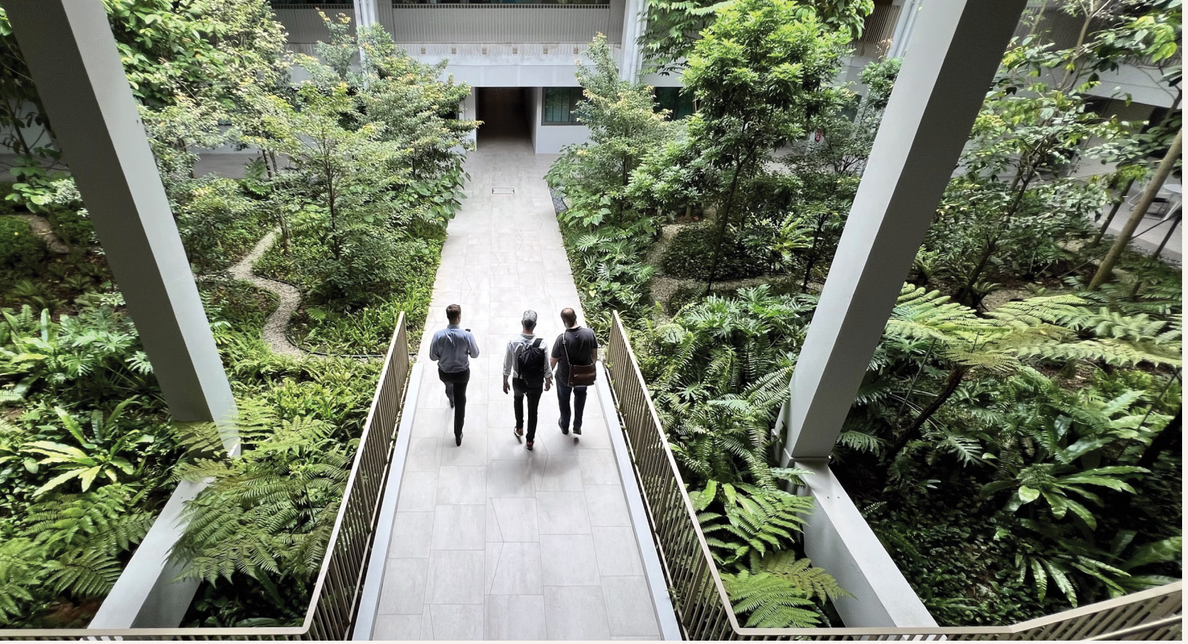


THE START OF THE TRANSFORMATION

We live in an era supercharged by transformation. Technology is reshaping industries, digital tools are becoming part of daily life, and the way we design, engineer and build is constantly evolving. From healthcare to energy, sustainability to smart cities, staying ahead means being responsive, agile and forward-thinking.

At NUS, this spirit of evolution is engraved in the DNA of our design and engineering education. The Faculty of Engineering and the School of Design and Environment were each created in response to national needs and global trends. Both nurtured thinkers and builders who would rise to the challenges of their time. This shared drive to forge new frontiers and create long-lasting impact was a natural catalyst for what came next: the formation of a future-focused institution where design and engineering come together.

That became reality on 1 January 2022, with the launch of the College of Design and Engineering (CDE). It marked a new chapter where traditional design and engineering silos were dismantled to encourage collaboration and spark innovation.

At its core, the merger was anything but a structural change. It was a golden opportunity to cultivate a new generation of talent fluent in both creative and technical dialects. Throughout history, breakthroughs have emerged when designers and engineers joined forces. In today's world, where disciplines increasingly intersect, CDE provides the environment for such synergy to thrive.

The formation of CDE is part of NUS' commitment to reimagining education for the future. The new College is built on four pillars: a common curriculum, greater flexibility, an interdisciplinary approach and lifelong learning. Together, these give students the tools and freedom to shape their own learning paths.

NUS President Professor Tan Eng Chye had long stressed that world-class education must be nimble enough to prepare graduates for a future marked by ever greater volatility, uncertainty, complexity and ambiguity. The creation of CDE epitomises this forward-thinking ethos.

The transformation began in earnest in August 2021, when about 1,800 students from the Faculty of Engineering and the School of Design and Environment began a newly designed common curriculum. Developed jointly by both schools, the curriculum combines broad general education with specialised courses that interweave design and engineering. It gives students unprecedented flexibility in tailoring their learning experience. By January 2022, these students officially became part of CDE.

Today, CDE is home to 10 departments under the leadership of Professor Teo Kie Leong. The College's guiding vision is to give its students the freedom to build a programme that is as broad or as specialised as they wish, and to graduate with the ability to see connections where others see boundaries.

From architects and engineers to designers and built-environment specialists, the next generation of problem-solvers, innovators and change-makers is taking shape at CDE — and this is only the beginning.

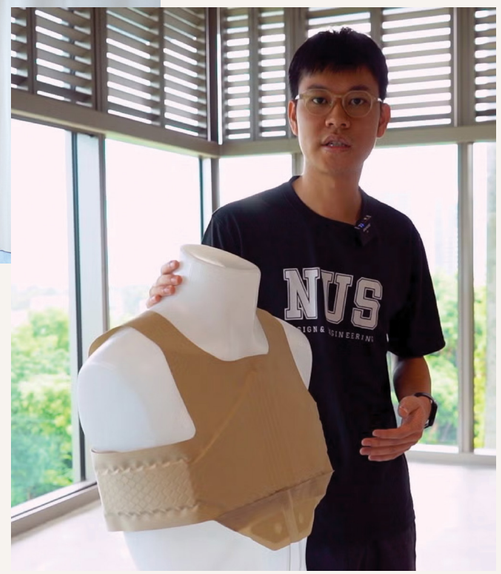
The formation of CDE is part of NUS' commitment to reimagining education for the future.

