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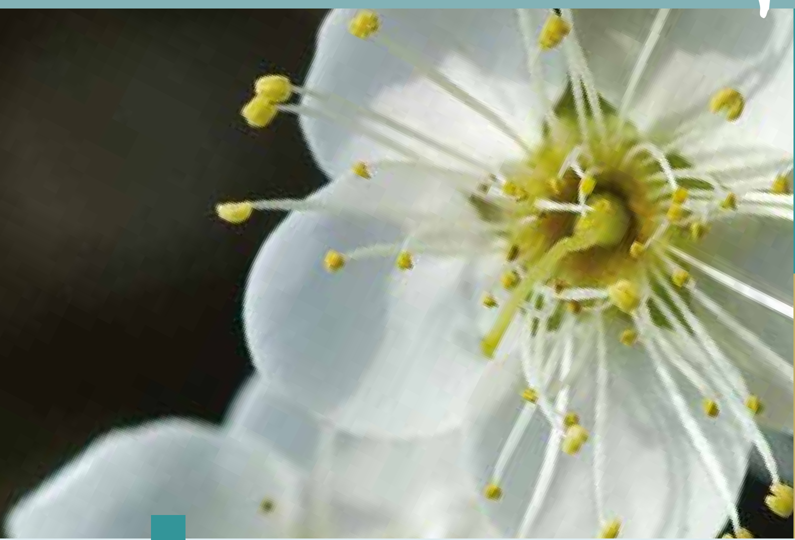

NATIONAL TSING HUA UNIVERSITY

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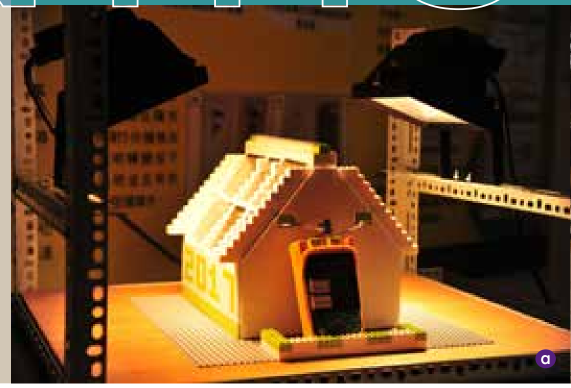


SMART GLASS DEVELOPED AT NTHU

Glass has just gotten smarter. A research team led by Prof. Tai Nyan-hwa of the Department of Materials Science and Engineering has recently used graphene to develop a type of heat-sensitive glass that becomes opaque when it reaches a certain temperature. While its primary application is for automobiles, where it can reduce internal heat, thereby saving energy and reducing the possibility of heat exhaustion or death of infants accidentally left inside on a hot day, it can also be used to help cool buildings. Tai is now applying to have his award-winning smart glass patented in several countries.

The concept of graphene smart glass was first conceived and developed several years ago by Tai and his doctoral student Chou Hung-Tao.

Tai said that graphene (GO) is able to transform optical energy into thermal energy, so that when it's mixed with a temperature-sensitive hydrogel it turns into a liquid substance which can be injected between two pieces of glass, and when the ambient temperature goes above 32°C, in 1 to 2 minutes the smart glass turns opaque, blocking most of the light. Used as automobile windows, once the air conditioning is turned on, the glass will resume full transparency after cooling.

ⓐ Testing the heat-reducing ability of graphene smart glass.

ⓑ Professor Tai Nyan-hwa of the Department of Materials Science and Engineering with his research team.

By adjusting the formula, the glass can turn different colors and be used to meet different needs.

"Look, just a bit of strong light and the glass changes color!" says Tai, pointing towards a LEGO house made by his students, half of which is fitted with ordinary glass, and the other half with graphene smart glass. After applying the strong light for five minutes at room temperature, the side with the graphene roof is 34°C inside, while the other side has soared to 44°C.

Developed by Tai's research team working at NTHU's Advanced Carbon Nano-

materials (ACNM) laboratory, the smart glass won third place in this year's Green Tech Contest held by the TECO Technology Foundation. The team consists of doctoral student Hsiao Chung-Hsuan, and master's students Hung Ya-Min, Chien Ming-Shen, Tsai Meng-Ting, and Li Ming-Yao.

In this age of global warming, with temperatures regularly topping 50 degrees Celsius, Tai's heat-reducing and energy-saving smart glass is already receiving lots of interest.

Graphene smart glass may appear similar to the lenses used in photochromic sunglasses, but the principle is completely different. As team member Li Ming-Yao explains, the photochromic lenses used in sunglasses have silver chloride or halide coated on the surface or inside, which undergoes a chemical reaction in UV light, resulting in a darkening of the glass. By contrast, smart glass uses a temperature-sensitive polymer, thus reducing the cost while also allowing the use of different colors.

Li says that the most difficult part of making smart glass is that bubbles tend to form when the liquid substance is injected into the glass, but this problem can be solved in the mass production process.

ⓐ Members of the research team working on the LEGO house fitted with ordinary glass and graphene smart glass.

