2025 PRESIDENTIAL SCIENCE PRIZE

總統科學獎

表揚實錄

PRESIDENTIAL SCIENCE PRIZE Award Ceremony Program

表　揚　實　錄

PRESIDENTIAL SCIENCE PRIZE
Award Ceremony Program

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獎項紀要

總統科學獎設立於 2001 年，今年已經邁入第 13 屆，象徵國內學術研究的最高榮譽，由中央研究院院長邀集相關部會首長，以及專家學者共 15 人組成「總統科學獎委員會」籌劃總統科學獎項，每 2 年頒發一次，以獎勵國內在數理科學、生命科學、人文及社會科學、工程科學領域，有重大貢獻之基礎學術研究人才，並提升臺灣之國際學術聲譽。

總統科學獎得獎人的產生，係由中央研究院院士或總統科學獎得主，或總統科學獎委員會得邀請學術、研發單位或團體及社會賢達人士提名，分由 4 組遴選小組推薦候選人，再經聯席會議審議遴選得獎人。本屆總統科學獎歷經縝密的推薦及遴選程序，計遴選出 2 位得獎人，為生命科學組梁賡義院士、工程科學組葉均蔚院士（依姓名筆畫順序）。

藉由總統科學獎的頒發，表達國人對科學前景崇高的冀望、對人才培育的重視與對知識份子的無限尊崇，除了彰顯得獎人的崇高學術地位之外，更期盼將科學的精髓發揚光大，裨益民生。

成 就 事 蹟

梁賡義

院士

生 命 科 學 組

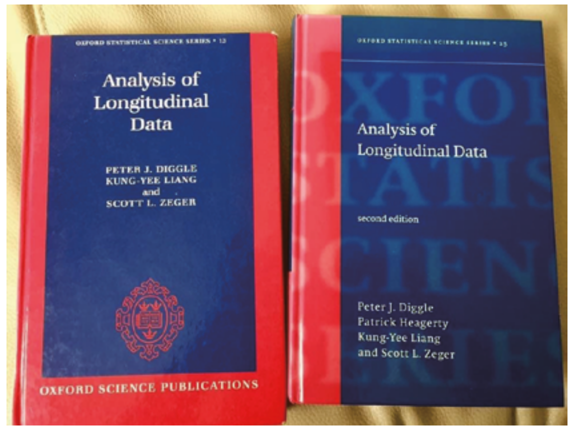
人本方程師 開創廣義估計方程式

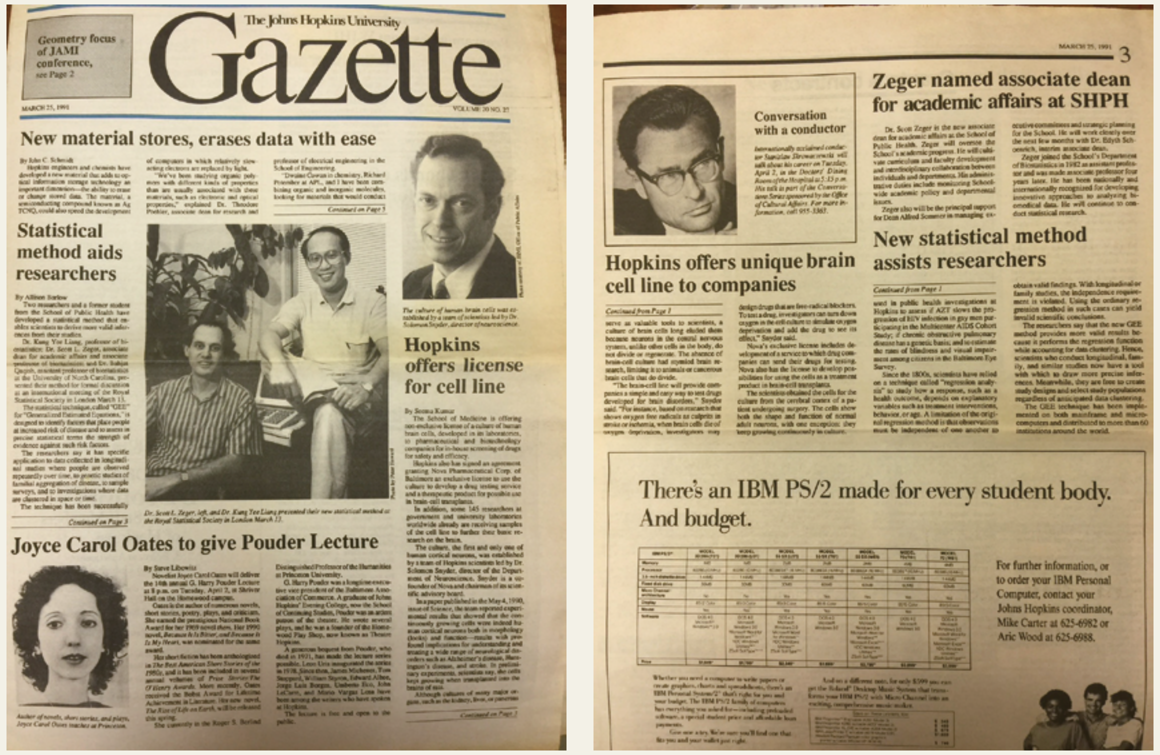
加速新藥問世 造福全球千萬病患

現任逢甲大學春雨講座教授，為人所熟知的前國立陽明大學校長——梁賡義院士，即便是「半路出家」從數學系轉向生物統計，卻靠著跨領域思維導出正確公式，最終發表聞名世界的廣義估計方程式 (Generalized Estimating Equations, GEE)，並在短短 4 年內即獲得生物統計界最高榮譽——美國公共衛生學會的 Spiegelman Award。

不論是實驗室、世代流行病學或臨床試驗，只要是縱貫式研究 (longitudinal study)，產學研界都會使用 GEE 進行統計分析，其不僅被納入所有主要統計軟體如 R、STATA、SAS 及 SPSS，論文更被引用超過兩萬兩千次。這項統計方法改變了過往透過長期觀察實驗組及對照組進行比對的方式，讓研究者可觀察同一人在固定期間內的數據變化，來得知臨床投入藥物的效果，進而大幅增加臨床試驗的效率。目前國際大藥廠最常用的前後測臨床試驗 (pre-post design for clinical trial designs)，便是運用 GEE，得以正確評估許多新藥的療效，如癌症、心臟血管及糖尿病等疾病，從而造福全球數以千萬計的病患。

放眼國內外生物統計研究所，GEE 都是其課程中最重要的一環，而梁院士與其他 3 位生物統計學者合寫發表在 Oxford University Press 的一本書《Analysis of Longitudinal Data》，對縱貫性研究的學者更是必讀及引用的文獻。接著，經由和歐美遺傳及精神疾病流行病學家的合作，梁院士將 GEE




The Johns Hopkins University Gazette

Geometry focus of JAMI conference, see Page 2

New material stores, erases data with ease

Statistical method aids researchers

Hopkins offers license for cell line

Joyce Carol Oates to give Pouder Lecture

Conversation with a conductor

Zeger named associate dean for academic affairs at SHPH

Hopkins offers unique brain cell line to companies

New statistical method assists researchers

There's an IBM PS/2 made for every student body. And budget.

美國約翰霍普金斯大學報導梁院士和 Scott Zeger 教授獲得美國統計學會頒發 1987 年 Snedecor Award

方法擴展與延伸，提出新的統計方法，協助生醫科學家探詢各種疾病是否有聚集性，進而尋找如思覺失調、強迫症及氣喘等疾病的遺傳因子，讓學界對疾病機制的形成與新藥開發的進展有更深入的了解。梁院士說：「我希望所做的事情，不管是直接還是間接，都能對這個社會、對人體的健康有幫助。」這份初衷成為他數十年來的研究動力。

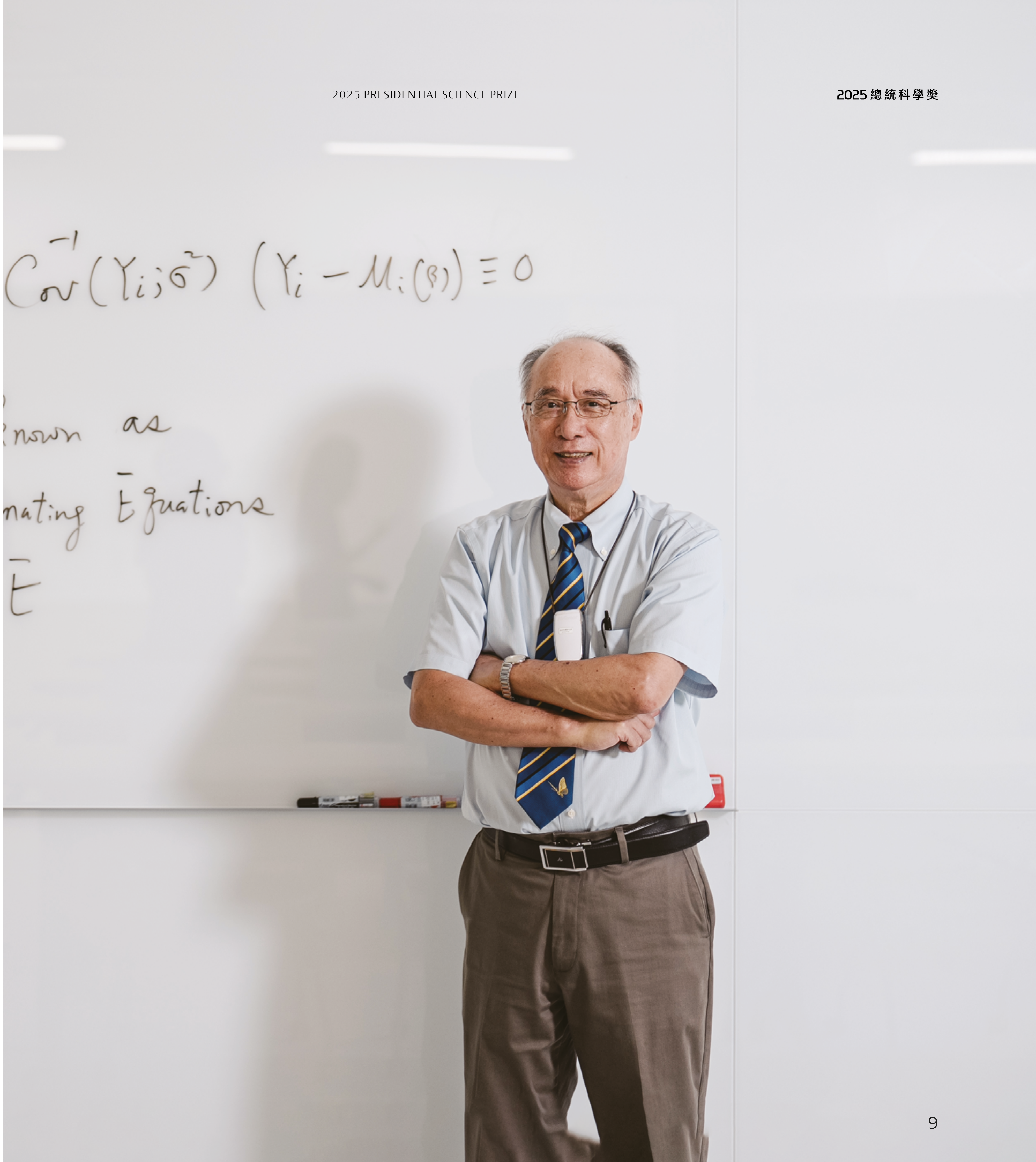
梁院士的學術與公共服務成就橫跨近 40 年，從統計理論的開創性貢獻到人才教育的推動，都留下深遠影響。自 1986 年發表「廣義估計方程式」以來，他的研究不只改變了生物統計的分析方法，也為全球公共衛生與臨床試驗帶來新的視野。許多以往難以處理的長期追蹤資料，透過梁院士的方法，不但分析變得更有效率，結果也更容易解釋，幫助研究者從複雜數據中看出疾病的發展脈絡與治療效果。

他的研究成果也在國際統計與公共衛生領域獲得高度肯定。梁院士曾獲得美國統計學會的 Snedecor Award、美國公共衛生學會的 Spiegelman Award，以及國際統計學會的 Karl Pearson Prize 等重要獎項，並當選為美國國家醫學院、中央研究院與世界科學院等 3 院院士，足見其學術貢獻的廣度與深度。

從統計理論的創新，到將研究工具落實於新藥開發、精神健康、慢性病防治等領域，梁院士以其深厚的專業實力與跨界整合能力，成為當代最具影響力的生物統計學者之一。他的工作，不只是寫在學術期刊裡的數學公式，更實際改善了全球無數病患的健康與生活品質，是運用數據知識推動醫學進步的典範人物。

國家桂冠故事

數學啟程 統計築夢



生統領域先驅與防疫推手

梁院士雖在當兵前不太清楚未來的人生方向，卻因為受到生命中的貴人——清華大學的導師徐道寧教授的引薦，確立了日後往統計學鑽研的道路。1986年在統計一流期刊《Biometrika》發表「廣義估計方程式」後，不僅大幅改變國際臨床試驗的方法，加快新藥療效的評估與上市，更成為國內外生物統計研究所的核心課程。

梁院士對生物統計學的卓越貢獻，不僅讓他獲得許多國際榮譽，更不忘以自己的人脈與資源回饋國家。在美任教期間，即幫助國立臺灣大學公共衛生學院成立生物統計博碩士學位學程，為臺灣生物統計界培訓更多優秀人才。

日後就任國家衛生研究院院長，也幫國衛院轉型為「任務導向」的機構，力求將實證研究的結果，落實成可幫助民眾健康與福祉的政策。梁院士更是在各國爭搶疫苗的疫情期間，用自己的人脈殺出一條血路，接觸到 AZ 公司高層，過程雖然幾經波折，但他最終以自己的誠心取得對方信任，成功爭取到近 12 萬的疫苗供第一線人員施打，穩定國內民心。

命運指引數學路 唯二熱愛恰成真

梁院士的父親白手起家，自基層一步一腳印，最終做到廣東、廣西電信局長的職位。國共內戰舉家遷臺後，父親因長年於電信界服務，自然而然地期待兒子能夠走上工程師的道路。雖然父母一向開明，從不強迫子女用功讀書，也不曾要求他們非得進入名校，但梁院士與雙胞胎哥哥始終明白父親的心願，每當被問及未來志向，兄弟倆總是回答「工程師」。

梁院士與徐道寧教授合影

然而，梁院士從小便展現出對數學的濃厚興趣與天賦。從小學開始，他便發現自己在理解及數學計算方面得心應手。在填寫大學志願時，雖然依循父親的期望填寫電機、工程相關科系，卻仍難以割捨自己對數學的深切熱愛，最終還是在第 3、第 7 志願的位置上填入了自己真正嚮往的選項：臺大數學系與清大數學系，這也成為命運轉折的關鍵。放榜當天，他的考試成績恰恰落點於清大數學系，實現了他最真誠的渴望。

「其實我也想過數學系出路窄，有過轉系的念頭。」梁院士說。但命運引導他走上這條他所熱愛的道路，又怎能輕言放棄？因此，梁院士毅然決定留在清大數學系，就此展開了他與數學、統計乃至與公共衛生領域長達數十年的深刻淵源。

沉澱心性 踏入統計新領域

梁院士就讀清華大學數學系時，統計學在國內仍屬新興領域，擁有統計學位的師資更是寥寥可數。恰逢他大四那年，黃提源教授甫自美國威斯康辛大學取得統計學博士學位，回國後即前往清大任教，梁院士於此首次接觸統計學便深受吸引。但此時的他仍對未來迷茫，即便對統計學有著濃厚的興趣，也並未決定以此做為未來的志願，畢業後便直接去當兵了。

幸虧，當時的班導師徐道寧教授收到東吳大學數學系系主任鄧靜華教授的請託，希望她推薦清大學生前來東吳大學擔任助教。徐教授照同學成績依序調查現況，才發現成績優異的學生幾乎都前往國外求學，便找到了當時對未來仍迷茫的梁院士，推薦他到東吳大學擔任助教。當時，梁院士心想快退伍了，也未想過未來的出路，便答應了下來。

梁院士與父母、雙胞胎哥哥合照

「在東吳的這段時光，其實算是我人生中的墊腳石」，梁院士說。在這教書的兩年時間裡，他得以逐漸沉澱心性，慢慢思考未來方向、專心讀書，擺脫了大學時期浮躁懵懂的氣息。後來梁院士決定出國進修統計學，黃教授更親自撰寫推薦信，助他順利申請上美國南卡羅萊納大學並獲得獎學金，開啟了他赴美攻讀統計碩士的學術旅程。

