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中技社107年技術研發計畫概述

淺談科技之星-CRISPR/Cas9基因編輯技術於育種或農業應用

2018兩岸循環經濟發展論壇

百年藥香 世代傳誠

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編輯手記

本社自 2014 年首度舉辦境外研究生企業參訪活動，由於行程緊密結合產業實地觀摩與人文親身體驗，深獲學生好評而致外溢迴響，報名人數逐年攀升，由一年一梯次改為兩梯次。今年第一梯次於 8 月 29 ～ 31 日展開，行程包含中國鋼鐵、光寶科技、河見電機、恒耀工業、統一企業、宏遠興業等 6 家知名企業，另由經濟部「投資臺灣事務所」簡介境外生在台工作、創業、居留，以及就業、襄助創業之媒合，協助解決申請簽證、就業金卡等後續服務。文創探索則包括嘉義蒜頭糖廠蔗埕文化園區、板陶窯交趾剪黏工藝園區，以及彰化鹿港臺灣玻璃館觀光工廠。

生命體就像超精密的化學工廠，各種物理反應相互影響；對生命體而言，這種複雜的系統藍圖資訊就存在 DNA 序列中。1869 年 DNA 被陸續解構後，科學家便致力解開此生命密碼，希望突破先天的限制或修正異常基因。譽為神之手的 CRISPR/Cas9 基因技術是超強大的 DNA 編輯工具，不但深入了解生命體運作機制，進一步透過基因體編輯達到育種目的；深信此技術未來的進展速度將越來越快，應用範圍亦越來越大。本社因應政府推動創新產業之需求，於 2018 年選定「整合數位展示科技應用於工程施工及設計」等 9 項技術研發計畫，以期開發具產業應用潛力，或即時解決現行工程問題之新技術。

2010 年全球資源開採量 700 億公噸，如維持現今供給模式，2050 年將達 1800 億公噸，將導致加劇氣候變遷、空氣污染、減少生物多樣性、關鍵資源短缺等風險；因應此危機，「循環經濟」應運而生。循環經濟是建立在物質不斷循環利用的發展模式，形成「資源、產品、再生資源」的循環。本社自 2016 年與中國循環經濟協會合作辦理論壇，以廢塑膠、廢紡織、廢輪胎、城市垃圾資源化、再製造與農業循環經濟 6 大主題進行專題報告，就兩岸循環經濟發展分享經驗。

新年度的藝文專欄，相繼介紹台北迪化商圈的百年老店，佐以台灣城市速寫畫家的實景描繪；希望透過遊走捷運巷弄，親身感受大稻埕世代傳「誠」的名店，以及淵遠的文化底蘊。

企劃暨工程科技室 楊顯整主任 · 鍾侑靜管理師

今年度延續規劃、辦理兩梯次的「境外研究生企業參訪」活動，秉持著積極扮演境外生與國內企業之間的交流、媒合平台的精神，持續帶領於臺灣之大學院校修讀博、碩學位的境外生，實地參訪國內著名企業，以增進境外生對臺灣企業之經營實況、企業文化及未來展望有更深入的瞭解，進而吸引境外生加入臺灣企業工作。企業除了對參訪的外籍學員們有面對面的溝通及互動、網羅優秀國際人才的機會之外，同時亦可藉此機會向來自世界各地、不同國家的學員宣傳推廣企業價值及品牌，繼續邁向培育外籍人才、企業雙贏的目標前進。

應廣大同學們的千呼萬喚，有別於歷年來規劃臺灣北部或中部優質企業參訪行程，特別於2018 年第一梯次首度策畫參訪南部大型知名企業，前二天行程安排參訪 (依參訪順序) 中國鋼鐵、光寶科技、河見電機、恒耀工業、統一企業、宏遠興業等六家盛名遠播且兼具實力的企業，並很榮幸地邀請到經濟部「投資臺灣事務所」專員，向境外生簡介在臺灣工作、創業、居留等相關資訊，後續還可進一步提供就業媒合、襄助創業媒合，以及協助解決申請簽證、就業金卡等可能遇到的問題，提供外籍人才一條龍式的國家級客製化服務。第三天的探索臺灣、參觀具地方文化特色行程，亦精心挑選到廣受遊客喜愛的嘉義蒜頭糖廠蔗埕文化園區、板陶窯交趾剪黏工藝園區、以及彰化鹿港臺灣玻璃館觀光工廠一遊，體驗臺灣最美的人文及豐富的文化蘊含。

參訪行程第一站，首先到達國內最大鋼鐵公司—中鋼，繞訪中鋼總公司位於小港臨海工業區，廠區鄰近港口、機場及捷運，原料進口及成品出口佔有地利之便。經由企業簡報瞭解到中鋼粗鋼年產量約 1 千萬公噸，製成鋼板、條鋼、線材等主要產品，產品內外銷佔比約為 7：3，加上在海外建廠的「越南河靜鋼鐵（簡稱越鋼）」一貫化大型鋼鐵廠投產，除助益於其國際市場的整體佈局，亦可就地發展中、下游鋼鐵與相關行業，深化多角化的經營。

榮獲湯森路透《2018 全球科技百強》殊榮肯定的光寶科技，旗下光電產品、資訊科技、儲存裝置、手持式機構件等產品皆居全球領先地位。為開創未來營運成長動能，光寶積極往雲端、LED 照明、車電、生醫與工業自動化等五大 IoT 應用領域拓展。藉由參訪光寶，學員們得以親眼觀摩產品製程及相關生產設備，加上工廠廠務代表詳盡的解說，讓學員們對實際生產運作情形有突破性的認識。

名列臺灣重要泵浦製造廠—河見電機，參訪當日，河見電機特別安排其外籍員工進行企業簡介，分享工作經驗並與學員互動。河見電機在各式泵浦專業製造上具有著舉足輕重的領導地位，更從其 20 個系列、300 多款應用範圍涵蓋各種領域的泵浦中，挑選具代表性、特殊性能的泵浦展示於產品展覽室中，千變萬化的泵浦令人嘆為觀止。經由導覽人員的詳細解說，全體學員對河見電機泵浦的流體技術、節能機械發展、以及低耗能特性感到拜服。

全球前十大螺絲螺帽廠—恒耀工業，核心產品為「焊接螺帽」，並延伸產製焊接螺帽的冷鍛成型核心技術，進入汽車用螺帽，朝「汽車金屬零配件整合製造」方向邁進，成為全方位車用零組件製造商。工廠內的智能生產設備及各生產線量產之不同功能、各式各樣的螺絲螺帽皆著實讓人大開眼界。

榮獲《臺灣 20 大國際品牌》殊榮的統一企業，除致力食品製造，持續拓展新事業，國內外轉投資相關企業超過 200 家，經營項目涵蓋多項民生消費相關的商品與服務，不僅帶給市場正面影響也改變人們的生活習慣。Q&A 互動問答與神祕禮物的加持，炒熱了氣氛也讓學員對統一的瞭解程度爆表。

以創新和永續聞名國際的智慧紡織廠—宏遠興業，未受全球景氣不好之影響，關鍵就在於透過投資來強化產業群聚競爭力。除創立研發中心、增設機械設備和投入新材料領域外，亦啓動「放膽射月 5+5 全球布局」，規劃海外布點增設 5 國紗布染廠、5 國成衣廠，打造智慧工廠，並將產業知識（Domain know-how）結合大數據分析，研發新機能布、找出商機及顧客。

第三天清早，前往蒜頭糖廠造訪超過百年歷史的古樸木造糖廠火車站，搭乘五分仔小火車出遊，緩慢行車速度，在車掌兼導覽員的妙語如珠



解說沿途田園景致及歡喜高歌中，沉浸在鄉間的一脈輕鬆悠閒。當然也不容錯過，一定要品嚐糖廠古早味的暢銷冰品，既清涼又消暑。接著來到嘉義縣板頭社區，從板陶窯出發，迎著除除微風騎著 4 人共乘協力車遊覽處處充滿藝術氣息的傳統社區，各家戶牆壁上的壁畫透露屋主之前經營行業、花漾門牌、小公仔造型郵筒或於各角落尋獲立體造型逗趣貓咪、小白兔陶偶，感受到在地人家日常生活，如此親切。社區大型剪黏壁畫以當地苦楝樹呈現春花、夏葉、秋果、冬枝的四季景象，如此驚豔。臺灣玻璃館內有令人目不轉睛的大型玻璃藝術品創作，亦有販售精巧玲瓏各式玻璃製品，而「黃金隧道」運用玻璃材料、搭配 LED 燈照射、輔以多重鏡面，創造奇幻視覺效果，彷彿進入新奇的魔幻秘境。第一梯次企業參訪旅程到此畫下完美句點，以下摘錄 27 位學員參與企業參訪活動的心得感想與衆同享。

The event of 2018 Enterprise Visit for International Graduate Students, which is arranged and sponsored by the CTCI Foundation, is a significant program which has been successfully administered for five straight years. Through visits to Taiwan's prominent enterprises which are representative of Taiwan's industries, CTCI Foundation hopes to act as a bridge, connecting international graduate talents with Taiwan's enterprises in an ever-globalizing world.

Specifically, the main goals of the visits are to foster a deeper understanding about prospect of Taiwan's corporations and working environments, as well as bring together positive interactions between corporations and international participants from diverse backgrounds that are in Master and Ph.D. programs at universities in Taiwan. Through learning about business philosophy, vision, and actual operations of Taiwan's corporations and industrial developments, CTCI Foundations hopes to enhance international students to pursue careers and join corporations in Taiwan, contributing their knowledge and expertise, thus creating a win-win situation for all parties.

Different from previous visits which were located at the northern or middle regions of Taiwan, this year's visits first time targeted prominent corporations in the southern regions of Taiwan. The hosting companies of the first tier of enterprise visit, in order of visiting sequence, include: China Steel Corporation, LITE-ON Technology Corporation, HCP Pump Manufacturer Co., Ltd., Boltun Corporation, Uni-President Enterprises Corporation, and Everest Textile Co., Ltd.-all of whom are successful and renowned in their respective industries as well as in the world.

It is also an honor to have **InvesTaiwan** on the visiting list. The governmental agency of InvesTaiwan walks international students through essential topics of staying, living, and working in Taiwan. By providing a simple and single-stop services, its supports range from providing job matching, working visa-related trouble-shooting, to business investment integration.

Activities on the third day include special tours to local sites which represent aspects of Taiwan's natural beauties, local artistic and cultural development. These include Yan-Cheng Cultural Park and Suan Tou Sugar Factory, Bantaoyao, and Taiwan Mirror Glass Enterprise Tourism Factory, all of which receive high praise from tourists and visitors.

As weather at the beginning of enterprise visit was under the influence of typhoon Prapiroon, the first two days of the visiting schedules were accompanies by heavy rains. Despite this, Tier One students showed up on time at the gathering point, and participated with great levels of enthusiasm and curiosity.

China Steel Corporation was founded in 1971, and located in Kaohsiung City, Taiwan. Situated at the Kaohsiung LinHai Industrial Park, its strategic location is very close to the harbor, airport, and rapid transit system, which makes import of raw materials and export of steel fast and convenient. It is known that CSC makes annual production of crude steel around 10 million tonnes. CSC produces wide range of products including plates, bars, wire rods, hot and cold rolled coils, electrogalvanized coils, electrical steel coils, hot-dip galvanized coils, and Ti/Ni-based alloy. The domestic market takes approximately 70% of CSC's production and the exports take the remaining 30%.