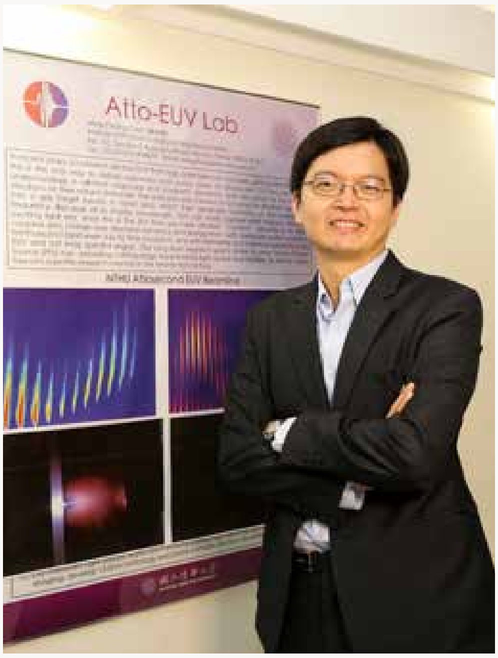
ⓑ After receiving two minutes of intense light, the ordinary glass (left) remains transparent, while the graphene smart glass has turned opaque.

Comparison between smart glass and the photochromic lenses.

	Smart glass	Photochromic lenses
Principle	Graphene is able to transform optical energy into thermal energy; when mixed with a temperature-sensitive hydrogel, light causes it to block both light and heat.	Photochromic lenses have silver chloride or halide coated on the surface or inside, which undergoes a chemical reaction in UV light, resulting in a darkening of the glass.
Speed of change	1–2 minutes	30 seconds
Cost	Low	High
Colors	Multiple	Single

TWO NEGATIVES MAKE A POSITIVE: MAJOR BREAKTHROUGH IN EUV TECHNOLOGY AT NTHU

Recently a major breakthrough in optoelectronics research at NTHU has solved two problems which have been a bottleneck for over a decade. As part of a multinational project, a research team led by Prof. Chen Ming-Chang of NTHU's Institute of Photonics Technology (IPT) has produced a form of extreme ultraviolet (EUV) light which is very small but very bright, making it possible to observe matter at the nanometer scale and to increase the speed of nanoscale research in the semiconductor and biomedical industries. This innovative breakthrough was recently published in the prestigious journal *Optica*.

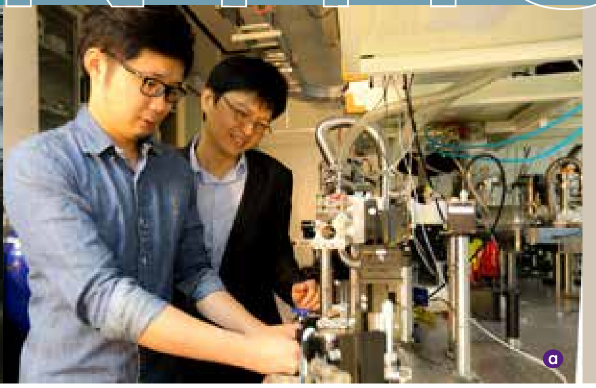


Prof. Chen Ming-Chang, Institute of Photonics Technology, NTHU.

According to Chen, "Human beings live in a world of seconds, but in the nanometer world time is calculated in attoseconds (10^{-18} seconds), so if you want to see how electrons, atoms, molecules, and materials work in the nanometer world, you need a faster and brighter light source." Chen further explains that the spatial resolution of imaging is determined by the wavelength of illumination light, so that the shorter the wavelength is, the smaller the structures that can be seen. Thus over the last 20 years researchers have been trying to develop the technology for using high-order harmonic generation (HHG) to produce table-top ultrashort EUV pulses which obtains temporal and spatial resolutions down to attoseconds and nanometers, respectively.

But over the past decade, scientists were unable to effectively enhance the brightness of 18 nm ultraviolet light, due to the "phase mismatch" problem. Because infrared and extreme ultraviolet light run at different phase velocities, resulting in low up-conversion yield of EUV beam. Chen's solution was to use a small iris to change the photon phase, resulting in a brighter 18 nm attosecond EUV.

His PhD student, Huang Pei-Chi, gives one simple example, explaining the "phase mismatch" problem. The way that light propagate is very similar to the walk way of human being. The walking speed for a child should be slower than that of an adult.



He compares the phase mismatch to a three-legged race in which the infrared ray (the adult) and UV light (the child) team up, but due to their differing step length they can't walk in tandem to reach the finish line.

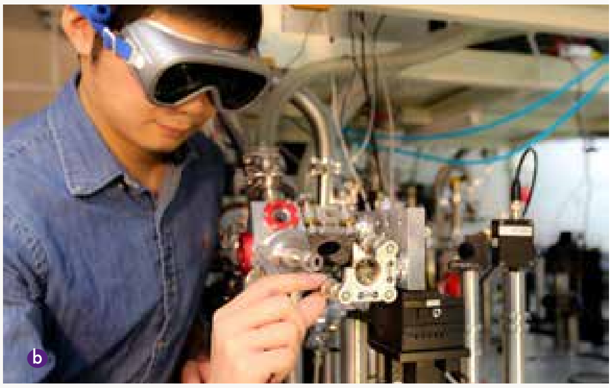
Taiwan has a National Synchrotron Radiation Research Center that can provide EUV light for research, but the light-emitting device is as large as 2 to 3 sports fields, making it difficult to be accessible. Thus when Chen moved his research career to NTHU in 2013, he spent the first nine months designing and developing a HHG source. The main purpose of "table-top EUV device" is to probe ultrafast dynamics in nano-world.