立志投身生物統計 師承當代生統泰斗

1970 年代後期的美國，正值生物統計學蓬勃發展的時期。當時正在就讀統計所的梁院士，在一次的校外學者講座中，注意到了「存活分析」(survival analysis) 這項統計分析方法（指在特定時間段內，分析投藥到死亡發生所需的時長以計算存活率，並確保新藥物的效益）。在第二次世界大戰結束後，西方社會的生活開始進入重口味、抽菸、缺乏運動的模式，進而導致各式慢性病及心血管疾病的盛行。這促使了各大藥廠開始研發相關藥物，希望能延長病患的壽命。然而，現有的統計方法並無法滿足藥物研發實驗的需求，因此存活分析在當時成為顯學。

「這算是我學術生涯的第一個轉捩點，也是一條不歸路」，梁院士說。這次參與的講座，是他第一次接觸到生物統計這個領域，同時他也意識到，原來統計學能對人類的健康有間接的幫助：「一個好的統計工具，能幫助臨床醫師和公衛學者回答很多有意義的問題」。於是，梁院士決定前往當代生物統計先驅 Norman Breslow 教授所在的西雅圖華盛頓大學攻讀生物統計博士。

在華盛頓大學，因梁院士是慕 Breslow 教授之名而來，也自然想跟隨他進行研究。當時，梁院士驚訝地發現，雖然 Breslow 教授是當時最有名的生物統計學者，但所收的學生並不多，只因他要求學生須自己決定論文題目，讓大部分學生望之卻步。但這項要求並未打退梁院士，他依靠在統計所所累積的深厚基礎，順利在 3 年內取得博士學位。


Norman Breslow 教授與梁院士


Scott Zeger 教授一家 2024 年來臺探望梁院士

讓梁院士印象深刻的是，身為當代生統泰斗的 Breslow 教授，在梁院士拿著一篇機率論文要和他討論時，自認有些內容已超過他的專業，便引薦了數學系的 Ron Pyke 教授協助指導；後來論文發表時，兩位教授竟都認為自己的指點與幫忙並不足以讓他們掛名為共同作者，覺得這些學術成果應歸功於梁院士本人。這樣不求名利的情操讓梁院士深深地被感動，也影響了他後續指導學生的態度：「不該有的，就不去求取」，若自認貢獻不多，便拒絕擔任共同作者的邀請，將成就留給年輕教授和學生。

開創縱向資料分析新時代 成果與世界共享

梁院士於 1982 年獲得西雅圖華盛頓大學生物統計博士學位後，隨即在美國約翰霍普金斯大學任教。期間梁院士最為重大的學術貢獻，即為與美國學者 Scott Zeger 教授共同發表的「廣義估計方程式」(GEE)。在統計學中，迴歸分析是探討自變數與依變數之間關係的重要方法，例如檢驗運動頻率是否會影響血壓高低。

然而，傳統迴歸分析建立在「觀測值相互獨立」的假設之上，但在許多情況下，這一假設並不成立，例如：同一位受試者在不同時間點的測量數據往往彼此相關，若兩週前血壓偏高，兩週後依然偏高的可能性也很高。傳統方法若忽略這種相關性，往往會導致偏差或錯誤結論。GEE 的出現，突破了傳統模型的限制，能在不需精確假設資料相關結


梁院士、Ron Brookmeyer 和 Scott Zeger 在 1990-1992 連續 3 年獲得美國公共衛生學會頒給 40 歲以下生統學者最高榮譽的 Spiegelman Award，系上特地為此留影

構的前提下，有效分析具相關性的縱向與叢集資料。

梁院士表示，GEE 的開創，始於在美國約翰霍普金斯大學公共衛生學院任教時，婦幼衛生學系有項研究在探討母親的壓力與孩子生病的機率，其中受試者必須每天記錄壓力大小與孩子是否生病。這些日復一日累積的觀測值，形成了一種「縱貫式資料」，資料彼此之間存在相關性。然而，當時的統計工具幾乎都假設數據彼此獨立，研究者擔心這種情況下所得出的結論會失真，因此請生物統計學系系主任協助。

剛開始，系主任找上的是 Scott Zeger 教授，還有同系的 Steve Self 教授參與研究。然而，在研究過程中，他們發現目前的統計工具已不適用，須發展新的統計工具以進行計算；但若要發展新工具，又須導入公式，來證明新公式的準確性。兩人在此遇到了瓶頸，便找上了梁院士幫忙。此時，梁院士想起自己於華盛頓大學攻讀博士時所修習的「廣義線性模式」課程，很快地便將結果導了出來，他也因此名列這篇論文的共同作者。這篇文章就是後來 GEE 的前身，也是和梁院士的多年好友 Zeger 的首次合作。

Zeger 是時間序列分析的專家，兩人在這項研究中，發現更多的可能性，便決定結合彼此專長，接續現有的研究，成功發展出「廣義估計方程式」。此法突破了數據獨立性的假設，能更準確分析重複測量或群聚資料，為縱向資料分析開啟全新局面。這項研究成果一經發表，短短 4 年間便在國際間廣為採用，並成為流行病學、臨床醫學甚至社會科學的核心分析工具。

梁院士不僅重視理論，也重視推廣與資源共享。他與 Zeger 教授積極爭取經費，請學生將 GEE 寫成可直接使用的應用程式，免費提供給學界使用。後來，這套方法更被納入 SAS 與 SPSS 等主流統計軟體，方便全球研究人員使用。

「其實公衛學院副院長曾問過我們有沒有申請專利的想法。」梁院士說，但他和 Zeger 教授當時並不以為然，而認為工具若無法供他人使用、對社會沒有幫助，那便失去了工具的意義，「生物統計是門『工具』科學，目的是為協助科學家尋找科學問題的答案」。

GEE 帶來的影響甚遠，在遺傳流行病學中，GEE 能精準分析家族成員間的資料關聯；在愛滋病藥物研發上，更能

利用短期縱向數據，提前驗證藥效，讓新藥得以更快通過食藥署 (FDA) 核准、投入臨床，為公共衛生與病患福祉爭取寶貴時間。

培育人文關懷醫者 強化國內人才國際視野與思辨

在美國約翰霍普金斯大學執教的 28 年間，即便研究業務繁忙、來自各地的演講邀約不斷，梁院士仍幾乎每年暑假都返國開研討會，將國際生物統計及流行病學尖端新知與國內學研界分享，對提升國內公共衛生及臨床研究水準貢獻良多。

從約翰霍普金斯大學退休後，梁院士回國投身高等教育，擔任國立陽明大學 (現為國立陽明交通大學) 校長 7 年 4 個月，將陽明大學打造成為教研並重的研究型大學。在他的努力下，陽明大學成功爭取到教育部「邁向頂尖大學計畫」每年 5 億元經費，推動成立國內頂尖的腦科學中心、腫瘤免疫中心及高齡健康研究中心，讓臺灣相關研究於國際舞臺上大放異彩。

同時，梁院士察覺臺灣高等教育常以追求國立大學排名為目標，而忽略學生身心靈的教育與發展，他提到，約翰霍普金斯的其中一位校長 Dr.Richardson 曾說：「我們學校培養出來的醫學生善於治療疾病，但不善於治療病患」，讓他十分認同。因此，秉持「人文關懷、學研並重」的理念，梁院士擔任校長時，致力於營造以學生為中心、如大家庭的文化，開學期間每個月在校長宿舍舉辦「與校長有約」活動，透過與學生一同用餐、聊天，前後超過 50 場次，學生有什麼疑難雜症，甚至來踢館，他都像武學大師一樣，用柔性溫暖的招式化解所有難題，建立師生間溝通與互信的橋樑。

梁院士提到，他對於推導數學公式得心應手，但對於記人名卻很不擅長。「但我有特別去花功夫」，梁院士說道，他的臉書有 3 千多名學生好友，每天忙完校長的業務後，他也會花時間去了解學生在想什麼、需要什麼幫助，也因此記下很多同學的長相和姓名。當校長在校園裡可以叫出學生的名字，會讓學生感受到自己被關心，「我想要的就是這樣，學生在感受到被關心後，才更能去關懷社會」。

為何梁院士會如此注重導師的關懷？這可追溯到就讀清華大學時，他曾因感冒打針感染 A 型肝炎，無奈只能返家由母親照顧起居。當時的導師徐道寧教授得知此事後，擔心梁院士會因長期休養導致被退學、人生規劃受阻，竟親自到臺北拜訪梁院士老家，提出讓梁院士住進自己家，由家中的阿姨照料飲食起居。雖然後續梁院士並未住進導師家

裡，但他每日前往導師家共用午晚餐，在導師及母親的關懷下，他順利康復，不至於中斷學業。

徐道寧導師影響梁院士甚遠，他深刻體會到作為教師，除了傳授專業知識之外，對學生付出關心，才是教育的精神。因此，他在陽明大學擔任校長時大力推動導師制度，希望透過導師的關心，在必要時對學生產生強大且正向的影響。「我們的學生將來都是要面對病人的醫護人員，身為師長的我們若不關心學生，那又如何要求他們將來做到視病猶親？」梁院士提到，人文素養、全人教育都是他在擔任校長時期推行的主要政策。

除了對全人教育的推動，梁院士也充分發揮自己的人脈與資源去募款，每年安排數十位醫學生到約翰霍普金斯醫學院、西雅圖華盛頓大學等國外一流機構實習，並提供醫學生每年 200 萬、共 5 年的獎學金，到國外頂尖大學攻讀博士，提升國際視野，並為臺灣培養未來醫師科學家儲才，成效卓著。他更進一步帶領陽明大學與中央研究院攜手合

作，爭取到國家科學及技術委員會「新世代跨領域科學人才培育計畫」，開設「人文講座」27 門通識課程及「巨人的肩膀」課程，大幅提升學生人文素養及獨立思考能力，課程更開放給臺北醫學大學及國防醫學院學生，以擴大其影響力。

打造任務導向研究院 提供政策與產業智庫支援

梁院士先後兩度在國家衛生研究院任職，第一次於 2003 至 2006 年間擔任副院長。任內，他積極推動國衛院由純研究機構轉型為以國家任務為核心的政策導向機構，專注於提供可落地的政策建議，解決國內疾病及公共衛生問題。2005 年禽流感疫情爆發，當時的衛生署曾希望向羅氏藥廠購買全國 10% 的克流感存量卻未如願。面對極度緊迫的情況，梁院士與院方督導國衛院生物製藥組，不眠不休地破解克流感公克級生產製程，僅用 18 天便完成量產準備，成功保障國內藥物供應充足。更重要的是，該事件首創國家強制授權藥物技術的先例，彰顯國家安全優先於專利權，也為守護全民健康立下里程碑。

「行政工作推動一些事情的可能性，比個人做研究的影響層面可能更廣、更深遠。」梁院士說。當時，國衛院在內湖的辦公室內，有一面地毯上有咖啡漬，是長期在上方倒咖啡導致的。他僅隨口請總務處同仁處理，當他隔兩週再次踏進這間會議室時，便發現地毯已全數換新。這件小事讓梁院士意識到「原來自己是這麼有影響力的」。從此他便時刻提醒自己「頭銜」所帶來的權力務必善用而非濫用。

2010 年衛福部為了妥適運用於 2009 年起菸捐調漲後之結餘，補助國內 12 家醫學中心透過實證研究提供政策建言，以期降低國內癌症死亡及發生率，並提升癌症患者生活品質。在此基礎上，2019 年衛福部責成梁院士以院長身分執行「癌症研究跨機構合作平臺及其整合應用」計畫，促成國內 8 個癌症研究團隊之整合、建置癌症研究資訊共享網站、進行跨醫學中心臨床資料整合，而後完成 16 個整合型癌症轉譯計畫資料庫建置，經此強化各癌症整合團隊之研究能量，並為政府推動「健康大數據永續平臺」奠基。

使命驅動 跨越危機的公共衛生實踐

2017 年至 2022 年間，梁院士再度重回國衛院接任第 6 任院長，帶領團隊迎戰 2020 年新冠肺炎疫情。他與副院長司徒惠康教授共同制定防疫主軸，並從 3 大方面展開積極行動：首先，國衛院迅速破解瑞德西韋藥物合成技術，取得原料後 15 天完成毫克級合成，僅 5 天後即達公克級規模，做好充足備戰準備並藉此安定民心；其次，研發基於 SARS 抗體篩選的新冠病毒快篩試劑，並於 2022 年獲食藥署緊急授權，確保國內快篩供應充足；第三，建立包括 DNA 疫苗在內的 4 大疫苗研發平臺，並推動 DNA 疫苗進入第一期臨床試驗，提升國家疫苗自主備製能力。梁院士同時鼓勵團隊接受媒體訪問，讓民眾了解國衛院努力，並增強社會信心。

領軍快篩與疫苗布局 穩定疫情關鍵科學支柱

2020 年 2 月，新冠疫情升級，梁院士受命擔任中央流行疫情指揮中心研發組組長，負責快篩檢測、藥物與疫苗研發以及流行病學預測等核心任務。他每週率領專家團隊一同檢視與討論國際文獻，提供數十項政策建言，成為防疫決策的重要智庫。

照片提供：國家衛生研究院

梁院士與夫人在臺東都蘭的新家

同年 7 月，梁院士協助台康生技與阿斯特捷利康製藥公司 (AstraZeneca) 牽線，安排 AZ 疫苗在臺灣設廠。雖後續因國內產能不足無法談妥，但基於這段時間的對談，梁院士也和 AZ 亞洲總部負責人 Jasper Meyns 建立了良好的互動，也順利於 10 月完成 1 千萬劑疫苗的預採購簽約。

「陳時中部長要我向 Jasper 表達，希望 AZ 公司在 2020 年底前能先提供 100 萬劑供國內醫護及防疫人員施打」，但此時英國國內的疫苗需求仍未被滿足，Jasper 也坦言，對先提供給臺灣施打，有其困難。沒想到，在 2021 年 3 月 3 日，鍥而不捨的 Jasper 親自來電告知，有 11 萬 7 千劑疫苗正經韓國運往臺灣！這 11 萬劑疫苗雖不多，卻對防疫成效與社會安定發揮了關鍵影響。「我深刻地感受到在人與人的相處中，互敬互信的重要」，梁院士說。

未來展望
縮短城鄉醫療與教育差距

完成疫苗採購任務後，梁院士於 2022 年底正式卸下國衛院院長一職，並重拾對高等教育的滿腔熱血，隔年接任逢甲大學春雨講座教授，教學過程中看到 AI 對學生的影響，擔憂會削弱學生的批判性思考與判斷能力。他進一步提醒，不應在技術追求中忽略人文精神。以醫療領域為例，AI 可以輔助診斷，但醫病關係中所蘊含的同理心與人性，是機器無法模擬的，這也是他堅持推行全人教育的理由。他語重心長地說：「不要忘了，我們是社會的一份子，我們還是要關心周遭的人事物。」

基於長年對臺灣社會的關懷，目前居住在臺東的他，也看到了城鄉醫療與教育差距的問題，正在積極協助國立臺東大學成立護理系事宜。他同時也十分關心 108 課綱的多元性對數學、物理與化學等基礎課程扎根的衝擊。他認為，在臺灣，他可以發揮更深遠的影響，除了將生物統計的專業應用在對社會有實質幫助的領域上，也希望能透過自身的影響力，讓臺灣的國民與高等教育走向更好的未來。