With its Ha Tinh steel plant already operating in Vietnam, this successfully paves the way for CSC's expansion in Southeast Asia, while integrating middle stream and downstream industries, all the while enhancing its operational synergy.



LITE-ON Technology Corporation is a worldwide leading provider of optoelectronics, information technology, storage devices, and mobile devices components. Their products are used in a broad range of applications, such as computers, communications, consumer electronics, automotive electronics, LED lighting, could computing, industrial automation as well as biotech and healthcare. According to Thomson Reuters, LITE-ON ranks amongst the "Top 100 Global Technology Leaders" alongside other international company brands.

During the visit, the up close and personal tours to LITE-ON's operational plant opened eyes and mindset of international students, as they were able to observe manufacturing equipment and watch process of product development stage by stage. Adding to this valuable experience was the detailed explanation by representatives at the plant, which help students to connect academic learning with actual industrial productions.

HCP Pump Manufacturer Co., Ltd. was established in 1979, HCP is the most successful submersible pumps manufacturer in Taiwan. Since its establishment until present day, pump is constantly the main product, and all HCP staffs are always enthusiastic in developing and implementing better hydrodynamic techniques with lower consumption. Based on the sustainable use and recycle of water resources, HCP continually reforms its products and offers best customer services in an effort to gain highest level of satisfaction from domestic and international customers.

Currently, HCP develops 20 different series and more than 300 models applications for: Waste Water, Municipal & Industrial Water Treatment, Oil & Gas Water Supply, Construction & Mining Dewatering, Agriculture Irrigation, Aquaculture, Landscape, Pumping Station for Flood Control. The output of HCP Pump is about 50,000 units annually, and the volume is increasing continuously.

On the day of the enterprise visit, HCP specially arranged its foreign employee to conduct the company introduction, share work experience and interact with the students. At the exhibition room, the staff explained about diversified pumps which are all made with streamlined technology, energy saving, and low consumption, much to the amazement of student participants.

Boltun Corporation has adhered to the concept of "Quality First, Customer First". It established a continuous improvement system of "independent innovation and internal thinking" and promoted ISO9001, QS9000, and TS16949 from the beginning. The emphasis is not on the acquisition of certificates, but on the implementation of the system and the deep cultivation of ideas to provide customers with stable and high-quality products.The company's products are general purpose fasteners such as welding screws, nuts and other hardware components, which is used for high-grade customized fasteners for the automotive, electronical industries, and industrial machinery with high standards and restrictions.

The tour through BOLTUN's plant provided students with a deeper understanding of the making of different kinds of screws with diversified functions and usages.

Uni-President Enterprises Corporation is dedicated to food manufacturing as well as new business exploration. Being awarded as "2017 Best Taiwan Global Brands", its business group is consisted of more than 200 companies both within Taiwan and abroad, with business operations covering a wide range of products and services of daily consumption.

After becoming a large business group, the company adopted "social marketing" as their core operating model, to fulfill their obligations as a corporate citizen with the mission of providing a healthy and happy lifestyle. Needless to say, Uni-President has successfully brought about positive influence and impact, as well as changing consumers' way of life and habits. Uni-President is aiming to become one of the largest food companies in the world. Realizing globalization is the crux to overcoming the constraints of an island economy, Uni-President has proactively constructed new plants in emerging markets throughout Asia Pacific, including China, Indonesia, Thailand, Vietnam, and the Philippines to meet the future development and challenges.

Everest Textile Co., Ltd was established in 1988 with its headquarter based in Tainan, Taiwan; it has become one of the few textile manufacturers vertically integrated from yarn, fabric

weaving, knitting, dyeing, printing, and garment manufacturing. Because of this unique advantage, Everest enjoys to have steady growth and profit despite economic recession abroad.

Everest owns five fabric factories, three garment factories, and eight overseas offices around the world. In 2016, the company implemented "Moonshot Thinking 5+5 Global Distribution Plan" to face global competition. From now on, Everest invests strategically for the future: the company currently has three factories in Asia (Taiwan, China and Thailand), and also plans to build a weaving and dyeing factory in North America and garment factories in Africa. Everest increases vertical integration by establishing garment factories for value-added service, extending weaving and dyeing, and garment factories from Asia to North Carolina and Ethiopia, producing locally for strategic values. Everest also manages to combine domain know-how with big data analysis for continuous research and development of upcoming functional wears. During the visit, participants had the opportunity to see functional sports wears.

On the third day which was a sunny and relaxing day, we headed for Suan Tou Sugar Factory to see its historical train stations with over hundred years of history. All the participants joyfully took the ride on the traditional mini trains, which were used to transport sugars in the past, listening to train guide's explanation and cherishing countryside scenery passing by. Students happily tried the local ice creams and popsicles under the hot weather for a new kind of cooling experience. Then, at arriving at the Bantaoyao, students rode on quadruplets at the neighborhood filled with artistic elements from decorated mail box, door plates, to pottery in cute animals' forms. The large wall decorations at the neighborhood, shows seasonal changes throughout a year through paintings of bead trees, representative of the spirit of residents at the local region. At the Taiwan Mirror Glass Enterprise Tourism Factory, we encountered a world with fascinating and creative glass art works. There were many large pieces of artwork, as well as small and delicate souvenirs. Probably the most fascinating amongst them is "Golden Glass Tunnel", a visually magical fantasy land created by clever uses of glass materials, LED lighting, as well as multi-dimensional mirrors, casting everlasting memory on the students.

The 2018 Tier One Enterprise Visit ended with high praise from student participants. For now, let us refer to the detailed feedbacks from 27 international graduate students from Tier One.

Aindri Yuliane 印尼 (Indonesia)
勤益科技大學 NCUT 冷凍空調與能源 碩士

This activity is very useful and interesting. As a foreigner, now I am aware that many Taiwanese companies offer job opportunities for foreign students. This activity provides all valuable information about how to apply for work permit and visa for employees. This is very useful for foreigners. Besides that, I also met many new friends from other countries and backgrounds. We were able to share with each other about our research and other things. At last, I really thank all the CTCI Foundation staff whom really take care of us. Overall, the three-day activity is really satisfactory. I will persuade my friends and my juniors to apply this activity in the near future.

Ali Montazami 伊朗 (Iran)
淡江大學 TKU 未來學研究 碩士

First of all, I would like to thank CTCI Foundation for this very high quality and useful program. Following are some feedbacks which I think are very good to keep for future visits. The program introduced various industries in Taiwan to international students and connected students and enterprises by providing a very good introduction on Taiwan's thriving industries and some companies' productions and services. The selection of enterprises to visit was very well done as they are amongst the industry-leading companies of Taiwan. It is an excellent decision to include InvesTaiwan Service Center in the program. It is also excellent to include attraction visits with very good sightseeing sites. Aside from that, it is very positive as we were able to make connection with other students of different nationalities from universities in Taiwan.

For me, this visit led to my growing interest to live and work in Taiwan. It also provided me with the opportunity to contact the enterprises and key managers there for future business and career purposes. I have an extraordinary respect to the CTCI Foundation team, for their professionalism, warmth, and friendliness. Emails were very well

designed to give enough information to participants to make us ready before the trip. CTCI staff especially had very good attention to details and didn't miss students' needs.

Bui Thi Hiep 越南 (Vietnam)
成功大學 NCKU 資訊工程 碩士

The 2018 Enterprise Visit activity had been very enjoyable. I really want to give thanks to the CTCI Foundation, accompanying staffs, InvesTaiwan, all enterprises and fellow participants. I thoroughly enjoyed the three-day trip, and believe it is one of the best activities for international students who want to work in Taiwan after graduation. The best thing about this activity is that, it helps me to understand the current developing trends of enterprises and technologies which are applied in industries today. From there, I can build a suitable roadmap to fulfill my ambition to apply computer science and information engineering in the industry, as well as contribute to the development of society in general. Through visits to the enterprises, I realize that besides having good professional skills, Chinese proficiency is one of the most important requirements for finding a good job in Taiwan. This is a message which I will inform my international friends.

And it would be a great omission if I forgot to mention our sightseeing on the third day of the activity. We visited various famous and interesting places in Chiayi and Changhua, places where we were immersed in beautiful nature and interesting stories of the country. I benefited tremendously from the 2018 Enterprise Visit. I will definitely introduce it to my friends, so that the benefits and meaning of the activity will be widely shared with everyone. Once again, I would like to send my deepest thanks to the CTCI Foundation, and especially accompanying staffs who worked really hard to give us a really great activity. I appreciate greatly and I am grateful for the assistance and support.

Darge Haile Fentahun 衣索比亞 (Ethiopia)
臺灣科技大學 NTUST 應用科技 博士

Generally speaking, I have been very satisfied with the trip of enterprise visits. Through it, I realize and learn about how each company started from scratch, built management system, took measures to deal with environmental pollution, and committed to the training and development of people, as well as quality of their products and innovations, so as to be competitive in the global market. I personally believe that this activity makes interesting impressions on students and helps us when considering about future career directions. As a student, it inspires me and shifts my future career direction to participate and contribute my best ability in different companies for better development. I am greatly appreciating CTCI Foundation for their initiations and grants for us to visit enterprises, and I recommend CTCI to continue this fantastic activity. Thank you so much!

Dashnyam Chuluunkhuu 蒙古 (Mongolia)
勤益科技大學 NCUT 空調冷凍與能源 碩士

I knew from before that Taiwan has advanced technology, from the visit, not only did I get to see very high technological development, but I also saw wonderful art performance. We visited China Steel Corp., Uni-President Enterprises Corp. and other international manufacturers in Taiwan, I have to say thanks to all of the hosting corporations as they were very kind and helpful to everyone. In the last day, we travelled together through old sugar train station of Suan Tou Sugar Factory, Glass Museum and Bantaoyao. All of us had a lot of fun and enjoyed much from the trip. During the visits, I saw some foreigners who are working in Taiwanese factories and they have inspired me even though they did not speak Mandarin well- they were all trying to do their best. Personally, working abroad is a very unique experience for me in life. CTCI Foundation staffs organized this wonderful visit, and moreover, they tried to help us to explore job opportunities, as well as assistant us to stay on this beautiful island. In addition, I met new friends from different countries, learning about each other's culture and helping each other out during the trip. A friend from Indonesia in particular has perspective that was completely different from mine. We exchanged ideas and thoughts about studies and many things. We are still keeping in touch, and now I have very good friends who are studying in other universities and in other cities of Taiwan. The CTCI staffs were helpful to everyone, talking and treating students with kindness. What I learned is that, kindness is

not only helping people on daily aspects, but also treating them with kindness. The students were from different countries, but we were all treated as the same without difference. This enterprise visit was very wonderful and there were a lot of enjoyment and new experiences in my life. We had been together only for three days, but I felt these days were very interesting and enjoyed a lot. Thank you CTCI Foundation!

DO TRONG NHAN 越南 (Vietnam)
成功大學 NCKU 土木工程 博士

I would like to thank CTCI Foundation for sponsoring all international participants for the interesting Enterprise Visit. I got a good chance to visit the top industrial companies in Taiwan. I can see and learn about how the companies are organized and running business logically.

