THE THIRTY FIRST
PROFESSOR CHIN FUNG KEE MEMORIAL LECTURE

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Dr Chuah graduated with BEng (Honors) with 1st Class Honors from University of Malaya in 1984 and MSc and Ph.D. in Electrical Engineering from University of California San Diego in 1989 and 1991, respectively. She spent 12 years at AT&T Bell Laboratories and Lucent Bell Laboratories where she was a Member of Technical Staff, a Distinguished Member of Technical Staff and later a Technical Manager. She joined Lehigh University as an associate professor in Jan 2004. She is currently a Full Professor and the Associate Chair of the Computer Science & Engineering Department at Lehigh University, USA.

Her research interests include mobile health, computer vision, healthcare data mining, cloud security and security design for Cyber Physical Systems. She has authored/co-authored more than 150 papers in international journals and conferences. Her research hasbeen funded by major funding agencies in United States, e.g., National Science Foundation, DARPA, DOE and companies such as Qualcomm and FORD. She has served as Technical Co-Chairs for several top international conferences such as Technical Co-Chair for IEEE INFOCOM 2010, Symposium Co-Chair for Next Generation Networking Symposium for IEEE Globecom 2013, Technical Co-Chair for ACM/IEEE CHASE Conference and IEEE MASS 2019 Security & Privacy Track Co-Chair. She has also served as associate editors for several top IEEE transactions such as IEEE Transactions on Mobile Computing and IEEE Transactions on Parallel & Distributed Computing Systems. She has been awarded 63 US patents and 15 international patents based on her research work at Bell Laboratories in the area of wireless data system design, resource and mobility management design, MAC layer quality of service design etc. Based on her strong contributions in these areas, she was elevated to be an IEEE Fellow in 2015 and a National Academy of Inventors Fellow in 2017.

31ST PROFESSOR CHIN FUNG KEE MEMORIAL LECTURE

MY INDUSTRY TO ACADEMIA RESEARCH JOURNEY AND ENERGIZING INNOVATIONS AMONG MALAYSIAN ENGINEERS

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ABSTRACT

In this talk, the author would like to share her research journey from industry to academia, first in Malaysia and then in United States. She was fortunate to receive a strong science & mathematical education in Malaysia, trained as an engineer at University of Malaya, worked with a team of talented R&D engineers at Motorola Communication Sectors Sdn Bhd in Penang before she went to United States for graduate studies. In United States, again she was fortunate to have several mentors who helped to inspire her to conduct great research first in industry and then in academia. She will first share her research journal from Malaysia to United States. Next, based on her experience, she will share some main ingredients one needs to cultivate to conduct great research, e.g., curiosity, diligence, and perseverance. Subsequently, she will also share her thoughts on how industry leaders, academic leaders and Malaysian government can collaborate to energize innovations among Malaysian engineers as well as young generations aspiring to be our next generation engineers. Cultivating curiosity in STEM fields at young age, providing opportunities for high school students to appreciate science through solving real life problems with college students, and creating opportunities for faculty members in STEM fields to spend sabbatical semesters at top universities or industry R&D laboratories to horn their skills are necessary steps to energize innovations among Malaysian engineers.

Keywords: mobile computing, artificial intelligence, healthcare analytics, computer vision, project based learning, design thinking

1.0 INTRODUCTION

Ir. Professor Tan Sri Dato Dr Chin Fung Kee is one of the most respected and outstanding civil engineers in Malaysia, both in engineering practice and also in engineering research and education [1]. He was a renowned leader in geotechnical and structural engineering. He played a key role in the development of engineering education, research and practice in the country. For example, Prof Chin played a major role in the formation and development of the Faculty of Engineering, University of Malaya, Kuala Lumpur. Professor Chin's significant contributions benefited the engineering fraternity nationally, regionally and internationally and his success was recognized worldwide. In recognition of Prof Chin's outstanding achievements and contributions, the Prof Chin Fung Kee Memorial Lecture was inaugurated in 1991 and jointly organized by The Institution of Engineers, Malaysia (IEM) and the Engineering Alumni Association of the University of Malaya. Also a Prof Chin Fung Kee Gold Medal was established in UM to recognize the top engineering student with the best result in the final year common subject on Management (and later was changed to award for the best engineering graduate) [2].

The author was grateful for the honor of being invited by the Organizing Committee to deliver the 31st Prof Chin Fung Kee Memorial Lecture which was presented on 31st, July, 2021 and this paper is a write up of her presentation.

The author received her education in both Malaysia and United States. She was honored to be a recipient of Professor Chin Fung Kee Gold Medal in Management and Tunku Abdul Rahman Gold Medal in her final year electrical engineering study in 1984. After her bachelor degree, she worked as a R&D engineer and later as a senior R&D Engineer at Motorola Communication Sectors, Penang between 1984-1987.

Her undergraduate education, initial R&D engineer experience at Motorola Penang and encouragement from a caring mentor Prof. Tan Hong Siang of University of Malaya spurred her desires to pursue her graduate studies in United States. Initially, she secured a full scholarship to start her graduate study at MIT in United States but could not adjust to the cold weather so she took a leave of absence for a few months

and later started her graduate study at University of California, San Diego where she obtained her Master's Degree and later a Ph.D. in Communication Systems & Theory from its Electrical Engineering Department in 1991.