Three years ago, while Chen and his master's student Sun Hung-Wei and his Ph.D. student Huang Pei-Chi were conducting a HHG, they aligned the laser beam through an simple iris and found accidently that by adjusting the aperture size of the iris they could precisely control the EUV's bandwidth and central wavelength. This was the breakthrough everyone had been looking for, since the simple iris actually increased the up-conversion yield of 18 nm more than one order of magnitude. Chen says that intense infrared ray basically first induces defocusing effect spatially, decreasing the laser peak intensity (the first negative effect for HHG) and then ruins the phase matching condition of HHG generation temporally (the second negative effect for HHG). Surprisingly, a proper defocusing effect of infrared ray which can be precisely controlled by the iris, actually helps compensate the phase mismatch between the infrared ray and the converted EUV light. In short, like chemistry, mixing these two negative elements actually produces bright HHG, while a simple iris acts as an essential catalyst helping this mixing effect.

Also using the analogy of the three-legged race, Huang Pei-Chi says that if you want to increase the brightness of EUV light, you have to invite more infrared ray (adults) to participate in this game. Definitely, doing so makes the game more difficult. And that's where the iris comes in, since it acts as "coach" shouting out directions so that the infrared ray and EUV (adults and children) coordinate their footsteps, thereby solving the problem of phase matching and increasing the brightness of HHG. Significantly, comparing to Synchrotron, the size of Chen's light source system is only about two meters long and more accessible to users.

EUV has been widely used in scientific research in such areas as materials, electronics, biology, medicine, physics, chemistry, chemical engineering, geology, archeology, energy, environmental protection, and micro-mechanics.

Especially, EUV has been the key technology for the next generation high-volume manufacturing of semiconductor devices. The table-top EUV light source will definitely make great impacts in industries.

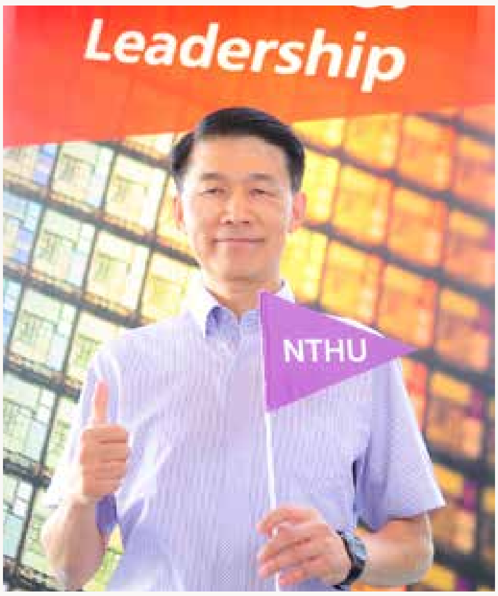


ⓐ Chen and his Ph.D. student Huang Pei-Chi demonstrating the EUV system.

ⓑ Ph.D. student Huang Pei-Chi demonstrating how to boost the up-conversion efficiency of HHG.

NTHU ALUMNUS DOUGLAS YU WINS PRESIDENTIAL SCIENCE PRIZE

"The best technology is the kind that you make yourself!" This is the idea that motivated Douglas Yu to develop a 0.13-micron copper process technology and invent wafer-level advanced packaging technology. Currently the vice president of the Taiwan Semiconductor Manufacturing Company (TSMC), Yu has received nearly a thousand patents in the United States, and has helped Taiwan become a global leader in semiconductor technology. In recognition of his many achievements, Yu has been awarded this year's Presidential Science Prize. A graduate of NTHU, in his speech at the award ceremony, Yu said, "I do search just like I go fishing, because I enjoy doing it. And if you are lucky, you can catch a few big ones."



The copper process technology developed by Yu's research team has helped Taiwan become a major player in the world semiconductor industry.

Yu also stressed the importance of doing things differently, rather than simply aping others, and that when you need something, it's better to do it yourself, since this brings the best results. Nonetheless, Yu also recognizes the importance of modesty, saying, "I'm just lucky to win the award on behalf of TSMC."

A man with a mission

Yu's "luck" came about through a long process of overcoming countless difficulties. Yu joined TSMC during the 0.25 micron era, when there was fierce competition with other companies to develop a smaller version. This was the mission entrusted to Yu by TSMC's new director of research and development. By solving each of the five main problems blocking the way, Yu succeeded in developing a 0.13-micron copper process technology.

TSMC initially considered buying the 0.13-micron copper process technology from IBM, but finally decided to develop the required technology on its own, even though its competitors chose to buy it. "No problem. As long as the company needs it, I will deliver it," was Yu's gung ho attitude at the time. Leading a team of less than 40 people

based in Tainan, for a year and a half Yu experimented with materials that were very different from those being used by their competitors. During this time the first thing they did every morning was to hold a meeting to get updated on the competition's progress.

As to why Yu was able to be getting ahead of the competition and making rapid progress in an area that so many bright minds were already working on, Yu said that the key is to eliminate uncertainty and avoid dead ends.

In Yu's way of thinking, which he learned from TSMC founder Morris Chang, a high degree of uncertainty leads you down lots of dead ends. So in a situation with lots of uncertainty, it's best to gain some clarity by doing small experiments to avoid the "dead ends."

