas they feel passionate about. Inspiring, intellectual challenges await our students in every field, and our alumni are well equipped to tackle them.

At SCS, we train students to think computationally as well as scientifically, to approach challenges with reason as well as creativity. They learn to identify systems that are working, to think critically about those that are not and to iterate accordingly. They learn to build robust interdisciplinary teams equipped to take on multifaceted problems. And they learn to follow their passion and purpose, allowing them to lead in any field they choose. Simply put, we teach our students to keep their hearts in their work.

Decades ago, many of our students set their sights on large tech companies. A burgeoning industry offered opportunities to pursue competitive careers in software engineering and to conduct ambitious research. Our alumni have risen rapidly to leadership roles at these companies not because of technical skills alone, but because of the breadth, curiosity and intellectual agility that define an SCS education.

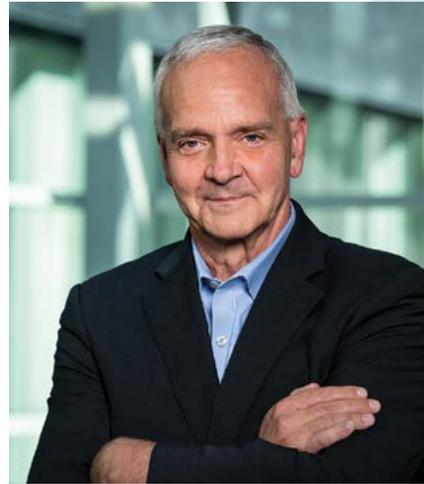
LINKING THE APERTURE

Today, as computing reaches into every corner of society, our graduates are expanding the footprint of computer science well beyond the traditional tech sector. Sports, entertainment, human health, fashion, the arts — wherever there are complex problems, our alumni are at the nexus of efforts to solve them. This issue of The LINK highlights just a few of the remarkable places that passion for work is taking our graduates, and these stories are only the beginning. When we widen our view, more stories of impact come into focus.

As AI and computer science enter new fields, they transform them. Watching our graduates lead this cycle of innovation is not only gratifying, it reaffirms what an SCS education is for.



Martial Hebert
Dean, School of Computer Science





AMY WHIPPLE

Bringing Computational Sciences

Early in his career at the Homewood Children's Village, **Walter Lewis** (SCS 2011) learned something interesting about the high school students who participated in their afterschool program. Most teenagers who had 100 hours or more of engagement raised their grades by an entire point within a year and continued to improve beyond that. Those whose grades didn't improve at first, but were putting in the time, showed acquisitions of soft skills and changes in their disposition toward school and life. Both of those shifts led to later academic improvement.

Lewis realized while digging deeper into this data that the successes surrounding 100 hours of engagement weren't about participating in specific activities but were about devoting the time

Seeing that communal ethos play out in quantifiable ways with teenage engagement, "helped shape the way that we deliver programs and deliver interventions," said Lewis, now the Village's president and chief executive officer.

While his work in human services may not look much like computer science, Lewis's impulse

Walter Lewis (SCS 2011), President and CEO of Homewood Children's Village



to Health and Human Services

to form meaningful relationships. In those 100 hours, a young person could see "someone cares about me, someone wants me to succeed, someone believes in me," said Lewis.

It was a feeling Lewis knew well from the adults who invested in him as a teenager and young adult in Philadelphia.

The Village, a nonprofit that serves children and their families in Pittsburgh's Homewood neighborhood, has long operated on the importance of communities. "We've got this falsehood in our culture that says we're supposed to do everything by ourselves," said Lewis. "It's just not real. It's not how people really operate and not how people really succeed."

to investigate the data from the Village's afterschool program came directly from earning his master's degree in computational biology from Carnegie Mellon University. Like other SCS alumni, Lewis' career showcases the versatility of his education, allowing him to apply concepts he's learned to a field that suits his passion.

"As a researcher, it was about learning. So, when I do this work, I'm always trying to learn." Lewis wants to know why an intervention is successful, not just that it is. "If you don't understand why it worked in the first place, it's going to be hard for you to make the adjustments while preserving what is working already."

Solving Cellular-Level Problems With Machine Learning

Less than two miles from the Homewood Children's Village, **Sarah Fisher** (SCS 2025) sits at a counter in her favorite coffee shop. She's one day away from the end of a three-week sprint to build an entirely new modeling engine for Revilico, an eight-person startup dedicated to creating virtual experimentation platforms. Her work allows chemical researchers to tweak their approaches to protein folding on a massive scale.

Fisher has windows open on her laptop for coding, connecting with her colleagues on the West Coast and the company's user-facing portal. The portal shows a 3D image of a protein sequence, a clump of green spirals like a bow on a package. An orange compound, which, from one angle, looks like a tiny pair of scissors, binds to the protein. Each click on the screen reveals a new combination of protein sequences and bonding chemical compounds.

Three weeks to build something new is unusually fast, but Fisher was ready for the challenge. To help herself think through a different approach to a model, she filled a notebook page with formulas and sketches of protein bonds.

The Revilico team completed the engine earlier in the week and the next task is running validation to ensure the product's reliability before they release it to the public. When they do, scientists will be able to use the engine to run computational chemical and biological simulations to test combinations of chemical compounds and targeted proteins. Tiny alterations

and iterations made possible through Fisher's work reduce the time and cost of otherwise lengthy and expensive wet lab experiments.

"Traditionally, a bunch of super smart people sit around and talk about ways that you can alter these chemicals," said Fisher. "Then they think really hard about it and then they try it. If it doesn't work, they have to start all over again."

As that generation of scientists reaches retirement, the next generation, even though they have less research experience, have the talent, new skills and tools necessary to take advantage of the sweeping advancements in machine learning. Completing months' or years' worth of finding and testing potential chemical iterations can now happen in an instant. The math behind the algorithms always existed, of course, but it wasn't possible to function at this scale, where a 24-hour turnaround for complex, heavy-computing-power problems is considered "a really long time," said Fisher. "We can cure many more diseases if we're able to automate this process."

Zhen (Jack) Liu (MCS 2024) is part of this new generation of scientists, working as a machine learning engineer at Genentech, a 50-year-old biotech company. He designs drug molecules with both efficacy and safety in mind.

"I've always really seen myself as a chemist who is dedicated to developing computational tools for faster or better drug discovery," Liu said. "What really helped me in my development is the interdisciplinary research culture at CMU."

About two years before completing his undergraduate degree in 2019, Liu read Olexandr Isayev's research on deep reinforcement learning and drug design.

“

We can cure many more diseases if we're able to automate this process.”

SARAH FISHER (SCS 2025)

Through the journal article, Liu learned about not just computational chemistry, but also the concept of machine learning itself. The combination of fields piqued Liu's interest even though he had no computer science experience.

He decided to take the risk and pursue computational chemistry anyway. Liu received admission to the Department of Chemistry's doctorate program and joined Isayev's lab. "It was a hard transition," he said, but he made it. His eventual dissertation in computational chemistry centered on using machine learning for predicting chemical reactions. His research has led to 11 peer-reviewed publications and conference papers.

Fisher also applied to CMU without a prior computer science education. "The field had been framed to me as problem-solving, and I was really excited to solve problems. I love puzzles and logic." She possessed a love of biology, too, and learning about the computational biology major seemed like a perfect combination.

Her real "aha!" moment happened in Phillip Compeau's Great Ideas in Computational Biology class. "The transition to college was really hard," she said. "It was a whirlwind. I was learning so much so fast."

Compeau's course — and his enthusiasm for teaching it — inspired Fisher to truly take in the possibilities in front of her. Her final project for the course, a four-week, small group endeavor, acted as a capstone for everything she learned in her first year in the program. The group created a model to find correlations within protein interaction networks. They not only successfully replicated the research paper they were working from, but furthered its results as well.

Sarah Fisher (SCS 2025)



Zhen (Jack) Liu (MCS 2024)

Phillip Compeau, Assistant Dean for Innovation in Computing Education and Teaching Professor in the Ray and Stephanie Lane Computational Biology Department



“*What really helped me in my development is the interdisciplinary research culture at CMU.*”

ZHEN LIU (MCS 2024)

"It changed my life," she said. "I was actually doing science for the first time. I was programming. I was using all of these skills that I had been trying to grab for two semesters." Fisher knew then that she wanted to be a researcher. She loved the work, she loved knowing she was capable of it and she loved that she could apply it in the real world.

Like Fisher, **Meghana Tandon** (SCS 2023) also took Compeau's class to heart during her first year at CMU. "That first course confirmed that I wanted to pursue this," she said.

In addition to computational biology, Tandon also wanted a solid foundation in computer science. With her dual major, she spent her time at SCS modeling and interpreting cellular signals for genetic and protein content, and conducting statistical analysis and analyzing images using machine learning. "I became a really well-rounded engineer because of that," said Tandon. In her professional life, her fluency in both biology and machine learning "garners trust and credibility a lot more quickly," she said.

"That little bit of exposure in every field has paid off significantly," Tandon added. "I was able to shape my degree in a way that was very valuable to my immediate career. So much so that I was able to move up faster than maybe I would have otherwise."

Tandon applies her skills at Insitro, a mid-sized biotech drug discovery startup, where she works on a clinical data team as a software engineer. She builds the tools to support the scientists' day-to-day jobs, looking for sticking points in their workflows. "Things sometimes take months or years because of how tedious each microstep is along the way. Nobody really realizes how time-consuming they are," she said.

As an example, Tandon helped create a piece of visualization software that helps research teams fine-tune their machine learning models for segmenting cells or structures in an image, such as extracting information from layers of the retina to learn how far an eye disease has progressed. "It's one of those things that is so microscopic that no human can actually sit there and measure it with a ruler, but it's in the imaging data that they collect anyway. By refining the model, we've brought the lifecycle down from months to days and weeks."

Tandon notes that it can be easy to feel detached from a company's mission when working upstream. Her initial work only reaches a handful of colleagues. "But then you hear it all coming together at company-wide meetings and that gets me really excited," said Tandon. "I know I had some part in it, and here are the outcomes of all of us working together."

Liu finds satisfaction in being part of the process, as well. "I'm always proud to be part of these efforts, especially seeing how the discoveries of the company really impact patients," said Liu.

Meghana Tandon (SCS 2023)



“
My fluency in both biology and machine learning garners trust and credibility a lot more quickly.”

MEGHANA TANDON (SCS 2023)

Computational Biology Goes to Medical School

Not all health-based SCS trajectories involve helping people so far upstream. For **Zahra Ahmad** (SCS 2023) and **Annie Nadkarni** (SCS 2022), earning their degrees in computational biology helped them get into medical school.

"I think in general a lot of people have a specific view of what a path to med school looks like," said Nadkarni. She and Ahmad both credit the supportive environment of the Ray and Stephanie Lane Computational Biology Department in SCS for being able to take the time to find the best fit. Ahmad said SCS faculty "really care. They want you to succeed. They want to figure out a path with you."

For Ahmad, now a student at Georgetown University Medical School, the computational biology curriculum integrated well with completing pre-med requirements like cell biology and genetics. Even so, "it was still kind of a

new path that I was trying." Compeau worked with her to figure out course sequencing and the result, Ahmad said, "ended up working perfectly in the end."

Nadkarni, currently a student at Hofstra/Northwell's Donald and Barbara Zucker School of Medicine, became interested in learning more about mental health in college populations while she was at CMU.

"I was interested in the brain and the mind," said Nadkarni. Realizing she could study neurological and neuropsychiatric disease from a computational perspective (neurogenomics) lit her up. "Oh my God, this is what I've been searching for," she said.