Emmanuel Leonard 海地 (Haiti)
中央大學 NCU 遙測科技 碩士

I want to thank the CTCI Foundation for organizing this interesting trip for international graduate students. I also really appreciated the hospitality of each company and this is a good sign of working environment which is extremely important to foreigners.The impact of such activity is obvious and visible: it is a great opportunity for us by connecting with successful companies and entrepreneurs, so we can learn from their experiences. These companies successfully integrate their working staffs as a team to achieve profit goals and earn money. The visit also inspires us as graduate students: I consider this as a good step for my future career, to bring back these experiences to our respective countries, and help contribute to our economic developments as well as environmental concerns. As the participating students are from different universities and specialize in various fields of study, this gathering helps us to build up new friendships which all of us can continue to profit in the future in many ways. Big thanks to the organizing and accompanying staffs who arranged the visit to each company and also the driver. I hope that CTCI keeps doing this kind of trip so that other new graduate students can enjoy exploring more things about Taiwan.

Gilang Baswara Anggara Putra 印尼 (Indonesia)
中央大學 NCU 應用材料科學 碩士

The 2018 Enterprise Visit held by the CTCI Foundation gave me a chance to learn a lot of new knowledge about enterprises and their factory operation in Taiwan. All the companies we visited are good and appropriate in the Industry 4.0 era. Few industries are categorized as steady industries such as China Steel Corporation and Boltun Corporation. CSC, which produces steel, improves its product quality by learning from different kinds of industries; while Boltun, which produces fasteners, adapts methods such as enlarging the range of industry to P2C by opening the Pineapple cake bakery store. I personally think CSC and Boltun have very good business models. In addition, these companies provided useful information about strategies on their industrial expansions in the future. Useful and emerging technologies were introduced, which opened new perspectives for these industries in the future. The trip also included sightseeing. The attractions we visited were interesting, especially the Taiwan Glass Factory. Through this Enterprise Visit event aims for international graduate students, all of us are able to understand how Taiwan conquers various industries globally. We learn a lot of new knowledge and company strategies on how to run business. Most important, this activity is an eye opening experience that could expand our job opportunities in Taiwan.

BALKEW ZEWGE HAILEMESKEL
衣索比亞 (Ethiopia)
臺灣科技大學 NTUST 應用科技 博士

The enterprise visit was perfect from the beginning until the end. Especially, it was great we were able to visit the Boltun Corporation and saw its actual processing operation. The coordinators gave detailed information throughout the visiting program. And the schedule and time management were efficient. I would like to say “keep up the good work”, and thank CTCI Foundation so much.

Iffandya Popy Wulandari 印尼 (Indonesia)
中央大學 NCU 機械工程 碩士

This is the first semester in my graduate study and the first time I visit industrial companies here in Taiwan. It is such a great experience

for my studies. Thanks to InvesTaiwan Service Center, I got a lot of information about working in Taiwan, which sure can let me pursue my career in the future. This is especially a good program for international students, and I also met new friends from other countries. Finally, I hope this event will exist year after year.

LOBO PACHECO ISAMARA ALEJANDRA
哥倫比亞 (Colombia)
南臺科技大學 STUST 機械工程 碩士

CTCI Foundation worked really hard with accuracy in finding and matching the most representative companies and participants that fulfill each other's needs during the enterprise visit. The enterprise visit was carefully planned-even the most minimal detail was taken into consideration. The enterprise visit is one of the best opportunities for foreign students to get to know more about different Taiwanese companies, recruitment procedures, and related requirements, as it is hard for some of us to get enrolled into Taiwanese companies. It's been a great experience and opportunity for me. My desires to grow personally and professionally increased from the trip. Thanks so much to CTCI Foundation for the quality job done this year.

Maaz Ajvad 印度 (India)
長庚大學 CGU 機械工程 碩士

I learned so many things about Taiwan's company culture, working environments, and job opportunities. Moreover, the presentation by InvesTaiwan Service Center gave us clear ideas about job and work permit which is the first step for any job seeking student. Most of the visited companies were somehow linked to my research as I came to learn about their job requirements. And I could consider if I want to seek jobs with these companies in the future. The most important thing about this trip is that there are candidates from different countries, cultures, universities and backgrounds, which helped me a lot when learning about different fields of studies and related trends. The CTCI staffs guided us during each company visit in such way that I don't have the words to express my feelings and gratitude towards them. The trip and its planning were wonderful, and hospitality from CTCI Foundation was awesome. Thanks to CTCI Foundation for organizing such a wonderful trip.

Martin Flemming Panggabean 印尼 (Indonesia)
中興大學 NCHU 科技管理 博士

Everything from the enterprise visit was perfect, and I have to say it is the best visit I have ever had during so many years living in Taiwan. We really enjoyed the enterprises' presentations. During the companies' presentations, the participants had the opportunity to ask questions and visit the operation sites. This allowed positive, active, and direct exchanges of experiences between visitors and host companies. However, in terms of job opportunities, I realize that Chinese language proficiency is also part of the company's necessary requirements to hire employees for their business. On the side, the accommodation in every city was very good-all the hotels were upscale and I had very good sleep as the rooms were very comfortable. Moreover, the foods were so delicious. And the driver was very good with his driving and drove very safely. The bus was also very clean and comfortable. It is really high-class visit. In summary, the whole trip was extremely well-organized and offered so much more than we expected with all the interesting side trips on the third day, sightseeing, and a lot of surprises. Thanks to CTCI Foundation because the enterprise visit went well and we were very satisfied. Thank you very much for having arranged the magnificent trip we took!!

Mohamad Nor Hisyam Bin Mion
馬來西亞 (Malaysia)
勤益科技大學 NCUT 冷凍空調及能源 碩士

I would like to thank the CTCI for give me the opportunity to be part of this knowledgeable program. I gain so many insights about the visited Taiwanese companies listed below: China Steel Corporation produces a range of steel products including plates, bars, wire rods, hot and cold rolled coils, electrical steel coils, hot-dip galvanized coils and Ti/Ni-base alloy. In its production, the corporate value of teamwork, entrepreneurial

approach, pursuit of innovation is easily to be seen. The CSC group, which including its 26 subsidiaries, deems environmental protection and energy saving and centers its development in Asia. It is making efforts to become a resource-saving and eco-friendly group of global distinction. LITE-ON products are used in a board range of applications, such as computers, communications, consumer electronics, automotive electronics, LED lighting, cloud computing, industrial automation as well as biotech and healthcare. And it has been shifting its production focus from IT and communication towards IoT applications such as cloud computing, LED lighting, automotive, biotech, and industrial automation. HCP Pump Manufacturer is the most successful submersible pumps manufacturer in Taiwan, and has developed 20 different series and more than 300 models, each with its unique usage.

Gaurav Pandey 印度 (India)
長庚大學 CGU 機械工程 碩士

The trip of enterprise visit was very informative, and it helped me to make connections with my own academic domain. Besides the focused learning, we also enjoyed a lot from the trip. I respect the CTCI Foundation as it continuously provides all the necessary requirements according to the norms and interests of the students from diverse backgrounds and different countries. I consider myself to be very lucky to get a chance to visit Taiwan leading companies, which I don't think it would be possible for me to visit by myself. Thanks to the CTCI Foundation for providing this wonderful trip and experience. Overall, the enterprise visit was good and one of the most resourceful and best trips I had in Taiwan. The work CTCI Foundation is doing is really unique. Thanks for everything.

PHAN DINH VAN 越南 (Vietnam)
元智大學 YZU 資訊管理 博士

First of all, I would like to give my thanks to the CTCI Foundation for organizing this high quality trip and guiding us throughout the three days. I knew that Taiwan has many big enterprises, but it was through internet or television, this opportunity allowed me to visit these companies directly for the first time. I also would like to thank all of the visited companies for their warm welcome and introductions. Although my current research is not very relative to the visited companies, this trip has affected my view for the future. When I finish Ph.D. program here, I hope that I will have an opportunity to cooperate with a company or research center in Taiwan. I hope I can also learn many things in the professional working environment of these companies. As a lecturer, I have gained much experience for my part, and I will share many stories from this trip with my students. It was a great trip.

Ramteke Nikita Anil 印度 (India)
高雄海洋科技大學 NKMU 航運管理 博士

Thank you so much for cordially selected and invited me in the enterprise visit tour. I appreciate all your efforts during the tour as well as I was highly impressed by pre-planning of three-day tour arrangements. I really enjoyed meetings with all famed enterprises. Finally, my high gratitude goes to entire CTCI team and all my international friends. I wish our contact with each other will last forever.

Resza Diwansyah Putra 印尼 (Indonesia)
東海大學 THU 化學工程與材料工程 碩士

Thank you for arranging this great event. Through this enterprise visit, I gain more insights to the industries in Taiwan. Hopefully, this event can act as bridge between international graduate students who wants to pursue their dream career to Taiwanese organizations.

Sudhir Pandey 印度 (India)
中國醫藥大學 CMU 生物醫學 博士

I enjoyed the Enterprise Visit and treasured the opportunity very much. The hospitality and dedication from the CTCI Foundation team were extraordinary, and these made me think the Taiwanese society is special. The visited companies are all great and doing remarkable business globally. We had a great learning experience while visiting these world-class renowned companies, having real-time glimpses of their manufacturing

and production processes. Visiting Uni-President Corporation was of special interest to me personally. Since I am studying in the field of Biomedical Science, therefore, it would be great if few healthcare or biotech companies could be included for future enterprise visits. I will look forward to hearing future information and update from CTCI. Thank you for the support for foreign students.

Phan Dinh Minh Tri 越南 (Vietnam)
高雄第一科技大學 NKFUST 國際管理 碩士

For the 2018 enterprise visit, the companies we visited in the trip are big and famous, and very well represent each specific industry. Through the company introductions and plant tours, we learned a lot about each corporation. As well, we also got to know some job opportunities. It was definitely a good starting point for us to look for a job in Taiwan. Furthermore, meals, transportation, and accommodation were all good. Thanks very much to CTCI Foundation for organizing such a meaningful event for international graduate students.

Veeramani Rajendran 印度 (India)
臺北科技大學 NTUT 製造科技 碩士

This visit is really fruitful to international students because it creates a good platform for international graduate students to understand the industrial requirements for work and employment in Taiwan. The visit covers different kinds of industries, this is actually a good idea as it is beneficial for students to meet their dream industry based on their educational and research interests. The visit also offers a chance to learn new and interesting things which are outside students' research circles. My feedback for the visited corporations and the visit is listed below:

(1) The presentation by InvesTaiwan Service Center speakers helped us to know more information about the procedure of applying for a work permit.It also helped us to know more about the types of VISA, respective advantages and requirements.
(2) The policy of green working environment by the Everest Textiles seems to be very attractive and unique. The strategies of "moonshot thinking 5+5 global distribution plan" and practice of AI during their manufacturing process demonstrate their future forecasting capability.
(3) Uni-President Enterprises is one of the unforgettable enterprises from the visit. I was so excited when I heard it is the manufacturer of daily products sold at 7-11 convenience stores. I appreciate the company's statement that the addition of new things is always required for business to turn successful.
(4) The visit to Boltun Corporation created ever-lasting memory because of their name which is made up of "Bolt" and "Nut". They displayed all kinds of bolt and nut and discussed a lot of technical information of manufacturing during the plant visit.
(5) The presentation of HCP Pump Manufacturer discussed about the importance of water and pump as well as changed the idea of the pump in general people's mind. I am excited to see that different research opportunities are available in pump manufacturing.
(6) LITE-ON Technology is one of the enterprises which I am personally glad to visit because my research is more related to the optoelectronic industry and it is my first time to visit a semiconductor fabrication plant site. I appreciate LITE-ON greatly because a lot of semiconductor industries would not allow guests to actually see their product processes.
(7) Since I got a chance to visit two leading public sector steel manufacturing industries while I was pursuing my bachelor studies, therefore, I could understand how hard it is to visit a grand steel factory site in one hour. CSC tried to show all the processes by sitting on a bus which was truly appreciated. That's the first time that I knew Taiwan has an integrated steel plant to produce in high quality and large quantities of steels compares to China.
(8) The sightseeing on the last day of the trip was really mind-blowing and I look forward to having such day again in my life. The photos taken in Taiwan Mirror Glass Gallery are stunning and I have received a lot of likes and comments from friends on the social network.