STUDENTS MAKING *IMPACT*

Bold ideas. A relentless drive. And a spirit of adventure that breaks boundaries. Across classrooms, workshops and global stages, students at CDE are turning their ambitions into achievements. Racking up awards, designing future-ready solutions and racing towards new horizons, here's how they are making their mark.

Luke Goh's Mammosense makes mammograms less painful.

Koh Bei Ning's Rollo soothes eczema flare-ups without damaging sensitive skin.



Innovation Through Empathy

For three consecutive years, CDE students have swept the national titles at the James Dyson Award, proving that empathy-led design can drive powerful solutions for real-world challenges.

In 2022, John Tay, valedictorian of his Industrial Design cohort, turned an unfortunate event into creative purpose. Motivated by his father's stroke recovery, John developed Rehabit — a set of therapy equipment that guides stroke patients through rehabilitative exercises at home. Light, sturdy and easy to use, Rehabit turns tedious exercises into simple habits, removing complexities and obstacles to free the patient to focus on what matters most: on what matters most: to relearn the vital ability to move.

Fellow graduate Koh Bei Ning earned the national runner-up spot with Rollo, a textured rollerball designed to soothe eczema flare-ups without damaging sensitive skin. Motivated by her own experience living with the condition, Bei Ning created a cooling, tactile solution that brings both relief and peace of mind. In 2023, her Kickstarter campaign for Rollo was a resounding success, raising over S$100,000 from nearly 1,000 backers. From product designer to entrepreneur, Bei Ning now helps others manage their itch more comfortably, one rollerball at a time!

The momentum continued in 2023 with Siew E Ian claiming the national winner title for Auxobrace, a rehabilitation vest for open-heart surgery patients. Having endured two heart surgeries himself, E Ian engineered a lightweight brace using vacuum-powered, tessellating air bladders to support the sternum during recovery. Developed in collaboration with medical teams at the National University Hospital, Singapore, Auxobrace offers patients greater comfort and control, addressing the limitations of conventional, bulky sternal braces.

In 2024, Luke Goh took home the national win with Mammosense, an innovative device aimed at reducing pain during mammograms. Spurred by his mother's uncomfortable experience, Luke harnessed LiDAR technology, along with advanced algorithms, to analyse breast tissue in real time, guiding radiographers to apply just the right amount of compression. Early trials show Mammosense can cut compression force by up to 34%, with a 25% reduction in reported pain during the compression.

The 2024 awards also spotlighted Project yaR, developed by Computer Engineering student Sparsh, in collaboration with Manas Bam from Computer Science at NUS Computing. Designed in partnership with the Singapore Association of the Visually Handicapped, the project features a wearable pendant that uses AI and image recognition to support users in daily tasks, from identifying medication labels to selecting matching outfits. Project yaR earned the team the national runner-up title. They were also the first runner-up at the Engineering Innovation Challenge 2024.

Siew E Ian's Auxobrace helps open-heart surgery patients recover better.

Community changemakers

Engineering education meets community action — that's the spirit behind bGood, a yearly initiative by the Department of Biomedical Engineering (BME) that empowers students to co-create solutions with and for communities in need. Through experiential coursework in assistive technology and gerontechnology, students work directly with partners, from local care homes to overseas NGOs, to address real-world challenges through human-centred design. Engineering with empathy — and a drive to do good!

For Nicholas, who lives with Duchenne muscular dystrophy, everyday tasks that we so often take for granted, like tapping an MRT card, can be difficult without arm mobility. Developed under bGood by students Edwin Chuah, Mervin Cheong, Glenice Kweh and Cathlin Theophilus, Armovin, a student-designed robotic arm fitted to Nicholas's wheelchair, enables him to travel independently. The arm support is built using a mix of 3D-printed and metal parts, and is light, adaptable and affordable — thoughtful engineering that restores function and freedom.

Tapping into gamification and AI, the Golden Gamers, comprising BME graduates Jonathon Leong, Fatin Sharafana and Denise Caluza, developed Primeplay, a suite of arcade-style fitness games tailored to older persons. From rhythm-based grip training to virtual bike rides through Chinatown, these personalised programmes transform passive exercise into engaging, therapeutic and visually stimulating activities that help seniors stay active. Their innovation won the top prize at the 2024 Huawei Tech4City competition.

The Golden Gamers' arcade-style fitness games help seniors stay active.

In Timor-Leste, students under bGlobal (an overseas extension of bGood that runs every year), immersed themselves in healthcare systems shaped by scarcity. Over 11 days, they visited hospitals and NGOs to understand frontline challenges, whether it's malfunctioning medical devices or a lack of basic resources. Gabriel Wong developed AAAdapt, a modular battery pack to replace hard-to-source button cells in donated thermometers with common AA or AAA batteries, while Swathi Kumar and Lakshmi Sujeesh harnessed the abundance of local seaweed to create Kasugel, a healing gel that could serve as a low-cost, locally made wound dressing. The programme was a powerful reminder that impactful solutions are often borne out of empathy and an understanding of local context.