An Interdisciplinary approach

In fact, it was during his studies at NTHU that Yu acquired a solid foundation in research and development. After earning his bachelor's degree from the Department of Physics, for his master's degree he shifted to the Department of Materials Science and Engineering, about which he said, "While studying physics, I did more thinking than doing; and when I began studying materials science, the habit of deliberation helped me understand things better than some of my classmates who had been studying materials science all along."

Thinking back on this period, Yu said, "This was a very important stage in my development. The teachers at NTHU were highly dedicated, especially Prof. Lee Yee-Yen and Chiang Heng-Ching, and this made a deep impression on me." He remembers Professor Lee as a young, erudite scholar with lots of enthusiasm and a deep-seated sense of mission, who personally compiled Chinese-language teaching materials for his students. Chiang was the Chair of the Department of Physics and in addition to teaching frequently helped his students after class. Yu said that even though he may not remember everything he learned at that time, what has stayed with him is the dedication and enthusiasm of his teachers.

Diligence, not toil

People often ask Yu if he finds the work environment in the high-tech industry to be toilsome and overly demanding. He tells them that it's definitely demanding, but not excessively, as long as you are self-motivated and enjoy what you're working on, which is something he learned during his time at NTHU.

Yu as a student at NTHU.

After completing his master's degree, Yu began studying for a Ph.D. in materials engineering at the Georgia Institute of Technology, which provided him with a scholarship. During his five years at Georgia Tech he also studied various related subjects, including electrical engineering, mechanical engineering, statistics, and management.

Yu, who grew up in a small town in northern Taiwan, said that during the early part of his studies and career, he often felt like a country bumpkin on the defensive and worried about not being able to keep up with his talented colleagues. However, rather than giving in to his doubts, he eventually rose to the top of his field by continually encouraging himself to work harder and strive for excellence, and by being daring enough to think outside the box.

An exemplar of gratitude

In light of Yu's outstanding contributions to the global IC industry and the NTHU spirit, the College of Science has lauded him as a distinguished alumnus. Moreover, in recognition of his major donations to NTHU, he has been made a member of the Tsing Hua Club One Hundred (THCOH).

He hopes to one day teach an innovative course at NTHU focusing on the cultivation of wholesome values as a way of helping students finding their ways to make a positive contribution to society.

After hearing that Yu had won the Presidential Science prize, NTHU President Hocheng Hong said that Yu's many achievements and modest demeanor make him an exemplary alumnus worthy of emulation by the entire NTHU community. President Hocheng also said that Yu's innovative approach to research and development clearly benefited from his cross-disciplinary experience at NTHU, and that Yu is a fine example of the thousands of NTHU graduates now employed in Taiwan's world-class high-tech industry.

NTHU alumnus Douglas Yu, winner of the 2017 Presidential Science Prize.

NOBEL PRIZE IN PHYSICS AWARDED FOR THE DISCOVERY OF GRAVITATIONAL WAVES

The 2017 Nobel Prize in Physics has been awarded to Rainer Weiss, professor of MIT, Kip Thorne and Barry Barish, professors of Caltech, for their decisive contributions which led to the discovery of the gravitational waves. Gravitational waves from a binary black hole merger was detected for the first time on Sep. 14, 2015 by Laser Interferometer Gravitational Waves Observatory (LIGO) in the United States, one hundred years after Albert Einstein's prediction from the theory of General Relativity.

The milestone publication on Physical Review Letters for the discovery was co-authored by members of the LIGO Scientific Collaboration (LSC) and Virgo-collaboration from more than 30 nations and 100 institutions all over the world. A five-men team in the LSC from National Tsing Hua University led by Prof. Chao Shiuh of the Institute of Photonics Technologies and EE Department participated in the activities for the mirror development of the LIGO detectors and made contribution to the discovery.

The research of Prof. Chao's team was funded by the Ministry of Science and Technology of the Republic of China. Chao's team includes graduate students Pan Huang-Wei, Kuo Ling-Chi, Huang Shu-Yu, and Cheng Chun.

Chao had a close encounter with Weiss and Thorne at the ceremony of the Shaw Prize in Astronomy 2016 in Hong Kong when the prize was awarded to Rainer Weiss, Kip Thorne and Ronald Drever who regrettably died in March this year.

In Chao's interactions with Weiss and Thorne he was very impressed with their modest and courteous demeanor, especially how they always give credit to the entire LIGO team. Chao also said that Weiss and Thorne aren't the kind of scientists that remain sequestered in the ivory tower, as seen in their hands-on leadership style and excellent communication skills.

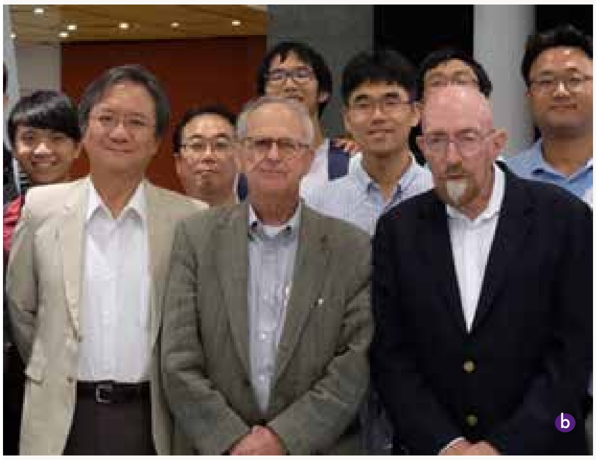
a The LIGO observatory in Louisiana, USA.

b LIGO Scientific Collaboration team member Chao Shiuh of NTHU's Institute of Photonics Technologies and EE Department.

c Chao (third from left) with LIGO pioneers Rainer Weiss (fourth from left) and Kip Thorne (third from right) at the Asia-Pacific Gravitational-Wave Forum held at the Chinese University of Hong Kong in 2016.