Studying neurogenomics allowed her to approach conditions like bipolar disorder and schizophrenia from a single-cell perspective. "You can try to figure out the molecular underpinnings of these diseases, but then you have that clinical side complement it," she said. "What is a clinician's model of disease versus a researcher's model of disease, and how do we bring those closer together?"

Her SCS background gives Nadkarni an advantage in a new era of medicine where everyone has a computer in their pocket, but doesn't necessarily know how to make the most of it. "You need to know how to utilize the resources available to you, and a lot of those are going to be computational tools," said Nadkarni.

Zahra Ahmad (SCS 2023)



Annie Nadkarni (SCS 2022)

(Continued from page 11.)

Nadkarni doesn't know yet what her day-to-day career will look like. But she does know that, fundamentally, she "would like to revolutionize the way mental health is approached." She's particularly interested in treatment efficacy and why some classes of medicine work for some people and not for others,

and what makes some conditions resistant to treatment.

Ahmad is leaning toward specializing in oncology, though she's still not certain. "Whatever I end up doing, I know that my eventual practice as a clinician should involve a fair bit of research," she said.

"The Way I Think"

No matter where their careers lead them after CMU, computational biology graduates know there are parts of SCS they'll never leave behind.

Lewis, who also sits on the SCS Dean's Advisory Board, said his time in the computational biology program "fundamentally shifted the way I think, the way I approach problem solving." He tells people that he uses his degree every day in the way he values listening, names problems and applies existing knowledge. "Oftentimes, the solution already exists," he said. "We just need to understand what someone else has already implemented and figure out 'how do you pour it over into this new context?'"

He points out that, for instance, afterschool programs aren't new and neither is the idea of working with children and their families. "But every environment is different. Every child is different. Every family is different," he said. What worked in one environment or with one child might not work when copied directly to another. "What might we need to tweak in our approach?" he asked.

For Nadkarni, looking at medicine through a computer science lens offers diversity of thought among her medical school peers. In SCS, she learned to strip complicated problems down to their core principle and then use that core principle to tie back to the complexities. "I actually found organic chemistry far easier after I took a theoretical computer science class," she added. Ahmad made the same observation about taking the Medical College Admission Test.

Nadkarni said that the dual language of computational biology taught her how to talk to people across disciplines. "How do I communicate what I do understand and what I don't, so we can get closer to the truth?" she asked.

"Now that I'm in med school and I'm actually talking to clinicians, explaining my research, I feel like I can properly explain: Here's a technical basis and this is how it applies to medicine," said Ahmad.

Fisher said she didn't realize in the moment how much the program's emphasis on logic would alter how she interacts with the world. "I think about everything better, and I can solve problems everywhere in my life better because I went to CMU." ■

“

I feel like I can properly explain: Here's a technical basis and this is how it applies to medicine.”

ZAHRA AHMAD (SCS 2023)

Marylee Williams contributed additional reporting for this story.



WHAT IF THERE WAS A TOOL TO ACCELERATE STUDENT SUCCESS NATIONWIDE?

Traditional education often relies on a one-size-fits-all approach that leaves too many learners behind. Carnegie Mellon University is changing this by turning the science of learning into action. By prioritizing partnerships with community colleges, two-year colleges and broad access four-year institutions, CMU in collaboration with Learnvia is poised to realize transformative academic gains at scale.

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SHERI HALL

GAME CHANGERS

How Carnegie Mellon Computer Scientists Are Reshaping Professional Sports



W

hen **Shivaas Gulati** (SCS 2010) looks at a professional sports franchise, he doesn't just see athletes and game strategies — he sees a complex system of interconnected elements reacting and interacting with one another. As the founder of Arkerio, a company that brings artificial intelligence to sports businesses, Gulati employs the strategies he learned at Carnegie Mellon and as a successful entrepreneur to transform how teams operate on and off the field. Arkerio's platform optimizes the complex elements of modern sports enterprise — cross-functional project management for gamedays, dynamic actionable insights, fan engagement and operational efficiency. Essentially, Gulati applies computational thinking to build sustainable, efficient sports businesses.

Gulati's work exemplifies a broader trend among Carnegie Mellon alumni, who are reshaping professional sports organizations across the globe. They're building platforms that help teams evaluate players, manage complex salary caps, connect season ticket holders with premium opportunities and enhance the stadium experience. Teams once operated more like small businesses and analytics departments focused narrowly on player performance. But today's sports organizations are discovering that computational approaches apply in all aspects of professional sports.

The migration of computer scientists like Gulati into sports represents a fundamental shift in how modern organizations compete in an entertainment economy worth hundreds of billions of dollars. Teams are striving to dominate on the field while managing real estate, media rights, fan communities and brand partnerships. The shift goes beyond simply collecting information. Now computer scientists are building systems that can convert data into actionable recommendations and improved fan experiences.



Shivaas Gulati
(SCS 2010)

Gulati is one of dozens of SCS alumni working with professional sports organizations. **Adam Brodie** (SCS 2016) — assistant director of research for the Houston Astros — focuses on translating data about player performance into usable information the Astros can employ at a moment's notice to develop players, select equipment, change strategy during a game and more. **Doug Fearing** (SCS 1999) serves as chief data officer for Teamworks, which provides technology solutions to more than 7,000 sports teams and military organizations worldwide to optimize talent acquisition, operations and performance development.

Other SCS faculty and researchers have changed the viewing experience for fans. For example, Takeo Kanade, the U. A. and Helen Whitaker University Professor of Computer Science and Robotics, created Eye Vision for Super Bowl XXXVI in 2001. The technology synthesizes video from 30 robotic cameras into a smooth, flowing image that rotates the angle of the view of the play. And Priya Narasimhan, a professor in the Department of Electrical and Computer Engineering, launched

YinzCam, an app that allows in-person fans to access video from stadium cameras on their smartphones for better in-game experiences and a closer look at the action, even from the nosebleed seats.

Across the board, the out-of-the-box thinking and complex analytical skills taught at SCS have helped launch careers in professional sports.

"Carnegie Mellon exposed me to a wide range of disciplines and, more importantly, to sharp, like-minded people — both within my program and across campus," Gulati said. "From SCS, the biggest lessons were grit and tenacity. The late nights grinding through assignments, pushing through complexity and constantly stretching beyond my comfort zone built a resilience that has stayed with me. That mindset — never giving up and being willing to grind through the hard parts — has been foundational in building 'Zero to One' companies ever since."

By using the term "Zero to One," Gulati is referring to the influential 2014 book by the entrepreneurs and investors Peter Thiel and Blake Masters about building innovative companies.

Helping sports teams catch the “AI wave”



For Gulati, the business of sports is a second career of sorts. After graduating from SCS with a master's degree in information technology in 2010, he co-founded Remitly, a digital remittance service. In 2021, the company went public through an initial public offering (IPO) valued at \$8 billion, the biggest consumer IPO in the Seattle area since Amazon went public in 1997.

Gulati always thought of himself as an entrepreneur. After successfully launching Remitly, he decided he wanted to explore the intersection of his work and a lifelong passion — soccer. “I see sports as a platform to create impact in people, communities and geographic regions,” he said. “The power of sports — big or small — is massive and compounds over time. Currently, there’s not a lot of technology application in the business side of sport, which creates an opportunity.”

After launching Remitly and investing in other tech companies, Gulati decided the best way to break into professional sports management was to buy into a team. So in 2024, he partnered with a group of investors to purchase Southend United Football Club, a professional team in Southend-on-Sea, Essex, England, that competes in the English National League.

“The purpose of buying a team was to understand the business problems from the inside and do something impactful,” he said. “It’s an amazing front row seat to understanding how dysfunctional soccer clubs are, but also their impacts on people, communities and families.”

So far, Gulati and his team of investors have used AI tools to better understand player contracts and provide performance data to the

coaching staff. They’ve moved to a cashless point-of-sales system in the stadium, which speeds up the concession lines. And they are moving toward using AI to improve operational efficiency across their business teams.

“We are solving things slowly,” he explained. “It’s a multiyear strategy to create a sustainable club that is underpinned with technology at the core of our business.”

For Gulati, Southend United FC provided a broader understanding of the sports industry. Last year, he began advising the Seattle Sounders Football Club on their AI and tech strategy, getting a first-hand look at one of the country’s top sports franchises. That work led him to launch Arkero in October. In January, Arkero announced it had raised more than \$6 million in a preseed funding round led by Roger Ehrenberg’s Game Changers Ventures, along with four other venture capital firms. Adrian Hanauer, owner of the Seattle Sounders and Seattle Reign football clubs, also invested.

“The software industry is going through a sea change, and industries like sports are behind the curve,” he said. “Many of these businesses are still running on email and spreadsheets, just like 15 years ago. Strategies are still being discussed on white boards in conference rooms without being quantified and recorded. Now every sports owner is saying, ‘How do we make sure we don’t miss the AI wave?’ To me, that’s a massive opportunity to build something specific to this industry.”

Arkero’s core premise is two-fold: helping sports teams build a cohesive operational plan that incorporates business strategy and using data collection and AI analysis to improve fan engagement, retention and revenue.

“How do we make these teams data rich and insight rich, with plans that they can actually implement?” Gulati said. “The goal is to build an intelligent system that understands the business and can tell me what actions I should take based on the insights we collect.”



Adam Brodie (SCS 2016), Assistant Director of Research for the Houston Astros

Translating sports data into action



he idea of analyzing data to help players, coaches and managers make real-time decisions sits at the frontier of sports analytics, explained

Adam Brodie, assistant director of research for the Houston Astros. “When you distill it down, we want to understand and predict why certain phenomena exist, and then we want to use that information to make decisions,” he said.

For Brodie, those decisions are broadly focused on the game: How do the Astros select players, adapt their strategy during a game, select the best equipment for each player and decide what players need to work on at practice? A recent focus has been creating web applications for communicating and distributing their insights to players and coaches on a daily basis.

A big piece of the puzzle comes down to which questions the data scientists decide to ask.

“I consider myself a baseball scientist,” Brodie said. “I am focused on the language and measures we use. I’m trying to better understand if this is really the best way to evaluate a player. Or is there an advantage to changing the information we use to emphasize things that are more relevant?”

In nine years with the Astros, Brodie has seen exponential growth in the research department. “The tasks have become more sophisticated,” he said. “We’re adopting practices that are more like a tech company rather than a mom-and-pop operation.”

Brodie’s penchant for deep thinking comes from his first academic love: philosophy. He received a doctoral

degree in logic, computation and methodology from CMU in 2017. “The Philosophy Department is untraditional because it emphasizes the foundations of mathematics, computer science and decision theory,” he explained.

Midway through his philosophy studies, Brodie decided he needed to find a way to apply what he was learning to an industry. So he simultaneously began working on a master’s degree in machine learning from SCS. There, one of his projects focused on baseball — specifically how the strike zone was changing in Major League Baseball, and what that meant for strikeout rates. From then on he was hooked. “I felt like we really learned something that would be useful to teams,” he said. “It’s to the credit of my advisors, Peter Spirtes and Sam Ventura, who were willing to help me.”

Today, Brodie uses much of what he learned at Carnegie Mellon on the job. “As my role has developed, I’ve learned to appreciate and apply more of the principles from my time at graduate school in both philosophy and machine learning,” he said. “The question is really, what do you want to model and how do you want to evaluate it? Reflecting on the things I learned in school gives me the breadth to understand there’s all sorts of resources out there.”

Perfection AI: Taking a Swing at the Perfect AI Coach

Athletics have helped Zack Li (ENG 2022, SCS 2024) through the most difficult periods in his life. From his days as a high school athlete to being the young entrepreneur he is today, Li has participated in a myriad of sports including badminton, snowboarding, ice hockey, tennis and golf.