VIPUL DUBEY 印度 (India)
臺北科技大學 NTUT 自動化科技 碩士

The CTCI Enterprise Visit is one of the

best group trips I have ever had in Taiwan. The enterprise visit was quite a learning experience about the working culture in Taiwan. I was able to meet many other students and develop some good contacts with these friends from different countries and working backgrounds.Being part of this program also opens the door to possible opportunities to work in Taiwan. During this enterprise visit, I came to realize the importance of Chinese communication skills for finding a job in Taiwan. Overall, this enterprise visit allowed me to link up with people of similar interests, to constitute a comprehensive learning experience that would be helpful for my career ahead. To sum up, I would like to really thank the organizing committee and praise them for all the efforts they put into making this trip a great experience for all of us. I believe that CTCI Foundation tried their best. I am highly impressed by the overall trip and would love to recommend my friends for future enterprise trips.

William 印尼 (Indonesia)
臺灣科技大學 NTUST 材料科學與工程 碩士

I enjoyed the Enterprise Visit event held by the CTCI Foundation and felt really satisfied. Aside from the great experiences of learning details of each company and its respective industry, I also made new friends. One of the advantages by participating in this event is that, I have an opportunity to forward my resume and CV to companies that we have visited. By viewing insights into the visited companies and real working fields, that help me better manage and prepare for the job requirements. CTCI staffs treated us very nicely and all schedules were arranged very well. Thanks to CTCI Foundation for the great experience!

ALELY RAMOS VELASCO
薩爾瓦多 (El Salvador)
中央大學 NCU 國際永續發展 碩士

Everything was perfect about the visits and its arrangement, and the visiting companies made us feel welcome. The overall experience was gratifying-it was an awesome opportunity to meet friends and learn about different enterprises in Taiwan, this would not have been possible by myself.

Zikril Hakim Bin Salam 馬來西亞 (Malaysia)
勤益科技大學 NCUT 冷凍空調與能源 碩士

This is my first time to join enterprise visit with participants from many other countries. Personally, I think the enterprise visit was good. Throughout this trip, I visited various representative companies and learned about their productions and products. It is great to know many Taiwanese companies hire foreign employees. This activity also makes me realize that Taiwan has many good companies that we can work for or do business with in the future. Through it, I have built good connection with other international students as well as with CTCI Foundation staffs. All the CTCI staffs are great people whom made this enterprise visit to be such a great one. You made our job easy and thank you for that. You did such a great job and you are awesome!

ZOGONA DANIEL 布吉納法索 (Burkina Faso)
中國醫藥大學 CMU 營養學系 碩士

Actually, the 2018 Enterprise Visit exceeded my expectation. The enterprise visit was a great opportunity for me to learn more insights about Taiwanese enterprises. Now I am considering getting a job here in Taiwan. As a foreigner, I could be a bridge between Taiwan and another part of the world. Thanks for all the information you have provided. Overall, CTCI Foundation did a great job to satisfy everyone. I was very happy to take part in this visit, and I would like to thank CTCI Foundation for this initiative. Keep up the good work! For sure, I will talk to many people about CTCI Foundation and the enterprise visit activities.

ZONGO Abel Wend-Soo
布吉納法索 (Burkina Faso)
中國醫藥大學 CMU 營養學系 碩士

The 2018 Enterprise Visit was well scheduled and conducted. A suggestion to make this useful activity even better is that, for each tier of the trips, CTCI Foundation could match the fields of interest and major of studies of participants with selected enterprises to be visited. That could help participants to enjoy their visits and have the opportunity to meet their potential future employers at the same time.

中技社 107年技術研發計畫概述

企劃暨工程科技室 楊顯整主任 ・ 劉惠君副管理師

因應政府推動創新產業之需求，本社極力開發具產業應用潛力、可即時應用及解決現行工程問題之新技術，107 年共選定 9 項技術研發計畫，重點概述如下。

軌橋互制行為及鋼軌伸縮接頭設置研究

國內工程公司積極參與國內外輕軌及捷運軌道等基礎建設工程，為改善舒適度與軌道維護的方便性並解決橋上長軌合宜之設計，進行軌道工程技術以提升軌道工程之整體競爭力。長焊鋼軌為現代化軌道工程技術的趨勢，但不同軌道系統通過不同型式橋梁所產生之複雜力學問題，攸關軌道系統挫曲 / 拉斷之安全及衝擊生活品質的振動噪音，已成為軌道設計的關鍵技術之一。

由於伸縮接頭、橋軌互制兩項課題須考量列車輪軸配置形式，橋梁跨距、枕木間距等因素，亦需要實測數據綜合研判車速與橋梁共振問題。本計畫將由行車安全角度切入，透過文獻回顧歸納高架橋上無碴軌道受橋軌互制力影響行為、軌道設計關鍵因素及相關規範，了解軌道鋪設於橋梁所產生之複雜力學問題。從靜力分析角度探討橋軌互制力之特性，評估是否需設置伸縮接頭來降低橋軌互制的影響。另參照國際鐵道聯盟規範 UIC 774-3R “Track/bridge Interaction Recommendations for calculations”，探討研究範圍與變因後，歸納相關文獻與理論。並根據規範建立橋軌互制有限元素分析模型，以及遵照條件及參數規定完成分析模型之基本驗證，確認分析結果符合國際規範，掌握橋軌互制理論、分析工具、設計能力。

轉動設備聲學監測之低耗能雛型產品開發

工業 4.0 其中一項是結合工業物聯網與大數據分析，應用在不同領域的製造場所，透過即時訊息蒐集，達成預防故障、降低成本、提高產能等目標。目前市場上最普遍使用的轉機設備預兆診斷系統是以量測振動變化的方式進行，如要達到精密量測的目的必須安裝昂貴的振動分析監視系統 (VAMS)，並在設計階段就必須進行規劃，無法安裝於既有設備上，且在現場需要配置電源與訊號傳輸線路，其建置成本昂貴，因此通常僅安裝在大型重要設備上，無法對於所有的設備進行監測，使得工廠存在不預期停車的風險。

目前在工廠中重要的轉動設備如馬達、減速機、壓縮機、引風機等，其內軸承等易磨損或故障之元件通常定期以聽診器檢查，或裝設振動、溫度量測之監測，作為分析設備劣化或損壞情形之依據。本計畫使用小型收音裝置收錄轉動設備所發出的噪聲，再應用大數據演算及機器學習等技術，取代人工聽診的方式來達到預知保養的目的。前期計畫已使用樹莓派 (Raspberry Pi) 加裝麥克風及音效卡做為現場收錄音裝置，再搭配開發的分析監視系統達到預警目標。唯樹莓派仍為較耗電之裝置，必須以外部電源持續供電才能維持長時間運作，實務上不符合易於安裝與使用的需求。因此與中正大學通訊工程學系研究團隊合作研發，以電池供電能運作一個月以上，並在工廠環境中傳輸成功率達 90% 以上的低耗能小型無線錄音模組雛型產品；並以設備噪聲分析為基礎的低成本預

兆診斷系統，結合前期成果開發可業務推展之低耗能轉動設備聲學監測產品，提供設備預兆診斷系統之解決方案，減少錯誤警報之機率。

化工 4.0 虛實整合系統示範工廠建置

國內半導體製造業堪稱我國電子產業龍頭，其中晶圓製造業、封裝業及導線架產業和光電業中的 LCD 及 LED 製造業所使用之化學物質及有機溶劑最多。依據環保署事業廢棄物管制中心資料顯示，國內廢溶劑之年產量約為 15 萬噸，其中屬一般性廢溶劑為 88,313 噸 / 年，屬於有害性廢溶劑則為 65,324 噸 / 年。目前半導體及光電產業的主要污染物可分為毒性及有機廢氣、廢溶劑及廢水。國內廢液處理之方式有：委託或共同清除、廠內自行處理、再利用、境外處理。民國九十年四月二日政府公布「水泥窯」可作為有機廢溶劑處理的技術之一，營業項目包含易燃性廢溶劑、廢潤滑油、廢污泥、去光阻液、蝕刻廢液及其他有機及無機廢液等，但是目前水泥窯處理方式有其缺點（磚窯品質低、排氣中含污染物廢氣），多家廠商不願意再承接處理，含水量高的廢液不易處理，導致處理費用升高。本計畫以廢異丙醇為出發點，分別以反應蒸餾系統加上滲透蒸發技術及化學迴路燃燒之製程進行處理。其中，反應蒸餾系統加上滲透蒸發技術可將廢異丙醇轉換且純化為高單價溶劑用於油墨、塗料溶劑、脫水劑等，而化學迴路燃燒可以產生極高純度的二氧化碳，進一步的做資源化建材或是將其二氧化碳封存。

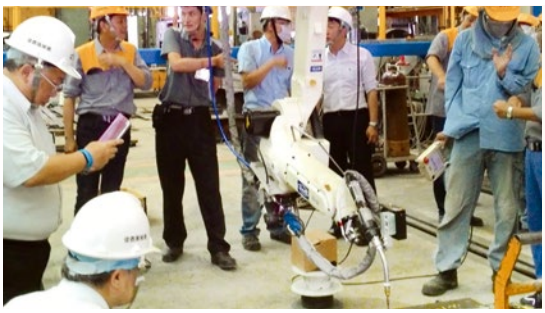
在虛實整合系統中，其核心為透過收集下來實部的數據，將實體模型數位化成數位雙生（Digital Twin）存在於虛（Cyber）的環境中。在虛部空間裡，由於數據擁有流動性（數據無國界無時差），所有的運算與資訊交換都可透過網路快速進行，因此可讓 Digital Twin 在任何地點或裝置上即時呈現最新狀態，忠實的紀錄與反應實部空間（Physical Space）的一切。而數位雙生最大的功用在於透過模擬優化，對實部模型進行指導與修正。然而若收集不到數據，就無法建構出數位雙生，也無法創造虛實之間的整合。因此，本項技術開發第一步要將 Pilot Plant 中各種設備與製程狀態相關參數收集下來，接著再建構出設備（如蒸餾塔、流體化床）之數位雙生。

虛實整合系統為工業 4.0 關鍵技術，藉由蒐集實部空間（Physical Space）感測器的訊息，透過新一代整合技術在虛部空間（Cyber Space）建立數位雙生（Digital Twin），且數位雙生能完整呈現系統的行為及特性，對實體空間的設備達到監測、分析及最適化的功能。因此，配合台科大異丙醇廢水處理研究，對反應蒸餾及化學迴路燃燒系統 Pilot Plant 進行虛實整合系統的建立。