Upon completion of her PhD study in 1991, she was given the opportunity to work at AT&T Bell Laboratories, a top notch industry research laboratory in the world. She joined as a Member of Technical Staff, and was later promoted to be a Distinguished Member of Technical Staff in 1999, and Technical Manager in 2001. Based on her research work at Bell Laboratories with her colleagues, she was awarded 63 US patents and 15 international patents. Most of her patents are related to designing future wireless data systems.

Encouragements from her siblings spurred her to move from industry to academia. She joined Lehigh University in Jan 2004 as an associate professor and later was promoted to be a Full Professor in 2010. At Lehigh, she conducted research related to network security, disrupted tolerant networks, mobile computing and mobile vision. Her research was funded by major US funding agencies such as DARPA and National Science Foundations.

In recent years, she started to do artificial intelligence related research, e.g., computer vision and healthcare data mining research. Despite changing her research topics, she successfully secured funding from companies such as FORD, Qualcomm and National Science Foundation to pursue new research topics.

Her research works were published at top international conference venues such as IEEE INFOCOM (the top networking conference), IEEE SenSys (one of the top sensor network research related conferences) and top journal venues such as IEEE Transactions on Mobile Computing, IWMUT. She has served as Technical Co-Chairs for top international conferences e.g. IEEE INFOCOM 2010, Symposium Co-Chair for Next Generation Networking for IEEE Globecom 2013, Technical Co-Chair for ACM/IEEE CHASE (health care related conference) in 2017 and IEEE MASS Track Co-Chair for Security & Privacy in 2019. She has also served as associate editors for top journals such as IEEE Transactions on Mobile Computing, IEEE Transactions on Parallel & Distributed Systems etc. She was elevated to be an IEEE Fellow in 2015 and selected as a NAI Fellow in 2017.

In this paper, the author first described her own research experience that spans from industry to academia and factors that help prepare her to become a productive researcher in the international research community in different areas that she chose to get involved in. Life is not a bed of roses so was her research journey from industry to academia. Thus, she would like to share how she overcame different obstacles to become a successful researcher with encouragements from friends and colleagues. By sharing her experience in transitioning from industry to academia, she hopes that she can encourage others thinking about doing the same to have the courage to do so.

In addition, she shares some habits that effective researchers have in common based on what she has learnt as well as from her conversations with other effective researchers. Last but not least, she also presents some ideas on what professional bodies like IEM, university administrators and the Ministry of Education (MoE) can do to help train future engineers that can create novel and innovative solutions to solve complex problems that mankind will face in future in this fast moving technological society.

2.0 AUTHOR'S RESEARCH JOURNEY

2.1 Author's Research Journey in Malaysia

The author took pride in being trained as an engineer in Malaysia. She started her primary school in Hu Yew Siah before continuing her secondary school education at Penang Chinese Girls' High School (PCGHS) and sixth form in Methodist Boys' School (MBS) in Penang. She recalled that she and another friend were the only two that did not attend Penang Chinese Girls' Primary School (PCGPS) when they first showed up at PCGHS. PCGPS was a well known primary school with many talented students. These two young girls were not intimidated and ended up being the top 2 students in their remove class (1st year in Chinese High School). After MBS, she secured a Bank Negara scholarship to enroll into the Electrical Engineering degree program at University of Malaya (UM). She had a hard time adjusting in her first semester at UM especially in a class where she had to learn how to draw engineering diagrams that typically civil engineers had to draw because she was not used to having to imagine how a 3d object looked like from different viewpoints. She nearly quitted but received encouragements from a few young engineers (trained at UM) who were her eldest sister's friends.

After graduating from UM, she started her engineering career as an R&D engineer at Motorola Communications Sector Sdn Bhd in Penang. She was assigned to write assembly language software that provided control features for new series of transceivers that the Penang R&D Team was in charge of designing for the company in competition with another R&D Team in United States. Both teams designed similar series of transceivers for different governments. Facing a competitive team allowed the team she was involved in to work hard and eventually they were able to successfully produce a prototype ahead of their competitive team. While at Motorola, she noticed that her colleagues who were trained in United Kingdom and United States seemed to have better problem solving skills. That triggered her to have the desire to pursue graduate study overseas just to find out how they train engineers differently. At Motorola, she and her colleagues designed a new feature that allowed engineers to clone software from one transceiver to another easily. This feature involves transferring data from one device to another. Such work led her to be interested in conducting communication network related research in her graduate study.

2.2 Author's Research Journey in United States

While at Motorola, she occasionally still visited UM and Prof Tan Hong Siang, who was the Department Head of Electrical Engineering at that time, encouraged her to pursue her graduate study in United States. She applied to the two best engineering schools in United States and was accepted to one of them (MIT) with a full scholarship. Unfortunately, she was not able to adjust to the cold weather there and decided to take a few months leave of absence after one semester. Despite having this setback, she was determined to overcome this obstacle with tons of love and supports from her family especially her siblings. She later started her graduate study at the University of California San Diego (UCSD) where she completed her Master and PhD degrees in electrical engineering.