"My own sports have been the north star of my life," he said. "Breaking physical limits and the spirituality of athletics have helped me grow, preserve and build mental muscles. I want more people to experience the same journey that I have with sports. To do this, good guidance is important. But I realized there are a limited number of coaches and not everyone has access to coaching resources."

This realization led Li to combine his two passions — sports and technology — to start Perfection AI, a sports technology company that provides accessible and individualized instructions via "digital twins" of human coaches. The company recently launched its AI-based golf coaching platform in the U.S. and plans to expand to other sports.

"Sports are an extreme form of expressing yourself," Li said. "Starting a business is also a form of expressing myself — maybe it's the ultimate one. This company reflects my values."



A screen capture of Perfection AI analyzing a golf swing.

Li developed the idea for Perfection AI during informal networking sessions with a fellow graduate student at CMU, Yuhao Gary Liu (ENG 2022, TPR 2022). "A few guys got together every week to talk about fun new ideas," he said. "We decided to vote on which idea we would want to turn into a business."

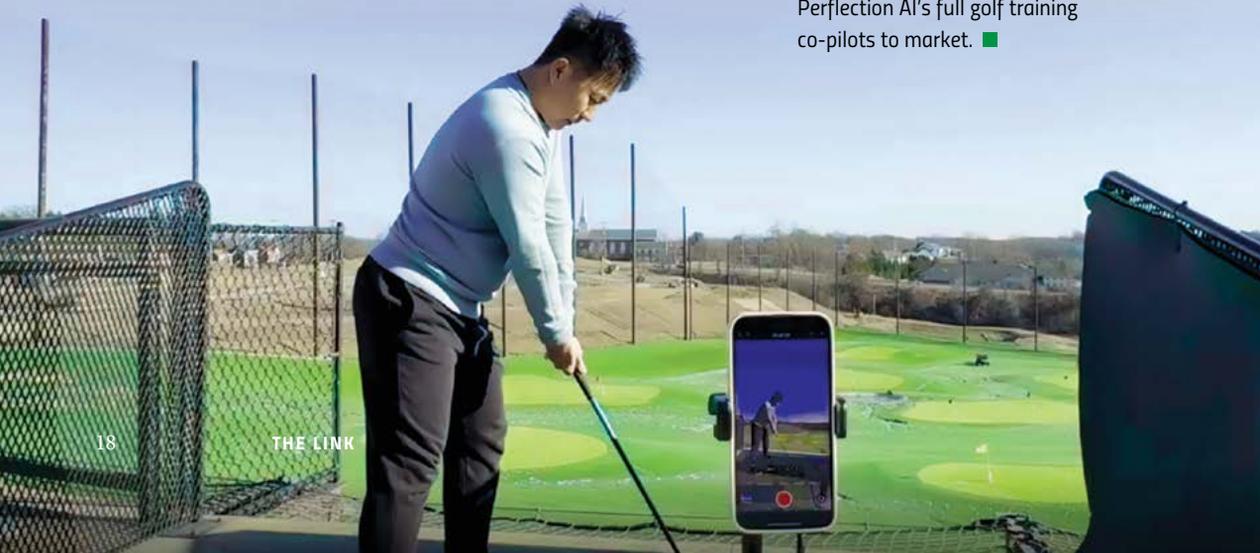
With the help of his advisor Ron Yurko, the director of the Carnegie Mellon Sports Analytics Center (CMSAC), Perfection AI was a finalist in the 2024 McGinnis Venture Competition, a startup competition run by CMU's Swartz Center for Entrepreneurship where the winners receive mentorship from alumni and funding for their projects.

Since then, some co-founders have left for other jobs, but Li has stayed on full time.

Li said the company began with golf coaching, in part, because he believes the spirit of the game mirrors starting a business.

"Even the best athletes make mistakes 60% of the time," he said. "It's entirely about embracing the uncertainty and working toward the goal of getting the ball in the hole. You can't think about your past failures or successes; you have to stay in the moment and focus on the goal."

Li will be raising a round of funding in early 2026 to bring Perfection AI's full golf training co-pilots to market. ■



“Solving challenging problems with talented people”

Similar to Gulati and Brodie, Doug Fearing (SCS 1999) never expected to find himself working in sports analytics.

After graduating from SCS, he spent five years at Trilogy Software. When he paused work to care for his newborn son, Fearing got into fantasy baseball and learned he had a talent for analyzing sports metrics. The hobby sparked the idea for a new career path, and Fearing enrolled in a sports management seminar while completing his Ph.D. at MIT.

Fast forward 10 years: the Los Angeles Dodgers hired Fearing to build its research and development department. (You can read about Fearing’s tenure with the Dodgers in the Summer 2018 issue of *The LINK* magazine.) From there, he teamed up with colleagues from Harvard to launch Zelus Analytics, a company focused on using player tracking data to support decision-making in professional sports.

Zelus offered analytic platforms focused on game play with the ultimate goal of influencing strategies, recruiting decisions and priorities at practice. “Seeing how players move in the field helps you better understand how they’ll perform,” Fearing said. “Once you understand the characteristics of their performance, you can deploy them better. For example, if you know that a certain kind of hitter is better against a certain kind of pitcher, you can more effectively deploy those players in games.”

Zelus began in professional baseball, but quickly expanded to soccer, basketball, football and ice hockey. The company uses player tracking data collected from video technology and wearable



Doug Fearing
(SCS 1999),
Chief Data Officer
for Teamworks



sensors and employs proprietary algorithms to analyze that data.

In 2024, Zelus was acquired by Teamworks, a sports management platform that offers data-driven products for talent acquisition, operations and performance development to professional and NCAA teams. As the chief data officer at Teamworks, Fearing runs their data science research group.

Across a broader range of teams and sports, Fearing still has the same goals as when he began in sports analytics. “How do you acquire the best players and build the best team, and then how do you deploy those players, understand their strengths and weaknesses, and their opponents’ strengths and weaknesses?” he said.

Answering these questions comes back to a core value that he developed as an undergraduate at SCS. “CMU really instilled in me a passion for solving challenging problems with talented people,” he said. “That’s been the through line of my career, starting with developing software in 1999 to working with Teamworks today.” ■

Let Me *Enter*





tain You

How SCS Trains the Minds Who Shape How We Play

Jessica Hammer (center), Associate Professor in the HCI and Director of the Center for Transformational Play, enjoying playing, learning and teaching with CMU graduates Dr. Tianying Chen (SCS 2021, 2025) (left) and Erica Principe Cruz (SCS 2025) (right).

NIKI KAPSAMBELIS

It's hardly a secret that human beings are hard-wired to crave entertainment. Entire industries, and spinoffs of industries, are devoted to capturing and holding our attention for as long as possible through games, stories and play. Whether we're enjoying some downtime after a long day, trying to forge new connections with other people or practicing a new skill, we innately gravitate toward the joys of entertainment.

In gaming specifically, the tools of the trade are often found deep in the heart of computer science. And the School of Computer Science has long prepared its graduates to apply those tools across a variety of fields that channel back to the art of amusement.

For those working in the entertainment field, play is serious business, combining elements not only of technical prowess but also of creative thinking, strategy and social sciences. When done well, the result is an approach that seeks to not only satisfy our desire to be entertained, but also to meet critical societal needs and thoughtfully shape the future.

Using Play as a Motivator

To understand the fundamental role entertainment plays in our lives, it's helpful to look at what drives us.



According to **Jessica Hammer**, an associate professor in the Human-Computer Interaction Institute (HCII) and director of the Center for Transformational Play (CTP), human beings have two approaches to motivation. One is intentional and purposeful, thinking about the long-term future of what we are doing: We might put together a budget or work out in the morning not because we want to, but because the process allows us to accomplish a later goal.

The second motivational state is wanting to enjoy the present, staying in the moment of what we are doing right now. If a process is not motivating enough on its own, introducing play — or gamifying the task — makes working on purpose-driven problems more palatable, Hammer said.

"It's a way of linking our commitments to our future selves and our commitments to our present selves," said Hammer, who holds a joint appointment at the Entertainment Technology Center.

Play can also help people reduce risks in social interactions, build intuitions about complex systems and explore new topics. So while time spent in play may seem frivolous at first blush, in reality, entertainment — and its subsets, such as gaming — are consequential.

Hammer didn't start out thinking computer science would play such an important role in her professional life. Although her interests leaned toward poetry, she took a computer science course as an undergraduate at the request of her parents.

But what she found was that understanding technology was the key to unlocking many of her other passions.

"The ability to create systems and prototypes that helped me articulate my ideas was so addictive," she said. "I found myself asking questions like, 'What would technology look like to address some of these issues that I'm learning about in my other classes?'"

The art of applying technical skills to real-world scenarios is a strength of SCS, she said. In particular, the HCII excels at asking people who they're making something for and why it matters.

"When you're training people with this approach, I don't think it's enough to have technical skills. I think you also need an understanding of how you connect computer science to your life's work," Hammer said. "It's not just about writing code. Writing code is one small part of being a great computer scientist."

“The ability to create systems and prototypes that helped me articulate my ideas was so addictive.”

— Jessica Hammer, Director of the Center for Transformational Play



Mathilde Pignol
(SCS 2002, 2004)



“For us, it’s a way to keep in touch and to bond. That’s sort of the ultimate reward.”

— Curt Bererton (SCS 2000, 2004)

Forging Connections

When she founded the CTP, Hammer said she fought an uphill battle to be taken seriously.

But today, both academia and the public recognize that games can change our lives. Hammer’s own daughter taught herself to read by playing Minecraft. And millions of people play Duolingo to gain competency in another language, or use virtual reality to make exercise more fun.

Hammer pointed out that game literacy could help us play music, write poetry or achieve wellness. Her students have designed games that support healthy sleep and also helped mentors and mentees connect.