The bGlobal team worked with various local organisations and hospitals during their time in Timor-Leste.

Shifting perspectives

Can we picture a world where buildings tell stories, and public spaces shift perspectives? Through conceptual depth, visual storytelling and thoughtful spatial design, CDE's architecture and landscape architecture students are reimagining the environments we live in. It is an invitation for us to view space through a different lens.

Ryan Quah (Class of 2024) won not one but two major awards in a standout year. His project Urban Tarzan, which rethinks urban infrastructure through a lens of sustainability and social function, won both Gold in Architecture and Best Design Impact at the Asia Young Designer Award 2023, besting 50,000 entries from 1,200 tertiary education institutions across 16 geographical locations. Recognised at home as well, Ryan was the sole architecture recipient of the NUS Achievement Award (Distinction), a rare honour in non-sports competitions.

Fellow alumnus Eugene Tan Wei Jie (Class of 2023) continued to dazzle on the international stage with his visionary thesis on the future of Pedra Branca. His evocative depictions, both poetic and political, imagine new relationships between architecture and ecology, earning him the top Drawing of the Year 2024 at Archisource, an Excellence in Digital Hybrid Media Award at the Ken Roberts Architectural Delineation Competition, and commendation at the RIBA Journal's Eyeline Drawing Competition.

In public-space design, Terence Tan Jia Ren won Gold in the Spatial Design Awards (SPADE) at the Design Excellence Awards 2024. His project, The Way of the Dojo, transforms overlooked campus spaces into a sanctuary for martial arts practice. Inspired by resilience and heritage, Terence's design channels the ethos of combat mastery through charred wood textures and immersive spatial journeys that honour the warrior spirit, inviting visitors to reflect on inner strength and tradition.

Ryan Quah's project, Urban Tarzan, rethinks urban infrastructure through a lens of sustainability and social function.

Eugene Tan's thesis on the future of Pedra Branca imagines new relationships between architecture and ecology.

Lean, mean student-built machines

Volts, velocity and a vision for impact, CDE's student engineers are building machines that make waves from track to tide.

In April 2024, Team Bumblebee made waves at the Singapore Autonomous Underwater Challenge (SAUVC), clinching first place against over 100 teams from 20 countries. The multidisciplinary team comprises students from Mechanical Engineering, Electrical and Computer Engineering, Computer Science and NUS Business School. Based at CDE, they design and build autonomous maritime vehicles capable of navigating underwater, on the water and in the air, performing complex tasks autonomously. Piloting AUV4, the only vehicle to complete every task — including the notoriously tough bins pick-up and navigating underwater currents — the team's precision and preparation paid off. Logging over 400 hours in-water before the event, the team proved that control and capability could outshine sheer speed, topping both the main competition and the bonus round.

Their winning streak soared higher in November 2024, when Bumblebee captured the championship at the Maritime RobotX Challenge in Florida — becoming the first team in the competition's history to win the title twice. Fielding ASV 4.0 and drone Jellyfish 2.0, the team nailed complex autonomous tasks, from drone take-offs and landings to seamless inter-vehicle communication. They also swept multiple special awards, including Best Presentation and Best System Assessment, outshining 15 elite teams from around the world.

Team Lead Teoh Xu En from Electrical Engineering described winning the competition as a profound mix of relief and gratitude. The team navigated through significant uncertainties leading up to the event, such as a potential cancellation of the competition due to Hurricane Milton. They also faced shipment issues, with their boat arriving just a day before the competition. Despite these challenges, the team adapted quickly to changes, and every member was well-prepared, knowing their specific roles and responsibilities.

Vroom vroom! What began as a pandemic pivot has powered the NUS Formula SAE (FSAE) team into new territory, as they shifted gears from internal combustion to electric, designing and building Singapore's first-ever electric race car.

The team's next-generation race car, R24e, competed against 79 teams worldwide at the Formula SAE 2024 in Michigan, where they clinched an impressive overall 10th-place finish in just their second year with an electric car. Across dynamic events like acceleration, autocross and endurance, the team's hard-earned testing mileage (over 500km) proved invaluable.

Left

Team Bumblebee made waves at the Singapore Autonomous Underwater Challenge, clinching first place against over 100 teams from 20 countries.

Right

The NUS Formula SAE team with their R24e electric car, which clinched 10th place in the 2024 Michigan competition.

Next destination: space

From designing lunar mining missions to launching satellites into orbit, CDE students are bringing their out-of-this-world ideas to fruition.

In 2022, a team of Innovation and Design Programme (*i*DP) students won the Grand Prize at the Global Navigation Satellite System (GNSS) Innovation Challenge, crafting an autonomous last-mile delivery system powered by satellite navigation technologies.

Hot on their heels, another *i*DP team soared to victory in February 2023, clinching the Grand Prize at the International Space Challenge with EclipseSat — a concept for a nanosatellite that orbits in sun-synchronous low earth orbit to capture photographs of cities at night to measure the level of light pollution. It uses a spectrometer and decomposes the light captured into specific wavelengths, analyses the types of light bulbs that are used by a city, and determines how these light bulbs affect the city's energy consumption.