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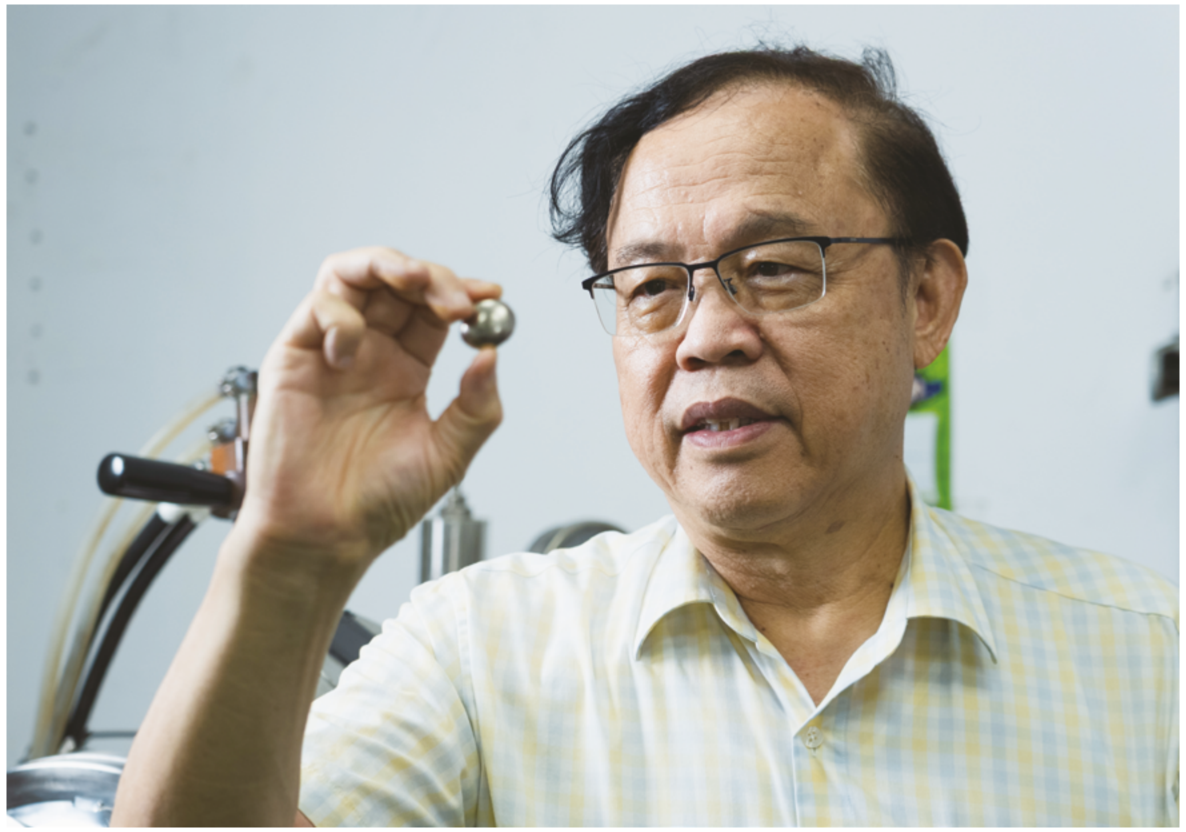
成 就 事 蹟



葉均蔚

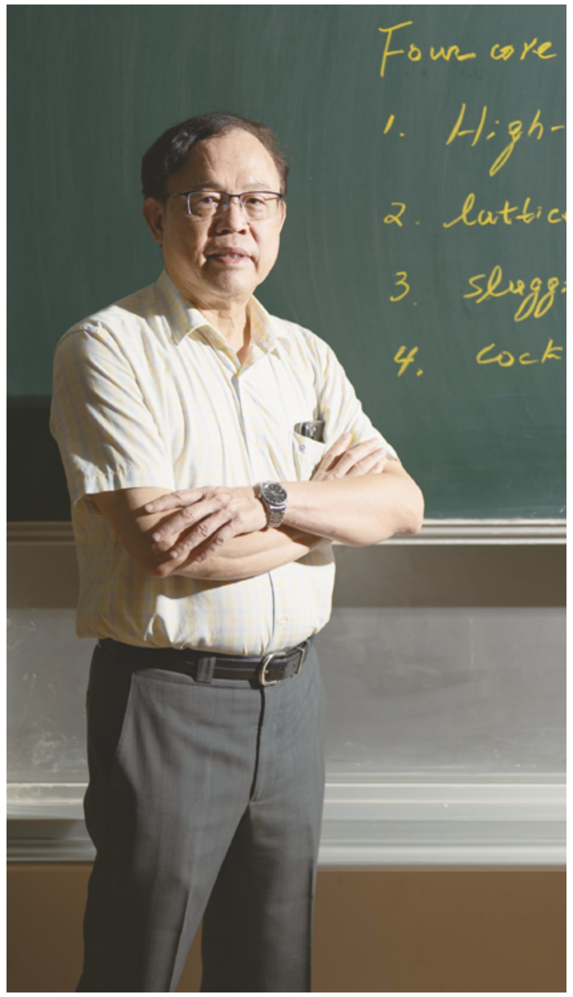
院士

工 程 科 學 組

全球第一且唯一「高熵合金之父」煉出地表最強金屬

搶先歐美日發表突破性材料一鳴驚人

在漫威電影的虛構情節中，美國隊長手上的盾牌和黑豹國家「瓦干達」極力保護的珍稀資源——汎合金，其金屬硬度號稱地表最強。然而，在現實生活中，國立清華大學的特聘研究講座教授——葉均蔚院士，卻真的發明出可耐高溫、耐腐蝕、抗輻射的地表最強金屬——「高熵合金」（High Entropy Alloys, HEAs），為 21 世紀材料科學帶來劃時代的突破，而葉院士也被譽為「高熵合金之父」。



傳統合金設計多以 1 種主元素為基礎，配合其他微量元素進行調整；然而，葉院士突破傳統思維，率先提出「以多主元素為核心」的全新材料設計理念，成功研發出高熵合金，可將 5 種以上的金屬以等比例或非等比例合成，該類材料不僅展現出優異的機械強度，亦為航空、航太、核能、軍工與電子等尖端產業應用帶來無限可能。

2006 年，葉院士提出高熵材料 4 大核心效應：（1）高熵效應，使多主元素混合時更易形成固溶相；（2）晶格扭曲效應，由於多種原子尺寸及元素間的不同鍵結強度，產生了相較於傳統合金更嚴重的晶格扭曲和應變現象，影響合金的電導率、熱傳導、硬度及強度等整體性能表現，可為高熵材料帶來強度高、韌性高等優良的特性；（3）緩慢擴散效應，因多元素原子競爭及晶格扭曲妨礙了原子擴散的效應，進而使相變化及性質改變變慢，促進材料的高溫穩定性；（4）雞尾酒效應，透過各種元素的特性、元素間相互作用及各結構因素對材料不同性質的影響，設計適當的成分及製程，得到更好的加乘特性，進而產生多元應用。

綜合上述 4 大核心效應，葉院士建立起完整的高熵合金物理冶金學理論體系，成為全球高熵材料研究的理論依據。這些理論不僅被國際學術界廣泛引用，也成為材料性質預測與新型結構合金設計的重要工具，極大推動了材料科學的發展。2024 年，葉院士更應《Nature Reviews Chemistry》邀請，發表重磅綜述文章〈Clarifying the Four Core Effects of High-Entropy Materials〉，系統闡述高熵材料 4 大效應，並針對學界過去對於部分效應的爭議點予以澄清與深化，鞏固其理論在國際學術界的權威地位。

史丹佛大學根據 Scopus 引用數據統計，2021 至 2025 年葉院士在材料領域科學影響力世界排名皆為第 2，華人第 1。他亦受邀擔任《High Entropy Alloys & Materials》期刊總編輯之一。2024 年，更於墨西哥坎昆榮獲第 32 屆 IMRC 卓越貢獻獎，大會並特別舉辦「高熵材料研討會」向他致敬，成為最熱門的專場，充分展現葉院士在國際材料領域的領導地位。

葉院士亦長期在清華大學致力教學，培育無數優秀學子，成為臺灣學術與產業的重要中堅。此外，他積極推動產學合作，成功將實驗成果轉化為具商業潛力的技術與產品，為產業注入強勁動能。

葉院士不僅是材料科學的開拓者，更是提升臺灣科研實力與國際能見度的重要推手。他表示：「跟在人家後面做，頂多是錦上添花，研究價值有限；唯有持續創新及突破，才能發揮最大的研究價值。」這份堅持創新的精神，正是葉院士對臺灣、對科學、對未來最珍貴的啟示。

2024 年國際材料研究高峰會在墨西哥坎昆舉辦表彰葉院士專題研討會頒發卓越貢獻獎

國家桂冠故事

突破傳統材料迷思
開創高熵合金領域

出身清苦拚翻轉
後來成為高熵合金之父

在材料科學領域，長期以來認為多元素合金難以兼容，極易生成脆性化合物而不具實用性。然而，臺灣的葉院士以逆向思維提出「高熵效應」，認為多元素合金在高亂度下反而能依據熱力學第 2 定律形成穩定固溶體，並展現出優異的強度與韌性等特性。1995 年起，他投入此艱難研究，最終於 2004 年發表開創性論文，為其命名並奠定「高熵合金」理論基礎，使臺灣站上國際材料研究的前沿。

葉院士的科學道路並非坦途。他出身宜蘭鄉村，成長清苦，卻磨練出不屈的精神。年少時曾因求籤被斷言「考不上大學」，但這反而激發鬥志，終考取清華大學物理系並轉入材料系，開啟科研之路。不同於多數人選擇留學海外，他堅持留在臺灣攻讀博士，立志以研究回饋土地。憑藉這份執著與信念，他在資源有限的環境中，開創出高熵合金的理論體系，成為全球公認的「高熵合金之父」，徹底改寫 21 世紀材料科學的發展格局。

宜蘭庄腳囝仔
立志苦讀翻轉命運

葉院士成長於 1950 年代的臺灣東北部——宜蘭縣南澳鄉，父親早年在福建擔任警察局長，後因戰亂動盪輾轉來臺，定居南澳與花蓮姑娘成婚，共育有 7 名子女。自小在鄉間長大的他，個性活潑好動，是個典型調皮搗蛋的孩子。5 歲時，葉院士跟年長的玩伴去偷摘別人家的水果，負責站門口當把風，結果只有他被逮個正著，母親得知後大為震怒，氣得舉起菜刀威嚇說要剁掉他的手，當時年紀尚小的他嚇得直說以後不敢了。葉媽媽見兒子如此頑皮，決定提早一年送他上小學，希望藉由教育來引導他走入正軌。

剛開始，他並不情願，但母親巧妙地說：「上學一天有 5 毛錢可領哦。」這句話勾動了年幼孩子的好奇與渴望，他便同意去讀書。不過這份小小的薪水只發了兩天就停止了。當他疑惑地詢問在河邊洗衣服母親時，母親冷冷地回應：「那你不要去啊。」這句話反而激起了他的自尊心。他直言：「老師同學都認識我了，不去怎麼可以？」於是他硬著頭皮，邊擦眼淚邊跑去學校上學，沒想到也從此走上了一條與眾不同的求學之路。葉院士曾問母親此一往事，才知媽媽是因為正蹲在河邊洗衣服，滿手肥皂泡，不方便拿錢。

葉院士一年級得第三名，即逕讀二年級，三年級起都是班上的第一名，但其實他本質上仍是個熱愛玩耍的鄉下男孩。直到小學五年級，他迎來人生第一個關鍵轉捩點。某日，他與父親站在家門口，父親突然指著一名從門口經過的牧童說：「如果你書讀不好，考不上初中，就去當牧童，一個月賺一斗米。」

1969 年葉院士 (後排左一)
與父母親、2 位哥哥及 4 位妹妹合影

那一刻，葉院士開始第一次思索人生的未來，立志上初中。

憑著堅定的決心與勤奮的態度，葉院士順利考取省立花蓮中學初中部（現為國立花蓮高中）。他在學業上表現優異，順利直升高中部，展現出不凡的潛力。當時的他對未來充滿信心，深信自己必定能考上理想的大學。然而，一次求神問卜的經歷，卻讓他陷入短暫的低潮。

高中入學前，他前往南澳媽祖廟擲筊詢問大學考試是否可順利考上，結果連續三次皆得否定回應。「神明說了三次考不上大學」讓他頓時如洩了氣的皮球，感到極度沮喪與人生無望的走回家。但也正是這樣的挫折，激起了他心中更強烈的鬥志與不服輸的意志。他不願被命運定義，更不願向命運低頭，於是更加努力地苦讀三年，如願考取國立清華大學物理系，他說這是媽祖的靈驗，他感恩媽祖用激將法。

留臺深耕
只因不願對臺灣無貢獻

葉院士在清大一路念到博士，始終懷抱為國奉獻的信念，堅持留在臺灣深耕教學與研究。儘管當時臺灣流行出國深造，赴美留學幾乎成為學術界的主流選項，葉院士卻選擇堅守清華、留在臺灣。他坦言，這個決定來自一份深沉的責任感：「我真的沒辦法忍受自己對臺

灣沒有貢獻，這也是我在大學畢業後，決定在臺灣讀研究所、攻博士的原因。當年看到學長們競相出國，而且幾乎都不回來，就想我如果出國念書，大概也不會回來了。」

他的選擇體現了對臺灣這片土地的情感與責任，直到現今，他仍不曾喝過一滴「洋墨水」，堅持在臺灣持續自己的創新研究。正因為這樣的信念，葉院士不僅在材料科學領域深耕，也培育了無數優秀學子，成為清大材料系不可或缺的中堅人物。

沉潛 8 年耐住寂寞
終於改寫材料發展史

葉院士在研究道路上始終追求創新。早年，他為了突破傳統合金的技術瓶頸，發明了「往復式擠型法」（reciprocating extrusion），有效提升合金材料的強度及韌性，並因此取得 7 國專利。但他也因而發現，傳統合金的技術幾乎已經觸及天花板，難以再有突破，這成為他轉而思考並投入更具創新性之合金研究的重要原因。

「高熵合金」這一革命性構想的誕生，來自一次看似平凡卻充滿靈感的經歷。1995 年 5 月某一天，葉院士正從新竹開車北上，沿途經過新埔鄉間小路，腦海中忽然冒出一個顛覆傳統的想法：「為什麼不嘗試讓多種元素同時融合？如果亂度變大，可能反而產生意想不到的效果及特性！」

這樣的念頭與當時主流材料科學的看法大相逕庭。過去的理論認為，多種元素共存，會於材料內部形成多而複雜的化合物，導致材料脆化，難以實用。但葉院士卻敏銳地察覺其中潛藏的機會：正是這種高組成複雜性，可能隱含著一種「高熵效應」，有助於穩定元素間互溶的固溶相結構，提升性能。

一回到新竹，他立刻前往實驗室，興奮地將這個突破性的想法告訴碩士班即將升二年級的學生黃國雄，並當場決定更換研究主題。他親自擬出幾個合金配方，開始展開第一輪試驗。這項全新嘗試幾乎毫無前例，沒有論文可參考、也沒有書籍指引，只能靠葉院士自身的理論判斷與多年累積的直覺去摸索。他選擇迎難而上，毅然投入這片尚未開墾的科學荒原。在熔煉結果出來之前，心中始終懸念著到底能不能成功？

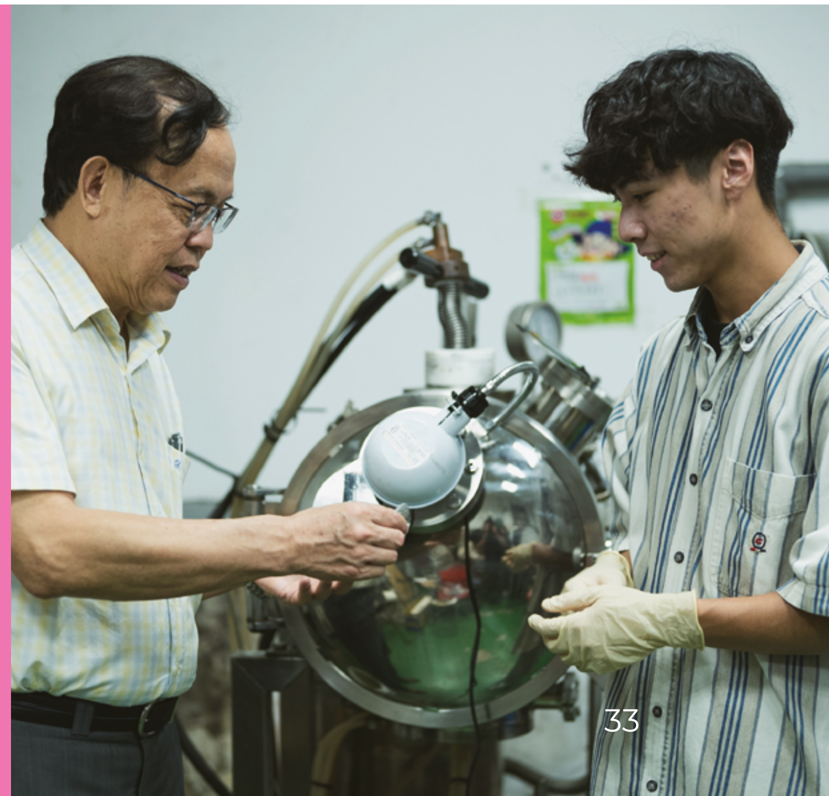
初期成果並不順利，熔煉出的第一個合金樣品裂成 3 塊，黃國雄沮喪地說：「老師，會裂掉！」但葉院士觀察後卻另有見解。他發現樣品是碎成大塊而不是破碎成細顆粒，表示各元素間已成功融合，問題在於熔得不夠均勻導致應力集中而破裂。