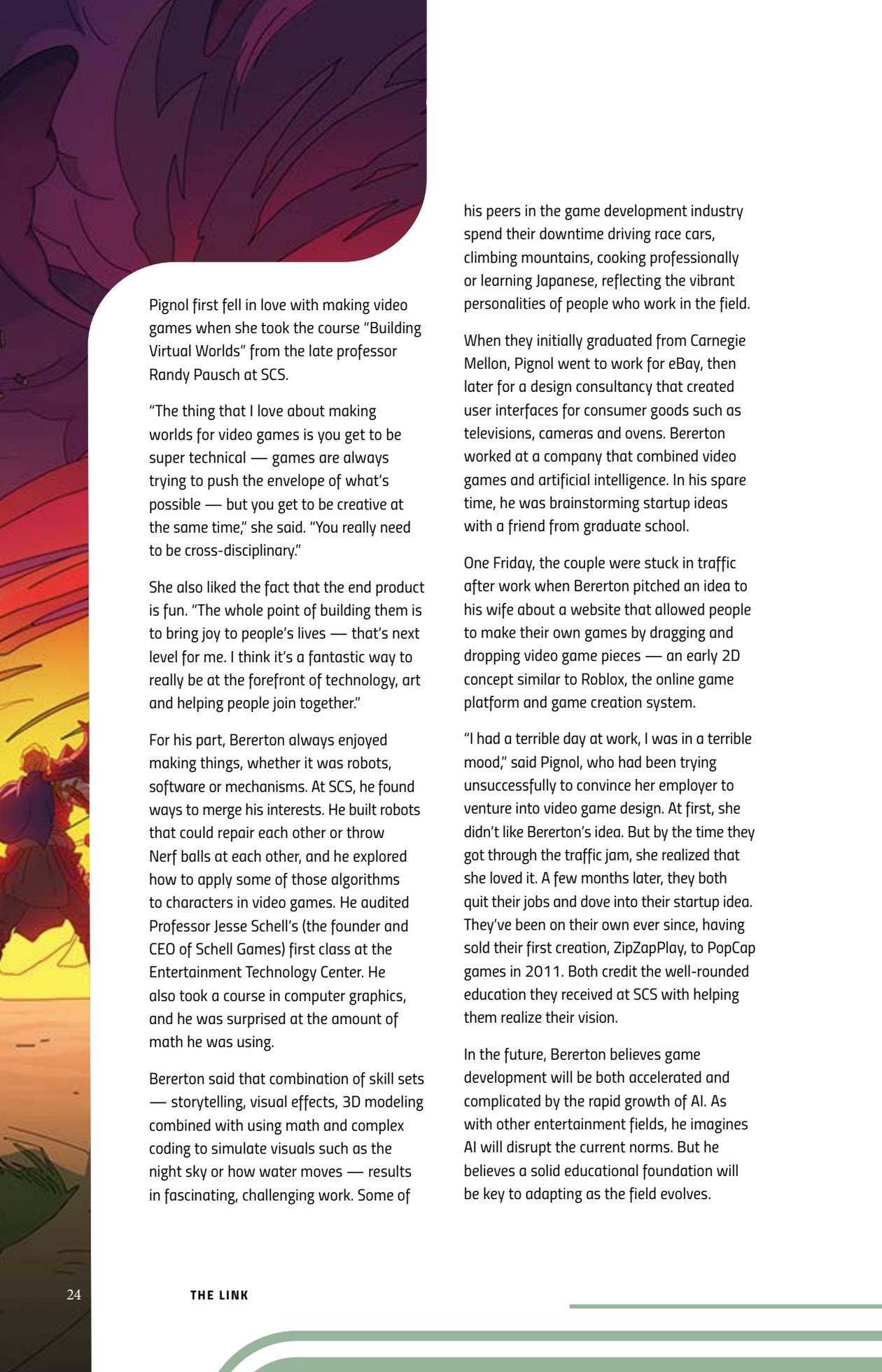
Sometimes, the meaning of entertainment is rooted in connecting with another person. Mathilde Pignol (SCS 2002, 2004) and her partner Curt Bererton (SCS 2000, 2004) — both veteran game designers — created a tagline for their latest venture, Roboto Games: “Good Alone, Great Together.” The premise being that the company’s games are fun to play solo, but even better to play with someone else.

“For us, it’s a way to keep in touch and to bond. That’s sort of the ultimate reward,” explained Bererton.

The inspiration for the approach was the fact that both Bererton and Pignol, who are married, now live far away from extended family (she grew up in France, he on a farm in northwestern Canada). Games became a vehicle for bringing loved ones together.

Currently, they are developing a game called Stormforge, which Bererton described as “Minecraft meets Zelda.” It’s a game that appeals to people who like to build things as well as those who want to fight, thus allowing people with different tastes to still play together. Currently previewed on the Roboto Games’ website, the company plans to launch Stormforge in the second half of 2026.





Pignol first fell in love with making video games when she took the course “Building Virtual Worlds” from the late professor Randy Pausch at SCS.

“The thing that I love about making worlds for video games is you get to be super technical — games are always trying to push the envelope of what’s possible — but you get to be creative at the same time,” she said. “You really need to be cross-disciplinary.”

She also liked the fact that the end product is fun. “The whole point of building them is to bring joy to people’s lives — that’s next level for me. I think it’s a fantastic way to really be at the forefront of technology, art and helping people join together.”

For his part, Bererton always enjoyed making things, whether it was robots, software or mechanisms. At SCS, he found ways to merge his interests. He built robots that could repair each other or throw Nerf balls at each other, and he explored how to apply some of those algorithms to characters in video games. He audited Professor Jesse Schell’s (the founder and CEO of Schell Games) first class at the Entertainment Technology Center. He also took a course in computer graphics, and he was surprised at the amount of math he was using.

Bererton said that combination of skill sets — storytelling, visual effects, 3D modeling combined with using math and complex coding to simulate visuals such as the night sky or how water moves — results in fascinating, challenging work. Some of

his peers in the game development industry spend their downtime driving race cars, climbing mountains, cooking professionally or learning Japanese, reflecting the vibrant personalities of people who work in the field.

When they initially graduated from Carnegie Mellon, Pignol went to work for eBay, then later for a design consultancy that created user interfaces for consumer goods such as televisions, cameras and ovens. Bererton worked at a company that combined video games and artificial intelligence. In his spare time, he was brainstorming startup ideas with a friend from graduate school.

One Friday, the couple were stuck in traffic after work when Bererton pitched an idea to his wife about a website that allowed people to make their own games by dragging and dropping video game pieces — an early 2D concept similar to Roblox, the online game platform and game creation system.

“I had a terrible day at work, I was in a terrible mood,” said Pignol, who had been trying unsuccessfully to convince her employer to venture into video game design. At first, she didn’t like Bererton’s idea. But by the time they got through the traffic jam, she realized that she loved it. A few months later, they both quit their jobs and dove into their startup idea. They’ve been on their own ever since, having sold their first creation, ZipZapPlay, to PopCap games in 2011. Both credit the well-rounded education they received at SCS with helping them realize their vision.

In the future, Bererton believes game development will be both accelerated and complicated by the rapid growth of AI. As with other entertainment fields, he imagines AI will disrupt the current norms. But he believes a solid educational foundation will be key to adapting as the field evolves.

Finding the Guardrails

The proliferation of AI throughout all corners of our culture, including entertainment, has led to an increased focus on the responsible use of computational tools.

Jaemarie Solyst, who earned a Ph.D. in Human-Computer Interaction from SCS in 2025, studies the social and ethical aspects of these technologies at scale.

Solyst, who was advised by Hammer and HCI professors Amy Ogan and Motahhare Eslami, is now a postdoctoral researcher at the University of Washington.

"I've always been interested in learning, and different ways of thinking and going about the world," she says. "I think there's a lot of power and impact happening in computing and technology."

One of her papers studied how the aesthetics of generative AI influence the way children perceive it. If the technology produces something that looks like what they are expecting, they overtrust it. And if an AI tool shows its reasoning, even if that reasoning is incorrect, children may often still believe it because they don't always double check the source material.

"People are willing to trust vibes," Solyst said.

Likewise, as generative AI becomes more robust, people can rely on it for things like friendship or romantic connections. Helping people to think critically about the limitations of technology is useful in combating problematic thinking, she said.



Jaemarie Solyst
(SCS 2025)

As the technology moves into more functions, it's important to preserve the human element so AI augments people instead of replacing them, including in entertainment applications.

For example, AI can help a writer or musician ideate a piece, but it shouldn't replace the joy of a human creating something. In one of Solyst's studies, she asked young people to use generative AI to design a new clothing aesthetic. As their visions came to life, they were then able to explore identities, narratives, ideas and perspectives, she said.

"A lot of exciting things can happen if we're thoughtful, if we have the right guardrails in place," she said.

And while the future of entertainment and AI in general remain somewhat of a mystery, the School of Computer Science's impact will influence that innovation, ensuring that tomorrow's technologies still speak to the same human impulse for connection, challenge and joy that have always drawn us to play.

"I think CMU is on the cutting edge of computing," Solyst said. "It's a really exciting time to be experiencing innovation as it's happening." ■



TRICIA MILLER KLAPHEKE

SINGING A **NEW** TUNE

School of Computer Science alumni are developing methods for computers to understand music, while making it easier for any musician, no matter their skill level, to compose it. The field of AI-generated music has come a long way over the last decade, and alumni, such as Sara Adkins, are leading the way.



Adkins is the AI music technologist at Suno, one of the premiere companies devoted to using AI for music composition. That title was written for her when she joined the company in the fall of 2024. The majority of her work centers on developing new models with the machine learning team, but a good portion consists of testing the models as an artist to help decide which ones to release to the public.

"I feel like throughout history we keep having more and more ways that make it easier and easier to make music, allowing more people to do it. And I see this as the next iteration of that," she said of her work at Suno.

Adkins graduated in 2018 from the Bachelor of Computer Science and Arts (BCSA) program, a unique experience for students who excel in both disciplines. Each year, three to five undergraduate students are admitted into SCS and the College of Fine Arts jointly, allowing them to build expertise in both computer science and one of the arts (architecture, art, design, drama or music). To be admitted to the dual program in computer science and music, students must audition and stand out; Adkins auditioned on classical guitar.

Sara Adkins performs live, combining playing instruments with coding. To see her performances on YouTube, follow the QR code.



Adkins went on to win a Fulbright Award, studying computer music and earned her master's degree in sound and music computing at Queen Mary University of London. In May 2025, she returned to Europe to perform live using Suno outputs and her laptop and guitar on stage in London; Antwerp, Belgium; Barcelona, Spain; and Lyon, France.

"I think the coolest one was the one I did in France," she recalled. "It was in this huge, abandoned warehouse, and the visuals were set up with what must have been 50 old-school CRT TVs that were displaying the code. It was a 12-hour continuous livestream of rotating performers."



Char Stiles (CMU 2018)

Char Stiles (CMU 2018) has also gone on to be influential in computer music and performance. Stiles also attended the BCSA program but as a student of fine arts. She was admitted as a painting student but says she never painted at Carnegie Mellon, instead using math to make art compositions and 3D graphics.

After graduating in 2018, she worked for a few different startups as a software engineer and eventually went to MIT to explore the future of creative coding while finishing her master's degree. Now she is making her mark through something she does for fun outside her full-time job as a graphic design engineer: live coding in front of audiences. She describes live coding as being "anti-AI." While AI might take a lot of human input and produce something average from it, live coding results in the unique product of a human who's working and making mistakes in real time, Stiles explained.

"In live code, the person is centered and their particularities are really central to the performance," she said. "You get the sense that coding does have a personal style."

CONNECTING THE ANALYTICAL WITH THE EMOTIONAL



Professor of Electronic Art **Golan Levin** believes the intersection between computer science and the arts is easier to understand now that game design and Hollywood movies, as examples, are entirely

digital. However, he emphasized, this wasn't the case when he helped create the BCSA program. One of his career goals has been to create a context where students can study across traditional silos.

"One of the things I'm proudest of having done at CMU is help co-create the Bachelor of Computer Science and Arts degree in 2008," he said. "I genuinely think that we're producing some of the world's finest undergrads at the intersection of art and technology, and we don't produce very many. It's a unique and rare student who's able to meet the selection criteria for a program like that."

Assistant Professor **Chris Donahue** teaches Introduction to Computer Music as well as a graduate course on music AI in SCS. Donahue grew up playing piano and drums. When he was nearing the end of his undergraduate degree in computer science, he took an elective class on computer music and was enthralled to find that he could combine his two passions. Donahue is the first to hold the chair endowed by Emeritus Professor Roger B. Dannenberg, who taught at SCS beginning in 1982 after earning his Ph.D. from CMU.

"Roger's work was enormously influential, both in advancing fundamental computer music research and practice, and in making CMU a leader in the area," Donahue said. "CMU's Computer Science Department (CSD) is one of the only U.S. computer science departments that considers

computer music a legitimate CS discipline, and that is largely because of the strength of Roger's research career. I continue to benefit tremendously from his legacy."

Donahue joined the SCS faculty in 2023 and has three goals for his work at Carnegie Mellon: to help build tools that expand what's possible in music; to help address the ethical issues raised when AI competes with music rights holders; and to elevate audio signal processing and computer music to be a foundational skill that all computer science students learn, similar to computer graphics.

Donahue's research group, the Generative Creativity Lab (G-CLeF), works to address the ethical questions raised when AI is used to create new music. Donahue believes that at this point, much of AI's impact on musicians has been negative. But he sees "potential to course correct" in three ways.