In April 2023, CDE students celebrated the successful launch of Lumelite-4, a microsatellite for maritime communications built at the Satellite Technology and Research (STAR) Centre at the Department of Electrical and Computer Engineering. Alumni-turned-researchers Marcus Tay and Yuan FangXing were part of the mission team, handling everything from satellite assembly to ground station operations, and witnessing their creation blast into space from India's Satish Dhawan Space Centre.

Just months later, in July 2023, Galassia-2 joined the fleet of student-built satellites in orbit. Developed by around 20 students across multiple disciplines, this CubeSat class of nanosatellite carries a multispectral camera to monitor agriculture and environmental changes. "The successful launch and deployment of Galassia-2 is another demonstration of CDE's leading role in training the next generation of space engineers here in Singapore," said Prof Teo Kie Leong, Dean of CDE.

At the International Space Challenge in February 2024, CDE students swept the awards. Team Venator claimed the Grand Prize with a visionary concept to mine water ice on the Moon, while Team Orbitus earned Merit for its asteroid sampling spacecraft. NUS Team 1 picked up the Most Innovative Project Award with a design to extract and convert water from celestial bodies into rocket fuel. All in all, a stellar showcase of creativity and engineering!

Second-year Electrical Engineering student Chew Yong Zhang impressed at the Space & Global Health Hackathon, held from 31 May – 1 June 2024, winning second place with a project using satellite data to monitor and predict urban heat distribution. Yong Zheng's experience, blending global health and space tech, sparked ambitions to pursue a PhD in his technical domain and join an international organisation to implement impactful ideas.

Galassia-2 project leaders Eugene Ee (right) and Ng Zhen Ning (left) overseeing integration of the satellite with the deployer system prior to launch.

Maritime

Focuses on the modelling, simulation and optimisation of future-ready ports and maritime operations. It addresses challenges in efficiency, automation and sustainability through smart logistics, autonomous vessels and integrated digital platforms. By leveraging advanced analytics and systems engineering, this research supports the development of greener, safer and more resilient maritime infrastructure in an increasingly connected global economy.

Materials Research and Manufacturing

Developing new materials and advanced manufacturing methods, with a focus on biomaterials, soft matter, AI for materials discovery, quantum materials and advanced characterisation.

Quantum Technology

Developing secure communication, computing, and sensing systems by integrating expertise from electrical, computer, optical and materials engineering to advance quantum technologies like networks, imaging and quantum-safe systems.

Research by Design

Advancing translational research through creative practice focused on Asia, with a strong emphasis on critical and creative engagement in architectural making, writing and thinking.

Robotics

Focusing on human-robot collaborative systems, advances in sensors and actuators, microelectronics and computing to enable a data-driven approach to computing in robotics that will create a new generation of robots that learn and adapt to human needs.

Urban Solutions and Sustainability

Creating sustainable and livable urban environments by addressing challenges in city design, transportation, energy systems, environmental quality (including air, noise, water, and wastewater), and using computational tools for urban planning and management.

OUR STORIES OF IMPACT

Here are just some of the many stories of impact at CDE, where research meets real-world relevance to tackle global challenges and shape a better future.

Architecture

What makes a city comfortable? A new AI-powered index offers clues

PI: Assistant Professor Filip Biljecki
Presidential Young Professor

What makes a city comfortable to live in? Assistant Professor Filip Biljecki developed a multidimensional AI-powered comfort index that factors in not just infrastructure, but also how people feel in urban spaces. Combining deep learning with environmental, socio-economic and street-level visual data, the model reveals surprising insights, such as suburbs outperforming city centres on comfort due to greenery and perceived safety. The index could help urban planners design neighbourhoods that feel better to live in, not just look good on paper.

Dragon Carts lead charge to empower community solutions

PI: Associate Professor Cho Im Sik

Led by Associate Professor Cho Im Sik, the Dragon Heart Community Platform blends online tools and mobile "Dragon Carts" to empower residents to co-create solutions for municipal issues. Piloted in Toa Payoh East with over 1,400 residents, the platform draws from social norms research and community co-design. Early results point to stronger place attachment, neighbourly ties and collective ownership as key drivers of better living environments.

Architecting resilient, future-proof cities

PI: Associate Professor Yuan Chao

Urban research at CDE is directly shaping how cities are designed to enhance liveability and resilience. The urban heat island (UHI) effect remains a growing concern for densely populated cities like Singapore, affecting everything from public health to energy consumption. Associate Professor Yuan Chao has developed a climate-sensitive framework that assesses UHI, wind flow and urban design implications to help urban planners and governments alike make data-driven decisions that balance climate resilience with urban development.

Shaping restorative environments using natural materials

PI: Associate Professor Shinya Okuda

Associate Professor Shinya Okuda partnered with Alexandra Hospital to develop BioHeal, an initiative that upcycles felled trees into timber installations for the hospital's new rehabilitation centre. Instead of regarding fallen trees as waste, the team's "trees-to-design" approach preserves their natural forms — adapting their sizes, textures and grains into functional yet aesthetically appealing elements. By repurposing trees naturally felled or removed for maintenance, the project showcases how upcycling can blend sustainability with biophilic design to create beautiful spaces that enmesh history, community and healing.