Chao also said that what he admires most about Weiss, Thorne and Barish is their pragmatic views and practices in academic politics, due to which the US National Science Foundation has continued supporting LIGO for over 24 years so far and more than a billion dollars were invested in the project. Chao added that one of the most important things he has learned from the laureates is that in areas of scientific research it's not enough to have a good idea; you also have to have the ability to persuade others to support it.

Chao said that Thorne once told him that when he was young he was strongly interested in music and film, played saxophone and clarinet, and even enjoyed rock music. Thus when Thorne retired at the age of 68 he picked up his early interests, and served as the scientific consultant and producer for the 2014 movie *Interstellar*, the director of which also has backgrounds in science. The movie was notable for its precise and accurate presentation on scientific facts. While a professor at Caltech, Thorne mentored more than 50 Ph.D. students, including Ni Wei-Tou, now a professor at NTHU and who is also active in the field of gravitational physics.



ⓐ One of the mirrors at the heart of the LIGO interferometer.

ⓑ Chao Shiuh of NTHU's Institute of Photonics Technologies and EE Department (left) with LIGO pioneers Rainer Weiss (center) and Kip Thorne (right) at the Asia-Pacific Gravitational-Wave Forum held at the Chinese University of Hong Kong in 2016.

Chao's team mainly worked on reducing thermal noise disturbance in the laser mirrors employed to observe gravitational waves, thereby making it possible to sensitively capture the "sound of the universe." According to Chao, most of his previous research works were conducted on laser mirrors for application on ring-laser gyroscopes. In 2010 researchers at LIGO Scientific Collaboration (LSC) read about Chao's previous publications on laser mirrors and invited him to join the collaboration. That's how Chao's team became the only Taiwanese research team to participate in LIGO.

Not content to rest on their laurels, LIGO's goal for the next three years is to increase the sensitivity of their instrument by 3 times, and to increase the observation volume by 30 times, so that it will be possible to make an observation once every few days and thus opening the era of the gravitational-waves and multi-messenger astronomy. Chao's research team is presently working on the development of mirror coatings for the next generation detector operated in cryogenics. Chao said that he was naturally excited and happy to be a part of such a historic discovery and proud to be a member of the team.

President Hocheng Hong said that he was very happy that NTHU faculty and students have contributed to this important project, adding that research excellence is a long-standing tradition at NTHU.

NTHU RESEARCH TEAM DEVELOPS ECG BIOMETRIC SYSTEM

Another breakthrough in biometric technology has been made at NTHU! A research team consisting of Assistant Professor Wu Shun-chi of the Department of Engineering and System Science and six of his students has developed a whole new system for recognizing heartbeats. By combining this technology with a mobile payment application, they developed a mobile payment system using cardiological identification called "*Instacardeal*," which won the top prize in the 2017 Arm Design Contest.

"Your heartbeat can only be recognized while you are still alive," says Wu, who previously worked on the development of wearable devices. Electrocardiography (ECG) is a way of recording the electrophysiological activity of the heart, which differs in each person in accordance with the size of the heart and its position in the thoracic cavity. All this got Wu wondering whether the heartbeat could be used in biometrics.

Wu soon found that foreign researchers were already working on using the heartbeat as a form of biometric identification, but their calculations were still rough. Thus three years ago he formed a team of students, and by analyzing 285 electrocardiograms they developed a suitable algorithm which resulted in a 98% recognition rate.

Wu points out that the existing payment systems using biometric identification all use external features that are easily stolen or counterfeited. Fingerprints can be imitated with silicone, and even photographs of fingerprints can be misused; as for the iris and face, these can be forged by using high definition printing technology. By comparison, an ECG is quite difficult to steal, and when combined with an existing authentication mechanism such as a password, it can provide a highly secure way to make electronic payments.

Under the guidance of Wu, team members

a Members of the research team at the Arm Design Contest. From left to right: Chen Peng-Tzu, Assistant Professor Wu Shun-chi, Shao Naijun, and Wei Shiying.

b Wu's team won first prize in the 2017 Arm Design Contest.

Chen Peng-Tzu, Shao Naijun, Wei Shiying, Zheng Jingwen, Shang Yenming, and Lin Jiaying developed the *Instacardeal* mobile payment system, which includes a mobile app, a device for taking the customer's ECG, and a cloud database.

Chen, who graduated earlier this year and now works at the Industrial Technology Research Institute, says that users have to first register their ECG in the cloud database, and when making a purchase the vendor measures the customer's heartbeat to make sure it matches up with the ECG in the database. In the future, this system can be adapted for access control.

The Arm Design Contest provides a showcase for the latest advancements in research and development, and this year for the first time included a short explanatory video in the evaluation criteria. Wu's team produced a lively and informative video featuring illustrations by Lin, which has been placed on the Facebook fan page of Arm Taiwan, and has already been viewed thousands of times.