Even though her stay at MIT was very short, she learnt a few important lessons that influence how she conducted research and communicated with others about research subsequently. She learnt that one should be brave to ask questions when he/she does not understand new concepts in class. She also learnt that it is okay not to know much when one started doing research in a new topic as long as you work hard to learn fast. She also learnt that it is okay to rely on new friends for emotional support when you are far away from family members. She learnt Artificial Intelligence (AI) and some database concepts at MIT. Interestingly, when she was asked to indicate her research interests at MIT, she picked communication networks and artificial intelligence. Even though she took an AI course at MIT, she hardly knew what type of AI research she would like to do. You will see how life came to a full circle 32 years later when she started to do AI related research at Lehigh.

While at UCSD, she worked with a young but bright assistant professor. She was not very interested in the research topic that her advisor suggested to her but she continued to push herself to conduct research under him because of a very good advice that he gave her, i.e. "It does not matter what topic you conduct your research in but the whole PhD process helps you become a great thinker. Once you get your PhD, you are free to do whatever research you want". When she graduated in May 1991, technical jobs were hard to find since the job market happened to be down that year. She struggled with whether she wanted to go back to Malaysia/Singapore or remained in United States. She did apply for an academic position in Singapore because she learnt science in English and not in Malay. Unfortunately, her application was not successful. With God's grace, later she was given an opportunity to join Bell Laboratories, one of the top industry research laboratories in the world.

In the first few years at Bell Laboratories, she was not given any interesting research projects but that did not dampen her spirit of continuing to learn new knowledge to prepare herself to do interesting research. At that time, her research center was not keen in doing any internet related research while she was interested in such research. She spent weekends reading others' research papers in this area and conducted such research during her own free time. Eventually, she was given the opportunity to participate in a very high impact research project involving wireless LAN. At that time, there was no standard that allowed wireless LAN to provide quality of service. In addition, since wireless LAN is a broadcast medium, having security feature is important in wireless LAN data system but not much security features are provided in such systems. Their team was the first that designed MAC layer features that provide quality of service as well as designed network layer protocols for providing virtual private network features for wireless LAN systems. Multiple patents were awarded from the work they did in this project. Subsequently, she also designed mobility management features for future wireless data systems, MAC layer features for 3G systems, and MPLS related features for routers in the internet. All these work led to her being awarded 63 US patents and 15 international patents.

After 12 years at Bell Laboratories, encouraged by her brother to move to academia, she joined Lehigh in January 2004 as an untenured associate professor. By October 2004, she already secured a big grant from DARPA to get involved in disruption tolerant networking (DTN) research. Her team was the first that designed a DTN multicast delivery scheme and also the first that implemented security features for DTN. Her publications related to DTN can be found in [3-7].

Transitioning from industry to academia was challenging for she had to make sure that she could recruit high quality PhD, Master's and undergraduate students to build a research group. She had to work hard to build connections with faculty members both at Lehigh and outside of Lehigh. She was fortunate to have a bright undergraduate American student who was interested in doing security research for his MS degree and a new Chinese PhD student who did his MS in Singapore to help her in this DTN related project. Subsequently, she recruited 2 or 3 more but none worked out. They either had personal reasons that force them to quit their PhD programs or they did not have the right attitudes to pursue PhD degrees. She had to work extra hard to make sure that her team completed the deliverables that were originally planned in the funded project.

Despite the initial DARPA grant success, submitting research proposals turned out to be a challenging task for one may have great ideas but without preliminary results, reviewers of the proposals may not believe in your ideas. However, being at a smaller private university where you do not have a large research group may mean that you could not produce preliminary results fast enough to compete with larger research groups elsewhere. However, despite multiple proposal rejections, she persisted and worked harder until she succeeded in getting her research proposals funded by National Science Foundation (NSF).

One of the benefits that university faculty members enjoy is the ability to have a sabbatical semester or year every 7 years. During her first sabbatical semester, she tried to determine the next research topic she wanted to explore. At that time, she was troubled by the difficulties that her sisters had to deal with in moving her parents from upstairs to downstairs just to get them to a doctor's office for regular checkup. Thus, she started working on mobile health related research in the hope that using intelligent wearable sensors, caregivers of seniors can help collect useful sensor data to send to the doctor's office without having to transport seniors to his/her office. Subsequently, she and her collaborator at Steven Institute of Technology started two NSF funded mobile healthcare related projects (see Fig 1).