工廠 P&ID 製程安全管理應用

在現今環保意識抬頭、寸土寸金的台灣，煉油石化工廠任何一個閃失發生毒性氣體洩漏，或管線腐蝕而破裂，都可能導致嚴重工安或環保事件，不但影響整座石化廠的運作，相關人員還可能需負刑事責任。如果建構一套完善的 P&ID 資料庫：在操作面，能夠提供正確且豐富的製程與設備資訊；在設計面，能有精確的規則檢查、一致的參考標準與彈性的屬性建立；在管理面，數據源自於唯一資料庫，讓版本管理更簡化，智慧保存更方便；在應用面，能透過建構製程安全相關資訊，突顯工廠關切的工安議題。整體而言，對於提升工廠的操作安全、維修品質，降低工安或環保事件的發生風險，都會有很大幫助。

面臨前述問題，導入智能化 P&ID 軟體 (例：SmartPlant P&ID 簡稱 SPPID) 刻不容緩，它的最大核心價值，簡單來說是採用資料庫的方式並規範出統一標準與規則，解決



管理及應用上的不便與缺失，透過它可快速進行整個工廠設備資料的統計分析、查詢、更新，甚至可以做到變更資料而自動驅動某些圖形的相對應變更、自動計算、產生不一致性檢查報表等功能。另外，可再透過各種外接程式語言，實踐客製化功能，協助進行相關自動化作業。

智慧光學量測系統 (iSharp) 開發計畫

過去傳統製造業的品管作業產品檢測過程皆人為操作，冗長的作業模式容易使操作者出現人為偏差、疲勞、注意力分散等問題。且使用人工進行產品檢測，只能採定時或批次抽驗，無法百分之百的全檢；若以智慧光學量測系統將人工檢驗作業全面自動化，將可減少現場及品管人力需求、縮短檢驗時間，即時掌握產品品質狀況，更能提高檢測速度而加快產品製造流程，提升出廠產品的品質水準，進而減少廢品的產生機率。

智慧光學量測系統的原理，主要是透過光學裝置和非接觸傳感器，自動獲取目標影像，再由影像處理設備根據所得影像的畫素分布、亮度和顏色等訊息，加以運算處理及判別分析，能在短時間內獲得所需的特徵訊息，或根據判別分析的結果，對現場設備進行運動控制；透過智慧光學量測系統的導入，物體的外觀資訊大量的被累積下來。不論是外形、尺寸、高低、顏色等都能夠快速地被記錄分析，產生可以做為控制判斷的資訊基礎。更進一步將這些累積下來的資料進行分析，加工的流程及作法都可依照資料所提供的訊息作為基礎得以改善優化。

為開發能用於傳統製造業生產加工製程的智慧光學量測系統，與工研院光電所光學合作，開發專業與影像處理 / 影像辨識技術，包括光學量測設備機設計、開發、組裝、調教 (含影像處理、物件量測軟體設計)，量測數據的傳輸、收集、儲存及大量量測數據之統計分析。本計畫成果可應用於塑膠加工產業之 PVC 塑膠硬管管徑及壁厚的自動量測，以達提升檢測速度、加快產品製造流程，並能提升出廠產品的品質水準，包含：自動即時取得被測物件之量測數據、量測數據可以做為生產控制判斷的依據，改善產品品質。量測數據不會因人而異，可信度提高、降低品管人員及現場人員人力需求、掌握光學設備機設計及光學設備調教技術、了解智慧光學量測系統的適用場域及限制，並建置完成智慧光學量測雛型系統。

機動型行李裝載省力智慧裝置計畫

為提升行李裝載從業人員工作效率及延長機場從業人員之工作壽命，降低高齡工作人員的職災等問題，行李裝載作業的自動化和半自動化未來將成為必然之趨勢，目前極力開發設計出符合行李裝載從業人員省時又省力之相關智慧省力裝置。

目標為簡化搬運流程 1/2，目前搬運行李流程為檢視裝載航班 -> 提行李 -> 手持機確認行李 -> 搬行李入櫃車，改善後搬運行李流程為檢核行李 -> 搬行李入櫃車；並使用省力智慧裝置，約可減輕搬運人員 2/3 施力。目前搬運行李人員每件行李所須勞力約 20 公斤，一個航班最多行李數為 600 件，以此類推每位搬行李人員須要在一定的時間內處理完成 12,000 公斤行李量；若由省力智慧裝置代勞，人員的施力將由 20 公斤降至 7.6 公斤，約可節省現有搬運人員約 2/3 的勞力。裝載行李若還需用手輸入相關資料，對搬運者非常不便，目前最有效方案是利用航空公司提供行李條碼及螢幕產生之新二維條碼，再用掃描機進行輸入。本計畫致力開發無限手套穿戴省力裝置產品，預期可提升行李搬運人員的工作效能，及增強物聯網相關技術整合及深度運用。

機器人智能銲接系統開發

近年工業上應用機器人於自動焊接過程已日益廣泛，例如車廠大量使用焊接機器人進行車架成型與車輛組立，皆可大幅提升生產效率與品質。可以說，藉由機械手臂在生產過程中進行點銲或平面銲接的製程已十分成熟與普遍，但也有許多製程因無法進行自動銲接仍採用人工銲接，主因是現有專用銲接手臂智能信息與整合功能化不足所致。環顧國內業者、研究機構與學校尚無整合機械手臂與各類自動化、半自動機具而能執行的成功案例。目前國內尚未具備智能銲接整合技術，因而此智能銲接整合技術的開發，對於未來工廠生產效能與品質提升更形重要。

本計畫將開發一套機械手臂用於銲接 Nozzle 之智能作業系統，智能系統包含以下三種功能：平面智能調整銲接系統、打底銲接及多層多道銲接。若能完成此三種功能之開發，將完成 Nozzle 的自動化銲接取代人力。本系統開發成功後會是國內首座智能銲接系統，將有效降低機械廠製造成本、提升產品質量，預期未來將有許多應用商機。

建立綠道路設計綱要及生命週期評估軟體

工程的生命週期分為原料開採、材料生產、材料運輸、施工、維護、廢棄等六階段，與營造相關的是材料運輸、施工兩階段。彙整材料運輸以及施工機具的油料耗用乘上碳排放係數，再加上施工階段所使用之水電能源耗用，即為施工階段碳排放量，從製造端介入計算，以建立更準確的前端盤查結果。

本計畫以常見之道路工程 (園區開發、市區道路與市區橋樑) 為例，分析工程設計之道路工程碳足跡，建立碳排放量基線。另結合開發的生命週期評估軟體，搭配設計及施工成本，進而制定減少碳排的綠道路設計綱要，使用碳排量少之材料，增進機具使用效率，最後執行道路的能耗碳排基線。利用全生命週期的碳足跡計算結果，建立工程專案的綠色施工基線 (baseline)，提出綠色設計與施工策略，如採購綠色材料、短距離運送、有效率使用施工機具、減少廢棄物等。

藉由建立碳排放量減少策略，在綠道路工程上取得前端、永續專業之優勢，進一步完善材料與機具碳排係數資料庫，導入生命週期評估概念。發展綠道路生命週期評估軟體，作為道路工程碳排放量評估工具並參考國際綠道路指標內容，建立綠道路設計綱要，提升國內業者在綠道路規劃設計能力。成果極具應用潛力，符合政府節能減碳政策。

整合數位展示科技應用於工程施工及設計

順應科技潮流與市場需求，工程單位積極投入多媒體技術，培養未來實現 VR、AR、MR 等互動式應用技術的實力，藉由高品質的展示內容，研究工程應用面數位科技化，除可強化公共工程及智能建築設施等設計，更能為社會大眾提供多元創新的服務。

為反應市場需求，本計畫將投入優化動畫製程與展示體驗相關研究與人才培育。目標是將虛擬實境（VR）的內容以「環景投影」展示，於製作產出內容的過程中，以既有的 BIM 系統與 3D 動畫經驗為基礎，並以「和技術相契合的內容生產力」為發展核心，配合三大策略方向：精準化（活用數據 / 企劃方向正確）、優化（內容與視覺精緻化）、程序化（提升創造內容的效率），與相關數位展示領域（虛擬實境的環景投影）之軟硬體技術研究。透過精進「展現的數位內容」使團隊的動畫技術愈來愈擬真。開發成功後有利於人員即時檢視建築、管架、機電、空調等設計成果，可降低施工風險與提升服務品質，並藉由視覺化的完工展現，提升與業主間的溝通。

淺談科技之星-CRISPR/Cas9基因編輯技術於育種或農業應用

能源暨產業研究中心 王釿鋙主任•許湘琴組長

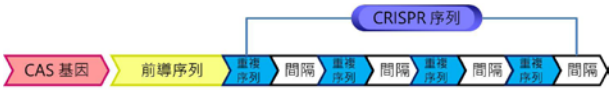
前言

每個生命體都宛如一座超精密的化學工廠，裡面大大小小的化學物理反應皆環環相扣相互影響，而對生命體而言，這複雜的系統藍圖資訊就存在於 DNA 序列中。自 DNA 在 1869 年被瑞典生化學家米歇爾 (Friedrich Miescher) 發現，1953 年被兩位劍橋大學科學家詹姆斯 • 沃森 (James Watson) 和弗朗西斯 • 克里克 (Francis Crick) 解構後，科學家便致力於解開這個生命密碼，希望能突破先天的限制，或是修正異常基因。

從人類開始農耕畜牧以來，育種成了一種普遍的方式，希望孕育出更符合需求的新品種，從早期的篩選配種，到分子輔助育種，進而到基因轉殖，以及最近新興崛起的基因編輯。如果說 DNA 的定序是解開生命密碼的序曲，近年備受關注的 CRISPR/Cas9 基因技術則是一個非常強大的 DNA 編輯工具，不但能幫助人們更深入了解生命體運作機制，更可進一步經由基因體編輯達到育種的目的，突破過往冗長的雜交育種程序，成為近年來最受矚目，也發展最快的基因工程技術，本文將就此基因編輯技術做一簡單介紹。

一、CRISPR/Cas9 基因編輯技術簡介

生命體除具有自我修復功能，還有一套抵制外來病毒與細菌的免疫系統機制，小至細菌也同樣有此功能。其中一個存在細菌與古細菌中的後天免疫機制就是 CRISPR/Cas 系統，此系統有兩個關鍵組成，一個是 CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)，這是由相同的重複序列 (repeat) 和不同的間隔序列 (spacer) 不斷重複所形成；另一個是 Cas (CRISPR associated proteins)，是一種核酸酶 (nuclease)，CRISPR 基因座 (locus) 結構如圖一。

