

# Serendipity - The Benevolent Attribute to an Accidental Achiever

Edmund Yee-Su Chao (趙以甦)

The word “Serendipity” means, “A faculty of making providential discovery by accident” according to Webster Dictionary, but in Chinese, it may carry the connotation of, “Being at the right time, at the right place and with the right person”. Therefore, if my “Youth Reflections” soon to be shared with you, would carry any weight at all, it must be by accident. To fit the category, “Youth”, I will only summarize the relevant events that occurred in my life from the time I got into the National Taiwan University (NTU) and until I was 40, according Confucius. Finally, as a loyal alumnus of NTU and a dear friend to Taiwan, I have brought back a special gift, which has grown, matured and shall bear fruits indefinitely! With this introduction, here are my reflections.

As far back as I can remember, I was growing up pretty much as a loner. With this unusually independent personality and the typical rebellious character that is natural in a young person, I did not seek advice from anyone when selecting the Department of Forestry as my major when entering the University. Reality struck quickly and I soon realized that I needed to find an academic department that would better fit my scholastic aptitude. I tried to transfer to Mechanical or Civil Engineering Department but ended up in Agricultural Engineering through default. Naturally, I was disappointed but determined that I should devote my career with the altruistic and noble mission of “Saving China through Mechanizing Agriculture!” However, entering this field shaped my life and career. The serendipitous detour guided me to a more interesting, inspirational and

meaningful professional pathway, all by accident!

In my junior and senior years, though my major was in Agricultural Machinery, most of my attention and energy went into courting my future wife, Jane (沈敬, 臺大外文系1962畢) and indulging in Chinese Martial Art novels by Yoon King (金庸). In one of my senior courses on “Agricultural Mechanics” taught by Professor Takasaka (高坂知武), I was much inspired when I realized that an understanding of simple mechanics could lead to the design of better hand held tools, which could improve human function. All of these could come from the basic knowledge of human anatomy. This was the first time that the concept of biomechanics or ergonomics entered my mind and it quickly became the driving force for my future studies. Thus, I owe my career to Professor Takasaka and my alma mater!

After graduating from the NTU, I spent a year in the military service and took a job as an agricultural machinery teacher at an Agricultural Technical School in the northern part of Taiwan. As I was boarding in the school, I spent nearly all days and nights with my students in the classroom, experimental laboratory, machine shops and the rice fields, trying out agricultural machinery and tools to understand how they work and challenged my students to figure out better ways to make and use them by considering human mechanics. This job and the close working relationship with the students left me no time to think about the future and the possibility of graduate study by going abroad. However, through the persuasion and encouragement from Jane, one year later I left Taiwan alone and enrolled in the masters program at

the Agricultural Engineering Department at the Virginia Polytechnic Institute (VPI) in Blacksburg, Virginia, USA.

Here at VPI, I began to truly appreciate how mechanics could help in all aspects of living plants and cash crops through improving equipment and developing new machinery. Under the mentorship of Professor Floyd Cunningham, my two years at VPI were very productive, enjoyable and inspiring. We worked on apple and cherry pickers; plow mechanics; aerodynamics of grain and chuff particles in a combine. My master thesis was on the theoretical and experimental work of two major types of fertilizer spreaders to optimize their efficiency, reliability while minimizing power consumption. This work had firmly established my intense interest in using mechanics to improve the function of living things. Before graduation, I had two job offered among the largest agricultural and industrial equipment companies, thanks to the extraordinary training and education I received from Professor Cunningham and at VPI.

In the spring of 1964, knowing that Jane was taking an ocean voyage from Taiwan via Panama Cannel with a stop at Charleston, South Carolina to Ann Arbor, Michigan for her graduate study in Hotel Management, I borrowed my advisor's 1957 Chevrolet, drove to Charleston, hijacked and married her in Blacksburg. Jane still would not forgive me for this derelict act of piracy even today. After consulting with Professor Cunningham, we accepted the job offer at the newly established Research Center of the John Deere & Co. in Moline, IL. "This is the first of its kind in the farm equipment industry to allow a young lad like you to fully explore what mechanics could do in a non-traditional engineering field" was the farewell advice from my advisor. In retrospect, this was a downright testimonial of being with the right person, in the right time and at the right place!