他沉思片刻後，反而微笑鼓勵學生：「再多熔幾次，讓成分更均勻，應該沒問題。」幾天後，第一塊完整的高熵合金樣品終於在清華大學材料科技館 3 樓實驗室誕生，這也成為全球高熵材料研究的起點。但是，葉院士當時並未張揚宣傳，深知單一樣品的成功難以動搖固有理論，唯有系統性、多元性的實驗結果，才能證明這不是偶然，而是一條嶄新科研領域。

因此，他持續設計更多合金組合，超過 40 種成分，讓學生日以繼夜熔煉、分析，不斷優化與驗證。他很清楚，臺灣資源有限，若論文一出，勢必引來世界各地科研強者投入，臺灣將無法保有領先優勢，容易被搶占功勞。因此，他謹慎而堅定地推進，等待最佳時機。

葉教授沉潛8年期間，夫人張秀慧老師是他最強力的後盾

葉院士與學生製作高熵合金材料



「我把種子埋在土裡，大家都看不到，慢慢灌溉。」他形容自己像育種的墾荒者，堅信高熵合金這顆科研的種子，必須在臺灣發芽、長成參天大樹，「因為我在國立大學教書，領的是人民的納稅錢，不能蹧蹋這個可以讓臺灣影響全世界的機會。」在成果尚未成熟前，他選擇不發表，而是投入大量心力於理論建構與實驗驗證，延至第 9 年才正式發表，他這 8 年的蹲馬步因而讓整個高熵合金理論體系更完整透徹。

他從熱力學中的「熵」概念出發，說明高亂度如何穩定結構、突破材料科學的既有框架，並結合動力學、結晶學與性質學，提出高熵材料的完整核心理論。這份深耕與耐心，最終讓一顆原本無人問津的種子，在國際學界的沃土中茁壯，改寫了材料發展史。

從二度退稿到世界注目—高熵合金的誕生之路

自 1995 年起，葉院士就獨自踏上這條被認為「不可能成功」的科研之路。他認為，真正的創新往往來自逆向思維，而開創性的突破也常誕生於眾人皆不看好的時刻。正是這份堅持與獨立思考，使葉院士持續深耕「高熵合金」這一概念。

2001 年，他帶著多年努力所得的實驗數據，提出創新性極高的「奈米高熵合金計畫」，向國家科學及技術委員會申請研究補助。雖然計畫獲得 3 位國外審查委員一致肯定，認為創意與可行性兼具，但在國內複審時卻遭遇沉重打擊。一位審查委員直言：「這個計畫若通過，將來可能會讓臺灣鬧國際笑話。」這句話至今仍深深印在葉院士心中，當時像刀刺心臟一樣的痛。

然而，也正因如此，他更加感念當時國科會的眼光與勇氣，不僅核准該計畫，還給予超過一般研究案的資金支持，讓他得以繼續前行。2003 年底，葉院士首次將提出高熵合金概念的論文投至《Nature》期刊，然而在短短 1 週內便遭退稿，隨即他又轉投至《Science》，雖進入審查，但 3 位審查中兩位推薦，一位不推薦，他的理由是建議刊登於較好的金屬期刊，雖經答辯但仍獲婉拒刊登。面對連番挫折，葉院士仍堅持理念不放棄，接續將稿件投至高影響力的《Advanced Materials》。該期刊編輯迅速回覆，認為內容更適合轉投至姊妹期刊《Advanced Engineering Materials》，終於遇伯樂，1 週內便接獲接受刊登通知「全文無需修改即可刊登」。如今此篇論文被各國學者引用超過 15,000 次，產生巨大影響力。

與高熵中心副主任林樹均教授合影

這篇開創性論文在 2004 年 5 月正式發表[1]，正式宣告葉院士沉潛 8 年、精心布局的研究成果全面爆發，光是在 2004 年，他便一口氣發表了 5 篇高熵合金相關論文。他坦言這背後有其策略性考量：「我就是想把這個領域的 credit 留在臺灣。第一年 5 篇，之後每年平均 10 篇地發表。當其他國家研究人員看到這個新領域想投入時，就會發現：『哇，這個領域已發表很多論文了，想追也追不上臺灣了！』」。

回顧這段歷程，葉院士笑說：「真的要能耐得住寂寞，還好我對自己的研究有信心。」他強調，自己的論文發表是有節奏、有規劃的，逐步推進、環環相扣，論述邏輯清晰且前後互不衝突。他也嚴格要求學生必須掌握正確且具說服力的第一手數據，因為這些資料未來都要經得起學術界的驗證與挑戰。

即使在取得相當成果及發表之後，外界對高熵合金的質疑仍不曾停歇。其

[1] Yeh, J-W., et al. "Nanostructured high-entropy alloys with multiple principal elements: novel alloy design concepts and outcomes." Advanced engineering materials 6.5 (2004): 299-303.

中一則惡意評論令他記憶猶新：「高熵合金應該被打入烏山頭水庫，永不翻身。」這樣的冷嘲熱諷不但沒有打擊他，反而激起他更強的鬥志。他坦言：「我對嘲諷及惡意批評早就免疫，認為他們因不瞭解而誤會，我反而感謝大家的誤會，才會輪到我來開發。若沒誤會，高熵合金早就被開發了！」也正是這份自信且坦然的胸懷，支撐他一步步走到今日的成就高峰。

打造突破性材料 獲邀接受《Nature》期刊採訪

葉院士於 1995 年開始進行高熵合金及材料的研究與實驗，深耕該領域 30 年而不輟，迄今發表之高熵合金及材料 SCI 論文已達 230 篇以上，帶動起全球高熵材料的研究風潮，包括美國、印度、德國、法國、英國、韓國及日本等國家皆大規模投入發展高熵合金及材料，每年相關論文數呈指數性增長，不僅對材料科學領域產生深遠影響，更使原本逐漸被視為「夕陽研究」的金屬領域期刊影響指數（Impact Factor）大幅提升，為學術界注入了新活力及新希望。

2016 年國際頂尖期刊《Nature》更為在學術影響力方面，葉院士於 Google Scholar 上已有十餘篇著作引用次數超過 1,000 次，其中最高更達 15,000 次以上，充分展現其世界級的研究地位。值得一提的是，傳統工程合金侷限於約 30 種合金系，如鋁合金、鈦合金、鈷合金及鎳合金等，範圍有限；然而，高熵合金的創新觀念卻使元素週期表上的所有元素都能參與組合，開啟無數新穎配方。這一突破為元素週期表立下新的里程碑，創造全新的材料榮景與生命，帶來無限的學術與應用契機，使葉院士享有「高熵合金之父」的美譽。

2016 年國際頂尖期刊《Nature》更為之撰寫專題文章「金屬調酒學——合成更強更韌更延合金」[2]，不僅高度評價高熵合金在先進材料領域的創新地位，也明確指出臺灣為這項突破性技術的起源地。

[2] Lim, Xiaozhi. "Metal mixology: stronger, tougher, stretchier: with a simple new recipe, metallurgists are creating a generation of alloys with remarkable properties." Nature 533.7603 （2016）: 306-308.

此外，他亦是 5 本高熵材料專書的主要作者，對於深化全球學界對高熵材料的理解與研究推展影響深遠。葉院士的努力不僅提升臺灣在國際上的能見度與學術地位，更使臺灣成為全球高熵材料研究的重鎮之一。

攜手國內 11 所大學及研究中心使臺灣成為高熵材料研究重鎮

2018 年，在教育部與國科會的共同支持下，葉院士率領團隊成立全球第 1 個「高熵材料研發中心」，成為該領域的創舉。

此中心集結國立清華大學、國立臺灣大學、國立陽明交通大學、國立中央大學、國立中興大學、逢甲大學、明志科技大學、國立臺灣科技大學與虎尾科技大學等資源，並與國家同步輻射研究中心及長庚醫院攜手合作，匯聚 30 位教授共同參與研究，執行 9 項高熵材料計畫。研究範疇涵蓋高性能材料、特殊合金、超硬合金及超耐溫複材、耐腐蝕材料、功能性薄膜、功能性陶瓷、生醫材料及相關學理，致力於探索高熵材料在理論與應用的前沿突破。

作為全球首座以高熵材料為核心的研發基地，該中心不僅聚焦學術研究，更積極推動跨域應用與技術轉移，涵蓋智慧製造、綠能材料、國防工業與生醫科技等領域。此舉不僅使臺灣材料技術從研究邁向產業，也強化了關鍵材料的自主生產能力，有效降低進口依賴並提升國際競爭力。

葉院士目前擁有超過 50 項傳統材料與高熵材料專利，其中十餘項已成功轉化為產業應用。例如，他開發的耐磨耗蝸輪，已廣泛應用於 CNC 數位控制加工機的第四軸與第五軸（分度盤），安裝數量逾 2 萬台以上，提升百億元級 CNC 機械設備的整體性能。

此外，他利用高熵合金研製出具超彈性的材料，應用於碳纖網球拍、羽球拍與高爾夫球桿打擊面，大幅提升產品表現。更具突破性的是，他研發出耐極端環境的高熵合金，製成可耐 1,200° C 的擠型模具，能擠型碳鋼與不鏽鋼等高熔點金屬，有助於奠定我國超高溫金屬擠型與壓鑄產業的基礎。

葉院士更創辦全球首家高熵材料科技公司，將清華大學授權的高熵材料技術導入產業，實質推動產業升級。這些成果不僅展現高熵材料的廣泛應用潛能，也證明其科研工作已深深扎根於產業實務，為臺灣創造可觀的經濟效益。

夢想飛碟
實現臺灣科研飛躍

葉院士的大學生涯始於清華物理系，卻因緣際會轉入新創立的材料科學工程系，從此踏上屬於料人的道路。

高熵材料研發中心所研發出的高熵合金材料

雖然僅在物理系待了兩年，但那段經歷深深影響他的一生，也啟發了他至今仍未放下的夢想——「有一天，我要做出飛碟。」

大一時，他的物理系同班同學中有位對 UFO 著迷的「飛碟迷」，時常談論外星文明與飛行器技術，還組織了飛碟研究社。葉院士受到他的影響，開始對飛碟產生強烈好奇與興趣。他開始思索：「如果飛碟真的存在，它是怎麼飛的？我們地球人同樣可以打造出來。」

葉院士持續關注來自全球的 UFO 新聞與影片資料，廣泛研讀相關書籍與理論文獻，在腦中拼湊出飛碟飛行的可能邏輯，認為飛碟的推進方式並非源自常規的螺旋槳或噴射渦輪引擎，而是利用電流與磁場交互作用所產生的動力。根據此構想，他推測飛碟的外型設計不會只是單純的碟狀，而是在碟形圓周設有一圈特殊凹槽，作為產生動力的關鍵結構，也就是在凹槽上下放電板間產生大量的電漿電流，而與飛碟周圍裝有超導螺圈磁場產生羅倫茲電磁力，進而推動飛碟。

更奇妙的是，就在他畫出心中飛碟構造約 1 週後，他到臺北重慶南路的書店逛書時，無意間抽出一本《星際訪客——飛碟》，赫然發現其中一頁清楚地印著與他自己構想高度符合的飛碟照片。那一刻，他內心無比震撼又驚喜，「這個發現，讓我更相信自己是對的。」

他說道。為了驗證自己的構想，他在課餘時間兼了 3 份家教，籌措實驗所需的經費，並親自拿著自繪設計圖跑去新竹市找工廠幫忙打造飛碟要用的發電機，趁暑假提回鄉下老家做實驗，並請他的二妹幫忙踩固定好的腳踏車帶動後輪的旋轉，藉輪面磨擦力帶動轉軸而發電。

多年後，這份敢於追夢與探索未知的精神，化為推動高熵合金研究的原動力。葉院士開發出兼具強度、耐蝕與高溫穩定性的突破性材料，不僅以「高熵合金之父」享譽國際，更以實際行動證明——科學不只是嚴謹的探索，更是一場勇敢通往無限可能的旅程。

當被問及目前實現「飛碟夢」仍缺乏哪些關鍵技術時，葉院士坦言：「室溫超導體與小型核融合反應器，正是未來我仍在努力追尋的方向。」這份對理想的執著，不僅象徵著科學家的浪漫與堅毅，也為臺灣科研描繪出奔向星辰大海的無限想像。

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About the Award

Established in 2001 and presented every two years, this is the 13th Presidential Science Prize. This prize symbolizes in the highest academic honor to pay respect to the most outstanding scientists in the Republic of China (ROC).

To promote Taiwan's position in the international science community, the Office of the President has established the Presidential Science Prize to recognize innovative researchers who have made monumental contributions to international research in the fields of Mathematics and Physical Sciences, Life Sciences, Humanities and Social Sciences, and Engineering Sciences, especially those scholars whose works have had major impact on the development and applications of these fields in Taiwan.

To implement the selection and award of this prize, the President of Academia Sinica has convened a steering committee of fifteen distinguished scientists and related cabinet ministers. Nominees for the Presidential Science Prize are only taken into consideration when

(1) they are nominated by academicians of Academia Sinica and/or Presidential Science Prize awardees;

(2) they are nominated by academic and research institutions and associations and leaders of the community invited by the Presidential Science Prize Steering Committee.

After nomination, four selection committees in the fields mentioned above perform nominee screening tasks. This year, through a careful nomination and selection process, the three awardees of this prestigious honor have been chosen as: Dr. Kung-Yee Liang (Life Sciences), Dr. Jien-Wei Yeh (Engineering Sciences).

Conferred by the head of state, the Presidential Science Prize gives recognition to those scientists for their long-term efforts at conducting scientific research and cultivating young researchers. This prize also aims to pay respect to outstanding scholars who have made top-notch academic achievements and to have scientific R&D fully benefit people's livelihood.

A Track Record of Achievements

Kung-Yee Liang

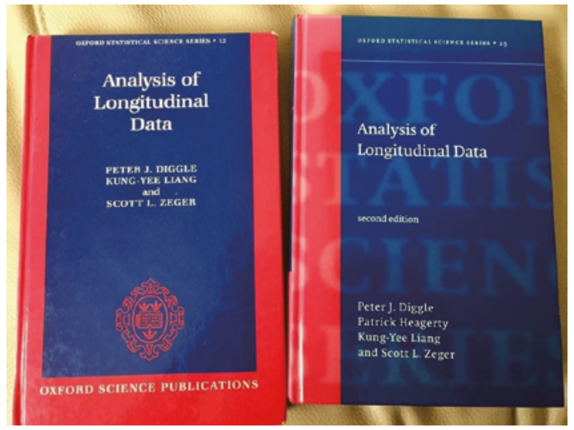
Life Sciences Category

Trailblazer in Biostatistics – Creator of the Generalized Estimating Equations (GEE)

Accelerating New Drug Development to Benefit Billions Worldwide

Dr. Kung-Yee Liang is widely recognized for his contribution to the development of the Generalized Estimating Equations (GEE), a statistical method that revolutionized the analysis of longitudinal data. He was the former President of National Yang-Ming University and now the Spring Rain Chair Professor at Feng Chia University. Though he originally trained in mathematics, Dr. Liang made a pioneering transition into biostatistics. By applying cross-disciplinary thinking, he derived the now world-renowned GEE. Within just 4 years of publishing this groundbreaking work, he was awarded the Mortimer Spiegelman Award, the highest honor in biostatistics, by the American Public Health Association.

GEE has since become a cornerstone of modern biomedical research. Whether in laboratory studies, cohort epidemiology, or clinical trials, any longitudinal study now routinely employs GEE. It has been incorporated into all major statistical software, including R, STATA, SAS, and SPSS, and has been cited more than 22,000 times in academic literature. This method fundamentally changed the way researchers analyze long-term observational data, enabling the evaluation of changes in the same individual over time. The result has been a dramatic increase in the efficiency and accuracy of clinical trials. Today, international pharmaceutical companies rely on GEE-based pre-post clinical trial designs to correctly assess the efficacy of new drugs, particularly in areas such as oncology, cardiovascular disease, and diabetes. Through this contribution, Dr. Liang's work has directly improved the health and quality of life of tens of millions of patients worldwide.



The Johns Hopkins University
Gazette

Geometry focus of JAMI conference, see Page 2

New material stores, erases data with ease

Statistical method aids researchers

Hopkins offers license for cell line

Joyce Carol Oates to give Pouder Lecture

Zeger named associate dean for academic affairs at SHPH

Conversation with a conductor

Hopkins offers unique brain cell line to companies

New statistical method assists researchers

There's an IBM PS/2 made for every student body. And budget.