"Firstly, as AI starts to compete with musicians, we need remuneration strategies that compensate music rights holders for the value that their data creates within AI systems," he said. "Secondly, we need to build AI tools that offer real value to musicians and creators. We recently deployed a Copilot-like tool for



Chris Donahue,
Dannenberg Assistant
Professor of Computer
Science in CSD

“ WE NEED TO BUILD AI TOOLS THAT OFFER REAL VALUE TO MUSICIANS AND CREATORS. — CHRIS DONAHUE

musicians called Hookpad Aria that has been getting some great feedback. Most broadly, to confront the increasing impact of AI on music, I believe we as researchers should be striving for a more holistic view of research, encompassing not only core AI methods but also broader human-computer interaction and societal questions."

DEMOCRATIZING MUSIC COMPOSITION AT HOME, IN THE STUDIO AND ON THE STAGE

There are two forms of AI music models. The first, more traditional model is symbolic, where the musician tells the model which instruments play specific notes at particular times. It requires more expertise and planning, so it can be more tedious. It tends to be a better fit for experienced musicians.

The second, newer audio models generate sound waves and moods so the resulting compositions can sound more natural and are easier for novices to produce. The drawback is that they can be harder to edit. Suno and Music Control Net, a project **Shih-Lun Wu** (SCS 2024) worked on with Donahue while getting his master's degree from the Language Technologies Institute (LTI), fall into the latter category.



Shih-Lun Wu (SCS 2024)

Wu grew up attending a music school in Taiwan, where he learned to play piano and viola and was well-versed in music theory, composition and ear training. He completed an undergraduate degree in computer science in Taipei before coming to Pittsburgh to earn his

master's from the LTI. He is now working toward his Ph.D. at MIT, looking for ways to unify the two families of music models and make them easier for musicians to use. Wu is interviewing musicians about their experiences using AI music applications, exploring ways to bridge the two models. He hopes to eventually develop a model that supports all the operations in the Digital Audio Workstation software that producers use.

"Although these are different representations of music, clearly as musicians there's a latent understanding behind these two

modalities," he said. "Whether you see the notes, the scores or hear the audio wave forms, your understanding of the music is kind of shared in between them."

Meanwhile, Stiles' live-coding session take the opposite approach. Instead of relying on a model to compose music, she writes code to provide an audio and visual experience for concertgoers.

"When I'm coding live, I'm usually coding in places where people aren't expecting there to be code, like festivals and clubs. People just want to come to dance and see visuals for an hour or two," Stiles said. "I don't think it's fair to expect them to enjoy looking at linear algebra and learning about the Pythagorean theorem."

Yet Stiles has become popular enough as a performer to attract fans herself. She started learning how to sing and play music in the last few years, then developed skills as a DJ, and finally, while she was finishing her master's degree at MIT, started performing live coding. In 2025, following advice from an art professor who encouraged students to make sketches and post them publicly, she began doing just that with her live coding experiments. One of her compositions caught on, and her musician friends asked to build on what she had created.

In her academic and professional work, Stiles has spent a lot of time thinking about the future of creative coding, a pursuit for coders who don't want AI to write code for them but who are so fluent in code that they can use it as a tool the way an artist uses a paintbrush. That's something she's doing with both visuals and music as a live coder.

"I'm really lucky to be in a place where this is appreciated," she said. ■

“

WHEN I'M CODING LIVE, I'M USUALLY CODING IN PLACES WHERE PEOPLE AREN'T EXPECTING FOR THERE TO BE CODE, LIKE FESTIVALS AND CLUBS.” — CHAR STILES (CMU 2018)



PRESERVING PITTSBURGH'S PUBLIC ART

ONE PIXEL

A Gigapan capture of the mural by artist Kyle Holbrook on the side of the Clemente Museum in the Strip District.



MALLORY LINDAHL

AT A TIME





301 West Main Street, Carnegie, PA

Public art, especially murals, can be fleeting. But Pittsburgh native Richard Palmer, a longtime collaborator with Carnegie Mellon University's CREATE Lab, has spent the last five years using innovative CMU technology to ensure the city's art and public murals won't be lost to history.

Housed on the CREATE Lab website, the Pittsburgh Public Art archive is a digital hub for murals and large-scale multimedia artwork that defines neighborhoods across the city. Visitors can explore art installations at extraordinary resolution, zooming in on precise details that would be difficult to see even in person. What makes that experience possible is a suite of imaging technologies developed at the CREATE Lab that allows these public artworks to be captured, preserved and shared on a large scale.

At the core of the archive is Gigapan, a robotic panoramic imaging system developed by CREATE Lab researchers that creates ultra-high-resolution images. Over time, Gigapan has transformed the archive from a collection of photographs into a dynamic record of Pittsburgh's evolving visual landscape.

While Palmer has spent recent years documenting the city's public art, his relationship with the CREATE Lab and Gigapan dates back to 2007, when he was living and working in Honolulu. While keeping up with Pittsburgh news, he spotted an



Richard Palmer, a longtime collaborator with CMU's CREATE Lab

Gigapan capture of the mural on the side of the Seventh and Liberty Avenues garage, Downtown Pittsburgh



advertisement in the Pittsburgh Post-Gazette indicating that the CREATE Lab was developing a new panoramic photography system. After several unsuccessful attempts to connect, Palmer sent the lab something memorable: a five-stanza poem set to the tune of "Gilligan's Island." The message caught the attention of the CREATE Lab's Illah Nourbakhsh and Randy Sargent. Within months, Palmer received an early alpha unit of the Gigapan system, marking the beginning of a collaboration that continues to this day.

Palmer's interest in large-scale imaging is tied to his scientific background. He joined the Hawaii State Department of Health after earning his Ph.D. in botany at the University of Hawaii. During his role as a conservation biologist, he documented different habitats in the state — urban, rural and undeveloped native environments. The work required detailed documentation at a high scale, making the CREATE Lab's emerging panoramic technology a natural fit.

The Palmer-CREATE Lab collaboration expanded when Palmer received an Outreach for Science Fellowship from the Pittsburgh Fine Family Foundation. The fellowship sent him to teach in Estes Park, Colorado, and also back to Pittsburgh, where he worked with other scientists to incorporate Gigapan technology into their daily research practices. Palmer trained researchers across disciplines, demonstrating how



Illah Nourbakhsh, Kavcic-Moura Professor of Robotics and Director of the CREATE Lab.

high-resolution panoramic imaging could support environmental monitoring, scientific analysis and public communication. In 2011, Nourbakhsh invited him to become a CREATE Lab sponsored visitor, a role he still holds today.

At the heart of Palmer's work is Gigapan's technical precision. Rather than relying on a single wide-angle shot, the system uses a programmable robotic camera mount that moves through a defined grid. Any high-quality camera can be mounted on the device, which then automatically advances and triggers the shutter hundreds to thousands of times. Specialized CREATE Lab software then stitches those images together into a seamless composite with shockingly high resolution.

"It's not the camera, it's the mount," Palmer said. "You can use your own high-end camera and lens. The Gigapan controls how the camera moves and how the images come together."

That technology became central to the Public Art Archive in 2021, when the Hill District Community Development Corporation approached the CREATE Lab with an urgent request to document a culturally significant mural "Looking Through a Keyhole Into a Jazz Club" before it was permanently covered. The CREATE Lab pointed them to Palmer, whose Gigapan experience made him uniquely suited to the task.

Gigapan capture of the mosaic mural by Paulina Braverman on James Simon's garage door on 5th Avenue near Jumonville Street.

The resulting image did more than preserve a single mural. It allowed viewers to zoom deeply into the artwork, preserving details and context long after the physical wall was covered. The project revealed how Gigapan could serve not only scientific research, but cultural preservation as well.

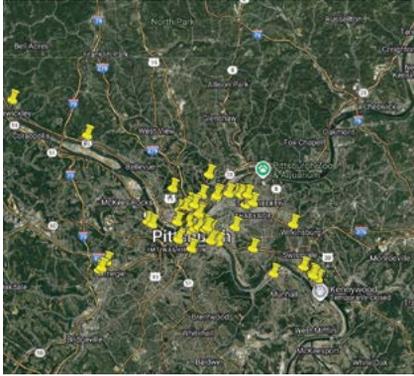
After documenting the jazz club piece and several other murals in the Hill District, Palmer began asking a broader question: What about the rest of the city's murals? With support from the CREATE Lab, Palmer expanded the effort, beginning to systematically photograph murals across Pittsburgh.

And the Pittsburgh Public Art Archive was born.

The growing digital collection now spans neighborhoods Palmer had never previously explored, from Lawrenceville and the Strip District to Bloomfield and the North Side. He captures each mural using the same high-resolution Gigapan process, allowing art installations to live on in an accessible location.



“ We hope these images bring Pittsburghers



The interactive Pittsburgh Public Art Archive map uses yellow pins to mark locations of art installations.

As the archive expanded, so did the need for sustained organization and maintenance. Josh Ambush, who manages the CREATE Lab website, works closely with Palmer on the archive’s design and coordination. Ambush helped develop the project’s interactive mapping infrastructure using Google My Maps and oversees the CREATE Lab webpage where the collection is hosted, supporting its continued growth and accessibility.

Palmer sees the archive as an ongoing, evolving project. “Every year, there’s something new,” he said. “Eventually, I’ll hand it off to someone else.” His long-term vision is for the archive to expand beyond Pittsburgh, becoming a national model for public art documentation.

For the CREATE Lab, the Public Art Archive reflects a core philosophy: technology should empower people, support communities and preserve knowledge that might otherwise be lost.

“Explorable images like Gigapans are a truly unique technology. They empower us to not just look, but to zoom and pan, exploring an image as if we’re walking next to the mural, crossing the street to see its details up close,” Nourbakhsh said. “We hope these images bring Pittsburghers closer together. They are truly extraordinary works of art that we should all celebrate.” ■



To learn more and interact with the Pittsburgh Public Art Archive map, visit the CREATE lab website.



closer together. They are truly extraordinary works of art that we should all celebrate. ”

— Ilah Nourbakhsh

MARYLEE WILLIAMS

Sharing Passions Through StuCo, the Student College

WHEN CARNEGIE MELLON UNIVERSITY STUDENTS ENTER EXAM SEASON, LIBRARIES FILL, COFFEE POTS OVERFLOW AND, FOR SOME, ROLLER COASTERS COME TO LIFE.

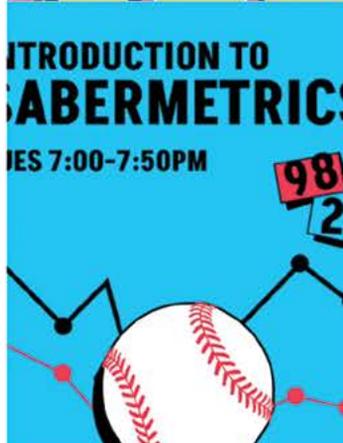


Taylor Roberts, Senior in SCS and StuCo Teacher

The coasters — made from pipe cleaners — are the final project for Roller Coasters: Background and Design, a course offered through CMU's Student College (StuCo). Run entirely by students, StuCo gives students the chance to turn their passions into classes offered for pass/no-pass credit. Students get out of the lab, build community and teach their peers about their interests, from hip hop to chess.

Taylor Roberts, a theme park enthusiast and senior in SCS, teaches the coaster course. He's one of several SCS students helping StuCo courses this semester. All of them are part of the rich history StuCo and SCS share.

Roberts said StuCo courses have enriched his CMU experience.





“Any given semester, there are probably 20 students on campus lecturing once a week about topics they love,” Roberts said. “We have a Pokémon StuCo and a chess StuCo. I’ve learned Tetris, mahjong, type theory and sword fighting. I’ve learned so many random little things, and, maybe more importantly, I’ve met a lot of people who are incredibly passionate about the things they do.”