Deere & Co. was and still is the largest farm and industrial equipment company in the world with its headquarter situated in the upper Mississippi Valley

between the States of Illinois and Iowa. As a young engineer, I was fortunate to work on many challenging problems. I helped to optimize the throwing mechanism of a hay-baler, improving the digging linkage of a backhoe, redesigned the main frame of a Rotoboom (a logging equipment in forestry), evaluated the Wanko Rotatory engine patent from Japan and studied the theory and design requirements of an eccentric dynamic soil compactor. At the end of my two years time at Deere, I felt that I needed more advanced study in order to pursue my major interest in mechanical simulation and optimization. I was encouraged to stay on and the Company would send me to either MIT or University of Michigan for PhD training in this new field. A new project was assigned to me to model and evaluate the Deere-patented non-linear pneumatic seat suspension system to improve the riding comfort for farmers suffering from chronic low back pain. I needed to model the human back but did not know where to start. Professor Rim of the Department of Mechanics and Hydraulics at the University of Iowa was spending his summer working at the Deere Research Center and introduced me to Dr. Carroll Larson who was the Chairman of Orthopaedics at Iowa and a spine specialist. This sequence of events not only changed my advanced study plan but also inadvertently led me to the crucial turning point of studying another branch of mechanics on humans, the "Biomechanics!"

I became a PhD student in Mechanics at the University of Iowa in 1967 and also worked for Department of Orthopaedics to support my family. These gave me the opportunity to learn about the biomechanics of human hip, knee and hand. Although modeling of the human spine was temporarily shelved, Professor Larson soon recruited a young orthopaedic surgeon, Dr. Richard Stauffer, trained at the Mayo Clinic in Minnesota as a faculty and we worked on the low back pain project together while forming a close bond. The years of practical experience in the industry and my

exposure to musculoskeletal system gave me the ability and confidence to formulate my dissertation topic to predict human joint moments during walking using the measured or prescribed motion. This turned out to be a difficult problem even after considerable simplification since it was indeterminate. To solve it, I needed to apply the optimization theory. I coined this class of problem as the “Inverse Dynamic Problem” not knowing that it had never been formulated before. I used a linkage system as my theoretical model to validate method since the solution was already known and the human walking as my biomechanical model to demonstrate its application potential in biomechanics. The “Inverse Dynamics Problem” became popularized in the Electrical Engineering fields years later, an example of serendipitous discovery at work! When presenting my thesis work at the Orthopaedic Research Society in Washington, D. C. in 1971, I attracted the attention of the surgeons at the Mayo Clinic and was recruited to join them together with Dr. Stauffer in 1972.

With a rocky start, I built the lab, trained the staff and established the validity and clinical utilization of biomechanics at Mayo. Soon, such trend spread across several medical subspecialties, which gave me the confidence to bring this new concept back home to Taiwan. After being away for more than 12 years, in

the winter of 1974 I accepted an invitation from South Korea government to assist their heavy metal industry to develop bone fracture fixation screws and plate system. I went to Seoul alone first and joined my wife and two sons in Taipei 10 days later. I gave two lectures on biomechanics, one in NTU's College of Engineering (Fig. 1) and the other at the National Taiwan University Hospital introducing the idea of combining engineering and medicine to expand academic research, improve patient care and develop new industry of medical devices. These introductory lectures had created a whirlwind effect in the local medical and engineering communities. I was soon invited back nearly on yearly basis to speak at all major universities and hospitals about my experiences and excitements working at the University of Iowa and the Mayo Clinic. Several engineering schools deans and hospital directors enthusiastically vowed to join force in exploring this interdisciplinary field as their major academic pursue. I brought several clinical colleagues to share their experiences and enthusiasm on the new discipline and to encourage young surgeons and engineers to study abroad (Fig. 2). Such educational interchange expanded to other medical and engineering fields and from Mayo to other famous institutions. These actions created immense and long lasting impact in Taiwan and there are Bioengineering Departments and/or Biomechanics laboratories on many university campuses and in large hospitals. The medical devices and health care/recreational equipment industry started in the late 1980s but mainly in outsourcing business. There are now several orthopaedic device companies with their own brand name and technology and all doing quite well.