Biomedical Engineering

AI platform enables doctors to optimise personalised chemotherapy dose

PI: Professor Dean Ho

Professor Dean Ho and his team developed CURATE.AI, an artificial-intelligence platform that customises chemotherapy doses based on a patient's clinical data. A pilot trial involving patients with advanced solid tumours has shown that clinicians accepted nearly 97 per cent of the AI-recommended doses, with some receiving optimised doses that were about 20 per cent lower on average. Their AI-driven tool dynamically adjusts treatments for more precise and effective oncology care — it also marks a big step towards integrating AI into clinical workflows.

DNA tech could speed up cancer diagnostics

PI: Associate Professor Shao Huilin

Associate Professor Shao Huilin has co-developed TETRIS, a DNA-based technology that decodes complex protein interactions in tumour cells with unprecedented detail. TETRIS enables accurate sub-typing of tumours and rapid identification of aggressive cancers, all within a matter of hours, by mapping how proteins assemble and interact within cancerous tissues. Tested on breast cancer biopsies, the method reveals molecular signatures that help clinicians tailor treatments more precisely.

DNA-barcoded gold nanoparticles for precision cancer therapy

PI: Assistant Professor Andy Tay
Presidential Young Professor

Assistant Professor Andy Tay has developed a high-throughput DNA barcoding method to identify gold nanoparticles best suited for cancer treatment. Through the tagging of nanoparticles with unique DNA sequences, his team uncovered how different tumour cell types respond to specific designs, with triangular nanoparticles showing high uptake and strong photothermal effects. The approach allows rapid screening of nanoparticle performance in living systems, enabling safer, more precise therapies and RNA delivery strategies tailored to specific organs or cancer types.

Teaching machines to see, reason and anticipate in medical settings

PI: Assistant Professor Jin Yueming

Assistant Professor Jin Yueming is teaching machines to see, reason and anticipate in complex clinical settings. Her research bridges computer vision, medical imaging and AI reasoning, with tools that work alongside — and not just for — clinicians. From Med-SA, a lightweight adapter that tunes generalist AI to interpret scans with expert-level precision, to Pro-NeXt, a unified model for specialist visual tasks, her work reshapes how intelligence is designed. Whether forecasting surgical steps or planning treatments, her algorithms aim to collaborate with human judgement — bringing clarity, consistency and context to high-stakes medical decisions.

Built Environment

Rethinking cooling: Solutions to break out addiction to air-con

PI: Associate Professor Adrian Chong

Can we stay cool without cranking up the aircon? At the Integrated Data, Energy Analysis + Simulation (IDEAS) lab, Associate Professor Adrian Chong and his team are rethinking Singapore's dependence on energy-heavy cooling. Combining simulations, sensor data and machine learning, the lab designs smarter systems that adapt to real conditions. In one trial office, cooling kicks in incrementally — from natural ventilation to spot cooling to air-conditioning only when needed — guided by real-time occupant feedback. This approach cuts energy use by up to 60%, showing how tech-enabled design can lead to a future where comfort and sustainability go hand in hand.

Modelling personal comfort: a smart thermostat that learns what temperature you like

PI: Assistant Professor Ali Ghahramani
Presidential Young Professor

How warm is *just right*? With ComfortGPT, a machine-learning model developed by Assistant Professor Ali Ghahramani, thermal comfort gets personal. Trained on data from over 100,000 smart thermostats, the system learns individual temperature preferences over time and adapts to seasonal shifts, moods and routines. By combining transformer architecture with comfort archetypes, it predicts what you'll want next, before you even reach for the remote. The result? Smarter buildings, happier occupants and a better balance between comfort and energy efficiency.

Call for urgent action on indoor air quality

PI: Professor Chandra Sekhar and Associate Professor Tham Kwok Wai

While cutting-edge sensors adorn buildings to boost operations and efficiency, indoor air quality (IAQ), a critical yet often neglected aspect of public health — remains under-addressed, even as most of us spend nearly 90 per cent of our time indoors. Professor Chandra Sekhar and Associate Professor Tham Kwok Wai are advocating for global IAQ standards to ensure healthier indoor environments, highlighting advanced ventilation systems, IoT sensors and real-time monitoring as solutions. Their policy recommendations emphasise the urgent need for mandatory IAQ regulations in buildings, which bridge the gap between research, policy and real-world implementation to create cleaner, safer indoor spaces.

Automating 3D scanning of built environments

PI: Assistant Professor Vincent Gan

Assistant Professor Vincent Gan developed autonomous systems that enable robots to map complex indoor spaces without human guidance. His team integrated Building Information Modelling with spatial data standards to optimise navigation and scanning routes, allowing quadruped robots to capture high-fidelity 3D models efficiently even in GPS-limited settings. By combining intelligent planning algorithms with robust sensing, the research streamlined the digitalisation of the built environment, reducing time, labour and error in construction and maintenance workflows, and advancing the use of robotics in creating smarter, more responsive cities.

Chemical and Biomolecular Engineering

Breakthrough boosts perovskite solar cell efficiency to new record

PI: Assistant Professor Hou Yi
Presidential Young Professor

Solar technology is making significant progress at CDE. Assistant Professor Hou Yi achieved a record-breaking 25.7 per cent efficiency in perovskite solar cells by developing a novel interface material using antimony-doped tin oxides. This chemically stable, highly transparent and conductive layer significantly reduces energy loss, bringing perovskite cells — seen as the likely basis for future solar cells — closer to the efficiency of their traditional silicon-based counterparts. Their lightweight and flexible nature opens up possibilities for integration into IoT devices, vehicle roofs and building facades.