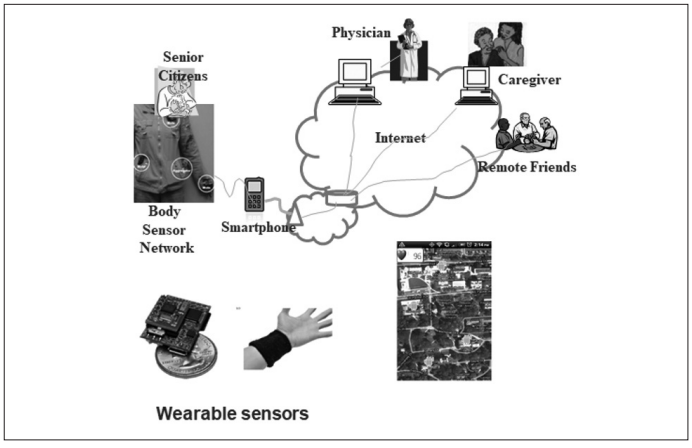

Figure 1: Mobile HealthCare Research

Funded by these NSF grants, she and her collaborators designed efficient schemes for monitoring gait patterns [8, 9] as well as using the Channel State Information extracted from WiFi

signals to infer human activities. Their work were published in several top conference and journal venues including IEEE Sensys [10] (one of the two top sensor network related conferences), ACM Ubicomp [11] (one of the top mobile computing related conferences). She also supervised undergraduate students to develop useful Android applications for healthy lifestyle and life-skill training for teenagers with autism disorder (Fig 2).

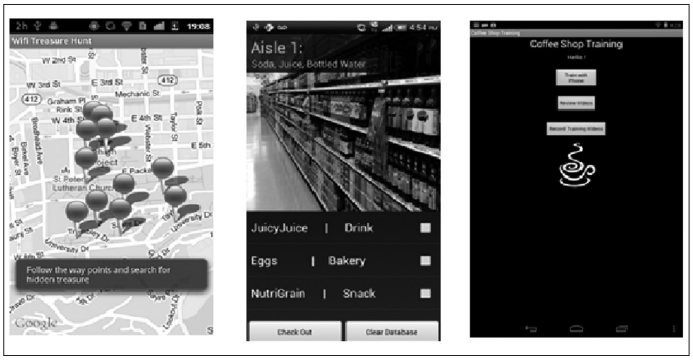

Figure 2: Android applications for healthy living and teenagers with ASDs

In addition, she was involved in designing a new internet feature called content centric networking feature and secured an NSF grant to develop a network prototype with such a feature. Since part of the goal of the project is to develop new application that can utilize large bandwidth, her research group started to explore how to support a video streaming feature in content-centric network. That project allowed her and her graduate student to travel to different locations within United States to give demos for their prototype during the GENI conferences. While touring some great places during off-times at these conferences, she thought of ideas for a new research project involving mobile vision that could allow tourists to retrieve interesting information about places of interests using images captured by tourists. Such thoughts eventually led her to start doing research in computer vision (Fig 3). This was the beginning of her Artificial Intelligence related research.

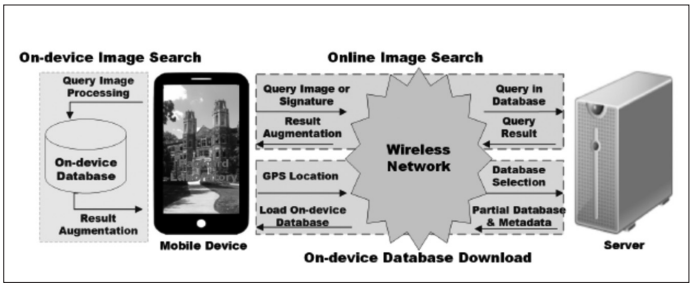

Figure 3: Mobile Vision Research

She started recruiting PhD students who are interested in doing computer vision related research. For the past 5 years, she has conducted research in topics such as object detection, tracking & trajectory prediction, few shot image/video segmentation. Such topics are useful in many application scenarios that affect our daily lives, e.g., analytics of videos collected during sport events, autonomous vehicles, video surveillance. Again, despite being new to these areas, she successfully secured funding from companies and NSF to conduct research in these topics. In order to conduct such research, she has to sharpen her knowledge by learning how deep learning models work and read many research papers. In addition, she has to find niche areas where she can contribute using her vast system research experience so that she can be competitive in securing research funding in a very hot research area where big name schools have large research groups to conduct such researches.

Furthermore, she became fascinated with the different domains that one can apply deep learning techniques to. Since she is always passionate about conducting research related to healthcare, she started exploring how she can apply such techniques for healthcare analytics. Since Lehigh is not a medical school which has access to tons of healthcare data, she had to work hard to see how she could get hold of some healthcare data to start her research in this area.

After not having any success in finding a publicly available healthcare dataset for nearly a year, she eventually found a data mining related challenge organized by a non-profit organization which is created to speed up research in ALS disease. This organization secured a dataset on ALS patients from two well-known hospitals that treat ALS patients and invited data mining researchers to participate in a challenge to develop the best data mining model that can predict ALS disease progression and ALS patients' survival rate. The challenge was over so she contacted the organizers to see if they were willing to share their dataset with her. Of course they were happy to share the dataset with her, and that was the beginning of her research in healthcare data analytics.

She and her PhD student conducted such research for several years. They designed an incentive mechanism which can encourage hospitals to share their datasets so that an aggregated model with better accuracy can be produced [12]. They also explored security issues related to deep learning models. Typically, healthcare data are often time series data and hence RNN models are often used to analyze such data. Unfortunately, one can attack such RNN models. She and her PhD student explored a new RNN attack that can affect the accuracy of RNN models [13] and suggest methods to detect and defend against such attacks. Recently, she started exploring how to use deep learning models to create an intelligent voice assistant to help college students deal with mental health issues [14].