Johns Hopkins University reports that Dr. Liang and Dr. Scott Zeger received the 1987 Snedecor Award from the American Statistical Association

At universities across the globe, GEE is now a core element of graduate-level biostatistics curricula. Dr. Liang, together with three leading scholars in the field, co-authored the authoritative volume *Analysis of Longitudinal Data* (Oxford University Press), a standard reference for scholars conducting longitudinal research. Building on his original innovation, Dr. Liang extended GEE methods in collaboration with European and American genetic and psychiatric epidemiologists, developing new approaches to explore disease clustering and identify genetic factors in conditions such as schizophrenia, obsessive-compulsive disorder, and asthma. These advancements deepened the scientific community's understanding of disease mechanisms and accelerated the search for novel therapies. As Dr. Liang has often emphasized: "I hope that what I do—whether directly or indirectly—will contribute to society and to human health." This guiding principle has driven his decades-long career in both research and public service.

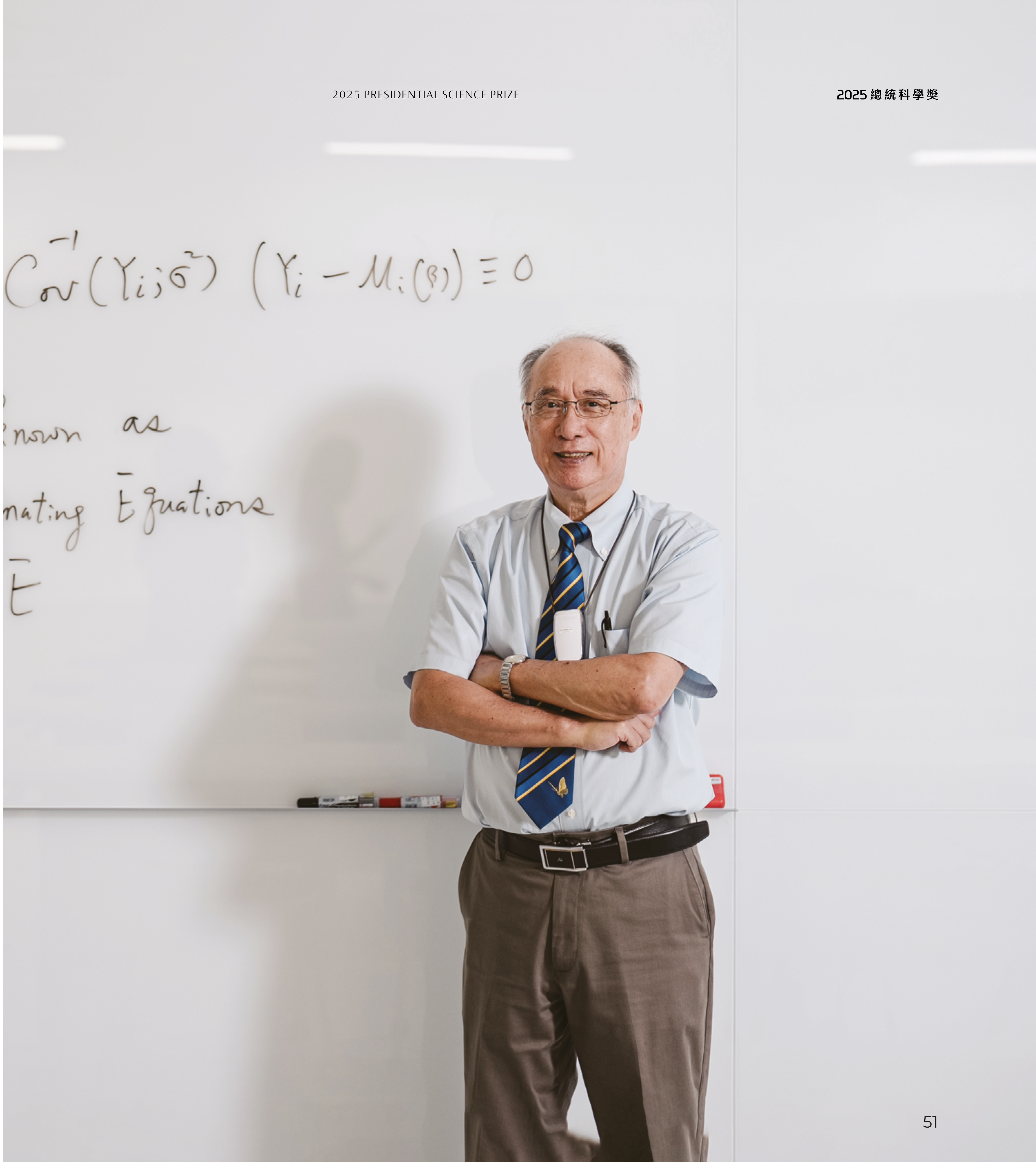
Dr. Liang's achievements in academia and public service span nearly four decades, leaving a profound impact from his pioneering contributions to statistical theory to his dedication to cultivating talent. Since publishing the Generalized Estimating Equations in 1986, his research has not only transformed methods of biostatistical analysis but also brought new perspectives to global public health and clinical trials. His approach has enabled researchers to efficiently analyze and clearly interpret long-term follow-up data that were once difficult to manage, helping them uncover patterns of disease progression and treatment effects from complex datasets.

Dr. Liang's groundbreaking work has earned him wide international recognition in both statistics and public health. He has received prestigious honors including the Snedecor Award from the American Statistical Association, the Mortimer Spiegelman Award from the American Public Health Association, and the Karl Pearson Prize from the International Statistical Institute. He has also been elected to the U.S. National Academy of Medicine, Academia Sinica, and The World Academy of Sciences (TWAS), a testament to the breadth and depth of his scholarly contributions.

From innovative statistical theory to practical applications in new drug development, mental health, and chronic disease prevention, Dr. Liang has demonstrated profound expertise and an exceptional ability to bridge disciplines, establishing himself as one of the most influential biostatisticians of our time. His work is not confined to mathematical formulas in academic journals; it has directly improved the health and quality of life of countless patients worldwide, making him a model figure in harnessing data science to advance medicine.

The Story of a Champion

From Mathematics to Statistics: Building Dreams in Biostatistics



A Pioneer in National Biostatistics and a Key Figure in Epidemic Prevention

Before his mandatory military service, Dr. Kung-Yee Liang had little certainty about his future path. Yet a pivotal introduction from his mentor, Dr. Dao-Ning Hsu of National Tsing Hua University, set him on a course that would define his future career in statistics. In 1986, Dr. Liang published his seminal work on Generalized Estimating Equations in the leading journal *Biometrika*. This breakthrough dramatically reshaped international clinical trial methodology, accelerating the evaluation and approval of new drugs, and became a cornerstone of graduate training in biostatistics both in Taiwan and abroad.

While garnering global recognition for his contributions, Dr. Liang never forgot to give back to his home country. During his years teaching in the United States, he helped establish Taiwan's first master's and doctoral programs in biostatistics at National Taiwan University's College of Public Health, cultivating a new generation of biostatistical talent.

Later, as President of the National Health Research Institutes, he transformed the organization into a mission-driven institute, dedicated to translating evidence-based research into public health policies that improve people's well-being. During the COVID-19 pandemic, when countries worldwide were competing for vaccines, Dr. Liang personally leveraged his international network to negotiate with senior executives at AstraZeneca. Despite numerous challenges, his sincerity won their trust, ultimately securing nearly 120,000 doses for Taiwan's frontline workers—an achievement that helped stabilize public confidence during a critical moment.

Dr. Liang pictured with Dr. Dao-Ning Hsu

Guided by Destiny, Fulfilling 2 Lifelong Loves

Dr. Liang's father, who rose from humble beginnings to become Director of the Telegraph Bureaus in Guangdong and Guangxi, had long hoped his sons would follow in his footsteps into engineering. After the family relocated to Taiwan following the Chinese Civil War, this expectation lingered. Although his parents were open-minded and never imposed rigid demands, both Dr. Liang and his twin brother were aware of their father's wishes, always answering "engineer" when asked about their future ambitions.

Yet from a young age, Dr. Liang displayed a deep affinity and talent for mathematics. By elementary school, he found mathematical reasoning and calculations came effortlessly to him. When it came time to select his university preferences, he dutifully listed electrical engineering and related fields in line with his father's expectations. But he could not suppress his genuine passion for mathematics, placing mathematics at National Taiwan University and mathematics at National Tsing Hua University among his top choices. On the day results were announced, fate intervened—his scores landed him precisely in the Department of Mathematics at National Tsing Hua University, fulfilling his truest desire.

"I did once consider switching majors, since mathematics seemed to offer limited career prospects," he recalled. But destiny had led him to the field he loved, how could he give it up so easily? And so, Dr. Liang chose to stay the course, embarking on a lifelong journey that wove together mathematics, statistics, and ultimately, public health, a journey that has shaped his career for more than four decades and left a lasting impact on the world.

Dr. Liang pictured with his parents and twin brother

Finding Inner Clarity and Entering the New Field of Statistics

When Dr. Liang enrolled in the Department of Mathematics at National Tsing Hua University, statistics was still a new and little-known discipline in Taiwan, with very few formally trained statisticians. In his senior year, Dr. Ti-Yuan Hwang, freshly returned from the University of Wisconsin with a Ph.D. in statistics, began teaching at Tsing Hua. It was here that Dr. Liang first encountered statistics, and he was immediately drawn to the subject. At the time, however, he remained uncertain about his future. Despite his strong interest in statistics, he had not yet considered it as a career path and proceeded to complete his mandatory military service upon graduation.

Fortuitously, his class advisor, Dr. Dao-Ning Hsu, received a request from Dr. Ching-Hua Teng, Chair of the Department of Mathematics at Soochow University, who was seeking to recruit teaching assistants. After reviewing the situation of his former students, Dr. Hsu realized that most of the top graduates had gone abroad for further studies. Noticing that Liang was still undecided about his next step, she recommended him for the position. Dr. Liang accepted, thinking it would be a suitable opportunity after completing his military service. “My time at Soochow turned out to be a stepping stone in my life,” he later reflected. Over the course of two years teaching, he found the stability to reflect on his future direction, devote himself to study, and shed the youthful restlessness of his undergraduate years. Ultimately, Dr. Liang resolved to pursue advanced study in statistics overseas. With Dr. Hwang’s strong recommendation, he successfully gained admission to the University of South Carolina with a scholarship, beginning his academic journey in the United States to pursue a master’s degree in statistics.

A Commitment to Biostatistics: Mentored by a Pioneer

The late 1970s in the United States marked a period of rapid growth for biostatistics. While completing his graduate training, Dr. Liang attended a guest lecture on survival analysis, a statistical method used to measure time-to-event outcomes, such as the length of time from drug administration until death, to evaluate treatment efficacy. In the decades following World War II, Western lifestyles shifted toward richer diets, heavy smoking, and physical inactivity, which led to widespread chronic and cardiovascular diseases. This prompted pharmaceutical companies to begin developing new therapies in hopes of extending patients’ lives. Yet existing statistical tools were inadequate for the demands of drug development, and survival analysis quickly became an essential approach.

“This was the first turning point of my academic career, and also a path of no return,” Dr. Liang recalled. That lecture marked his first encounter with biostatistics, and it was then that he realized statistics could indirectly but powerfully improve human health: “A good statistical tool can help clinicians and public health researchers answer many meaningful questions.” Motivated by this insight, Dr. Liang decided to pursue a Ph.D. in biostatistics at the University of Washington in Seattle under Dr. Norman Breslow, one of the pioneers of the field.

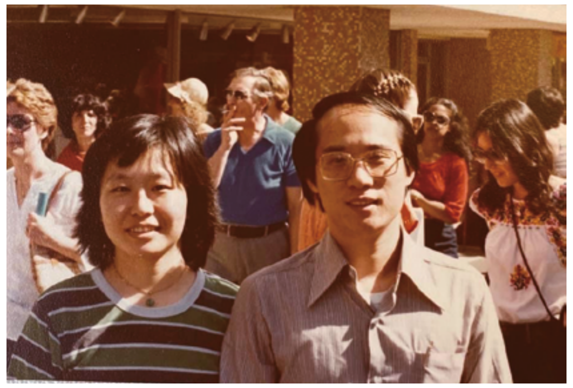
Dr. Norman Breslow and Dr. Liang

At Washington, he naturally sought to work with Dr. Breslow, whose reputation had inspired him to study there. To his surprise, despite being one of the most renowned biostatisticians of the time, Breslow accepted very few students because he required each to define their own dissertation topic. This demand discouraged many, but it did not deter Dr. Liang. Drawing on the strong foundation he had built in statistics, he completed his doctorate in only three years.

One of the experiences that left the deepest impression on Dr. Liang occurred during his time at the University of Washington. When he brought a probability theory paper to Dr. Norman Breslow for discussion, Breslow admitted that parts of the work extended beyond his own expertise and referred him to Dr. Ron Pyke in the Department of Mathematics for additional guidance. Later, when the paper was published, both professors declined co-authorship, insisting that their input had been too limited and that full credit should go to Dr. Liang himself. This spirit of humility and integrity profoundly moved Dr. Liang and shaped his own philosophy as a mentor. As he has often said: “If authorship is not deserved, it should not be sought.” Throughout his career, he has followed this principle, declining co-authorship when he felt his contribution was insufficient and leaving recognition to younger faculty and students.

Pioneering a New Era of Longitudinal Data Analysis: Sharing the Results with the World

After receiving his Ph.D. in biostatistics from the University of Washington in 1982, Dr. Liang joined the faculty at Johns Hopkins University. It was during this



period that he made one of his most influential contributions to science: the co-development of the Generalized Estimating Equations (GEE) with Dr. Scott Zeger. In statistics, regression analysis is a key method for examining the relationship between independent and dependent variables, such as evaluating whether the frequency of exercise affects blood pressure.

Traditional regression models, however, are built on the assumption that all observations are independent of one another. In many real-world cases this assumption does not hold true. For example, repeated measurements taken from the same subject over time are often correlated: a person with high blood pressure two weeks ago is likely to still have elevated blood pressure two weeks later. If such correlations are ignored, conventional methods can produce biased or misleading conclusions. GEE overcame this limitation by allowing researchers to analyze correlated longitudinal and clustered data effectively, without requiring precise assumptions about the structure of the correlation.

According to Dr. Liang, the development of GEE began when he was teaching at the Johns Hopkins School of Public Health. A study in the Department of Maternal and Child Health was investigating the relationship between mothers' stress levels and the probability of their children falling ill. Mothers were asked to record daily levels of stress along with whether their children were sick. Over time, these repeated observations created what is known as longitudinal data, with strong correlations

Dr. Scott Zeger and his family visited Dr. Liang in Taiwan in 2024

Dr. Liang, Ron Brookmeyer, and Scott Zeger were awarded the Spiegelman Award, the highest honor given to biostatisticians under the age of 40, by American Public Health Association for three consecutive years from 1990 to 1992. The department took a special photo for this occasion

across measurements. At that time, nearly all available statistical tools assumed independence among data points, raising concerns that any conclusions drawn from the study would be unreliable. The researchers sought help from the Department of Biostatistics.

At first, the department chair assigned the project to Dr. Scott Zeger, with Dr. Steve Self also participating. As the study progressed, however, they realized that existing statistical tools were inadequate. Developing a new tool was essential, but this required new formulas to establish statistical validity. Facing this impasse, they turned to Dr. Liang for help. Drawing on his training in generalized linear models from his doctoral studies at the University of Washington, Dr. Liang quickly derived a workable solution. He was named co-author of the resulting paper, which became the precursor to GEE and marked the beginning of his long-standing collaboration with Dr. Zeger, who was a specialist in time-series analysis.

Seeing broader potential in their findings, Dr. Liang and Dr. Zeger decided to combine their expertise and build on the earlier work, ultimately developing Generalized Estimating Equations. This breakthrough method overcame the restrictive assumption of independent observations and allowed for more accurate analysis of repeated measures and clustered data, opening an entirely new chapter in longitudinal data analysis. Once published, GEE was rapidly adopted worldwide and within just four years became a core analytical tool across epidemiology, clinical medicine, and even the social sciences.

Dr. Liang valued not only theoretical innovation but also accessibility and resource sharing. Together with Dr. Zeger, he secured funding for students to build GEE into a ready-to-use software, which was distributed free of charge to the academic community. The method was later incorporated into mainstream statistical software such as SAS and SPSS, making it readily available to researchers globally.

"As a matter of fact, the associate dean of the School of Public Health once asked if we had considered applying for a patent," Dr. Liang noted. Yet both he and Dr. Zeger believed that if a tool could not be freely used to advance society, it would lose its very purpose. As Dr. Liang put it: "Biostatistics is a tool science; its purpose is to help scientists answer meaningful scientific questions."

The impact of GEE has been far-reaching. In genetic epidemiology, it has enabled precise analysis of correlations within family data. In HIV drug development, it has allowed researchers to use short-term longitudinal data to verify drug efficacy more quickly, thereby accelerating FDA approval and clinical application. In this way, GEE has saved invaluable time for public health efforts and improved the lives of countless patients.