Nanotechnology and the future of farming

PI: Assistant Professor Tedrick Lew
Presidential Young Professor

What if plants could tell us when they're stressed — before they show any signs? At the Lew Lab, Assistant Professor Tedrick Lew leads a multidisciplinary team exploring how nanotechnology can revolutionise smart agriculture. By embedding fluorescent nanosensors into plant tissues, his team has enabled real-time monitoring of plant health using just a smartphone. The lab also designs nanocarriers to deliver nutrients or treatments with precision, boosting crop resilience while reducing chemical use. With these nano-enabled tools, the Lew Lab is engineering crops that can thrive in tougher climates, enabling high-yield farming in an ever-changing world.

Innovative CO_2 conversion offers hope for cutting emissions

PI: Assistant Professor Wang Lei
Presidential Young Professor

The fight against climate change is taking centre stage, with researchers rethinking how carbon emissions can be captured and repurposed. For instance, Assistant Professor Wang Lei is advancing the electrochemical reduction of carbon dioxide into useful chemicals. In one study, his team developed a palladium catalyst enhanced with polyvinylpyrrolidone (PVP) to convert the greenhouse gas into formic acid, a key industrial chemical used in agriculture, pharmaceuticals and fuels. Importantly, PVP improves the catalyst's performance and longevity, which enhances its potential for industrial applications.

Taking a bite out of carbon emissions

PI: Professor Yan Ning

As the world searches for sustainable ways to feed its population, Professor Yan Ning explored "green chemical farming" — a new paradigm that uses chemistry and engineering to create food without conventional agriculture. His team proposed transforming simple molecules like water, carbon dioxide and ammonia into nutrients that microbes such as algae and yeast can convert into edible proteins. The method could reduce dependence on farmland and livestock while cutting resource use and emissions, revealing how future food production could be driven not by soil and sunlight, but by science.

Civil and Environmental Engineering

Waste plastics on roads: Building a circular economy

PI: Associate Professor Raymond Ong

Each year, Singapore generates over a billion plastic items, most of which end up incinerated or in landfills. Associate Professor Raymond Ong is tackling this problem by embedding plastics into the very roads we drive on. His team's research examines how recycled plastics can be used in asphalt mixes without compromising durability, safety or environmental standards. Working with agencies such as the Land Transport Authority, they have developed plastic-bitumen composites that enhanced road durability by 30% while showing no microplastic leakage. By turning discarded materials into infrastructure, the project offers a practical route to a circular economy where waste plastic finds a second life underfoot.

Turning food waste into wealth

PI: Assistant Professor Iris Yu

Singapore generated 755,000 tonnes of food waste in 2023 — over a tenth of the nation's total waste. Assistant Professor Iris Yu is tackling this challenge by developing a low-energy process that converts food waste into high-value bioproducts. Her team uses microwave pulses to break down starchy and sugary waste, producing a nutrient-rich feedstock for growing microalgae, which are fast-growing organisms that can be harvested for biofuels, animal feed and nutritional compounds. From stale bread to sugar-rich wastewater, the approach transforms discarded materials into useful resources, supporting both waste reduction and Singapore's circular economy goals.

Clearing the air for sustainable cities

PI: Professor Rajasekhar Balasubramanian

At the intersection of environmental science, public health and urban policy, Professor Rajasekhar Balasubramanian has advanced global understanding of tropical air pollution, particularly the environmental and health impacts of biomass burning. His studies on urban air quality — from tracking exposure to airborne particles across global cities to revealing how lockdowns reshaped pollution patterns — have provided critical evidence for policy action. As a member of the United Nations Environment Programme's Asia Pacific Clean Air Partnership, he continues to inform international strategies on reducing particulate matter and improving air quality in rapidly urbanising regions.

Building the future with 3D concrete printing

PI: Dr Du Hongjian and Associate Professor Pang Sze Dai

Dr Du Hongjian and Associate Professor Pang Sze Dai are advancing research in sustainable materials and construction automation to transform how cities are built. In collaboration with Woh Hup and the National Additive Manufacturing Innovation Cluster in Singapore, their projects develop low-carbon printing mixes from waste glass powder and calcined clay, and explore how 3D printing can be structurally integrated into high-rise modular construction. Their efforts combine materials innovation with structural design, driving a new generation of urban construction that is cleaner, more efficient and better suited to Singapore's tropical environment.

Electrical and Computer Engineering

Energy-efficient inorganic membranes for a cleaner future

PI: Professor Ho Ghim Wei

Professor Ho Ghim Wei has developed a synthesis strategy that enables the creation of freestanding, ultrathin inorganic membranes, advancing energy-efficient separation and conversion technologies. The method allows inorganic building blocks to self-assemble in liquid, producing membranes whose thickness and pore structures can be precisely tuned for different uses. Lightweight, selective and highly customisable, these membranes could improve energy usage in applications such as filtration, catalysis and sensing, offering cleaner pathways for production and resource recovery while advancing the global drive toward sustainable, low-carbon processes.

Cutting-edge chips for ultra-low-power AI connected devices

PI: Professor Massimo Alioto

Professor Massimo Alioto is leading the charge to bring ultra-low-power AI to edge devices. At the FD-fAbrICS joint lab, which he directs, his team is developing next-generation silicon systems using fully depleted silicon-on-insulator (FD-SOI) technology. These chips slash energy consumption, extending battery life and cutting wireless power demands — a boon for smart wearables and IoT devices. In partnership with Soitec and NXP Semiconductors, the lab's work is scaled through the FD-SOI & IoT Industry Consortium, aimed at accelerating adoption across Singapore's semiconductor landscape.