To be a productive researcher, one has to proactively look for new research topics that one can contribute to. Security research has always been an important research topic. At that time, researchers have started to explore how to make power systems more scalable using intelligent monitoring devices that can be connected to the internet and such smart device enabled power system is referred to as smartgrid. Being a security researcher, she started brainstorming with an external young faculty to see if he would be interested in collaborating with her in smartgrid security related research. That young faculty was willing to provide a PhD student for this collaborative work. They ended up publishing both a conference and a journal paper in this topic. Later, she collaborated with another external faculty and her PhD student in another smartgrid security related topic. They also published a conference and a journal paper. Subsequently, there were two Electrical Engineering faculty who were interested in forming a team at Lehigh to collaborate with four other universities to submit a smartgrid security related to proposal to the Department of Energy. A young faculty at the leading institution was aware of the papers that she has co-authored and requested that she became a core member of the Lehigh team. They succeeded in getting a $3.2 million 5-year project in smartgrid security.

In summary, her research direction has always been influenced by her strong desire to use technology to solve real problems. Given an opportunity, she will work hard to learn new knowledge so that she can contribute innovative solutions to solve problems that society faces, e.g., healthcare domain, smartgrid security, autonomous vehicles.

3.0 FACTORS THAT HELP CULTIVATE INNOVATIONS

Over the years, she work with many talented researchers both younger and older than her. She learnt several useful lessons that help her to become a better researcher. Here, she summarizes what she has learnt in the hope that these suggestions may help future Malaysian engineers do well in pursuing their dreams of changing the world.

3.1 Right Training and Lifelong Learning

Before one can build a beautiful building, one first needs to learn how to build a strong foundation. Thus, before one can be a great engineer or STEM researcher, one needs to have a strong Math & Science foundation. She was glad that she was trained in Malaysian primary and high school educational systems that focus on training young children with a strong Math & Science background in her days and hope that such tradition continues to persist in Malaysia these days. Teachers cannot teach you everything so developing a curious mind while one is young does help. Her dad owned a small grocery store when she was young and she would spend time checking the invoices issued by employees since she liked Mathematics. She often caught mistakes made by employees. Her dad did not ask her to do this. She did it due to her interests in Mathematics.

In addition, having a lifelong learning attitude also helps. These days, technology changes take place rapidly. Thus, any STEM graduate should not think that he/she is done learning once he/she graduates but should have that passion to learn new technology that is of interests to them for we never know when such knowledge becomes handy.

She shared two testimonies from her own experience. When she was at MIT, she had no idea what types of research she wanted to do. She ended up working with a professor who did database related research. She knew nothing about database but she diligently read research papers and by the end of the semester she learnt something about database. Initially, she thought that she would not use that knowledge since her research at UCSD was related to communication networks. When she first showed up at Bell Laboratories, her supervisor remembered that she told him during her interview that she took a neural network course towards the end of her PhD study. He happened to have a database related problem that he wanted her to explore if she could come up with any new approach that could achieve higher accuracy in matching records from various databases with different data formats. That research resulted in her 1st US patent and she was told 5 years later by a PhD student they interviewed that it prevented Microsoft from filing a similar patent. The second example is related to her deep learning related research. When she took the neural network course at UCSD, she has never imagined that one day she will be involved in deep learning related research where neural networks are used to solve different problems in our daily lives, e.g., healthcare analytics, perception system for autonomous vehicles, etc.

Furthermore, one should develop a strong logical thinking skill at his/her young age. When she was at UM, she was a book worm that studied hard what the lecturers taught her but she seldom stepped back to think about bigger pictures and developed a strong logical thinking skill. Lecturers often quiz students based on what they teach. She recalled her Physics teacher in Form 6 behaved very differently from other teachers. He often tested his students using questions that students need to think hard about how to apply the knowledge he taught in his class. Students couldn't adjust easily to his teaching style. She got the lowest score in his class (despite still being top in the class) over all classes that she had taken over her years of education in Malaysia. Now that she looked back, she could appreciate deeply what he was trying to do. Students need to learn how to develop strong logical thinking skills so that they can have better problem solving skills. The college professors in United States often cultivate such skills by testing how well their students learn the concepts they teach in examinations and not how well they remember what they say in classes.

3.2 Motivation

The second factor that drives innovations is motivation. Often a researcher that has a strong dedication to a cause will drive himself/herself to create innovative solutions to solve real life problems that is related to the cause that he/she is passionate about. When this author was at UM, there were only 6 female students in her engineering class of about 200 students. Female students were not given any special privilege. They had to arrive at the lecture halls early so that they could occupy front row seats for they could hear the professors better at front row seats. At that time she was highly motivated to do well so that she could prove to others that female students could be great engineers too.

Another motivational factor for her to be successful in STEM careers comes from a healthy sibling competition. She has a younger brother who is also an electrical engineer and a professor in a Malaysian university. He was 2 years her junior at UM. Since Malaysia educational system often has national exams (LCE, MCE) for FORM 3 and FORM5 students, the two of them would compete with each other. She would do well in LCE and her brother would try to outperform her when it was his turn. When they were young (primary school), they often quarreled and argued, but when they grew up, they became great friends who encourage each other.