Roberts’ love of roller coasters started early because he grew up in Tampa, Florida, with Busch Gardens nearby. When he came to CMU, he joined the Theme Park Engineering Group, a club for people interested in themed entertainment who want to work in that industry. Someone from the club has taught Roller Coaster Design since 2016, and Roberts took the class twice before taking over as its instructor this past fall.

SCS senior Kenechukwu Echezona was both a StuCo student and an instructor in fall 2025. He took Roberts’ roller coaster course and also taught Intro to Freestyle Rap,

which he wanted to teach because it’s a great way to share his interests and improve his own freestyling skills. Echezona said StuCo courses offer students the chance to simply relax and have fun — something that can be particularly helpful for students with challenging course loads.

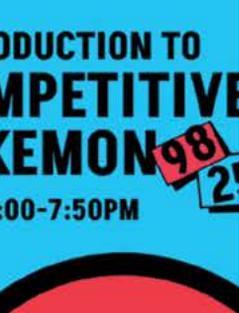
“StuCo courses can be a change of pace and a way to unwind from the rigor,” Echezona said. “I believe it’s important to always embrace and learn from new experiences in life. It makes us more whole as people, keeping us from being too rigid in what we already know. Trying new things can even give us interesting lenses to look through as we approach our primary work.”

SCS and StuCo have ties that go beyond the students teaching its courses. The school actually helped create CMU’s Student College in 2001. Mark Stehlik, now the University Teaching Professor in the Computer Science Department, said StuCo got its start when an SCS undergraduate asked to teach a class about the card game bridge.

“At the time, there were a number of aspiring bridge players in SCS who wanted to learn how to play, so it seemed reasonable to pursue this as a student-taught course,” Stehlik said. “It was initially offered as a pilot in the Physical Education department because there was no mechanism for student-taught courses, so there was no department to house it.”



Roller Coasters: Background and Design is just one of the courses available through StuCo, CMU’s Student College initiative.



Stehlik said one of the biggest hurdles at the time was making the distinction between a StuCo course and a club. The difference, he said, came down to teaching skills rather than hosting a gathering of like-minded hobbyists. After guaranteeing that StuCo courses wouldn't replicate any courses currently offered at CMU, StuCo launched in 2002.

One of the longest-running StuCos, Fun With Robots, is still offered today. CMU alumni Brian Kirby (TPR 2003) and Tom Lauwers (ENG 2003, SCS 2010) were its first instructors. Electrical and computer engineering students Nick Yaeger and Matthew Kibarian led the course. The pair agree that it's surreal to be at the helm of a course that about 850 CMU students have taken over the last two decades.

But just because a course has been around for a while doesn't mean it's stagnated. Each instructor brings something different to the class, updating course material or incorporating new lessons into the syllabus.

In Chess Tactics and Strategy, SCS junior Andrew Peng crafted lessons about DeepBlue, the chess computer that beat a reigning world champion. The work for DeepBlue started at CMU in the 1980s with ChipTest, a pioneering project that developed custom chess-playing hardware for computers.

"This will be my fourth time teaching the class, and every time we encourage each instructor to include whatever they're passionate about because chess is such a broad area to explore," Peng said. "You can talk about anything. It's a great experience."

Beyond the final projects and presentations, StuCo aims to create community at CMU. Roberts said that's one of the most important reasons to enroll in a StuCo.

"You develop a small community with your classmates for that semester," he said. "You get to know the people in your class better than you would otherwise because it's a room full of students. There's no intimidating professor in charge and a lot of collaboration typically happens. People are constantly chatting and engaging because everyone in the room is interested in being there." ■



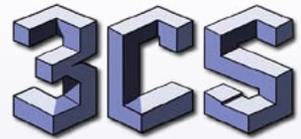
Students in discussion during the popular StuCo "Taylor Swift: Through the Eras."



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FROM
SCHOOL
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RESEARCH

SCS ALUMNI
REIMAGINE ROBOT
LOCOMOTION

Curiosity allows humans to pull ideas from fiction and give life to them in the real world. For CMU alumni Aditya Sripada (SCS 2021) and Abhishek Warriar (SCS 2025) a question inspired by a fictional robot in the film “Interstellar” served as the impetus for building, testing and ultimately reenvisioning how robots can move.

The result was TARS3D, a minimalist, shape-shifting robot that combines the efficiency of wheels with the adaptability of legs. The project went on to earn recognition at the 2025 IEEE-RAS International Conference on Humanoid Robotics, where it was selected as a finalist for the Mike Stilman Award. The award, which honors the legacy of Robotics Institute alumnus Mike Stilman, annually recognizes conference papers that demonstrate notable originality and innovation in humanoid robotics.

Sripada, who earned his master’s in robotics, and Warriar, who earned his master’s in robotics systems development, both now work at Nimble Robotics in California. Here, they discuss how a science fiction idea evolved into a real-world robot, what motivated them to pursue the project outside a formal lab and how their time at Carnegie Mellon shaped their approach.



Aditya Sripada
(SCS 2021)



Abhishek Warriar
(SCS 2025)

How did starting with a pop culture inspiration affect your creative process?

ADITYA: “Interstellar” is my favorite movie of all time. In the film, the TARS robot is a unique, all-terrain robot that can both walk and roll. But because the movie used a mounted prop for those scenes, there was no real precedent for how such a robot would move in real life. I always wondered if it truly was something we could accomplish in the real world. Approaching the project from that “Is this even possible?” angle meant we weren’t constrained by existing robotics conventions. Instead of trying to improve on a standard legged robot, we were trying to bring a fictional mechanism to life. That gave us permission to think more experimentally.

You two worked on this project during your free time without any funding or formal affiliations. How did you stay motivated?

ADITYA: For us, motivation came from pure curiosity and enjoyment. This started as a passion project — just wanting to build robots again and finally explore a question that had been lingering for years. I had a bunch of actuators lying around from another project, and had just bought a new 3D printer, so we accomplished rapid prototyping and testing rather easily. Working without a funded lab meant we had to engineer creative solutions to challenges that normally require specialized, expensive equipment — which honestly made it more rewarding. It felt like getting back to our roots. We are just two people building robots because we love it. That made it easy to stay motivated.

ABHISHEK: It also helped that we’ve known each other since undergrad in India. We were two years apart in our schooling, but we were in the same robotics lab, where we worked on locomotion projects together. Later, we both ended up doing our graduate degrees at CMU, so we maintained that connection. Even without external funding or deadlines, we pushed each other forward simply because we both cared about the problem and enjoyed the challenge.



The robot created by Sripada and Warrior, modeled after the TARS robot from the movie “Interstellar.”

TARS3D can walk and adapt its movement in ways traditional legged robots can’t. For people outside robotics, what real-world problems could a minimalist, shape-shifting robot like this help solve?

ADITYA: With humanoid robots, we often see that walking tasks are ideal for navigating uneven terrain or stepping over obstacles, but it takes a lot of energy to just stand up and maintain balance on their legs. On the other hand, wheels are super efficient for getting from point A to point B, but they can’t handle discrete terrain the way legs can. So a robot that could both walk and roll would be incredibly beneficial. Structures like TARS3D are naturally stable. They don’t have to constantly fight gravity to stay upright, which means they can save a lot of energy while still being versatile. That combination could be valuable for applications like planetary exploration — on Mars or the Moon, you need a robot that can handle unpredictable terrain without wasting energy, because every watt matters. TARS3D started as a curiosity-driven question: Can sci-fi-inspired designs actually work? By proving the concept, it opens new avenues for design exploration that the robotics community can take further.

ABHISHEK: The architecture and design are very simple. It only has seven degrees of freedom. It can walk and it can roll. It can maintain stability without having to rely on active motor torques at the joints. All of this would make robots like TARS3D useful in extreme environments with unpredictable terrains or obstacles.

You presented your paper at the IEEE-RAS International Conference on Humanoid Robotics, where it was a Mike Stilman award finalist. How was this experience for you?

ADITYA: It was pretty surreal, honestly. It's amazing to think that something that started purely as a passion project ended up being a finalist for an award given to the most innovative work at one of the top conferences in humanoid robotics. It felt really validating, and it was also just great to reconnect with a lot of people from CMU that I hadn't seen in a long time.

ABHISHEK: I was unfortunately not able to travel to the conference in person, but it was still a really meaningful milestone. The humanoids conference is known for having a high bar and a specialized community. So getting the paper accepted and then selected as a finalist felt like a strong validation of the work we put in. It was exciting to share it with people who really understand the technical challenges behind it.

What aspects of your training or past research at CMU prepared you for this work?

ADITYA: Being advised by Hartmut Geyer at CMU really helped with this experience. He's one of those advisers who believes that how you communicate your research is just as important as the research itself. He always pushed me to explain things in a way that someone outside my specific field could still understand. Being clear, intentional and grounded in the core science really shaped how I approach problems. I learned that the best research comes from deeply understanding a problem and communicating that understanding clearly. That philosophy stuck with me and taught me how to investigate questions systematically, which directly influenced how I tackled the TAR3D project. Through that whole process, I think I really came to understand the essence of research and how to systematically approach a problem.

ABHISHEK: To add onto that, one thing that stands out from my time in the master's in robotics systems development program is how much emphasis there was on technical writing. We wrote reports, documented our work and even had grammar quizzes in the second semester to sharpen how we communicated our ideas. As funny as that sounds, it

really helped us to clearly explain our reasoning and our results, which helped us put together the TAR3D paper. Those skills have been one of CMU's biggest contributions to my journey. Plus, at CMU we were trained to think about research — the problem-solving mindset, the structure, the discipline — it all has really stayed with me. It made it easy to know how to break down a problem and decide what to do next.

Do you have any advice for other computer science students who may want to pursue a passion project but may not know where to start?

ADITYA: Keep at it. I know the time and the means are hard to come by, but if you're passionate about something, the process itself will be so rewarding that the work won't even feel like it's too hard or like it's taking a lot of your time. When I first started this project, I had no expectation that it would go anywhere. It was just something I tried over a weekend, but that's really all it takes to begin. There's real joy in building something with your own hands, whether it's software or hardware, and then watching it actually do something in the real world — that feeling is one of the biggest dopamine hits you can get.

ABHISHEK: I think it's never been easier to get into robotics, given how many resources and how much open information is out there now. It's important to remember that whatever you build doesn't need to have an immediate application or a big impact for it to be worthwhile. The real value is in taking an idea from something that lives in your head to something that exists in the physical world. Like Aditya said, the process is incredibly rewarding on its own. And remember, a lot of great work in robotics starts from simple inspiration — sometimes even from science fiction. ■

YOUR GIFTS IN *action*.

“

CMU CS Academy has greatly expanded access to quality computer science education for students at Agahozo-Shalom Youth Village in Rwanda, helping young learners discover their potential in technology. It also deepened my own passion for the field and helped pave the way for my master's studies at CMU-Africa in computer science and data science. **I am deeply grateful to all the SCS donors whose support made this impact possible.**”



Egide Kamuzinzi Nizerimana (ENG 2022), former teacher and CMU CS Academy user at Agahozo-Shalom Youth Village.

CMU CS Academy is our world-class, online, interactive high school computer science curriculum that we provide entirely free in classrooms all over the world. Learn more at academy.cs.cmu.edu.

IMPACT REPORT: DEAN'S INNOVATION FUND

The SCS Dean's Innovation Fund is a flexible general fund that allows the dean to support new and groundbreaking ideas from our community that emerge during the year but are not covered by the operational budget or research grants. Donors to the Dean's Innovation Fund include more than 1,300 alumni, whose gifts empower SCS to act quickly to fund urgent or time-sensitive projects. In the past we've used the fund to:

- Establish the world's first undergraduate major in artificial intelligence.
- Develop and deploy a new online teaching platform.
- Fund cutting-edge projects in haptics, soft manipulator robots and AI-driven biomedical research.