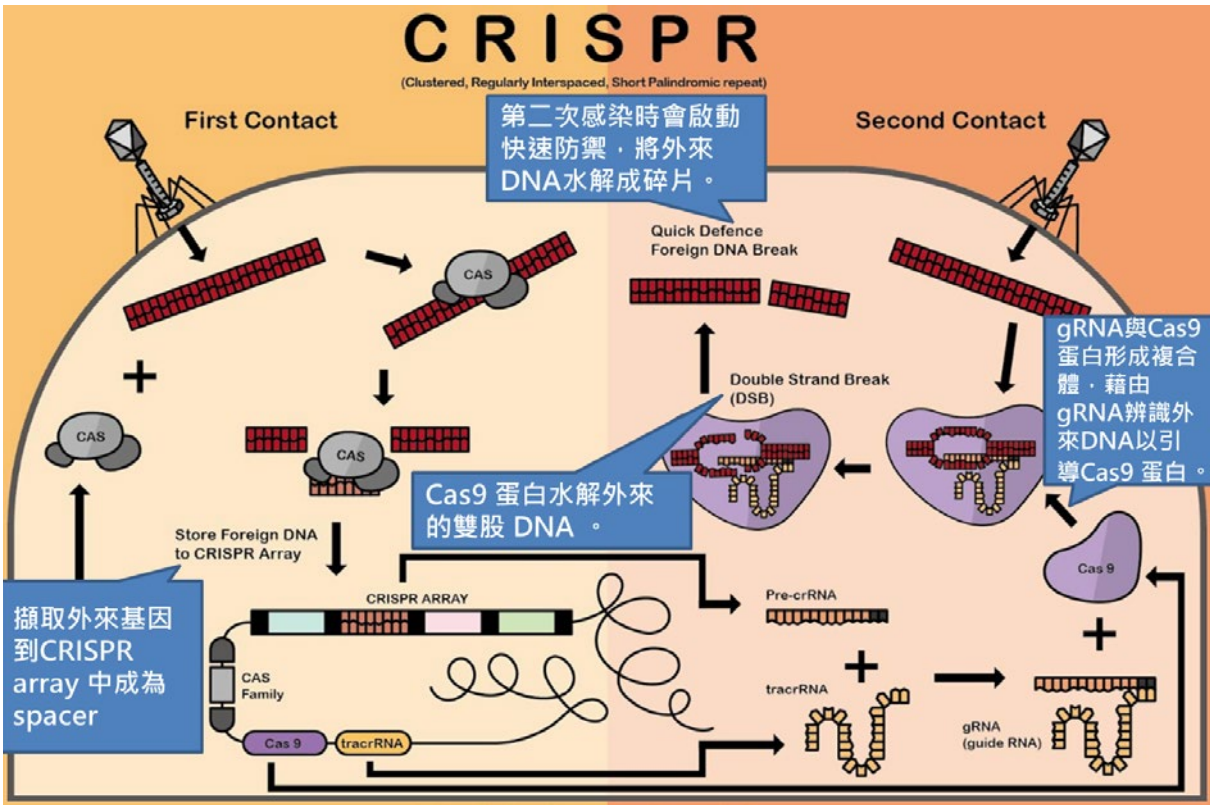


圖一、CRISPR 基因座結構

其運作機制是當每次有外來病毒入侵時，如果細菌存活下來，便會把病毒遺留的 DNA 片段加到自己的 CRISPR 序列中成為一段 spacer 留下紀錄，所以 spacer 記載了不同病毒的基因片段序列，且越新捕獲的病毒序列，就會越靠近前導序列 (leader sequence)，有越早做比對的作用，當下一次遭受到曾記載過的病毒侵略時，CRISPR/Cas 系統會自動將此病毒的 DNA 轉錄成 RNA 型式來做比對，稱之為 CRISPR RNA (crRNA)，有時還會需要另一段特別的 RNA 來調控 crRNA 活性，稱之為 trans-activating RNA (tracrRNA)，來幫助尋找病毒的 DNA，兩個 RNA 結合成一個 guide RNA (gRNA)，找到互補的病毒 DNA 後形成一個標示，誘導 Cas 進行水解，達到防禦效果，這就是整個免疫系統基本的運作方式，如圖二。

不同細菌種類所擁有的 CRISPR/Cas 系統不盡全然相同，大致上可粗分為 Type I、II 和 III 三大類型，Type I 與 Type II 的作用目標為 DNA，而 Type III 的目標則為 DNA 與 (或) RNA。Type I 與 Type III 兩者都只需 crRNA 就可辨識病毒 DNA，但須多種 Cas 參與，並先形成一個複雜的蛋白複合體 (Cascade-like complex) 來辨識與分解病毒 DNA；Type II 的機制較為簡易些，僅須透過 Cas9 核酸內切酶 (endonuclease) 結合 crRNA 與 tracrRNA 形成的複合體，就可進行辨識與分解功能，亦稱之為 CRISPR/Cas9 系統，當今生技領域最受關注並寄予厚望的基因編輯技術就是從此系統衍生而來。

目前 CRISPR/Cas9 基因編輯技術，主要是透過一個來自化膿性鏈球菌 (Streptococcus pyogenes) 的 Cas9 核酸內切酶與 crRNA 與 tracrRNA 形成的複合體，藉由 tracrRNA 及設計與目標序列互補的 crRNA 黏合為一單股 RNA，稱為 single guide RNA (sgRNA)，引導 Cas9 核酸內切酶到 DNA 序列中想要進行編輯的位置進行編輯。



來源：轉譯自 Welgene Biotech Co., Ltd.

圖二、CRISPR/Cas 系統運作機制

二、CRISPR/Cas9 基因編輯技術之優點

CRISPR/Cas9 技術之所以被稱為引發基因編輯大革命之史上功力強大的基因編輯技術，主要是此技術具有下列幾項優點：

1. 可應用層面廣：此技術並無物種的限制，舉凡從微生物、植物到動物，皆可藉由此技術達到優化動物和作物育種的目標。

2. 製程簡單：只須對兩種 RNA 進行人工設計，即可對欲修改的基因序列進行編輯。

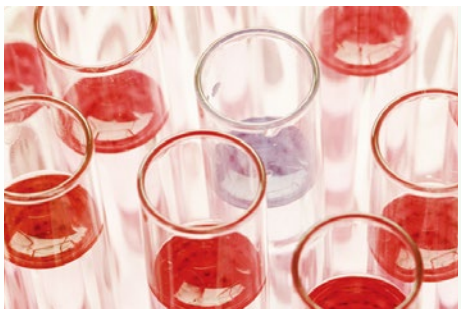
3. 準確性高：以往的編輯工具無法很準確定位，但此技術利用 DNA 與 RNA 鹼基互補配對原則，提高定位與編輯準確率。

4. 時程短：撇開過去傳統育種，動輒耗費數年不說，早期的基因編輯技術，用來標的蛋白質不易製作，且實驗流程繁複，往往需耗時一年多，而此技術平均數周即達到相同的結果，大幅縮減基因編輯時間。

5. 成本低：由於製程簡單且時程短，再加上製作材料所需成本較傳統方法為低，故此技術成本相對於其他基因編輯技術便宜很多。哈佛基因學家 George Church 曾表示，成立一間 CRISPR 實驗室只需二千美元，而實驗成本甚至低至一百美元。

三、CRISPR/Cas9 基因編輯技術之脫靶效應

綜觀上述優點，不難想像各領域之研究人員對 CRISPR 技術的未來應用發展上充滿想像，但事情通常不會只有好的一面，接下來就來談談此技術發展關鍵阻礙之一的脫靶（off target）效應。在前文中，曾簡介 CRISPR 基因編輯技術的原理和機制，了解到這個技術是仿造生命體免疫 (CRISPR/Cas) 系統的概念而來，而這個免疫系統主要功能是進行敵我辨識，稍作比對後對外來基



因序列進行剔除工作，所以在生命體內，並不是執行基因編輯的功能，所以在學理上，它並不是一個很精準的基因編輯系統。也就是說，雖然此技術是利用 DNA 與 RNA 自動鹼基互補配對的現象，提高標的與編輯準確率，但當基因在鹼基排列組合上有相似情況時，即可能產生誤認情形，而此誤認情形亦可能對整個生命體造成狀態的改變，引發非預期的副作用。

為解決這個問題，很多科學家投入不少心力想辦法降低這個脫靶效應，近期也有不少成果，如 CRISPR-Cas9 技術發明人之一的 Jennifer A. Doudna 團隊，發現一種 anti-CRISPR 蛋白，能與 Cas9–single guide RNA 複合體結合進而干擾複合體辨識標的 DNA，通過調整將 anti-CRISPR 蛋白或者 Cas9 添加到實驗中的時間，能讓 CRISPR-Cas9 在基因編輯一段時間後關閉其活性，防止後續在基因點上隨意剪切編輯，將 CRISPR 導致的脫靶效應降低四分之一。換言之，anti-CRISPR 蛋白將有望成為 CRISPR-Cas9 系統中的調控者，可讓編輯行為在何時何處發生，完成任務後又可自動失去活性，提供有效控制脫靶效應。又如 CRISPR-Cas9 技術另一位發明人張鋒團隊，將 Cas9 核酸酶中的約 1,400 個胺基酸中的 3 個胺基酸進行修飾，這個增進版的 Cas9 讓脫靶比率顯著性地降到無偵測的層級；此外，又發表一款 CRISPR-Cas13 系統，只對 RNA 進行編輯，好處是編輯 DNA 會帶來永久性的基因體改變，但 RNA 會自動降解，因此在編輯之後，提供一個自然修復的方式，不會影響整個基因體的表現。隨著越來越多的研究，相信人類對此項科技的發展會更完善，一些不確定問題的相應方法與策略也會一一被提出，這也是新技術演進必經的過程。

四、CRISPR/Cas9 基因編輯技術在農業上的應用

CRISPR/Cas9 基因編輯技術，應用層面相當廣泛，舉凡人類醫療、農業、能源等領域都有其可發揮之處，如修正導致疾病之基因、農作物改良、創造生物燃料等。由於此技術應用於人體基因治療還存在安全性、風險性，以及倫理道德之爭議，故本文僅針對此技術目前在農業上之應用簡單介紹。

1. 提升抗病蟲性
   - 玉米黑穗菌一直是美國甜玉米的勁敵，過去就曾因為玉米黑穗菌的危害而造成美國經濟嚴重損失。德國科學家利用基因編輯技術來干擾玉米真菌病原體 (Ustilago maydis)，透過研究其病原體的感染能力與機制，育成抗玉米黑穗病的新品種。

   - 在水稻栽培過程中，常遭稻熱病 (rice blast) 危害，是全世界水稻主要的流行病，稻熱病是由真菌 Magnaporthe oryzae 所引起的，而植物中的乙烯反應因子 (ethylene responsive factors，簡稱 ERF) 是一群受乙烯調解的轉錄活化因子，在水稻中它也是稻熱病的易感因子。科學家利用 CRISPR/Cas9 技術突變了 OsERF922 基因，提升水稻對 Magnaporthe oryzae 的抗性，但不影響水稻的其他農藝性狀。

   - 豬藍耳病是一種高致病性的傳染病，且小豬最容易受感染，死亡率高達 8 成，一經感染對養豬人家造成重大損失。曾於 1996 年成功複製桃莉羊 (Dolly) 誕生的英國愛丁堡大學 Roslin Institute 研究團隊，利用 CRISPR/Cas9 技術編輯與豬藍耳病毒感染有關的基因，讓豬隻具有完全抵抗力，阻止感染和傳播。預估全世界養豬產業每年將減少數十億英鎊損失。

2. 抗逆境
   - 全球暖化氣候變遷下，農業損失年年創新高，為選育抗旱逆境的玉米優良品種，美國科學家利用基因編輯技術突變玉米葉片基因，增加葉片的光澤度與表皮蠟質構造，防止水分散失。

   - 氣候炎熱、多雨是培育可可豆的理想環境，但現今熱帶雨林的降水量正在逐漸減少，甚至有可能變乾旱，如果持續下去，可可豆將在幾十年內從地球消失。柏克萊大學的 Myeong Je Cho 實驗室正在研究可可植物種子，藉由基因編輯技術來增強可可豆適應天氣變化的能力。