Reflections and retrospective hindsight from someone else are always beneficial to guide a young person's academic and career path. When the editor of the NTU Bimonthly Alumni Journal invited me to write this article in English to appear in their special issue, “My Youth




1974 Lecture at the NTU School of Engineering. 左1, Director of the Electronics Research Institute; 左2, 陳俊雄, 臺大電機系教授, 作者建中同班同學; 左3, 作者; 左4, 工學院虞兆中院長; 左5, 農工系主任施嘉昌教授; 左6, 電子研究所教授。





1983年亞太外科年會（會長施純仁教授，左8）會後會，生物力學在骨科，創傷，及運動醫學臨床的應用講習會。左3，臺大骨科劉堂桂教授；左4，三總馬耀教授；左5，Mayo Morrey 教授；左6，Mayo Sim 教授；左7，作者；左9，榮總楊大中教授；左10，Mayo Stauffer 教授；左11，Mayo Linscheid 教授。

Reflections” , I took the offer with pleasure. However, I soon became rather apprehensive for the concerns that I may not have an exciting story to tell. Besides, I had never tried composing literary essay other than technical papers and this article is no exception. Nonetheless, I rationalized writing it as a way to express my heartfelt thanks to the National Taiwan University, to those who helped me, and especially, to my dear wife Jane (Fig. 3). Without her patience, tender-loving care and enormous sacrifice, none of these would ever have happened. She has been my Minerva to assure that I never feel bigger than what I really am. Enormous gratitude must be given to those who inspired me and stirred me to the right direction at the right time. A well-known Hindu proverb stated that, “No disease like hope!” and I would venture to declare that, “No medicine like reality!” I had never hoped to become rich and famous, but only did my job and assignments with faith, dedication and perseverance while let reality follow its course. “Serendipity” was chosen for my story telling since anyone who was born as

an ordinary person, raised in a humble environment, and received an averaged education would have equal chance to excel. 



作者及夫人沈敬女士。2005年退休後移居南加州Glen Ivy。



## CURRICULUM VITAE: Edmund Y. S. Chao, Ph.D.

**Current Title:** Emeritus Professor of Mayo Clinic & Mayo School of Medicine; Emeritus Professor of the Johns Hopkins University; President of BJED Consulting, LLC; Senior Medical Consultant, Aspen Medical Products Co. Ltd.

**Research Expertise:** Dynamics Analysis of musculoskeletal joint system; Virtual Biomechanical Models & Visualization of musculoskeletal system anatomy & function for research, education and patient care; Interaction between biology and biomechanics in Bone Remodeling and Fracture Repair; Connective Tissue and Joint System Testing and Material Characterization; Joint Implant and Bone Fixation Device design and testing; Patient Functional Assessment; Joint Reconstructive Procedure Simulation and reoperative Planning.

### **Education:**

National Taiwan University (國立臺灣大學) /B.S. 1960/Agricultural Engineering  
Virginia Polytechnic Institute/M.S. 1964/Agricultural/Mech. Engineering  
University of Iowa, Iowa City, IA/Ph. D. 1971/Applied Mechanics

### **Past & Present Positions:**

Professor of Orthopaedic Surgery, Johns Hopkins University 1993-2005  
Professor of Biomedical Engineering, Johns Hopkins University 1993-2005  
Professor of Mechanical Engineering, Johns Hopkins University 1993-2005  
Vice Chair Res., Dept. of Orthopedics, Mayo Clinic, Rochester, MN 1992-1993  
Professor of Bioengineering, Mayo Medical School 1980-1993  
Director, Biomechanics Lab., Orthopedic Dept. Mayo Clinic 1972-1992  
Asst. Prof., Dept. of Mechanics and Hydraulics, U. of Iowa 1971-1974  
Senior Res. Engineer, Research Center, Deere and Company 1964-1968  
Visiting Professor, Kaohsiung Medical University, Kaohsiung, Taiwan 2005  
Voluntary Clinical Professor of Orthopaedics, University of California, Irvine 2005-2012  
Honorary Professor, Hong Kong Chinese University 2006-2012  
Honorary Guest Professor, Chengdu Hwa-Xi Medical University /Tian-jin Medical University, China 2006-2012  
Special Consultant, Tainjin Free Tax Zone, Tianjin, China 2007-2010  
Special Consultant, Taiwan Metal Industry R&D Center, Kaohsiung 2008-2009