Chen edited four different versions of the video and showed them to her mother. She reasoned if her mother could understand the content, so would the general public. Lin says that it was challenging to present complicated scientific research in an easy-to-understand format, so after lots of discussion and revision they finally decided to use a spider web pattern to show the relationship between the "internet of things," third-party payment, and daily life.

Wu says that they are now applying for a patent for their heartbeat identification system, and expect that before long it will be produced on a commercial basis and used in a variety of ways.

Team members Chen Peng-Tzu (front), Shao Naijun (standing on right), and Wei Shiying (standing on left) displaying their *Instacardeal* mobile payment system.

INNOVATIVE AI PROGRAM ESTABLISHED AT NTHU

ⓐ NTHU President Hocheng Hong (right) and Winbond Chairman and CEO Arthur Chiao holding the contract officially launching the WTSSP.

ⓑ Participants at the WTSSP inauguration ceremony.

Understanding people is a key element in developing a realistic robot in addition to mechanical knowledge. This is the guiding principle of a new interdisciplinary program jointly established by NTHU and the Winbond Electronics Corporation for training the next generation of artificial intelligence (AI) engineers. Encompassing eight NTHU colleges, the program includes classes in psychology, linguistics, anthropology, philosophy, and system neurology, and focuses on the design of robots which can be used in such areas as manufacturing, household chores, childcare, and medical treatment.

Known as the Winbond-Tsinghua Symbolic Systems Program (WTSSP), this ambitious undertaking was officially launched by NTHU President Hocheng Hong and Winbond Chairman and CEO Arthur Yu-Cheng Chiao, who recently signed a contract at the Innovation Incubation Center.

President Hocheng said that it was Winbond's reputation as a leading learning institute in the IT industry that inspired NTHU to jointly set up this unique cooperation between industry and academia. With a diverse group of researchers approaching AI from their respective disciplines, the innovative program aspires to match the achievements of the well-known Symbolic Systems Program at Stanford University.

Predicting that in 30 years, about 90% of work in Taiwan will be performed by robots, Chiao said that enterprises need to find a way to adapt to this situation. He expects the program will help Winbond employees acquire the knowledge and skills needed to play a leading role in the workplace of the future.

Chiao pointed out that in the recent film *Arrival*, the two individuals sent to communicate with the aliens are a physicist and a linguist, indicating that such a task is not something that engineers, as we know them currently, can do by themselves. Similarly, to communicate with robots, we have to understand such things as linguistics and drawing.

Moreover, the manager of the future will need to be able to manage not only people, but also robots.

Lin Wenyuan, the director of NTHU's Center for General Education, which is organizing the six-month program, said that it encompasses 8 colleges and 14 departments, and that about half of the classes are in subjects directly related to AI, such as mathematics and electrical engineering. The other half are subjects relating to human communication. The program features small classes and two small-group practicums.

One of the classes is "The Cognitive and Emotional Neuroscience of Humor," taught by Prof. Chan Yu-chen of the Institute of Learning Sciences and Technologies. Chan specializes in psychology, and uses nuclear magnetic resonance and brain waves to explore the neural mechanisms related to humor. She is also investigating the possibility of inventing a robot that has a sense of humor.

Prof. Lin Tzung-de of the Institute of Sociology is teaching a class on the ethical issues relating to robotics.

Amongst the first group of students is Tai Yanjie, the director of the Human Resources Department at Winbond. Tai said that AI's time has come and that her motivation for participating in the course is to understand how AI will change the world. She also said that she's looking forward to delving into a number of subjects that are quite new to most people in the IT industry.

NEW PUBLIC ART UNVEILED ON CAMPUS

You may have noticed that a huge pair of Chinese redbud leaves has recently appeared on the lawn in front of the TSMC Building, near the school's south entrance. This is the latest creation of the noted Spanish landscape artist Juanjo Novella. Titled *Leaf*, this eye-catching piece of landscape art also gives the impression of a butterfly getting ready to take off. By day, sunlight passes through the rust-colored veins to project a flowing tapestry of light and shadow.

With a height of 8.7 meters and a width of 7.5 meters, the sculpture is slightly tilted, and weighs about eight metric tons. Made by drilling over ten thousand holes into steel plates, despite its huge mass, it has a lightweight and elegant feel, and only touches the ground at three points.

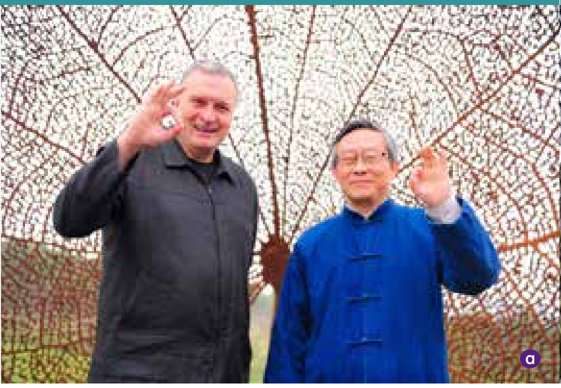
Novella said that, having already applied brown paint, he plans to allow the steel to age naturally, and that after about half a year, its hue will stabilize and become even more beautiful. Novella's inspiration for his latest work came when he was given a Chinese redbud *leaf* while taking a tour of the NTHU campus in 2016.