3. 提高產量
   - 日本農業和食品產業技術綜合研究機構（茨城縣築波市）運用基因組編輯技術，使水稻中的兩個基因喪失原有的功能，改

變植物體內的生長激素平衡，使稻穗上的稻穀數量和大小增加，藉以增加產量，預估可提高 5 成水稻產量。該機構已獲日本政府批准，2017 年 5 月種植了約 10 公畝利用“CRISPR-Cas9”基因組編輯技術改造的水稻，成為日本首次基因編輯水稻的戶外田間試驗。

4. 提高健康成分
- 韓國基礎科學研究所（Institute for Basic Science, IBS）基因組工程中心的研究人員，利用新的 CRISPR 基因編輯技術，對大豆中的兩個 FAD2 基因進行切割，這兩個基因編碼是將油酸轉化為多元不飽和亞油酸的關鍵酵素。藉由編輯這兩個 FAD2 基因，讓大豆種子中的油酸比例增加，製造更加健康的脂肪含量。

- 馬鈴薯在冷藏過程中，澱粉會緩慢分解成蔗糖、葡萄糖和果糖，之後在油炸的情形下，糖類在高溫下分解成一種致癌物丙烯醯胺 (acrylamide)。而 Calyxt 公司利用基因編輯技術破壞馬鈴薯基因體中的一個控制澱粉分解的基因，進而減少此致癌物的產生。

5. 採後保鮮
- 蘑菇在採摘後，因內生性的酚氧化酶的物質，非常容易發生褐變現象，進而腐爛。一個普通的白蘑菇含有六個多酚氧化酶的基因，科學家使用 CRISPR 技術剔除其中一個基因，就使酶的活性降低了 30%，從而讓蘑菇具備抵抗褐變的能力，延長白蘑菇的保質期。2016 年 4 月，美國農業部 (USDA) 宣布將不會對採用基因編輯工具 CRISPR/Cas9 進行遺傳工程改造的蘑菇實施管控，成為第一個得到美國政府單位綠色通行證的基因編輯食物。

6. 遠離汙染
- 在工業的推展進程，帶來經濟繁榮，也產生不少汙染問題，而工業廢水造成的土壤污染，進而產出鎘米，一直是發展經濟中的國家常遇到的糧食問題。中國科學家利用 CRISPR 技術修改水稻調控金屬離子穿膜傳送蛋白，降低水稻胚芽中鎘離子的濃度。

除農業多方應用外，在能源領域也不乏有科學家利用 CRISPR 編輯技術針對能源作物或藻類、菌類等微生物進行編輯，如提高光合作用效率、增加含油量、縮短工業製程等，對綠色生質能源的推進又邁出一大步。

五、結語

過去的基改食品，最讓社會大眾質疑的，莫過於植入外源基因造成的健康風險，以及種籽等關鍵資源被幾個生技公司所壟斷。將 CRISPR/Cas9 基因編輯技術應用在農業上，最大的優勢就是可以從植物自體基因加以編輯，而不需引入其他外源的基因，這就像生命體為適應外在環境的變異，自我突變演化的現象一樣，只是這個技術加速了這個過程。此外，以前孕育一個新品種或新性狀的動植物或微生物，需耗費大量資源，需擁有豐厚財力的公司才容易做得到，但此技術跨入的門檻較低，再加上許多新創公司，創造新的商業模式或開放技術平台，拉近了各方在此技術應用上的競爭力。對臺灣農業而言，不失為一個再次躍升的契機。

被譽為神之手的 CRISPR/Cas9 基因編輯技術，基於應用面廣、製程簡單、準確性高、時程短、成本低的優勢，在短短幾年時間，已在多方面領域累積不少的應用成果，也催生了不少科技新創公司，提供不同的商業模式與技術平台，相信此技術在未來的進展上，速度只會越來越快，應用範圍將越來越擴大。但於此同時，也有不少人對此技術的便利與對未來不確定性的風險感到憂心。人類通常會認為維持現狀是較安全的選項，或許採取行動會讓人擔心害怕。然而，有時無動於衷則易錯失讓社會環境變得更好的機會，所以應將此技術讓更多人知道，大家公開討論其利弊，然後對選擇的結果負責。換言之，如選擇繼續發展此技術，就要思考如何管控，並承擔風險的責任，如選擇不使用此技術，也要有對錯失機會的後果負責，這應是一個理性社會對一個的新技術的認知與態度。

(感謝臺灣大學農藝學系林彥蓉教授
郭舒孟小姐協助本文定稿)

環境暨經濟研究中心 陳潔儀組長．潘惠萍管理師．郭佳韋助理研究員

根據 2016 年聯合國國際資源委員會 (UN-IRP) 報告中顯示，全球資源開採量從 1970 年 220 億公噸上升到 2010 年 700 億公噸，如維持現今資源供給模式，到 2050 年將達 1800 億公噸，此將導致加劇氣候變遷、空氣污染、減少生物多樣性、關鍵資源短缺及戰爭衝突的風險。全球為因應此危機即提倡「循環經濟」，與線性經濟造成的資源衰竭不同，循環經濟是建立在物質的不斷循環利用上的經濟發展模式，形成「資源、產品、再生資源」的循環。在循環經濟中，我們學習大自然的法則，「只有放錯地方的資源，沒有真正的廢棄物」，進而從根本上解決經濟發展與環境衝擊的矛盾。

本社於 2006~2011 年透過「物質循環」、「永續資源管理」、「建構循環型社會」等議題建構循環經濟領域知識能量；2012~2014 年開始銜接產業需求，以「稀有資源」、「資源循環產業發展」為研究對象，除掌握產業現況外，並透過政策建言向政府反映相關政策的內涵；2015 年則以全球最新發展的視野，探討國內轉型循環經濟的模式及關鍵要素；隔年 (2016 年) 分析台灣產業的綠色創新需求，並參考中國大陸十三五規劃，歸納產業因應之道，提出提升產業競爭力的模式。去年 (2017 年) 針對循環經濟四大關鍵議題：「台灣動靜脈產業的協作及困難」、「台灣產品設計及製造的瓶頸、生產者延伸責任」、「消費者的認同及顧慮」及「科技發展對循環經濟的影響」進行探討，並提出建言供政府施政參考。

中國大陸從十一五規劃期間開始注重循環經濟，2008 年 8 月頒布循環經濟促進法，2009 年 1 月實施，積極推動循環經濟，2017 年中國國家發改委和科技部等 14 個部門，根據「十三五規劃綱要」，共同制定「循環發展引領行動」，主要目標為建立綠色循環低碳產業體系、城鎮循環發展體系、新的資源戰略保障體系以及綠色生活方式。本社自 2016 年起，與中國循環經濟協會合作辦理論壇，共同對循環經濟發展主題進行交流，今年已邁向第三年，由本社邀請協會產官學代表及台灣產學界共 14 位，以廢塑膠、廢紡織、廢輪胎、城市垃圾資源化、再製造與農業循環經濟 6 大主題進行專題報告，就兩岸循環經濟發展交換推動經驗。論壇當天先由本社潘文炎董事長及中國循環經濟協會趙凱副會長致歡迎詞，均認同全球資源匱乏的急迫性，而循環經濟是支撐新世代經濟發展的重要主軸之一；再由中國循環經濟協會首席政策專家齊建國教授、與成功大學環工系張祖恩特聘教授，以兩岸循環經濟發展現況報告揭開序幕，接續安排兩岸各 6 位專家作主題報告，分享運用科技解決環境負擔、與資源有效利用的經驗。最後由本社余騰耀執行長和中國循環經濟協會趙凱副會長，共同主持綜合座談及閉幕，與會專家對於包括落實永續農業、廢棄物減量、清潔生產模式等，有諸多交流。並藉由兩岸產業經驗分享，尋找合作的契機，共同為地球永續努力。會議當天近百人共同參與盛會，專題內容摘要如下。

一、廢塑膠

塑膠無法經自然分解回歸自然界循環

使用，而造成了所謂的「萬年垃圾」，因此基於愛惜資源及疼惜環境，回收並重複使用廢塑膠物品有其必要。廢塑膠回收後經過清洗、粉碎、乾燥等過程，其中 PET 材質可直接運往工廠或紡織廠，進行抽絲及紡織等再利用，其餘的材質如 PVC、PE、PP、PS 等，還需先送到造粒廠，經造粒後製成二次塑膠原料，再經射出成型或壓模等過程，製成各式塑膠產品。

此議題邀請到湖北科普達高分子材料股份有限公司柯斌董事長，以及遠東新世紀公司張春田協理，分享廢塑膠的回收再利用之經驗。科普達公司是一家專門生產光纖電纜塑膠護套的工廠，其護套有 2/3 是使用再生塑膠製成，並符合歐盟 RoHS2.0 要求的品質標準。遠東新世紀公司則積極投入新設備製程，克服污染衛生問題，讓用過的瓶子可以重新回到源頭再製成新瓶子使用，改變了過去寶特瓶只能回收製成毛毯、衣物，卻無法再製回瓶子的窘境。

遠東新世紀塑膠瓶回收再製成塑膠瓶 (遠東新世紀公司提供)

二、廢紡織

此議題報告者是上海緣源實業有限公司臧列副總經理以及寰陞國際公司王家祥創辦人。緣源公司是投入上海廢舊服裝回收利用試點計畫的首家公司，採用網路管理收運情況，運用 GPS 及警報系統形成物聯網，監控回收箱，並將收來的舊衣物選擇品項較新、沒有破損和污漬的禦寒衣物，經消毒處理後無償提供給經濟貧困的群體，夏衣則出口至非洲，達成廢紡織回收再利用。

王創辦人指出，台灣 2017 年舊衣回收量約 6 萬噸，三成送往慈善社福機構，七成流向舊衣回收廠，其中有部分飄洋過海到非洲，剩餘的衣服都被送進焚化爐。台灣舊衣供過於求，社福團體根本無法全部接收，在工廠跟社福回收站裡，為數不少的名牌衣服連吊牌包裝都沒拆，當中甚至有上萬元的名牌風衣，顯見台灣的問題是花大錢買衣服又不穿，白白浪費資源。目前在服飾更新淘汰速度極快的演藝圈已興起租賃模式，以避免藝人服飾無法重複而穿過一次就捨棄的問題；其他像是二手衣收購交換商店興起；或是將回收的舊衣再製造成其他商品等，皆為廢紡織源頭減量以及回收再利用的案例。

三、廢輪胎

此議題邀請環拓科技公司吳俊耀總經理，以及無錫翼龍航空設備有限公司蘇榆總，經理分享廢輪胎回收再利用之經驗。全世界一年產生 2 千萬噸的廢棄輪胎，廢輪胎因無法自然分解，而成為環境問題。目前世界上主要的處理方式有 3 種，分別是燃燒、打碎後作為原料再利用、及掩埋，而大部分作為汽電共生的燃料，將資源轉為能源，半數以上資源消失，並非最佳之循環利用方式。