### **Professional & Governmental Appointments:**

Korean Advanced Institute of Technology, Special Consultant 1976-1980  
US NIH Study Section, Ad-Hoc Member 1982-1984/Member 1984-1988  
US FDA Orthopaedic Devices Panel, Consultant 1982-1984 /Member 1984-1987  
US National Center of Medical Rehabilitation Research Advisory Board member 1992-1996  
NCMRR, NICHD, NIH, Visiting Researcher (part-time) 1999-2001  
Committee on Engineering Education, National Academy of Engineering 1999-2002  
National Health Research Institute, Taiwan, ROC, Council Advisor 1996-2002

### **STUDENT & FELLOW Trained:**

Undergraduate Students: 40  
Medical Students: 35  
Engineering or Bioengineering MS Students: 30  
Engineering or Bioengineering PhD Students: 7  
Post-doctoral Fellow: 170

## HONORS:

1983 Volvo Award, International Lumbar Spine Society  
1983 Shands Award, Orthopaedic Research Society  
1984 Kappa Delta Award, AAOS and Orthopaedic Research Society  
1984 Brooks-Hollern Professor of Bioengineering, Mayo Clinic  
1986 John Charnley Honor Award, American Hip Society  
1989 Research Award, American Orthopaedic Society for Sports Medicine  
1989 Docteur Honoris Causa de L' Université de Rennes I, Rennes, France (Honorary Doctor)  
1989 Veterinary Orthopedic Society, Honorary Membership  
Merit Research Award, National Cancer Institute, NIH  
Honorary Professor, Shanghai Third University of Medicine/The Third Military General Hospital, Lanchow/Beijing Capital University of Medicine  
Emeritus Professor, Mayo Clinic & Foundation, Rochester, MN  
Honorary Professor, National Taiwan University/Veteran's Medical Center/Chung Gung Medical Center and University  
1996 Lee Riley, Jr. Professor of Orthopaedic Surgery, Johns Hopkins University  
1996 President, International Society of Fracture Repair  
President & Secretary General, International Society of Limb Salvage  
1997 Honorary Technical Director, Nobuhara Institute of Biomechanics, Tatsuno, Hyogo, Japan  
1998 Member, National Academy of Engineering, USA  
2000 Member, Board of Trustees, AO Research Institute, Davos, Switzerland  
2003 Distinguished Engineering Alumni Academy, University of Iowa  
2004 Distinguished Alumni Award, Mayo Clinic/Foundation & Mayo Clinic Alumni Association  
2004 William Mong Distinguished Lecture, The University of Hong Kong

**PUBLICATIONS:** Referred Journal Papers: 342; Book Chapters: 184; Books: 5

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演講日期	演講嘉賓	演講題目
11 / 14	國立臺灣大學經濟系－李顯峰教授	講題未定
11 / 21	財團法人語言訓練測驗中心－高天恩主任	英美詩歌與終身英語學習
11 / 28	臺大醫院內科－許金川教授	疼惜阮的肝
12 / 05	國立臺灣大學中文系－劉少雄教授	但願人長久-東坡詞中的兄弟情
12 / 12	臺北科技大學電子工程學系－李仁貴教授	講題未定
12 / 19	國立臺灣師範大學英語學系－張武昌教授	從雙語標示談英語學習
12 / 26	臺大醫院－陳明豐院長（邀請中）	講題未定

※連絡單位：臺大校友會館 黃羽婕秘書。

※演講時間：個週六早上10:00至12:00。

※演講地點：臺北市中正區濟南路1段2之1號 臺大校友會館4樓演講廳。

※洽詢電話：02-2321-8415\*9 /活動網站：<http://www.ntuaa.ntu.edu.tw>

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