And there is more work ahead of us. Two recent projects that will benefit from the fund's investment are featured here:

Mayank Goel and Sensing Systems



Mayank Goel joined Carnegie Mellon in 2016 as an assistant professor in both the Software and Societal Systems Department (S3D) and the Human-Computer Interaction Institute (HCII). He leads the collaborative **Smart Sensing for Humans (SMASH) Lab**, where his

team develops sensing and machine-learning solutions to health and technology problems. The lab focuses on repurposing and extending the capabilities of existing sensors and devices all around us, finding new ways to use the passive behavioral and health-sensing data they collect.

Working to keep people healthy at home, Goel aims to use data from wearables to personalize the interventions that help individuals achieve this goal. Such personalization would allow for more tailored recommendations and behavioral prompts, a significant improvement over the generic advice current devices on the market might provide. Could we analyze passively collected data, for example, to determine whether exercise before bed helps a person sleep or keeps them awake?

For many members of our SCS community, donating appreciated stock is a great way to give even more to CMU — and to maximize your tax benefit.

For more information, please contact Jenny Belardi, SCS Chief Advancement Officer, at jbelardi@andrew.cmu.edu, or scan to learn more about gift planning.



SCS ANNUAL GIVING BY THE NUMBERS (FY25)

TOTAL DOLLARS IN ANNUAL GIFTS TO SCS FUNDS

\$1,171,441

MEDIAN GIFT SIZE

\$100

OF SCS ALUMNI WHO GAVE TO CMU IN FY25

1,327

OF FIRST-TIME DONORS TO SCS IN FY25

274

TOTAL \$\$ FROM EMPLOYER MATCHING GIFTS MADE BY SCS ALUMNI

\$163,284

The same data collection can have additional positive impacts, including helping people with dementia to complete their daily tasks or alerting them to turn off a running faucet; monitoring high or low hyperactivity levels in children; and supporting patients as they manage their postsurgical recovery.

Goel's research has already benefited students here on campus. A few years ago, he used data from smartphones and fitness trackers to create a new machine-learning approach for identifying worsening depressive symptoms in first-year college students, helping to pinpoint students who most needed help.

Goel says that the funding he received through the Dean's Innovation Fund will enable him to focus more on human/AI interaction systems, particularly when it comes to patient-centered, patient-driven communication with medical professionals. For example, he plans to develop an AI model that interprets raw data collected by wearables to help patients build awareness of their physiology and its relationship to their behaviors. The patient can then choose to share those insights and patterns with their doctor, rather than handing over the raw data itself, thus, providing the doctor with a window into patients' lives away from the clinic and bridging the knowledge gap between the patients and medical caregivers.

Goel enjoys working at SCS and says that one aspect that has continually impressed him is the students who inspire him with the projects or visions they come up with and inform his research agenda. Another impressive aspect is the abundance of high-level collaborators. After all, "CMU is so big that it has experts in almost every field," he said.

He appreciates the spirit of innovation at SCS, a spirit he recognizes as an innate part of the culture and one that is always grounded in impact.

DID YOU KNOW?

In November 2025, we celebrated both CMU's 125th anniversary and the close of Make Possible, the largest and most successful fundraising effort in our university's history!

Over 72,000 alumni, parents, faculty, staff, students and friends, including many thousands of those in the SCS community, joined together to make this possible. They launched endowed scholarships and fellowships for undergraduate, master's and Ph.D. students; invested in new and improved spaces for students to learn and grow; and funded innovative new academic and research programs.



Many thanks to our donors who made it all possible! Scan to learn more.

Patrick Carrington and Accessible Tech



Patrick Carrington joined CMU in 2017 as a postdoctoral research fellow in HCII, and in 2019 became an assistant professor. Carrington directs the interdisciplinary AXLE Lab, where he and his team support, enhance, understand

and celebrate ability in its many forms. The AXLE team also improves the quality of human lives through the thoughtful application of technology and social interventions.

As an accessibility researcher, Carrington focuses on understanding user needs and designing technology systems that enhance and leverage the full potential of users with diverse abilities. For example, Carrington and his team have examined ways to support upper extremity health management for people in wheelchairs with **Wheelposer**, a real-time pose-estimation system specifically designed for wheelchair users.

Carrington prioritizes working directly with practitioners, developing tools that enable real-time access to everyday activity and movement data. Past studies have covered a broad range, from kitchen accessibility — working with instructors at a vision rehabilitation center and legally blind home cooks — to digital accessibility, interviewing visually impaired people about their experiences with YouTube makeup tutorials.

thank you

Interested in making your own gift to the SCS Dean's Innovation Fund — or to the that fund means the most to you?

DID YOU KNOW?

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After you do this, don't forget to let gift-administration@andrew.cmu.edu know; this ensures your gift goes where you'd like it to go, and that you get the credit for the gift!

We now have another option: a DAFpay button on our giving page, which allows you to make a gift directly through your DAF login!

Carrington plans to use the Dean's Innovation Fund to move his research even further into the community, to more deeply investigate how to make daily living tasks more accessible. He says the funds will make it possible to expand his research on usable systems that support both the informational and physical needs of users.

Carrington is grateful for SCS, a place where so many talented people do so many different things. Both the school and the university support the vision researchers have for the impact of their work, he said, without forcing that research in a particular direction.

"We are already recognized as a leader in the field of computer science," he said, "so rather than chase that status, we have the ability to instead define what impact it will have." ■

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Help Us Build a Next-Generation
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RICHARD KING MELLON HALL OF SCIENCES



“

We owe so much of our professional lives to Carnegie Mellon. The rigorous computer science and math education I received here was the bedrock of my gaming company, just as my wife Melissa's research in cognitive psychology at CMU paved the way for her graduate studies and career in user research. It is an honor to give back to the place where it all started. By supporting the new RK Mellon Hall of Sciences, we hope The Kaufmann Family Classroom becomes a space where students across all scientific disciplines can collaborate and find the same inspiration that fueled our own journeys.”

— Sam Kaufmann (MCS 2011, SCS 2011)



For more information on the Richard King Mellon Hall of Sciences, please visit: cmu.edu/hall-of-sciences

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AMAZON AND CARNEGIE MELLON LAUNCH STRATEGIC AI INNOVATION HUB

THE COLLABORATION WILL ADVANCE RESEARCH IN GENERATIVE AI, ROBOTICS, NATURAL LANGUAGE PROCESSING AND CLOUD COMPUTING WHILE FOSTERING INNOVATION IN FOUNDATIONAL AND EMERGING TECHNOLOGIES.

Amazon and Carnegie Mellon recently announced the launch of the CMU-Amazon AI Innovation Hub, reinforcing a shared commitment to advancing cutting-edge research through academic-private sector partnerships.

The Hub builds on existing collaborations between Carnegie Mellon and Amazon and will include research on generative AI, robotics, natural language processing and cloud computing technologies. As part of the collaboration, Amazon will provide substantial funding for research projects, doctoral fellowships and community-building initiatives designed to accelerate innovation in foundational and emerging technologies.



The convergence of agentic AI, robotics and natural language processing represents





At Carnegie Mellon, we believe that true innovation happens when discovery and application move hand in hand.”

— Theresa Mayer, CMU's Vice President for Research

“The convergence of agentic AI, robotics and natural language processing represents an unprecedented opportunity to reshape how we live and work,” said **Swami Sivasubramanian**, vice president of agentic AI at Amazon Web Services. “By partnering with CMU, a recognized pioneer in these fields, we’re creating an ecosystem where breakthrough research can be rapidly transformed into solutions that benefit society at large.”

The Hub's initial focus areas leverage both institutions' strengths in artificial intelligence and robotics, supported by Amazon's global leadership in cloud computing and AI services. Research projects will explore challenges in responsible AI development, advanced robotics systems and next-generation cloud infrastructure, utilizing CMU's cross-campus interdisciplinary approach.

“At Carnegie Mellon, we believe that true innovation happens when discovery and application move hand in hand,” said **Theresa Mayer**, CMU's vice president for research. “By bringing together our faculty and students with Amazon scientists, we will harness some of the most promising opportunities in AI, robotics and cloud computing. This partnership embodies our strategy to strengthen collaboration across disciplines with industry — creating new pathways for innovation that benefit society and expand the frontiers of knowledge.”

The Hub will support:

- **Joint research projects between CMU faculty and Amazon scientists**
- **Ph.D. fellowships focusing on key technical challenges in AI**
- **Regular symposia and workshops to foster collaboration**

The first Hub-sponsored research symposium occurred in October 2025 on CMU's Pittsburgh campus and brought together leading researchers from both institutions to share insights and establish collaborative research agendas.

Amazon has maintained a growing presence in Pittsburgh with research teams focused on natural language processing, automatic speech recognition, machine translation, information retrieval, spoken-language understanding, edge computing and text-to-speech. With support from Pennsylvania Governor Josh Shapiro and other government leaders, the company announced plans last summer to invest at least \$20 billion in Pennsylvania to expand its data center infrastructure for AI and cloud computing. ■



CHRIS QUIRK

VATICAN CALLS ON WAIBEL TO HELP SHAPE AI ETHICS

POPE CONVENES GLOBAL AI WORKING GROUP THAT INCLUDES SCS PROFESSOR

As we apply artificial intelligence to more of the mechanisms of our world — from education and healthcare to transportation and finance — debates around AI's role and power in society are sharpening.



Alex Waibel (right), professor in LI, pictured signing documents with other members of the Vatican Working Group on September 12, 2025.



In September, at the invitation of Pope Leo XIV, **Alexander Waibel**, a professor in SCS's Language Technologies Institute, participated in the AI and Human Fraternity Working Group at the Vatican, to discuss and hammer out recommendations to ensure AI benefits humanity, and to suggest ways to mitigate AI's potential risks. Pope Leo has called AI a critical matter and said that it poses "new challenges for the defense of human dignity, justice and labor."

In 2023, more than 350 AI industry leaders and researchers signed on to a one-sentence statement declaring AI an extinction risk on the level of nuclear war and pandemics. The list included such AI luminaries as Nobel Prize winner and former SCS faculty member Geoffrey Hinton and Yoshua Bengio, a co-winner of the 2019 A.M. Turing Award. Hinton and Bengio were both part of the 12-person September working group convened by Pope Leo, along with Waibel, Grammy-winning artist will.i.am., and other AI thought leaders.

The working group developed a set of AI guidelines that recognized its threat, implored that AI always be used as a tool under ultimate human control, and called for responsible development. "Vast and rapidly growing sums are devoted to creating agentic technologies with the potential to surpass human intelligence — what many in the AI research community refer to as 'superintelligence,'" the letter stated. "These challenges call for moral leadership and urgent concrete actions."

The first postulate regarding the regulation of AI, according to Waibel, is that AI cannot be stopped. "We all share concerns about AI having a bad impact, but if you try to inhibit it or take a six-month moratorium, others will double down and do more," he said. "There will always be geopolitical and commercial contests, and we will never get them to have the well-being of society as a primary interest. That sounds cynical, but I think it is realistic. So, it's up to us to come up with mechanisms that guide the technology in the direction we want it to go."

Waibel's thoughts demonstrate the difficulty facing those who wish to reap the benefits of AI while reducing its potential harm. In the face of powerful nations and corporations with their own interests, a panel of experts and thinkers, even those of the highest caliber, will be waging a contest for hearts and minds to sway those with the power of the purse and policy, and those with technical expertise, to think broadly about potential threats.



Alex Waibel (left), takes a selfie with some of the other members of Pope Leo XIV's working group on AI guidelines at the Vatican.

Waibel suggests efforts begin at home. "At CMU for instance, if we put our heads together, we could take a bunch of these problems and look at ways at which we can impose different objective functions in the learning of AI," he said. "I really do believe this is technically feasible."