Cultivating Physicians with Compassion and Broadening International Perspectives

During his 28 years of teaching at Johns Hopkins University, despite the heavy demands of research and frequent invitations to lecture abroad, Dr. Kung-Yee Liang made it a point to return to Taiwan almost every summer. He organized workshops and seminars to share the latest advances in international biostatistics and epidemiology, making a lasting contribution to raising the standard of public health and clinical research in Taiwan.

After retiring from Johns Hopkins, Dr. Liang returned to Taiwan and devoted himself to higher education, serving as President of National Yang-Ming University (now National Yang Ming Chiao Tung University) for more than seven years. Under his leadership, the university was transformed into a research-oriented institution that balanced teaching and research. He successfully secured NT$500 million annually from the Ministry of Education's "Aim for the Top Universities Grant," which funded the establishment of Taiwan's leading centers for neuroscience, tumor immunology, and healthy aging research. These initiatives brought Taiwan's biomedical research to international prominence.

Dr. Liang also recognized a weakness in Taiwan's higher education system: the tendency to focus on national university rankings while neglecting the holistic development of students. He was profoundly influenced by a remark from Dr. Richardson, a former president of Johns Hopkins, who once said, "Our medical students are skilled at treating diseases but not at treating patients." This philosophy resonated strongly with Dr. Liang. As president, he championed a vision of "humanistic concern and a balance between teaching and research." He fostered a student-centric culture, hosting more than 50 "Meet the President" gatherings at the presidential residence, where students could dine, talk, and even challenge him directly. With warmth and openness, he addressed their concerns, building a bridge of communication and trust between faculty and students.

Although adept at deriving complex mathematical formulas, Dr. Liang admitted he struggled with remembering names. "But I made an effort," he explained. With over 3,000 students as friends on Facebook, he would spend time after his administrative duties learning about their thoughts and needs, committing many of their names and faces to memory. When the president could greet students by name on campus, they felt genuinely cared for. "That is exactly what I hoped for. Only when students feel cared for can they in turn learn to care for society."

Why has Dr. Liang placed such emphasis on the role of mentors and their care for students? The answer goes back to his undergraduate years at National Tsing Hua University, when a simple injection for a cold led to a hepatitis A infection that forced him to return home under his mother's care. His mentor, Dr. Dao-Ning Hsu, worried that a prolonged absence might cause him to be expelled and jeopardize his future. Out of concern, she personally visited Dr. Liang's home in Taipei and even offered to have him stay with her family, where a family caretaker could care for him. Although Dr. Liang ultimately remained staying at dormitory, he joined her mentor's family daily for lunch and dinner. With the combined support of his mother and mentor, he recovered fully without interrupting his studies.

This formative experience left a profound mark. Dr. Liang came to realize that true education is not only about imparting professional knowledge but also about

caring for students as individuals. This conviction guided him years later, when as President of National Yang-Ming University he strongly promoted the mentor system, believing that mentorship could provide powerful and positive support at critical moments in a student's life. "Our students will one day become physicians and nurses caring for patients. If we, as teachers, do not show care for them now, how can we expect them to treat their patients with the same compassion?" he emphasized. Humanistic education and holistic development were therefore central to his policies as president.

Beyond promoting holistic education, Dr. Liang also drew on his network and resources to secure funding that allowed dozens of medical students each year to undertake internships at world-class institutions such as Johns Hopkins School of Medicine and the University of Washington in Seattle. He further established a scholarship program

providing NT$2 million annually, for five consecutive years, to support medical students pursuing doctoral studies abroad. These initiatives significantly broadened students' international outlook and created a pipeline of physician-scientists for Taiwan's future. Dr. Liang also led National Yang Ming University into a strategic partnership with Academia Sinica, successfully securing support from the National Science and Technology Council for the Interdisciplinary Science Degree Program. This initiative introduced 27 new liberal arts courses and the "On the Shoulders of Giants" program, greatly enriching students' humanistic education and independent thinking skills. The courses were also opened to students at Taipei Medical University and the National Defense Medical Center, expanding the program's influence even further.

Building a Mission-Oriented Research Institute: Supporting Policy and Industry with Knowledge

Dr. Liang served twice at the National Health Research Institutes (NHRI), first as Vice President from 2003 to 2006. During his tenure, he actively promoted the transformation of NHRI from a purely research-focused institution into a mission-driven, policy-oriented think tank dedicated to providing actionable policy recommendations and solutions to pressing national health and disease challenges. When the avian influenza outbreak struck in 2005, the Department of Health sought to purchase Tamiflu equivalent to 10% of the national stock

requirement from Roche but was unable to secure the order. In the face of this urgent crisis, Dr. Liang and his colleagues led the NHRI biopharmaceutical division to reverse-engineer Tamiflu's gram-scale production process. In just 18 days, his team completed preparations for mass production, ensuring a sufficient domestic drug supply. More importantly, this achievement established Taiwan's first precedent for compulsory licensing of drug technology, underscoring that national security takes precedence over patent rights, and setting a milestone in safeguarding public health.

"Administrative leadership can often achieve broader and deeper impact than what an individual's research alone can accomplish," Dr. Liang observed. A small incident further impressed upon him the influence of his position: At the NHRI offices in Neihu, there was once a carpet stained by years of spilled coffee. Dr. Liang casually asked the administrative staff to have it cleaned, and when he returned two weeks later, he found the entire carpet had been replaced. This small incident made him realize, "I truly carry significant influence." From then on, he constantly reminded himself that the authority of his position must be exercised responsibly, never misused.

In 2010, following a government increase in tobacco surcharges, the Ministry of Health and Welfare allocated surplus funds to support 12 domestic medical centers in conducting evidence-based research aimed at reducing cancer incidence and mortality while improving patients' quality of life. Building on this foundation, in 2019 Dr. Liang was entrusted as NHRI President to lead the "Cancer Research Inter-Institutional Collaboration Platform and Integrated Applications" program. This initiative united 8 cancer research teams nationwide, established a cancer research information-sharing platform, integrated clinical data across medical centers, and created 16 comprehensive cancer translational research databases. These achievements strengthened the research capacity of Taiwan's cancer research community and laid the groundwork for the government's Sustainable Platform for Big Data in Health.

Mission-Driven Leadership: Public Health in Times of Crisis

From 2017 to 2022, Dr. Liang returned to the NHRI as its sixth President, leading the organization through the unprecedented challenges of the COVID-19 pandemic. Together with Vice President Dr. Huey-Kang Sytwu, they set the strategic direction for epidemic prevention and launched three key initiatives: First, NHRI scientists rapidly decoded the synthesis pathway for the antiviral drug remdesivir, achieving milligram-scale synthesis within 15 days of receiving raw materials and scaling up to gram-level production just five days later. This readiness provided both practical preparation and public reassurance. Second, NHRI developed a COVID-19 rapid test based on SARS antibody screening, which received emergency use authorization from the Taiwan Food and Drug Administration in 2022, ensuring a

Photo credit: The National Health Research Institutes stable domestic supply of test kits. Third, NHRI established 4 vaccine development platforms, including one for DNA vaccines, and advanced a DNA vaccine candidate into Phase I clinical trials, strengthening Taiwan's self-reliance in vaccine preparedness. Dr. Liang also encouraged his team to engage with the media, ensuring the public understood NHRI's efforts and thereby reinforcing societal confidence during a time of uncertainty.

Leading Rapid Testing and Vaccine Initiatives: A Pillar of Stability

In February 2020, as the pandemic escalated, Dr. Liang was appointed head of the Research and Development Division at Taiwan's Central Epidemic Command Center (CECC). He was tasked with overseeing rapid diagnostics, therapeutic and vaccine development, and epidemiological forecasting. Each week he led teams of experts in reviewing international literature and provided dozens of policy recommendations, making the division a critical think tank for government decision-making.

In July 2020, Dr. Liang facilitated discussions between Taiwan's EirGenix and AstraZeneca, opening the possibility of local vaccine production. While production capacity constraints prevented an agreement, these discussions fostered a strong working relationship with AstraZeneca's Asia regional head, Jasper Meyns. This trust led to the successful signing of a pre-purchase agreement in October 2020 for 10 million vaccine doses.

At the request of Minister of Health and Welfare Chen Shih-Chung, Dr. Liang conveyed to Meyns Taiwan's hope of receiving one million doses by the end of 2020 to protect healthcare and frontline workers. Although supply shortages in the United Kingdom made this difficult, Meyns personally informed Dr. Liang on March 3, 2021, that 117,000 doses were being shipped from South Korea to Taiwan. Though modest in number, these vaccines played a decisive role in bolstering epidemic prevention and maintaining public confidence. "I deeply realized the importance of mutual respect and trust in human relationships," Dr. Liang reflected.

Looking Ahead: Bridging Gaps in Healthcare and Education

After completing the critical task of vaccine procurement, Dr. Liang stepped down as President of the NHRI at the end of 2022. Rekindling his passion for higher education, he assumed the Spring Rain Chair Professorship at Feng Chia University the following year. In the classroom, he observed the growing influence of artificial intelligence on students, expressing concern that over reliance on technology could weaken their critical thinking and judgment. He emphasized that the pursuit of technology must never come at the expense of humanistic values. Using medicine as an example, Dr. Liang noted that while AI can assist in diagnosis, the empathy and humanity at the heart of the doctor–patient relationship can never be replicated by machines. This conviction continues to drive his commitment to holistic education. "We must not forget that we are part of society, and we must continue to care for the people and things around us," he reminded his students.

Now based in Taitung, Dr. Liang has turned his attention to addressing the disparities in healthcare and education between urban and rural areas. He is actively supporting the establishment of a Department of Nursing at National Taitung University. Also, he is closely following the impact of Taiwan's Curriculum Guidelines of 12-year Basic Education on foundational subjects such as mathematics, physics, and chemistry. Dr. Liang believes that Taiwan is where his influence can be most profoundly felt. Beyond applying his expertise in biostatistics to fields with tangible social benefit, he hopes to leverage his leadership and experience to help guide Taiwan's K-12 and higher education toward a brighter future.

Dr. Liang and his wife in their new home in Dulan, Taitung

List of Selected Publications

01. K.-Y. Liang and S. L. Zeger, "Longitudinal data analysis using generalized linear models," Biometrika, vol. 73, no. 1, p. 13, Apr. 1986

02. K.-Y. Liang, S. L. Zeger, and B. Qaqish, "Multivariate regression analyses for categorical data," Journal of the Royal Statistical Society Series B (Statistical Methodology), vol. 54, no. 1, pp. 3–24, Sep. 1992

03. K. Y. Liang and S. L. Zeger, "Regression analysis for correlated data," Annual Review of Public Health, vol. 14, no. 1, pp. 43–68, May 1993

04. K.-Y. Liang and S. L. Zeger, "Longitudinal data analysis of continuous and discrete responses for pre-post designs," Sankhya Series B vol. 62, no. 1, pp. 134–48, 2000

05. K.-Y. Liang and A. E. Pulver, "Analysis of case-control/family sampling design," Genetic Epidemiology, vol. 13, no. 3, pp. 253–270, Jan. 1996

06. K.-Y. Liang, C.-Y. Huang, and T. H. Beaty, "A unified sampling approach for multipoint analysis of qualitative and quantitative traits in SIB pairs," The American Journal of Human Genetics, vol. 66, no. 5, pp. 1631–1641, May 2000

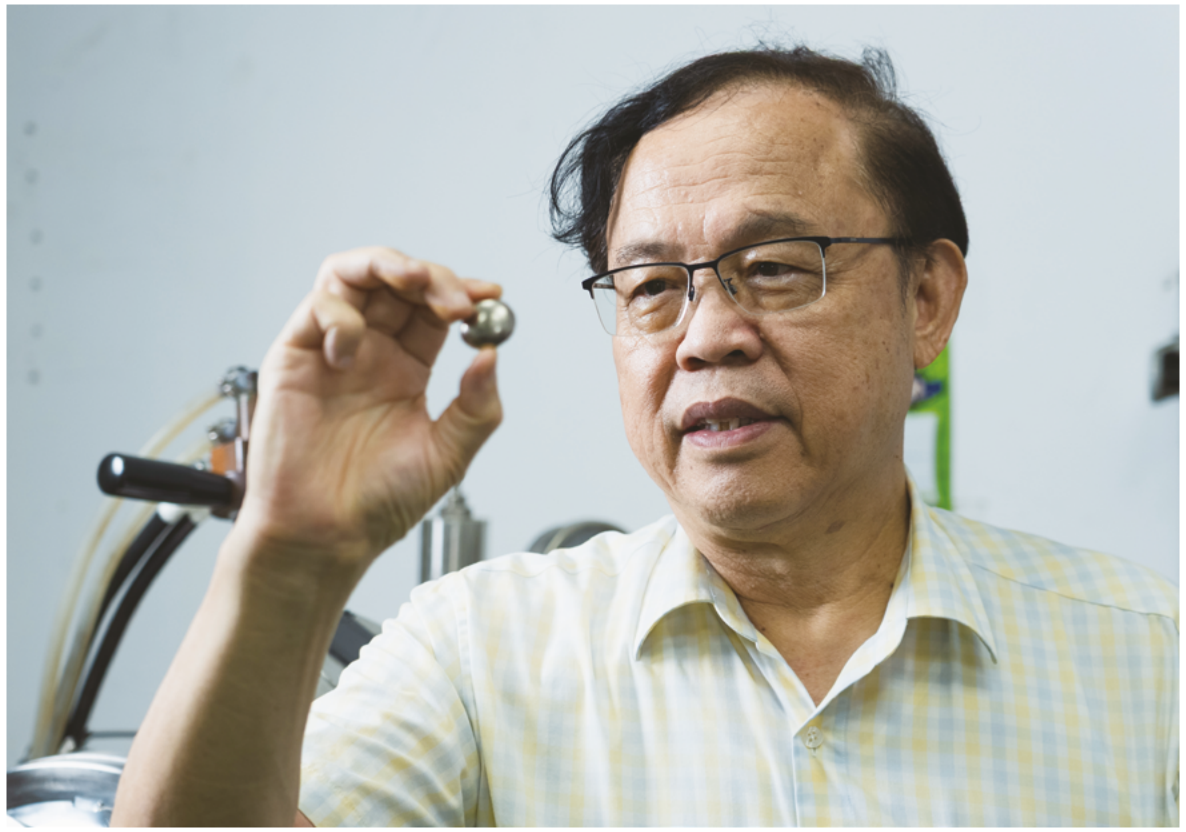
07. K.-Y. Liang, Y.-F. Chiu, and T. H. Beaty, "A robust Identity-by-Descent procedure using affected SIB pairs: multipoint mapping for complex diseases," Human Heredity, vol. 51, no. 1–2, pp. 64–78, Oct. 2000

08. K.-Y. Liang, F.-C. Hsu, T. H. Beaty, and K. C. Barnes, "Multipoint Linkage-Disequilibrium–Mapping approach based on the Case-Parent trio design," The American Journal of Human Genetics, vol. 68, no. 4, pp. 937–950, Apr. 2001

09. K.-Y. Liang and S. L. Zeger, "Inference based on estimating functions in the presence of nuisance parameters," Statistical Science, vol. 10, no. 2, May 1995

10. K.-Y. Liang and S. G. Self, "On the Asymptotic Behaviour of the Pseudolikelihood Ratio Test Statistic," Journal of the Royal Statistical Society Series B (Statistical Methodology), vol. 58, no. 4, pp. 785–796, Nov. 1996

A Track Record of Achievements



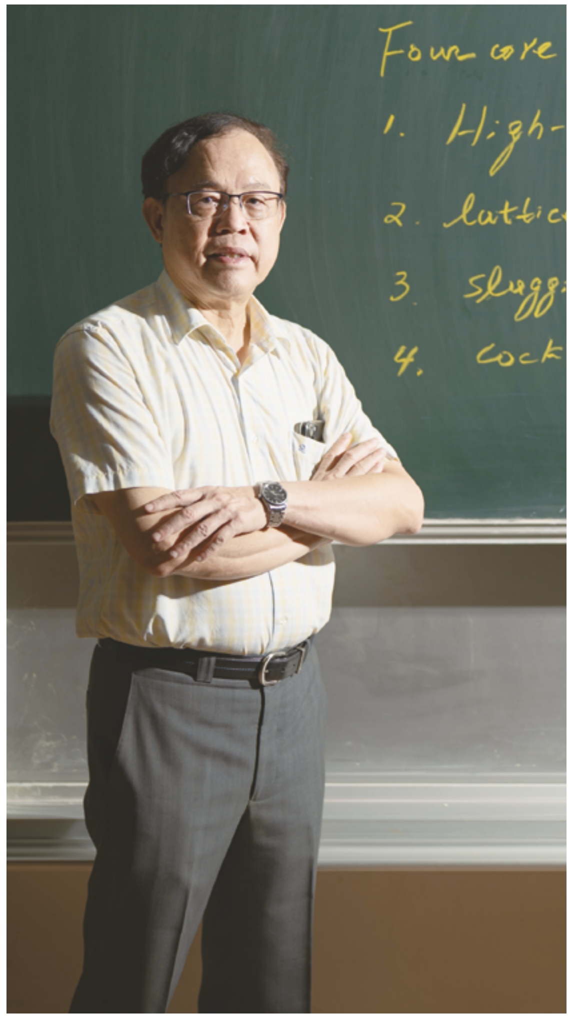
Jien-Wei Yeh

Engineering Sciences Category

The World's First and Only "Father of High-Entropy Alloys" Forges the Strongest High-temperature Metal on Earth