Since their parents came from families where both of their grandfathers passed away when their parents were very young, their parents were not given the opportunity to finish primary school education. However, their parents worked hard to provide for their children and encouraged their children to do well in their studies. They however do not exert pressures on this author and her brother to pursue graduate studies since they were already proud of them for finishing their college degrees. Her upbringing led her to have passions to help those that are less fortunate than them. It also led her to have passions to improve people's lives especially people's health. Her passion for doing research in mobile health and health analytics are motivated by such desires. For example she supervised undergraduate students to develop mobile applications that help train autistic teenagers

so that they could speak better and they could learn skills that allow them to function well in their daily lives.

3.3 Environment

No one can work alone. They need friends and supportive colleagues to nurture them along their way to become a successful researcher. Having a great relationship with your PhD advisor helps. Her PhD advisor conducted very theoretical researches when they first met but when she visited him 9 years after she graduated, he told her that he was doing a startup company with his current PhD student. He told her that what she told him inspired him to look at how to apply his research skill into solving more practical problems. Thus, having a great relationship with your MS or PhD advisor helps both of you to grow professionally.

Our technical communities can also provide supportive environments for young researchers to succeed. In United States, there are several funding agencies that fund faculty research. They are competitive but opportunities exist every year. For some important research topics, there are sometimes multiple opportunities every year. Within universities, university administrators also establish internal research grants to help to promote strong research.

Often, researchers need to read research papers published by other researchers to help trigger new ideas. However, subscribing to journal transactions, registration and traveling costs for attending top conferences can be expensive. Malaysian researchers can identify conference venues where strong researchers publish their researches on topics that are of interests to them. Then, they can see if such papers are shared by the researchers on arXiv using Google search engine. Thus, young researchers can still access the latest research papers without having to incur expensive costs. Often researchers also share their research codes on github and such codes can be used to train graduate students to conduct new research effectively.

3.4 Communication

Despite brilliant ideas you may have, such ideas are worth million dollars only if they can be communicated well to others. Since her PhD advisor was a young faculty, he did not spend much time training her how to write well. This author started learning how to write well technically at Bell Laboratories. She recalled that her first supervisor told her that he thought the technical report which she wrote was more like her reporting chronologically what she has done despite the fact that she spent much time in writing the report. However, she accepted his critiques and strived hard to improve her writing. She continued to learn how to write well from a faculty who is younger than her because that faculty writes very well.

STEM researchers are often asked to communicate their research to different audience. Sometimes, researchers give presentations to other researchers that are familiar with their research fields but sometimes researchers give presentations to those who are not familiar with their fields. Thus, researchers need to know how to communicate well and if needed, use non-technical terms to explain their research. They can use analogies and metaphors to help explain their concepts so that their targeted audience can understand better what they are trying to communicate across. One needs to be humble in order to be a good technical communicator. One of the lessons this author learnt at MIT was to witness a very famous Artificial Intelligence professor practicing his lecture in an open lounge for faculty and students. He was already a well-established researcher but he took every opportunity to improve his teaching. Such role models often motivate us to become better technical communicators.

We can also improve our presentation skills by watching how famous researchers present their ideas. Top conference venues often host presentation videos given by researchers so Malaysian researchers can benefit by watching such videos to understand better the research papers that these researchers publish. Malaysian researchers should also be brave to write to these researchers when they have questions related to the published papers. This author recalled that when she was a graduate student at UCSD, she read a Bell Laboratories researcher's paper and sent him an email to ask questions about his paper. Guess what, she ended up in the same R&D department with him when she joined Bell Laboratories.

3.5 Constraints

Whether we are industry or academic researchers, we face constraints all the time. Conference submission deadlines and bosses' deadlines in finishing the design of new products are not within our control. In addition, we only have access to limited human resources, e.g., the number of PhD students we have, the number of team members we have. Furthermore, we often have to work within limited budgets. Others may view these constraints as excuses why we cannot be competitive but effective researchers often work within their constraints.

For example, this author was only exposed to C programming during her final year study at UM but she used whatever knowledge she had and improved on it while she was at MIT. She was fortunate that a senior PhD student was very patient in helping her improve her C programming skill. Another example was related to her current computer vision related research. Compared to other top computer vision researchers that often have 10-20 graduate students to work with, she only has 2 PhD students who work in this area. Thus, they have to find a niche area that top computer vision researchers seldom look at and see how they can contribute. Eventually, they came up with more efficient schemes that can run faster but still achieve slightly better performance in video action recognition because others assume they have access to tons of GPU resources while her group faces the constraint of only having limited GPU servers in her research lab. She was very fortunate that her PhD student knew how to build GPU server from scratch and hence they were able to have 2 (eventually 3) GPU servers by building their own and getting a GPU donation from Nvidia.