Asked about his long-term forecast for AI, Waibel says that while he is wary of potential dangers, he is generally optimistic. "We have to pay attention. We must develop societal guardrails and regulation for the technology. I think we need to work hard on making sure we find good counterweights to all of this, rather than simply stopping it, which is neither desirable nor realistic." ■

MARYLEE WILLIAMS

FIXING KIDS' SPEECH ISSUES WHILE PRESERVING IDENTITY

CHILDREN WITH SPEECH DISORDERS, LIKE A LISP, OFTEN HAVE TROUBLE BEING UNDERSTOOD BY FAMILY, TEACHERS AND FRIENDS, WHICH CAN MAKE SCHOOL SITUATIONS AND EVERYDAY COMMUNICATION HARDER.

To compound the problem, there aren't enough speech-language pathologists nationwide to keep up with the demand for kids who need help. And most speech-reconstruction tools, which can help correct how someone talks, are built for adults.

Researchers from Carnegie Mellon University's School of Computer Science have created an AI tool that could help fix a child's speech and preserve their identity and personality by allowing them to hear the reconstructed speech in their own voice.

Children's Reconstructed Speech for SSDs (ChiReSSD) combines machine learning with human speech to generate audio clips of corrected speech that sound like the child. For example, if a child struggles with pronouncing double-r words, like "curry," the tool can generate an audio clip of that child saying the word correctly using only a clip of the child talking and text input.

"The potential clinical applications are really significant to me," said **David Mortensen**, an assistant research professor in the Language Technologies Institute (LTI). "The idea that a child could hear how they would say something in their voice, except with the sound of the disordered pronunciation removed, could be really transformative."



David Mortensen, Assistant Research Professor in the Language Technologies Institute

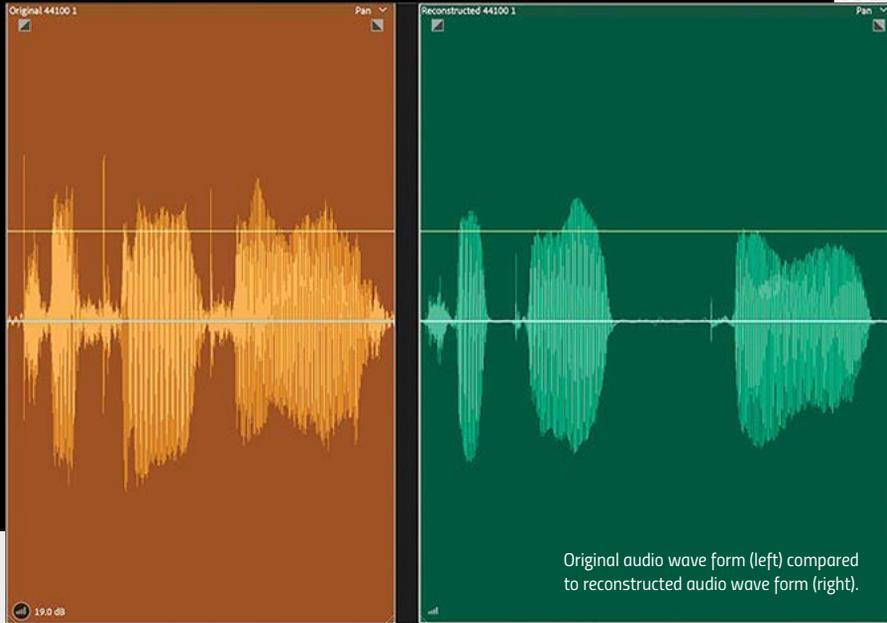
Mortensen's interest in creating technology to assist children with speech disorders started with his daughter. He said the speech-language pathologist who worked at her school was so overloaded that his daughter was only seen once or twice. Mortensen knew that his daughter would have benefited from technologies that could help speech-language pathologists treat children more efficiently.

Professor **Carlos Busso** and Ph.D. student **Karen Rosero**, both in the LTI, see ChiReSSD as a critical step to developing both audio and video tools that can address children's speech disorders. While ChiReSSD focuses on audio generation, Rosero and Busso developed video-based AI tools in previous work to analyze speech articulation after cleft lip and palate repair surgery.



We can localize the errors children are making and create more targeted interventions, like particular words that address the specific speech issue.”

— Carlos Busso, Professor in the Language Technologies Institute



“The big idea we are working toward is to generate speech that sounds like the kids and generate facial images that look like the kids,” Busso said. “These audio and video clips can be combined to compare and contrast disordered and reconstructed speech. Then, we can localize the errors children are making and create more targeted interventions, like particular words that address the specific speech issue.”

ChiReSSD only needs an audio clip of the child to generate reconstructed speech, and it can be of the child saying anything. The tool separates a child’s voice identity — their pitch or acoustic patterns — from the phonetic content of their speech, or what they’re saying. The AI-based model learns from speech representations of the child’s vocal identity. The system then identifies and corrects the mispronunciations based on the phonetic content. Finally, using the understanding of the child’s vocal identity

and a text input, like the words “chicken curry” or “rabbit,” ChiReSSD generates a corrected audio clip that sounds like the child saying these target words.

“Psychological studies demonstrate that having the same voice as a reference benefits the patient,” Rosero said. “For children, if the text-to-speech tool provides an adult or a standard plain voice, it may not be as beneficial as having their own voice as a reference for what to target in pronunciation.”

Busso said this work makes significant strides in audio speech correction. The team’s next step will be to focus on making the same impact in video.

Along with the LTI researchers, the team included Eunjung Yeo, a visiting scholar previously in SCS; Courtney Van’T Slot, a speech-language pathologist; and Rami Hallac, an associate professor from the University of Texas Southwestern Medical Center. ■

MALLORY LINDAHL

ROBOTS ON THE RUNWAY

FASHION AND ENGINEERING MEET TO REIMAGINE HOW HUMANS AND ROBOTS COEXIST



Robots took to the runway — strutting, spinning and dancing — in a fashion show that brought art and engineering together to rethink how humans and machines might coexist. Draped in metallic fabric and sculptural garments, the robots appeared alongside human partners in a rare performance that blended engineering with artistic expression.



Jean Oh, Associate Professor in the Robotics Institute

The robot fashion show, held at the 2025 IEEE-RAS International Conference on Humanoid Robots and co-hosted by the University of Seoul Startup Support Foundation, wasn't just about style. It was also about challenging static, industrial images of robotics and highlighting how collaboration across art, design and technology can spark new ideas for building safe robots that move more gracefully among humans.

Jean Oh, an associate research professor in the Robotics Institute (RI), and **Jie-Eun Hwang**, a professor in the Department of Architecture at the University of Seoul and a former visiting professor at the RI, served as creative directors. Together, they envisioned the event as an opportunity to build an interdisciplinary community, inviting more roboticists, artists, musicians and designers to work side-by-side. The show's theme centered on safety and coexistence — the idea that a soft, shared layer between humans and robots could make interaction feel more natural and less intimidating.

"As AI and robotics become more popular in the public eye, interdisciplinary efforts like the robot fashion show empower robotics researchers to communicate thought-provoking ideas to a broader audience," Oh said. "In the future we will need to



“The event was designed as a melting pot for robotics and creative expression.”

— Hyun Woo Park, Research Associate in the Robotics Institute

enable robots to perform contact-rich operations while maintaining the safety of people through both physical and social compliance. Through artistic approaches like fashion, we can shed light on underexplored topics such as safe and graceful motion-generation or soft wearable robotics for both humans and robots.”

Participants, many of whom are both artists and researchers that designed their own robots, were selected through a peer review and invitation process that emphasized creativity, innovation and perspective.

“The event was designed as a melting pot for robotics and creative expression. It was especially exciting because it’s uncommon for researchers, artists and designers to work together for a shared goal in the field of robotics. We all came together to present fashion as a means of culture, expression and technology,” said **Hyun Woo Park** (Hyun Parke), a research associate in the RI, participating designer and art director of the show.

Park’s work centers on combining inflatable objects with robotics to make robots safer and more approachable. For the show, he created an air-filled vest and skirt that wrapped around the

humanoid robot’s rigid frame to soften it and allow for safe, comfortable physical interaction between machine and human.

“For robots to build close relationships with people when they enter society, the first requirement is that they be safe to physically interact with,” he said. “That’s why I began with the idea of making an airbag-like jacket, something that could allow hugs — dressing the robot to enable physical interaction.”

“The cold touch of robots, the unavoidable motor noise and vibrations when they move — these awkward sensations create distance and people feel estranged,” said Junhee Cho, another participating designer. “Through this fashion show, I want people to reflect on how we should welcome robots when they enter our societies and how we can share happiness together.” ■



To read the full story, visit the Robotics Institute news page.

Names in the News



Riku Arakawa, a fifth-year HCI Ph.D. candidate, received the **Gaetano Borriello Outstanding Student Award** and **Best Doctoral Colloquium Contribution Award** during UbiComp/ISWC.



Angel Jordan University Professor of Computer Science **Tuomas Sandholm** received the **Alfred Kordelin Prize**, one of Finland's most prestigious honors.



The HCI's **Dominik Moritz** received the **InfoVis Test of Time Award** at VIS 2025 for work that has had a major influence both within and beyond the visualization community.

Faculty members **Andrea Bajcsy**, **Fernando De La Torre** and **Maarten Sap** received **Amazon Research Awards** to advance reliability, safety and performance in emerging AI systems.



Computer Science Department Ph.D. alum **Juncheng Yang** received the **2025 ACM SIGOPS Dennis M. Ritchie Doctoral Dissertation Award** for his contributions to and impact on software systems research.



Computer Science Department Ph.D. alum **Gabriele Farina** earned the **2023 AAAI/ACM SIGAI Doctoral Dissertation Award**.



The American Computer and Robotics Museum presented a **Stibitz-Wilson Award** to SCS faculty member **Lorrie Cranor**.



Graduate students **Michelle Zhao**, **Conrad Borchers** and **Thomas (Hanwen) Zhu** have been named **2026 Siebel Scholars**.



Ten CMU students will receive support from Amazon through the company's new **AI Ph.D. Fellowship Program**.

(Top L-R) **Apurva Gandhi**, **Karish Grover**, **Aashiq Muhamed**, **Yuxiao Qu**, **Danqing Wang**
 (Bottom L-R) **Mengdi Wu**, **Xinyu Yang**, **Zeji Yi**, **Zichun Yu**, **Xinran Zhao**

Andrea Bajcsy, an assistant professor in the Robotics Institute, earned a **DARPA Young Faculty Award**.



Master's student **Ashman Mehra** was selected as a **2025 Quad Fellow**.



Ph.D. student **Aakash Lahoti** has been named a **2025-2026 Jump Trading Fellow**.



The Language Technologies Institute's **Maarten Sap** earned a **2025 Packard Fellowship for Science and Engineering**.



SCS honored faculty members **Carolyn Rosé** and **Jun-Yan Zhu** with **endowed chairs** for their research contributions and to support their future work.

Ph.D. student **Anupama Sitaraman** received an **NSF Graduate Research Fellowship**.



Alumna **Ranysha Ware** earned the **2025 SIGCOMM Doctoral Dissertation Award**.



SCS faculty member **Yun William Yu** received a **Maximizing Investigators' Research Award** from the National Institute of General Medical Sciences.



Matt Fredrikson, an S3D faculty member, received the **2025 ACM Conference on Computer and Communications Security Test-of-Time Award**.

Carnegie Mellon University

School of Computer Science

OFFICE OF THE DEAN
5000 FORBES AVENUE
PITTSBURGH PA 15213-3890

      SCSatCMU

cs.cmu.edu

magazine@cs.cmu.edu

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