Publishing Breakthrough Materials Ahead of Europe, the U.S., and Japan — an Astonishing Debut

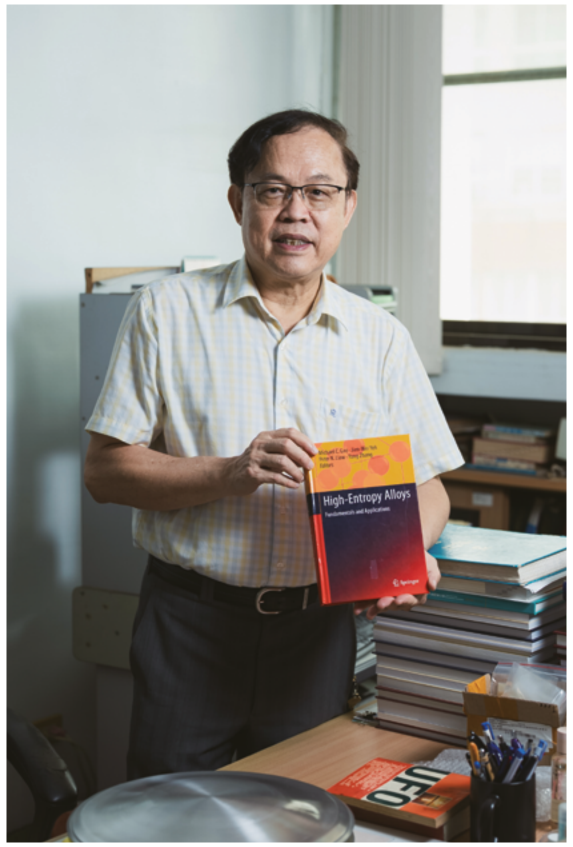
In the fictional plots of Marvel movies, Captain America's shield and the rare resource that the nation of Wakanda fiercely protects —Vibranium alloy — are said to possess the hardest metal on Earth. However, in real life, Distinguished Research Chair Professor — Dr. Jien-Wei Yeh of National Tsing Hua University — has in fact invented a metal claimed to be the strongest high-temperature alloy on Earth that resists high temperatures, corrosion, and radiation, which is of "High Entropy Alloys (HEAs)" bringing an epoch-making breakthrough to 21st-century materials science. Dr. Yeh has also been hailed as the "Father of High-Entropy Alloys."



Traditional alloy design typically uses one principal element as the base and adjusts it with small amounts of other elements; however, Dr. Yeh broke with conventional thinking and was the first to propose a brand-new materials design concept focused on "multiple principal elements." He successfully developed high-entropy alloys that can contain five or more metal elements in equal or unequal proportions. These materials not only exhibit excellent mechanical strength but also bring infinite possibilities for advanced industries such as aviation, aerospace, nuclear energy, military industry, and electronics.

In 2006, Dr. Yeh proposed four core effects of high-entropy materials: (1) the high-entropy effect, which makes the formation of solid solution phases easier when multiple elements are mixed; (2) the lattice distortion effect, where different atomic sizes and element interactions produce severe lattice distortion and strain compared to traditional alloys, affecting overall properties such as electrical conductivity, thermal conductivity, hardness, and strength; (3) the sluggish diffusion effect, whereby competition among multiple elemental atoms and lattice distortion hinder atomic diffusion, slowing phase transformations and changes in properties, thereby promoting high-temperature stability of the materials; (4) the cocktail effect, in which the characteristics of various elements, interactions among elements, and structural factors together influence different material properties — by designing appropriate compositions and processing, synergistic enhanced properties and diversified applications can be achieved.

Combining these four core effects, Dr. Yeh established a complete physical-metallurgy framework for high-entropy alloys, which has become the theoretical basis for global research on high-entropy materials. These theories have been widely cited by the international academic community and



have become important tools for predicting material properties and designing new structural alloys, greatly advancing materials science. In 2024, Dr. Yeh was invited by *Nature Reviews Chemistry* to publish a perspective review article, *Clarifying the Four Core Effects of High-Entropy Materials*, which systematically elaborated the four core effects of high-entropy materials and clarified academic debates on certain effects, consolidating the authority of his theory in the international academic community.

According to Stanford University's statistics based on Scopus citation data, Dr. Yeh ranked second in the world for scientific influence in the materials field from 2021 and 2025. He was also invited to serve as one of the editors-in-chief of the journal *High Entropy Alloys & Materials*. In 2024, he received the IMRC Outstanding Contribution Award at the 32nd IMRC in Cancún, Mexico; the conference specially organized a "High-Entropy Materials Symposium" to honor him, which became the most popular session, fully demonstrating his leadership in the international materials field.

Dr. Yeh has long been committed to teaching at National Tsing Hua University, nurturing countless outstanding students and becoming an important mainstay of Taiwan's academia and industry. In addition, he actively promotes industry-academia collaboration, successfully translating experimental results into commercially promising technologies and products, injecting strong momentum into industry.

Dr. Yeh is not only a pioneer in materials science but also an important promoter of strengthening Taiwan's research capacity and international visibility. He stated: "Following others only decorates what's already there and has limited research value; only continuous innovation can realize the greatest research value." This spirit of persistent innovation is Dr. Yeh's most precious inspiration to Taiwan, to science, and to the future.

Dr. Yeh received the IMRC Outstanding Contribution Award at the 32nd IMRC in Cancún, Mexico; the conference specially organized a "High-Entropy Materials Symposium" to honor him in 2024

The Story of a Champion

Pioneering the Field of High-Entropy Alloys: Breaking Through the Myths of Traditional Materials

Born in Poverty, Dr. Yeh Worked Hard to Become the Father of High-Entropy Alloys

In the field of materials, multi-principal-element alloys were long considered prone to form lots of brittle compounds in materials. However, Dr. Yeh of Taiwan, using contrarian thinking, proposed the "high entropy effect," arguing that multi-principal-element alloys at high temperatures could, in fact, form stable solid solutions in accordance with the second law of thermodynamics, exhibiting improved strength and toughness. Beginning in 1995, he devoted himself to this arduous research, and published a groundbreaking paper in 2004, naming the alloy as "high entropy alloy", laying the theoretical foundation and placing Taiwan at the forefront of international materials research.

Dr. Yeh's scientific journey was not an easy one. Born in rural Yilan, he faced poverty but was forged to have an indomitable spirit. As a young man, he was told by the draw fortune sticks in Muzu temple, telling that he would not pass the entrance examination of university. This, in turn, fueled his determination, leading him to pass the examination, enter the Department of Physics at Tsing Hua University and transfer to the Department of Materials Science and Engineering, thus embarking on his scientific research journey. Unlike many who choose to study abroad, he remained in Taiwan to pursue his doctoral degree, determined to give back to his homeland through research. This perseverance and conviction enabled him, despite limited resources, to develop the field of high-entropy alloys, earning him the global recognition of the "Father of High-Entropy Alloys," fundamentally reshaping the development of materials science in the 21st century.

Dr. Yeh (first from the left in the back row) took a photo with his parents, two brothers and four sisters in 1969

A Country Boy from Yilan: Determined to Study Hard and Change His Destiny

Dr. Yeh grew up in Nan'ao Township, Yilan County, in northeastern Taiwan in the 1950s. His father, a police chief in Fujian, later fled to Taiwan due to the war and unrest. He settled in Nan'ao and married a woman from Hualien. They had seven children. Growing up in the countryside, he was active and playful, a classic mischievous child. At the age of five, he and his older playmates went to steal fruit. He was assigned to stand guard at the door of orchard and was the only one caught by the orchard owner. Upon learning of this, his mother was furious and threatened to chop off his hand with a kitchen knife. The young boy was so frightened that he declared he would never do it again. Seeing her son's mischief, Yeh's mother decided to send him to elementary school a year early as a boarding student, hoping that education would help him find a way back on the right path.

At first, he was reluctant, but his mother cleverly said, "You'll get fifty cents a day for school." This piqued the child's curiosity and desire, and he agreed to go. However, this small salary only lasted two days before it stopped. When he asked his mother for the bonus money, who was washing clothes by the river, she coldly replied, "No. Then don't go to school." This statement actually awoke his self-esteem. He said bluntly, "My teachers and classmates all know me. How could I not go?" so he gritted his teeth, wiped his tears, and ran to school, unexpectedly embarking on a unique educational path. Dr. Yeh said he once asked his mother about this incident and learned that she was squatting by the river washing clothes, her hands covered in soap bubbles, making it difficult for her to take money.

Dr. Yeh ranked third in his first grade and was admitted to second grade. From third grade onward, he was the top student in his class, but at heart, he was still a playful country boy. It wasn't until fifth grade that he reached his first pivotal turning point. One day, he was standing at the doorway with his father. His father suddenly pointed at a passing cow boy and said, "If you can't study well and can't get into junior high school, you will become a cow boy and earn a dou of rice (equivalent to about 10 liters)". At that moment, Dr. Yeh began to contemplate his future for the first time and resolved to attend junior high school.

With unwavering determination and diligence, Dr. Yeh was admitted directly to the high school department without taking the entrance examination. He was brimming with confidence, he felt he would enter his dream university after three years. However, an experience seeking divine guidance caused him to experience a brief period of depression.

Before entering high school, he went to the Nan'ao Mazu Temple to cast divination blocks to inquire about his chances of passing the university entrance exam. Three consecutive rejections were met with a "no" response. Feeling like a deflated ball, he returned home feeling extremely depressed and hopeless. However, it was precisely these setbacks that ignited his inner unyielding will. Refusing to be defined by fate, he diligently studied for three years and was finally accepted into the Department of Physics at National Tsing Hua University. He credited this to Mazu's divine intervention and expressed gratitude for her reverse psychology.

Staying in Taiwan to Work Hard: I Don't Want to Contribute Nothing to Taiwan

Dr. Yeh earned his doctorate at National Tsing Hua University, always clinging to the belief of serving his country and remaining in Taiwan to deepen his teaching and research. Although studying abroad became a popular option for academics at the time, Dr. Yeh chose to remain at Tsing Hua and in Taiwan. He frankly admitted that this decision stemmed from a deep sense of responsibility: "I simply couldn't bear not contributing to Taiwan. This is why, after graduating from university, I decided to pursue graduate school and my doctorate in Taiwan. Seeing my seniors rushing abroad, and few returning, I felt that if I went abroad to study, I probably wouldn't come back."

During 8 years of silence, Dr. Yeh's wife, Chang Hsiu-Hui, was his strongest supporter.

His choice reflects his deep affection and sense of responsibility for Taiwan. To this day, he has never studied abroad or taken a drop of "foreign ink", a metaphor for Western education, steadfastly pursuing his innovative research in Taiwan. Precisely because of this conviction, Dr. Yeh has not only deeply cultivated the field of materials science, but has also nurtured countless outstanding students, becoming an indispensable pillar of the Department of Materials Science at National Tsing Hua University.

After 8 Years of Hard work and Perseverance, He Finally Rewrote the History of Materials Development

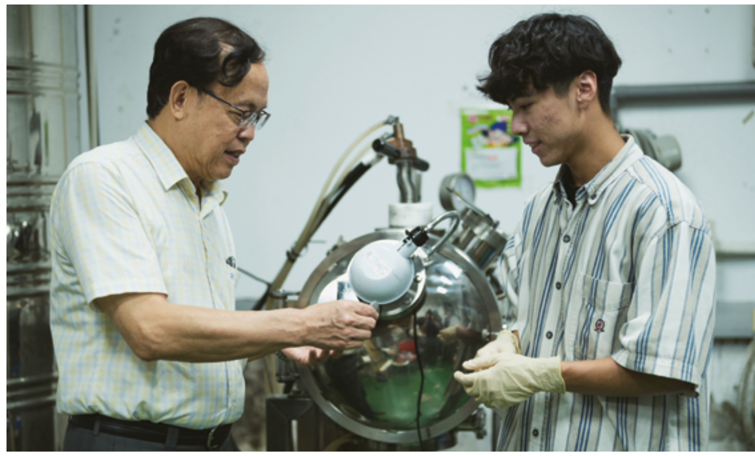
Dr. Yeh has always pursued innovation in his research. Early on, to overcome the technical bottlenecks of traditional alloys, he invented the "reciprocating extrusion method," effectively improving the strength and toughness of alloy materials and got patents in 7 countries. However, he also discovered that traditional alloy technology had almost reached its ceiling, making further breakthroughs difficult. This cognition became a key factor in his shift to more innovative alloy research.

The revolutionary concept of "high-entropy alloys" was born from a seemingly ordinary yet inspiring experience. One day in May 1995, Dr. Yeh was driving north from Hsinchu. Passing through the country roads of Xinpu, a radical idea suddenly occurred to him: "Why not try mixing multiple elements simultaneously? If the degree of randomness increases, unexpected effects and properties may emerge!"

This idea was in stark contrast to the prevailing view in materials science at the time. Previous theories held that the coexistence of multiple elements would form numerous and complex compounds within the material, rendering it brittle and impractical. However, Dr. Yeh keenly perceived the potential opportunity within this: this high compositional complexity might harbor a "high entropy effect" that could help stabilize the solid solution structure of multiple elements and enhance performance.

Upon returning to Hsinchu, he immediately headed to the lab and excitedly shared this groundbreaking idea with Huang, Kuo-Shung, a second-year master's student. He then agreed to change his research topic. Dr. Yeh devised several alloy compositions for beginning his first round of experiments. This was a completely new challenge, with no papers to refer to or books to guide him. Dr. Yeh relied solely on his own theoretical judgment and years of intuition.

Initial results were not promising. The first alloy sample melted broke into three pieces. Huang, Kuo-Shung dejectedly exclaimed, "Dr. Yeh, it's going to break!" However, Dr. Yeh observed the sample and had a different perspective. He discovered that the fragmentation into large pieces, rather than into fine particles, indicated that the elements had been well melted and mixed. The problem lay in the uneven melting, which led to stress concentration and cracking.



Dr. Yeh and his student made high-entropy alloys materials.

After a moment of contemplation, he smiled and encouraged his students, "Just melt it a few more times to make the composition more uniform. It should be fine." A few days later, the first complete high-entropy alloy sample was finally produced in a laboratory on the third floor of the building "Materials Science and Technology" at Tsing Hua University, marking the beginning of global high-entropy materials research. However, he kept it to himself at the time, knowing that the success of a single sample would hardly shake established theories. Only systematic

and diverse experimental results could prove that this was no fluke, but rather a new scientific field.

Therefore, he continued to design more alloy combinations, reaching over 40 compositions, for his student to synthesize, analyze, and continuously optimize and verify the results. He was well aware that Taiwan's resources were limited. If the papers were published, it would inevitably attract investment from scientific experts around the world, and Taiwan would lose its leading edge and be easily overtaken for credit. Therefore, he proceeded cautiously but firmly, waiting for the optimal opportunity.

"I buried the seeds in the soil, invisible to everyone, and slowly watered them." He describes himself as a pioneer in seed breeding, firmly believing that the seed of high-entropy alloy research must germinate and grow into a towering tree in Taiwan. "Since I teach at a national university, I receive the public's tax dollars. I cannot squander this opportunity for Taiwan to influence the world. He chose not to publish his findings before they were fully developed, instead devoting considerable effort to theoretical development and experimental verification. Official publication was delayed until the ninth year. These eight years of hard work resulted in a quite complete and thorough theoretical framework for high-entropy alloys.

Starting with the concept of "entropy" in thermodynamics, he explained how high disorder stabilizes structures, breaking through the existing framework of materials science. Combining dynamics, crystallography, and properties, he proposed a comprehensive core theory of high-entropy materials. This dedication and patience ultimately allowed a previously undiscovered seed to flourish in the fertile soil of international academia, rewriting the history of materials development.