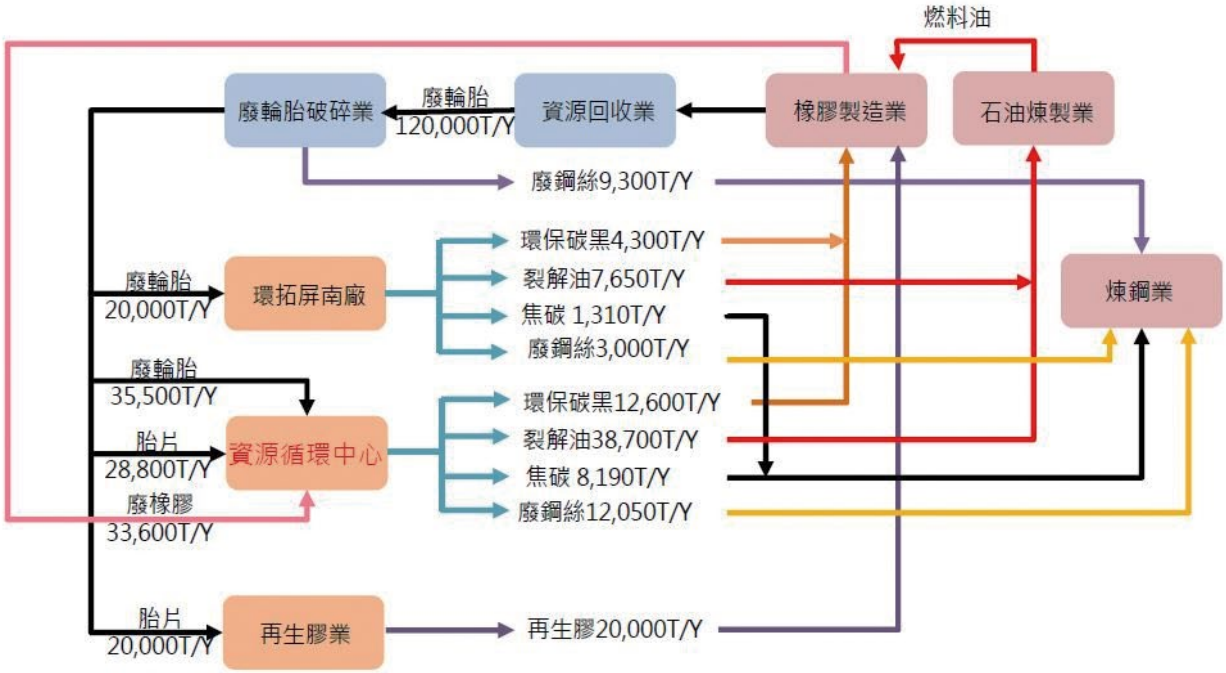
環拓科技投入研發及設備，開發出全球

唯一的廢橡膠裂解再生技術，裂解油可作為燃油、裂解氣作為內部循環能源、鋼絲作為再生鋼絲，而環保碳黑則應用於潛水衣、車用踏墊、輸送帶等產品。無錫翼龍航空設備有限公司運用專利科技於飛機輪胎及汽車高速輪胎的翻修再利用，被中國大陸國家發展和改革委員會指定為中國大陸高速度級汽車輪胎再製造研發基地，2017 年首條可年產 10 萬條高速輪胎的生產線完成後，2018 上半年即正式投入生產。

四、城市垃圾資源化

台灣垃圾清理政策是以「源頭減量、資源回收」為主要方向，全國平均每人每日垃圾清運量至 2016 年已較歷史最高減少 64.71%，垃圾回收率達 58%，但仍有近 4 成無法回收的垃圾必須透過焚化或掩埋方式最終處理。垃圾焚化後可能產生大量灰份之煙氣，易造成鍋爐各階段煙道之燒結物堆積、沖蝕、沉積及阻塞。加上台灣許多座垃圾焚化發電廠都已接近契約年限 (即營運 20 年)，面臨設備老化造成處理效率降低的問題。信鼎技術服務公司刁秀華總經理分享岡山焚化廠效率提升的經驗，從改善爐床系統、燃燒系統到導入智慧系統，有效紓解高雄市廢棄物處理壓力。

大陸方面，習近平指出普遍推行垃圾分類制度，關係 13 億多人生活環境改善，以及垃圾能不能減量化、資源化、無害化處理，因此要加快建立垃圾分類收集、運輸、處理的垃圾處理系統。北京綠博偉業環保科技有限責任公司李春總經理則分享公司結合大數據加互聯網的垃圾分類回收商業模式，民眾若進行垃圾分類則可賺取現金或積分，而且垃圾分類智能回收機可即時顯示條碼，民眾可用微信掃描就能賺取微信紅包兌現，藉此提高垃圾分類意願。目前已在北京、呼和浩特等都市進行試點。



廢輪胎循環經濟圈資源再生循環 (環拓公司提供)

垃圾分類智能回收機(北京綠博偉業環保科技公司提供)

五、再製造

再製造是以廢舊零件為對象，以低污染的修復工藝，來修復或改造廢舊產品並重新利用，落實節能減碳與源頭減量。慧與科技公司的江惠櫻協理分享公司的再製造策略和經驗，包含重塑產品和服務的設計、製造、使用和恢復，達到延長產品使用壽命、可回收再製造重複使用，其再製品如同新品一般的規格及性能；另外也將業務和運營轉向結合物質與服務，提供租賃方案，到期即回收淘汰的資產設備並重新再製造利用。

上海宜達勝科貿股份有限公司陳衛權董事長則提及，中國大陸目前物質消費日益增加，導致勞動力、物資和訊息等社會資源大量閒置與浪費，因此提倡發展物聯網結合共享經濟，挖掘上述閒置資源的再利用潛力，體現循環經濟的源頭減量。

六、農業循環經濟

循環農業意指一種將資源利用效率發揮至最大化，並結合物質再生技術，達到廢棄物減量的農業生產模式。歐盟呼籲：對抗全球暖化，必須更有效率的處理生物廢棄物，才能減少溫室氣體的產生。

此議題邀請中國循環經濟協會農業循環經濟與生態修復專委會潘文智副秘書長，以及特克斯科技公司洪歆怡董事長，分享畜牧養殖行業循環經濟之經驗。潘副秘書長報告大陸畜牧養殖行業循環經濟發展趨勢分析，從中國大陸畜牧養殖業的背景及發展歷程談起，在環保壓力下，產能向大戶集中，規模養殖戶增加，散戶養殖減少，禽畜糞便年產量約 83 億噸。現階段禽畜糞便治理政策，主要有飼料化、基質化、能源化、肥料化等模式，亦有將上述處理模式綜合運用的作法，各種處理方式各有其優缺點，未來將與同業共同尋求更有效的農業循環經濟發展模式。

洪董事長則針對禽畜糞便資源化堆肥處理進行報告，報告中指出禽畜糞便及蔬果堆肥通常是農民普遍採用的有機肥料，但要把有機廢棄物變成有機肥，需要歷經 2、3 個月的堆肥，讓微生物自然分解，以達到完全腐熟，堆肥不僅耗時、佔空間，還會散發臭味、排出臭水。更甚者，一旦處置不當，其所孳生的病菌也容易傳播感染，或造成水源及土壤的汙染問題。

隨著生物科技發展，禽畜糞便最佳的處理模式是經資源化堆肥處理後，再回饋到農作物使用；運用 HMD(High-temperature Microbiological Decomposition System) 高效能處理系統，不需經過加熱乾燥，不需添加副資材，佔地面積小、低能耗、低人力需求，就地處理無需載運，單套設備日處理量約 10 噸，發酵後的腐熟肥料還可以施作還於田間。如今，堆肥更成接軌國際的綠金，從循環經濟中找到新出路。

項目	HMD	傳統堆肥
	處理每20公噸之有機廢棄物	
製程時間	7-14天	90-180天
處理面積	400m²	1800m²
人力需求	3	8
製程控制	易	難
異味防治	佳	難
處理成本	低	高
含水率等參數限制	寬容度較高 含水率85%亦可直接處理	需控制在50-60%

HMD 高效處理系統與傳統堆肥比較
(特克斯科技股份有限公司提供)

論壇會議資料歡迎至中技社網站點選參閱
(http://www.ctci.org.tw/)

百年藥香 世代傳誠

1913 年，楊靜如、楊誠法兩兄弟以 40 圓龍銀，懷抱「六脈不調須藥石 · 安身無恙即神仙」的期許，於福建省惠安縣網川鄉創立「六安堂中藥鋪」，以行醫、製藥，名揚鄉里。1949 年遷台，第二代傳人先後於延平北路及饒河街承繼志業；第三代傳人楊世福立志建立品牌、永續經營，於是在 1987 年直搗中藥材集散地一級戰區「迪化街」，2002 年榮獲全國第一品牌金字招牌獎。2009 年拆除重建並於 2012 年竣工，2013 年即獲經濟部評選為優良百年老店，2017 年提前交棒甫由日本留學返台的第四代傳人楊凱宇，期望藉由新世代的新思維，賦予百年老店繼起的動力。

走過、路過，千萬不要錯過，許多人往往被「六安堂參藥行」金碧輝煌的華麗門面震懾而卻步。正門的鍍金招牌加上一對金獅鎮店，挑高正廳鑲嵌翠玉之中的「六安堂」是鐳射拓刻草聖于右任親題的墨寶，周圍輔以銅錢、人參、靈芝等圖騰，豐實淵遠的韻涵，彷彿預許主、客間「六安致寶 · 人生如意」的默契與祝福。

從小籠罩在一年 365 天只休 5 天的藥材店，對家業有點排斥，但赴日留學之後，感受到同學在畢業前夕求職的艱辛，才深深體會家業的可貴以及父母的勞苦，於是攜手有志一同的日裔美嬌娘返台接班，希望將既有的資源再接再厲，更上一層樓。近年來，中藥的顧客面臨斷層的危機，同時為因應 M 型社會，楊凱宇以「預防勝於治療」的理念，開發許多價錢平易近人的調味包、藥茶包、漢方浴劑，可以說是將中藥材發揮得淋漓盡致。如果想喝沒有咖啡因的茶，極力推薦由藥材打碎配製的茶包，喝起來就像歐美花草茶一樣，讓年輕人樂於接受與認同。

傾聽是改進客服的最佳管道，曾有日本客戶反應台灣的熱炒雖然很好吃，但上過廁所後就不敢再上門光顧。楊凱宇聽了之後，立刻改造店內廁所，不但媲美五星級飯店，還點燃獨門調配的藥材薰香。台灣人普遍比較務實，日本人則著重視覺設計；楊凱宇將自家精製的藥材包，以環保的概念稍加包裝，並標示日期、成份、療效，另印製詳盡的中、日文產品目錄，讓消費者一目了然，便於選購且安心食用。Line 席捲全球也顛覆傳統藥材行的銷售模式，上一代用電話或傳真機談生意，楊凱宇用 Line 滑生意，而且經由群組引來專程上門的日本顧客，這完全要歸功於楊凱宇的細心觀察與用心付出。

接手一年以來，秉承「製藥用心 · 堅持品質 · 價格公道 · 以誠為本」的六安堂文化，楊凱宇非常感謝父親放手讓自己在實務中接觸與成長。相較於日本的商店街，台灣的商圈還有很大的發展空間；面對變化多端的市場，的確需要大家集思廣益、凝結共識，促成世代的融合，以及文創新店與傳統老店的聯結，讓曾經繁華熙攘的迪化街歷久彌新，成為北門捷運站必逛的新創商圈。

採訪整理 / 張兆平組長 · 羅佳慧管理師

四季裡
生長在土裡的
冒出地面的
結實在枝頭的
只要能給我們能量，都是好食材

我們都該好好對待

圖／文 楊麗玲

大安堂夢藥行

朱啓助於埔里、台中、台北實景指導，讓沒有美術基礎的速寫愛好者達成「旅行繪畫」的夢想，目前籌辦並邀請各國代表參與 2018 亞洲速寫年會。

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