First demonstration of a secure quantum network with untrusted quantum devices

PI: Associate Professor Charles Lim

Researchers at CDE are making significant headway in quantum key distribution (QKD), a method of securely sharing a secret key between two parties using the principles of quantum mechanics. Associate Professor Charles Lim co-led a team that demonstrated, for the first time, a device-independent QKD protocol, which ensures secure key exchange without requiring users to trust the underlying quantum hardware. This approach harnesses quantum principles to securely share secret keys, even in noisy conditions, making it resistant to potential vulnerabilities like tampered devices or hacking attempts. Importantly, it brings long-term, unbreakable security closer to reality and lays the groundwork for future quantum networks that offer safer, more resilient communications.

Tracing the family tree of AI models

PI: Assistant Professor Wang Xinchao
Presidential Young Professor

AI models often inherit traits from predecessors. But can we trace their lineage? Assistant Professor Wang Xinchao has developed methods to detect "neural ancestry," revealing how models evolve through fine-tuning. One approach scans a model's internal structure for familial fingerprints; another trains AI to spot inheritance patterns from data. Asst Prof Wang's framework accurately maps model relationships, providing a powerful tool for bias tracing, accountability and AI governance.

Industrial Design

A microscope with an ergonomic design

PI: Associate Professor Christophe Gaubert

With CALIPSO, an ergonomic microscope system designed for organoid imaging, Associate Professor Christophe Gaubert and his team have reimagined the interface between scientists and their tools. The system's intuitive form, from its sliding access door to its user-focused spatial layout, enhances precision, ease and focus during imaging workflows. CALIPSO's thoughtful functionality was recognised with a Red Dot: Best of the Best award in 2024, the highest honour awarded at the Red Dot Design Awards.

Smart fabrics for health monitoring

PI: Assistant Professor Irmandy Wicaksono
Presidential Young Professor

Assistant Professor Irmandy Wicaksono is developing "soft technologies" — textiles that seamlessly integrate sensors and electronics into wearable fabrics. Using digital knitting techniques, his work enables clothing to track heart rate, breathing, movement and posture in real time, turning everyday garments into health-monitoring tools. Designed to be comfortable, durable and washable, these fabrics open new possibilities across patient care, rehabilitation and sports. His research has even been tested in zero-gravity conditions that point to future applications in space suits.

Serving innovation on a ceramic platter

PI: Assistant Professor Clement Zheng
Presidential Young Professor

Ceramics are everywhere: on our tables, in our homes. But they are rarely thought of as interactive. Assistant Professor Clement Zheng is changing that. By carving intricate circuit traces into glazed ceramic and filling them with conductive ink, his team has created touch-sensitive tableware, temperature-responsive tiles and even flowerpots that monitor soil moisture. Marrying craft with computing, these smart ceramics serve up new possibilities for home interfaces — beautifully blending form and function, and offering a poetic new take on how everyday objects can sense, respond and connect.

Training first responders through extended reality

PI: Associate Professor Yen Ching-Chiuan

Associate Professor Yen Ching-Chiuan and his team collaborated with the Home Team Science and Technology Agency and the Singapore Civil Defence Force to develop a world-first extended reality (XR) training system for emergency responders. The system combines virtual reality with a multi-sensory suit that simulates sight, sound, heat and even smell, allowing officers to train for road traffic and hazardous materials incidents safely and realistically. Having been deployed at the Civil Defence Academy, the award-winning system redefines how first responders learn, turning simulation into a powerful tool for readiness and resilience.

Industrial Systems Engineering and Management

Trust, but verify: a new framework for smarter decision-making

PI: Assistant Professor Cheung Wang Chi

Historical data can help or hinder, so knowing when to trust it is crucial. Assistant Professor Cheung Wang Chi tackled this dilemma by developing MIN-UCB, a new algorithm that weighs past data against present uncertainty. His theoretical study shows that without context, historical insights can mislead, but if the "margin of error" is known, decisions can be both cautious and informed. His work lays a foundation for smarter, more reliable decision-making in dynamic environments like e-commerce, resource allocation and beyond.

Connecting power, sharing progress

PI: Dr Su Bin

Dr Su Bin modelled how linking ASEAN's power grids could accelerate the region's transition to net zero. His study shows that cross-border electricity trade would cut system costs by 12% and lower average power prices by over 10%, while allowing nations to tap one another's renewable strengths. With an integrated grid, renewables could supply more than 90% of the region's electricity by 2050. The findings underscore how cooperation, not isolation, can drive Southeast Asia's clean energy ambitions faster, fairer and at far lower cost.

Simulating the mega ports of the future

PI: Dr Li Haobin

At the Centre of Excellence in Modelling and Simulation for Next Generation Ports, Co-Director Dr Li Haobin and his team have developed SINGAPort Studio — a digital twin software that reimagines how container terminals are designed, planned and optimised. Powered by advanced object-oriented discrete-event simulation and optimisation methodologies, the platform can model mega ports handling up to 20 million twenty-foot equivalent units a year with millimetre precision and millisecond timing. From static design evaluations to dynamic, data-driven operations, SINGAPort Studio provides a high-fidelity environment for testing ideas, refining decisions and shaping the future of port performance in Singapore and beyond.