From Twice-Rejected Paper to World Attention: The Birth of High-Entropy Alloys

Since 1995, Dr. Yeh has embarked on a scientific research journey that was once considered "impossible." He believes that true innovation often comes from unconventional thinking, and groundbreaking breakthroughs often occur when everyone has misconception. It is this persistence and independent thinking that has enabled him to continue to delve deeply into the concept of "high-entropy alloys".

In 2001, armed with experimental data gleaned from years of hard work, he proposed the highly innovative "Nanostructured High-Entropy Alloys" project and applied to the National Science and Technology Council for a research grant under Special National Funding for Nanoscience and Nanotechnology. While the project received unanimous approval from three international reviewers, who deemed it both creative and feasible, it encountered a significant setback during the domestic review process. One reviewer bluntly stated, "If this project passes, it could make Taiwan an international laughing stock." These words remain deeply etched in Dr. Yeh's mind, a pain like a sword stabbing his heart.

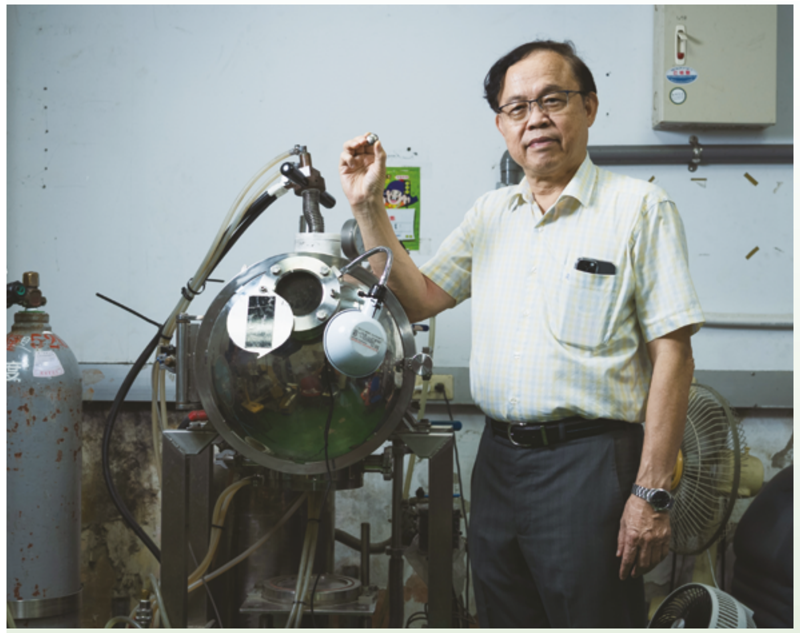
However, precisely because of this, he is even more grateful for the vision and courage of the National Science and Technology Council at the time. They not only approved the project but also provided funding exceeding the typical research project, allowing him to expand high-entropy alloy research. At the end of 2003, Dr. Yeh submitted his first paper proposing the concept of high-entropy alloys to the journal *Nature*. However, it was rejected within a week. He then submitted it to *Science,* where it went through review. However, two of the three reviewers recommended it, while one did not. The reason was that he would recommend publication in a better metals journal. Despite response with a rebuttal, the paper was still rejected. Despite repeated setbacks, Dr. Yeh remained steadfast in his ideals and submitted his manuscript to the high-impact journal *Advanced Materials.* The journal's editor quickly responded, suggesting that the content would be better suited for submission to its sister journal, Advanced Engineering Materials. He agreed with the transfer to the sister journal. Within a week, he received a notification of acceptance: "The full paper will be published without revisions." Today, this paper has been cited over 15,000 times by scholars worldwide, demonstrating its enormous impact although the sister journal's impact factor was actually far below that of Advanced Materials.

This groundbreaking paper, published in May 2004, officially marked the full flowering of Dr. Yeh's eight years of meticulously planned research. In 2004 alone, he published 5 papers on high-entropy alloys. He admitted that this was a strategic decision: "I simply wanted to preserve the credit for this field in Taiwan. Five papers in the first year, and an average of ten papers per year thereafter. When researchers in other countries saw this new field and wanted to delve into it, they'd realize, 'Wow, there are already so many papers published in this field! We can't catch up with Taiwan, even if we try!'"

Looking back on this journey, Dr. Yeh said with a smile, "It really takes patience to be alone, but fortunately, I have confidence in my research." He emphasized that his own paper publications follow a rhythmic and planned process, progressing step by step and linking each other. His arguments are logically clear and consistent among his publications. He also strictly requires his students to possess accurate and persuasive first-hand data, as this information will withstand future verification and challenges from the academic community.

Even after achieving considerable success in publishing his work, external skepticism about high-entropy alloys persisted. He vividly remembers one malicious comment: "High-entropy alloys should be punched into the Wushantou Reservoir in an upside-down way, never to turn the face up." Such cynicism, far from discouraging him, actually fueled his fighting spirit. He admits, "I've long been immune to ridicule and malicious criticism. I believe they misunderstand me just due to a lack of understanding. Instead, I'm grateful for the misunderstanding, which led to my development. If it hadn't been for the misunderstanding, people would have already developed the high-entropy alloys, and I would have no chance to be the first!" It is this confidence and openness that has sustained him, step by step, to the pinnacle of achievement he has today.

With the deputy director of the center, Dr. Lin Su-Jien



Creating Breakthrough Materials and Being Interviewed by *Nature*

Dr. Yeh began researching and experimenting with high-entropy alloys and materials in 1995 and has devoted himself to this field for 30 years. To date, he has published over 230 SCI-indexed papers on high-entropy alloys and materials, sparking a global wave of research on high-entropy materials. Countries including the United States, China, India, Germany, France, the United Kingdom, South Korea, and Japan have all invested heavily in the development of high-entropy alloys and materials. The number of related papers has increased exponentially each year, which has not only had a profound impact on the field of materials science but has also significantly increased the impact factor of metals' journals, which was once gradually regarded as "sunset research," injecting new vitality and hope into the academic community.

In terms of academic influence, Dr. Yeh's more than ten publications have garnered over 1,000 citations on Google Scholar, with the highest citation exceeding 15,000, fully demonstrating his world-class research status. It is worth noting that traditional engineering alloys are limited to approximately thirty alloy systems, such as aluminum, titanium, cobalt, and nickel. However, the innovative concept of high-entropy alloys allows all elements on the periodic table to be combined, opening up countless new formulations. This breakthrough marks a new milestone for the periodic table, creating a new material landscape and potential, and bringing endless academic and application opportunities, earning Dr. Yeh the title of "Father of High-Entropy Alloys."

In May 2016, the internationally renowned journal *Nature* published a featured article titled "*Metal mixology: stronger, tougher, stretchier: with a simple new recipe, metallurgists are creating a generation of alloys with remarkable properties.*" The article not only highly praised the innovative status of high-entropy alloys in the field of advanced materials, but also clearly identified Taiwan as the origin of this groundbreaking technology.

Furthermore, Dr. Yeh has long been committed to promoting international exchange and knowledge dissemination in the field of high-entropy materials. He has served as guest editor for numerous international academic journals, including *Materials Chemistry and Physics*, and *Entropy*. He has been elected Chair of the International consortium of *High-Entropy Materials* since 2018 and has served as one of the Editors-in-Chief of Nature Springer's journal: *High Entropy Alloys & Materials* since 2022, actively contributing to the development of key academic platforms in this field.

He is also the lead author of five books on high-entropy materials, significantly influencing the global academic community's understanding and research of high-entropy materials. Dr. Yeh's efforts have not only enhanced Taiwan's international visibility and academic status, but have also established Taiwan as a global center for high-entropy materials research.

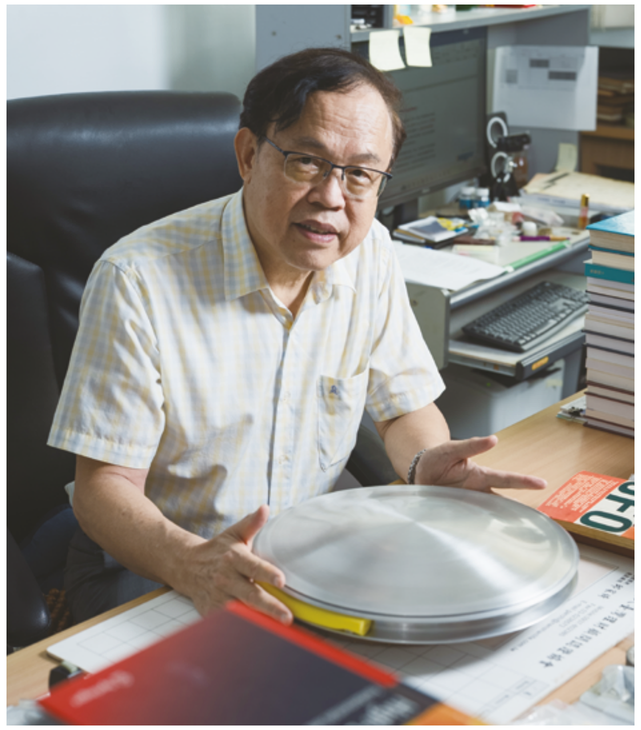
Collaborating with 11 Universities and Research Centers in Taiwan to Make Taiwan a Major Center for High-Entropy Materials Research

In 2018, with the joint support of the Ministry of Education and the National Science and Technology Council, Dr. Yeh led his team to establish the world's first "High Entropy Materials Center", a pioneering effort in this field.

The center brings together resources from National Tsing Hua University, National Taiwan University, National Yang Ming Chiao Tung University, National Central University, National Chung Hsing University, Feng Chia University, Ming Chi University of Science and Technology, National Taiwan University of Science and Technology, and National Formosa University. In collaboration with the National Synchrotron Radiation Research Center and Chang Gung Memorial Hospital, it brings together 30 professors to collaborate on nine high-entropy materials projects. Their research encompasses high-performance materials, special alloys, super-hard alloys and ultra-high-temperature composites, corrosion-resistant materials, functional thin films, functional ceramics, biomedical materials, and related disciplines, striving to explore cutting-edge breakthroughs in the theory and application of high-entropy materials.

As the world's first R&D base centered on high-entropy materials, the center not only focuses on academic research but

High entropy alloy materials developed by the High Entropy Materials Center



also actively promotes cross-disciplinary applications and technology transfer, encompassing areas such as smart manufacturing, green energy, national defense, and biomedical technology. This moves not only advances of Taiwan's materials technology from research to industry but also strengthens Taiwan's independent production capabilities for key materials, effectively reducing its reliance on imports and enhancing its international competitiveness.

Dr. Yeh currently holds over 50 patents for traditional and high-entropy materials, more than 10 of which have been successfully applied in industry. For example, the wear-resistant worm gear he developed is now widely used on the fourth and fifth axes (indexing tables) of CNC machining centers. Over 20,000 units have been installed, significantly improving the overall performance of CNC machinery valued at tens of billions of yuan.

Furthermore, he developed a superelastic material using high-entropy alloys, which he applied to the frame of carbon fiber tennis rackets, badminton rackets, and striking faces of golf clubs, significantly improving product performance. Even more groundbreaking, he developed a high-entropy alloy resistant to extreme environments, creating an extrusion die capable of withstanding temperatures of 1,200°C. This allows the extrusion of high-melting-point metals such as carbon steel and stainless steel, helping to lay the foundation for Taiwan's ultra-high-temperature metal extrusion and die-casting industries.

Dr. Yeh also founded the world's first high-entropy materials technology company, bringing high-entropy materials technology licensed from Tsing Hua University to industry, significantly driving industrial upgrading. These achievements not only demonstrate the broad application potential of high-entropy materials but also demonstrate that his research is deeply rooted in industrial practice, creating significant economic benefits for Taiwan.

Dreaming of UFO: A Leap Forward in Taiwan's Scientific Research

Dr. Yeh began his undergraduate career in the Department of Physics at Tsing Hua University, but after two years he transferred to the newly established Department of Materials Science and Engineering, embarking on his journey as a materials scientist. Although he spent only two years in the Department of Physics, the experience in this period profoundly influenced his life and inspired a dream he still holds to this day: "One day, I want to build a flying saucer."

During his freshman year, one of his classmates was fascinated by UFOs. He even formed a UFO club to research UFO. Influenced by him showing the magazines on UFO and giving related knowledge, Dr. Yeh developed a strong curiosity and interest in UFOs. He began to wonder, "If UFOs really exist, how do they fly? We, Earthlings, could also build UFOs."

Dr. Yeh continuously monitored UFO news from around the world, and extensively studied related books and theoretical literature. He pieced together the possible logic of UFO flight in his mind, concluding that the propulsion of UFOs was not derived from conventional propellers or jet turbine engines, but rather from the interaction between electric current and magnetic fields. Based on this, he speculated that the UFO's design would not be simply a disc shape, but rather having a special groove around the circumference of the disc, which served as the key structure for generating power. This groove generated a large amount of plasma current between the upper and lower discharge plates, which interacted with the magnetic field of the superconducting coil surrounding the UFO to generate the Lorentz electromagnetic force, thereby propelling the UFO.

Even more remarkable, about a week after he sketched his vision of a flying saucer, he visited bookstores on Chongqing South Road in Taipei and encountered with a book *Visitors from the Stars: UFOs*. He was stunned to discover a page clearly showing a photo of a flying saucer that perfectly matched his conception and drawing. At that moment, he was deeply shocked and delighted. "This discovery reinforced my belief that I was right," he said. In order to verify his idea, he took on three tutoring jobs in his spare time to raise the funds needed for the experiment. He personally took his own design drawings to Hsinchu City to find a factory to help build the generator for the flying saucer. During the summer vacation, he returned to his home village Nan'ao in the Yilan county to conduct experiments, and asked his second sister to help pedal a fixed bicycle to drive the rotation of the rear wheel, using the friction between the wheel surface to drive the shaft and generate electricity.

Years later, this spirit of daring to pursue dreams and explore the unknown became the driving force behind his research into high-entropy alloys. Dr. Yeh earned international acclaim as the "Father of High-Entropy Alloys" and demonstrated through his actions that science is not just about rigorous exploration, but also a courageous journey toward limitless possibilities.

When asked what key technologies are still lacking to realize the "flying saucer dream", Dr. Yeh frankly stated, "Room-temperature superconductors and small nuclear fusion reactors are exactly what I will continue to strive for in the future." This dedication to ideals not only symbolizes the romance and perseverance of scientists, but also paints a picture of infinite imagination for Taiwan's scientific research, heading towards the stars and the sea.

List of Selected Publications

01. J. -W. Yeh et al., "Nanostructured High-Entropy Alloys With Multiple Principal Elements: Novel Alloy Design Concepts and Outcomes," Advanced Engineering Materials, vol. 6, no. 5, pp. 299–303, May 2004

02. C.-J. Tong et al., "Microstructure characterization of Alx CoCrCuFeNi high-entropy alloy system with multiprincipal elements," Metallurgical and Materials Transactions A, vol. 36, no. 4, pp. 881–893, Apr. 2005

03. K. -Y. Tsai, M. -H. Tsai, and J. -W. Yeh, "Sluggish diffusion in Co–Cr–Fe–Mn–Ni high-entropy alloys," Acta Materialia, vol. 61, no. 13, pp. 4887–4897, Jun. 2013

04. J.-W. Yeh, "Physical metallurgy of High-Entropy alloys," JOM, vol. 67, no. 10, pp. 2254–2261, Aug. 2015

05. C.-Y. Cheng, Y.-C. Yang, Y.-Z. Zhong, Y.-Y. Chen, T. Hsu, and J.-W. Yeh, "Physical metallurgy of concentrated solid solutions from low-entropy to high-entropy alloys," Current Opinion in Solid State and Materials Science, vol. 21, no. 6, pp. 299–311, Sep. 2017

06. J.-W. Yeh and S.-J. Lin, "Breakthrough applications of high-entropy materials," Journal of Materials Research/Pratt's Guide to Venture Capital Sources, vol. 33, no. 19, pp. 3129–3137, Aug. 2018

07. C.-W. Tsai et al., "Portevin-Le Chatelier mechanism in face-centered-cubic metallic alloys from low to high entropy," International Journal of Plasticity, vol. 122, pp. 212–224, Jul. 2019

08. K.-H. Lin et al., "Different lattice distortion effects on the tensile properties of Ni-W dilute solutions and CrFeNi and CoCrFeMnNi concentrated solutions," Acta Materialia, vol. 221, p. 117399, Oct. 2021

09. J.-W. Yeh, "Strength through high slip-plane density," Science, vol. 374, no. 6570, pp. 940–941, Nov. 2021

10. W.-L. Hsu, C.-W. Tsai, A.-C. Yeh, and J.-W. Yeh, "Clarifying the four core effects of high-entropy materials," Nature Reviews Chemistry, vol. 8, no. 6, pp. 471–485, May 2024

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