3.6 Diligence & Illumination

Thomas Edison once commented that even genius relies only on 1% inspiration but 99% perspiration. Irrespective of how smart you are, if you are not hardworking, you will be left behind in this fast changing technological world. Thus, it is important that researchers work hard to improve their own skill sets so that they can have sharper minds to tackle new research problems. For example, this author was not familiar with computer vision research when she first started. That did not deter her from learning together with a PhD student that

had prior computer vision experience. Having a humble heart to learn from others especially those younger than you helps you to be able to accomplish more in your own research. Diligently and continuously sharpening one's skillsets allows a researcher to prepare himself/herself to get involved in new research areas when opportunities arise.

In addition, we also often need to change our routine and take vacations to give us opportunities to create new ideas for ideas can come from anywhere. Reading news articles about others inventions can sometimes inspire us to come up with new ones ourselves. For example, this author read a Yahoo news article about a startup company in United Kingdom that sold wearable products similar to FitBit which allow users to track their physical activities, e.g., their walking steps. Their business model is different in the sense that it works with companies that sell healthy products and entice users to continue to use their wearables by giving them coupons to buy these health products after they achieve certain milestones in the total number of walking steps that they take every week or every month. She thought that such a system can easily be manipulated by users by lending their wearables to friends to help achieve these milestones faster. Thus, she collaborated with another female faculty on how to design an efficient scheme that can infer if the walking steps are actually the owner's steps or others' steps. They ended up publishing their work in a top conference venue [8] and they also published a journal version at IEEE Transactions on Mobile Computing (one of the top journals in mobile computing) [9].

3.7 Opportunity & Perseverance

Often success in research occurs when you happen to be at the right place at the right time. Recalled that this author mentioned she was not given any interesting projects to work on when she first started at Bell Laboratories. Her dad became ill so she took a leave of absence to go to the wireless research center at National University of Singapore for a few months. During that time, she started building a simulator to evaluate new MAC features. She kept in touch with her US Bell Laboratories supervisor and he happened to just receive words from the upper management that they were going to have this new Wireless LAN project that needed an engineer to innovate on MAC features. Her dad recovered from his illness and hence she accepted her supervisor's invitation to go back to Bell Laboratories in United States to get involved in this project which ultimately resulted in her and her team mates being awarded multiple US patents.

Researchers also need to have perseverance in order to succeed in their research. This author encountered multiple obstacles in her research career but she did not give up easily. For example, when she was doing my undergraduate thesis, she ran into difficulties. The PCB board that she designed in the 1st round did not work. She was disappointed but she continued to work hard on improving it and she finally succeeded. She was given the best undergraduate thesis award. At UCSD, her PhD advisor was very young and sometimes not experienced in coaching her. When he told her that he couldn't help her further when she got stuck in a research problem, she did not give up. She prayed and sought guidance from above and was able to overcome her problem and finished off her thesis related research.

When this author first started her mobile healthcare related research, she also ran into obstacles. She was eager to design something to help the elderly but there was no faculty at Lehigh who is an expert in elderly care. However, she managed to start developing mobile applications to help autistic teenagers. There are a few autism experts in College of Education. She had to work hard in reading autism related papers that typically CS researchers do not read so that she could understand the typical jargons that researchers in this field used before she was able to convince her colleagues to discuss with her. Thus, when young researchers face obstacles, they should not just walk away. Instead they should work hard to see how they can remove such obstacles so that they can conduct certain research. Sometimes, we may have to change our direction a little bit to hit a gold mine of interesting research problems.

3.8 Additional Advice to Young Researchers

In this subsection, this author provides some additional advice to young researchers how they can improve their chances of becoming effective researchers. First, they need to set their priority right. Every one only has 24 hours per day. Some of us have to play multiple roles in our lives: faculty, researcher, mom/dad, care-givers to older parents, etc. Thus, it is important for young researchers to plan ahead to set aside some time where they can focus on just doing research. They should learn how to say no to service responsibilities that others can take care of. In addition, they should look for collaborators within and outside of their departments for research these days is often interdisciplinary. To make others more willing to be collaborators, young researchers should do their homework to show others that they are serious in doing the research that they are seeking collaborators' help. They should also make sure that they are aware of new research that others are doing in that particular topic and be able to educate their potential collaborators. Often brainstorming sessions need to take place before one can find a niche problem that the team can work on. Thus, they should cultivate patience when they start new research.

Young researchers should be aware of top conference venues in their fields. Reading most recent high quality conference papers allow young researchers to learn new problems and techniques that others propose to solve such problems. Often, one does not need to attend such conferences in-person if resources are not available to do so. They can watch online video presentations. If such conferences are held in nearby countries, e.g. Singapore or China, they can seek support to attend such conferences. They should read published papers ahead of time so that they can ask questions when authors are presenting their papers. Having in-depth technical discussions with authors that may have more knowledge than them help to improve their knowledge and eventually make them better researchers.

4.0 COLLECTIVE GOVERNMENT, HIGHER INSTITUTION & INDUSTRY EFFORTS FOR FUTURE MALAYSIAN ENGINEERS

The recent statistics in Malaysia has shown that fewer students are considering STEM education and STEM related careers. Efforts need to be carried out to reverse this trend for society needs young generations with creative ideas to come up with

innovations that can benefit mankind. Here, this author would like to share some of the efforts she knows various communities in United States are doing to ensure that they continue to instill creativity mindset among young children, high school and college students. Such efforts can be easily implemented in Malaysia if the government, higher institutions, professional bodies and industry join their efforts together.