Materials Science and Engineering

Fluid-like electrons unlock new tech possibilities

PI: Associate Professor Denis Bandurin
Presidential Young Professor

Assistant Professor Denis Bandurin has shown that electrons in graphene can flow like a fluid — a behaviour that defies traditional models of electronics. One of his team's studies revealed that terahertz radiation reduces the viscosity of this electron fluid, which boosts conductivity. This effect enabled the creation of viscous electron bolometers, ultra-fast sensors capable of detecting terahertz waves. These findings open new directions for designing future electronic devices, where electron flow is harnessed more like a liquid than a wire.

Unveiling black phosphorus's potential for innovative spintronics

PI: Professor Barbaros Özyilmaz and Assistant Professor Ahmet Avsar

Black phosphorus may hold the key to next-generation spintronic devices. Led by Professor Barbaros Özyilmaz, researchers found that the material's unique crystal structure enables directional, long-lasting electron spin transport — a critical requirement for low-power electronics. In contrast with conventional charge-based electronics, spintronics uses the spin of electrons, which dissipates far less heat. The team also demonstrated electrical control of spin flow in black phosphorus, which could lead to efficient, tunable spintronic technologies.

Ultrafast, energy-efficient memory and logic devices

PI: Professor Chen Jingsheng

Professor Chen Jingsheng and his team have achieved a breakthrough in antiferromagnetic spintronics, demonstrating all-electrical perpendicular switching of chiral antiferromagnetic order. Using a specially engineered bilayer structure, they showed that electric currents alone can toggle magnetic states without magnetic fields or heat — a feat long thought to be out of reach. Their discovery advances next-generation spintronic technologies, enabling ultrafast, low-power memory and logic devices that could redefine the future of computing.

Turning silicon transistors into artificial neurons

PI: Associate Professor Mario Lanza

Associate Professor Mario Lanza has shown that a single, standard silicon transistor can behave like a biological neuron and synapse when operated in a novel way. By adjusting the transistor's resistance, his team replicated neural firing and memory-like behaviour — the basis of brain-inspired computing. This breakthrough led to the creation of a two-transistor Neuro-Synaptic RAM cell that merges memory and computation in one place. Scalable and compatible with existing semiconductor technology, the approach brings energy-efficient, neuromorphic chips a step closer to powering the next generation of artificial intelligence.

Setting new electronic benchmarks with graphene

PI: Assistant Professor Alexey Berdyugin
Presidential Young Professor

Assistant Professor Alexey Berdyugin and his team have achieved record electron mobility in graphene, surpassing traditional semiconductors for the first time. By shielding graphene from electrical disorder using either twisted multilayer structures or ultra-thin metallic screening, the team reduced charge inhomogeneity to unprecedented levels, enabling quantum effects to appear at extremely low magnetic fields. These breakthroughs set new records for graphene's electronic limits and open new possibilities for high-speed, low-power electronics, precision sensing and quantum technologies.

Mechanical Engineering

Enhancing home mobility with soft robotics

PI: Professor Cecilia Laschi

Inspired by the dexterity of octopus arms, Professor Cecilia Laschi has developed a soft robotic arm that offers both physical assistance and emotional comfort, with potential applications in eldercare. The arm gently wraps around the user to provide support, stiffening only when needed, such as during sit-to-stand transitions. Unlike its rigid cousins, the robot's soft, adaptive form enables safe, close interactions. Designed for home use, the system is being enhanced with machine learning and mobility features, with the goal of bringing dignified, intuitive support into everyday living spaces.

Pioneering new energy and sustainability solutions

PI: Professor Lee Poh Seng

Professor Lee Poh Seng is spearheading efforts to reimagine how we power the future. As founding director of the NUS Energy Solutions Hub (NESH), he brings together interdisciplinary expertise across NUS to develop integrated, data-driven and context-specific solutions for a low-carbon world. From sustainable multi-energy districts to energy-conscious computing and tropical urban resilience, the hub's research priorities reflect a systems-level approach to sustainability, one which considers not only technology but also policy, urban form and human behaviour.

Unlocking the potential of active matter

PI: Assistant Professor Zhu Lailai

Assistant Professor Zhu Lailai's team has uncovered how self-propelled micro-droplets, a form of active matter, can shift between solid, liquid and gas-like states, and even stir turbulence in fluids despite their minuscule size. These droplets move by chemical reactions and self-organise into dynamic patterns, with their behaviour changing as activity levels rise. His study reveals how active matter can be tuned to reshape flow and structure simultaneously, giving rise to adaptive materials that mimic the responsiveness of living systems.

Uncovering the drivers of extreme weather in the tropics

PI: Assistant Professor Gianmarco Mengaldo

Assistant Professor Gianmarco Mengaldo and his team have revealed how shifting tropical weather patterns are fuelling more frequent heatwaves and heavy rainfall across the Indo-Pacific. Using a dynamical systems approach to analyse daily weather behaviour, the study uncovered new large-scale patterns emerging since the 1990s — changes linked to the Pacific Walker Circulation and potentially driven by global warming. The findings provide new insight into how extreme weather develops in one of the world's most vulnerable regions, helping improve climate models and guide future resilience planning.

...and that's just a glimpse of what's happening at CDE! Discover more breakthroughs by our researchers at

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