In fact, the Chinese redbud was one of the runners up for NTHU school flower (the plum blossom was the winner), and is the namesake of the annual Redbud Fair, one of the most popular events on campus.

ⓐ Novella in front of *Leaf*, his latest work of public art.
ⓑ Juanjo Novella (left) and President Hocheng Hong in front of *Leaf*.
ⓒ A large number of students attended the unveiling ceremony.

During the unveiling ceremony, President Hocheng Hong said that he is overwhelmed by the beauty of this steel *leaf* and it is a welcomed addition to the wide range of public art spreading over the entire campus.

Novella has been producing public art for over three decades, and said that this is an excellent site for this work, allowing it to take



on a different appearance throughout the day and night. His primary inspiration comes from nature, and he specializes in creating works that highlight the natural transformations of light and shadow without blocking the surrounding scenery. "To me, these two leaflets represent the polarities of both man and nature—positive and negative, yin and yang, black and white," explained Novella, adding that they might also be seen as a shelter, an umbrella, a shield, or even a door inviting people into his world, to peer through these two leaves while enjoying the sunrise and sunset.

Novella is an internationally acclaimed landscape artist whose works can be seen in Spain, Portugal, the United States, Dubai, and elsewhere. One of his more ingenious works is a half-leaf in Sestao, Spain, which becomes whole when its shadow appears. *Leaf* is Novella's first piece of public artwork in Taiwan.

Having developed a liking for traditional Chinese culture, Novella has taken to wearing a Tang suit, and has transliterated his given name Juanjo into Mandarin as Huangho (黃猴, Yellow Monkey), and is planning to design a yellow monkey logo for himself.

a Juanjo Novella (left) and President Hocheng Hong in front of *Leaf*.
b Novella in front of *Leaf*.
c *Leaf* illuminated at night, with the TSMC Building in the background.
d The stylized *leaf* invites viewers to interact with it both day and night.

AT THE VANGUARD OF INNOVATIVE EDUCATION WITH ERIC MAZUR

On December 6 Harvard professor Eric Mazur, known worldwide as the father of "flipped learning," gave a talk at NTHU titled "Innovating Education to Educate Innovators." Held in the International Conference Room, the event was attended by nearly 400 teachers and students. During his talk Mazur displayed the Chinese characters for "knowledge" (學問 *xuewen*), and said that they remind us that learning comes from questioning. He also stressed that we need to adopt innovative teaching methods for teaching the innovators of the future.

Mazur pointed out that in the past 50 years, many low-level jobs have been replaced by machines, and he foresees that in the next 50 years even more will be replaced by artificial intelligence and computers, including some of the work done by lawyers and doctors. Thus universities need to adopt a new approach to education focusing on problem solving and the work that can't be done by machines or artificial intelligence.

Mazur currently holds a chair at Harvard University as Balkanski Professor of Physics and Applied Physics and was the Dean of Applied Physics. He is also a member of the faculty of education at the Harvard Graduate School of Education, and President of the Optical Society. He has taught at Harvard for 35 years, during which time he has continually asked himself how to teach better by adopting experimental and innovative teaching methods. In addition to physics and education students, a large number of faculty members were on hand to learn Mazur's views on education and to ask questions.

Professors stuck in the past

Early in his talk, Mazur displayed an old painting of a lecture given at the University of Bologna in 1125 and said that in the intervening nine centuries, very little has changed in the way professors teach—standing at a podium, lecturing to students quietly taking notes. Early in his teaching career, Mazur also adopted this traditional approach, but soon began to see its limitations and wonder about how it might be improved.

In the process of teaching, Mazur gradually realized that

Harvard professor Eric Mazur, explaining that the Chinese characters for "knowledge" remind us that learning comes from questioning.

Mazur said that his approach to education is very similar to what Confucius was advocating long ago.

thinking is a very important part of the learning process, but that it's difficult to both listen and think at the same time." No student has ever asked me to shut up in class so he could think quietly for five minutes." He also soon discovered that even though all his students could recite Newton's third law, most couldn't correctly apply it to real-world problems in physics. Mazur said that one of the main obstacles faced by professors is what has been called "the curse of knowledge," whereby the more you know about a subject, the more difficult it is to present it in a way easily understood by beginners.

"I used to think that I was a fantastic professor of physics, and that all my explanations were completely clear, because I always received good evaluations from my students. However, I later discovered that they weren't really learning as much as I thought they were," Mazur candidly revealed.

Mazur said that the traditional approach to education focuses on the transfer of information and the regurgitation of existing knowledge, an approach which makes it difficult to generate new ways of thinking. By contrast, the approach he advocates focuses on teamwork and creative thinking so as to enhance students' ability to think independently. Moreover, in the traditional teaching method, the simpler ideas are covered in the classroom, while the more difficult ones are given as homework. By contrast, Mazur advocates a "flipped" approach to teaching in which the concepts covered in class are those the students find most difficult to assimilate.

An innovative learning process

The teaching methodology developed by Mazur can be broken down into the following process: teacher questions → students quietly think for a few minutes → students use a button or cell phone to answer the question → students discuss with each other → answer again → teacher answers.

For this process to work as intended, the students have to prepare in advance by reading the teacher's notes or participating in an Massive Open Online Courses (MOCCs).

According to Mazur, it often happens that after just two minutes of lively discussion, students suddenly grasp concepts which they could barely make sense of after listening to the teacher lecturing for ten minutes. Suppose student A helps student B to understand a certain principle, and student C helps student D to do the same. Although the part that B and D failed to understand at first may have been totally different, they both cleared up their misunderstanding, something which a professor in front of a large class could never accomplish. Moreover, knowing that A and C have understood the principle they were grappling with would encourage B and D and motivates them to catch up with their classmates.

To demonstrate his model of flipped learning, Mazur explained the principle of thermal expansion and contraction and then posed the following question: "Consider a rectangular metal plate with a circular hole in it. When the plate is uniformly heated, will the diameter of the hole increase, decrease, or stay the same?" Then he asked everyone to choose an answer. Next came the discussion segment, in which he had everyone find somebody who answered

differently, and try to convince him to accept one's own answer.

Mazur pointed out how enthusiastically everyone discussed the question, and said that this demonstrates that even though his explanation failed to sufficiently convey the principle, "At least I succeeded in arousing everyone's interest in this boring topic." He also pointed out that this type of discussion is an effective way to learn how to cooperate with others and hone valuable communication skills.

Learning at every turn

At this point, Mazur said that his approach to education is very similar to what Confucius was advocating long ago when he stated, "When doing something together with three other persons, there must be one who will have something to teach me. When I see that someone has a strong point, I emulate it; when I see that someone has a weak point, I correct it in myself." When Mazur's speech ended, the audience burst into warm applause. Afterwards, a number of NTHU faculty members asked questions, beginning with how to balance the dual responsibilities of research and teaching. Mazur said that it's ironic that teachers who teach well are often asked to teach more classes, while those who teach poorly have their teaching load reduced. He also said that in his experience, when professors are chatting together, they usually talk about such topics as research, seminars, and publications, but rarely talk about how to improve their teaching. They just go into the classroom, shut the door, and teach exactly as they've always taught. Such an approach to teaching isn't conducive to improvement, and this is something universities need to think about.

Mazur's talk was attended by nearly 400 teachers and students.

At the vanguard of physics and innovative education

Mazur was invited to speak at NTHU by his long-time associate, Prof. Pan Ci-ling of the Department of Physics. In his introduction, Pan said that Mazur is a fellow of the American Physical Society, and is widely recognized for his research work in the field of nanophotonics. He has won many major awards in both physics and education, and has founded several very successful startups.

The event was organized by the Center for Teaching and Learning Development. The Center's director, Professor Chiao Chuan-chin, said that Mazur began developing his "flipped classroom" over two decades ago while teaching university classes with over 200 students. He also said that in an age when lots of professors are at a loss as to how to teach students accustomed to sleeping through class or constantly fiddling with their mobile phones, Mazur's innovative approach to education comes as a real eye opener.

NTHU'S TU VICTORIOUS IN THE GOLDEN GLOVE

a Tu Po-wei (right), a sophomore in the Department of Physical Education, defeated his Sri Lankan opponent (left) to come out on top in the 46–49kg weight category at the Golden Glove Tournament held in Belgrade, Serbia.

b Tu is the first male boxer from Taiwan to win an international tournament.

Tu Po-wei, a sophomore in the Department of Physical Education, recently represented Taiwan at the 60th Golden Glove International Boxing Tournament held in Belgrade, Serbia. With a formidable combination of speed, strength, and explosive power, Tu came out on top in the 46–49kg weight category. Indeed, so impressive was Tu's performance that quite a few European coaches were eager to find out more about him. Tu credits his victory to the rigorous training under coach Ko Wen-Ming and says he is looking forward to competing in future international competitions.

The Golden Glove Invitational, held annually in Belgrade, the capital of Serbia, is one of Europe's oldest boxing tournaments. This was the first time a male boxer from Taiwan has won an international tournament. In the preliminaries, Tu won an easy 3-0 victory over his Serbian opponent. In the finals he dominated his Sri Lankan opponent from start to finish, winning another 3-0 victory.

Coach Ko says that European boxing matches tend to be fierce and relentless, yet the Golden Glove is relatively more professional. Held in a large gymnasium with thousands of spectators, the highly charged atmosphere has a certain impact on the participants, but didn't hinder Tu's remarkable performance.

Competing in the lightest weight class, the mild-mannered Tu has an engaging smile, but once he gets in the ring he takes on an intense countenance brimming over with strength. Tu took first place in the 2015 Taipei City Cup International Boxing Tournament, and won silver medals at the 2016 World University Boxing Championship and the 2017 Taipei City Cup International Boxing Tournament.

"It's probably God's purpose that I took up boxing," says Tu, who initially excelled at track and field. But during junior high school a member of the boxing team invited him to join; he decided to give it a try, and the rest is history.

Tu, now 20, says that at first he wasn't very good at boxing, but he did enjoy it, and soon began to train in earnest. While in the ninth grade, he won second place in the National High School Games, and afterwards there was no looking back.

Tu's father is from Hsinchu and his mother, a member of the Atayal tribe is from Ilan. When his parents saw the intensity with which he boxes, they reluctantly gave him their blessings. Known for his courage and tenacity in the ring, Tu says, "I've had my share of defeats in the past, but each one has made me a better boxer!" Tu is currently preparing to compete in the Asian Games in August.

NTHU

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Undergraduate Program: November 15~January 15
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