4.1 Cultivating Creative Minds in Young Children

It is never too early to cultivate creative minds among young children. Instead of spoon-feeding students with information, young children in kindergarten need to be given toys, materials easily found at homes to create new things that are of interests to them. Children in primary schools should be exposed to interesting activities that can motivate them to learn science and mathematics. For example, students in elementary (equivalent to primary) and middle schools in United States are encouraged to use the MIT Scratch platform [15] to learn programming skill. With Scratch, one can program his/her own interactive stories/animated games, and share them with others in the online community. Scratch [15] is a free resource and enables young generation to learn how to think creatively, develop systematic reasoning skill, and work collaboratively. These are essential life skills in the 21st century.

There are also multiple websites with many interesting robotic projects using materials one can find at home for young children [16-18]. Typically, young children love to spend time doing interesting activities and having community centers organize small workshops where young children can do these robotic projects together help children cultivate creativity. Such activities not only allow them to learn how to work in teams early but also can excite them to learn more about science and consider STEM education.

4.2 Cultivating Creativity Among High School Students

To produce creative students, we must cultivate a classroom culture where students are allowed to let their minds roam around in an encouraging and supportive atmosphere. Typically, creativity happens not in exams where students are expected to spit out information that they memorize from what teachers say in class. Instead, having project based learning [19] helps high school students to flourish in creating new ideas. It gives students opportunities to build creative skills through exploration, creative thinking, brainstorming ideas with other students, evaluate feasible solutions and giving effective presentations to others about their solutions [19].

In project based learning [19], students work on a problem which allows them to solve a meaningful real-world problem over a period of time. Students conduct research to learn deeper relevant knowledge, develop critical thinking and communication skills. There are useful websites that provide information regarding how to incorporate project based learning into classrooms [20,21].

To encourage creativity, students at high schools can form different clubs which aim to solve societal problems in different domains. For example, students interested in solving climate change issues can form a club where they can seek donation support from communities to plant more trees, encourage students to bike to schools rather than drive. Students interested in ensuring every child has the opportunity to learn mathematics and science can form another club where they can organize weekend workshops to let primary school children in rural areas enjoy fun-filled activities involving solving mathematical problems that they encounter in their daily lives. Students interested in building things can form a club where they can help to build a community garden which allows others in urban community to enjoy greener scenery while they learn additional botany knowledge. Solving real life problems provide opportunities for cultivating creativity.

Middle and high school should have a maker space, equipped with varying tools and materials, where students can explore ideas and invent new things that are useful to their communities. In such a space, students can innovate, explore and build prototypes. Often our classrooms are set up too rigidly where students just sit and listen to what teachers say. Classroom should be redesigned to facilitate group discussions and have movable white boards for students to scribble their ideas and solutions.

Teachers in middle and high schools should be trained to encourage and support students in their creativity processes. Instead of teaching concepts by merely providing facts, teachers should use diverse daily life examples to motivate why students need to learn such concepts and also use different teaching formats, e.g., via having different teams conduct research about that topic and report back to class by creating posters of their research. Instead of merely testing students if they can memorize certain facts, teachers should evaluate if students know how to apply the concepts they learn in class. For example, instead of testing if a student remembers the equation for computing the volume of a cylinder, a teacher can test if a student knows how to solve a problem in a kitchen where he/she needs to pour fluid from a big cylindrical container into smaller containers.

Instead of merely relying on textbooks and lesson plans, teachers should introduce more unconventional learning material to encourage students to think outside the box and encourage them to dive deeper into the lesson. Teachers can google for free online resources that can help inspire them to come up with their own ideas. Teachers can also encourage students by having them watch Ted talks on interesting STEM topics. Role models plays an important role in the creative development of students in a class so arranging for them to listen to inspiring Ted talks can motivate them to pursue STEM education.

4.3 Cultivating Creativity Among College Students

Recently, several colleges and universities have started a variety of campus initiatives to teach creative thinking. Centers and institutions dedicated to creativity and innovation are formed. For example, Stanford University's d.school, Harvard Universtiy's i-lab, Lehigh University's Creative Inquiry Office. These initiatives hope to teach approaches to creative problem-solving, including design thinking, which is a core part of engineering education. Design thinking [22,23] is a methodology that leads students to break down complex problems into various stages to come up with creative solutions. Students go

through a discovery phase to understand the problems they need to solve, an interpretation phase to understand the constraints of possible solutions. Subsequently, they can brainstorm and explore the feasibility of their ideas during the idea formulation phase. Next, they create prototypes and solicit feedback during the experimentation phase, and refine them through a series of iterative designs during the evolution phase [22,23].

Universities and technical schools need to develop courses and programs devoted specifically to developing students' creativity. University of Michigan at Ann Arbor has an interdisciplinary creative-process course and Vanderbilt University has a program for creativity and innovation. Such courses help students develop the mindsets needed to approach ill-defined issues, understand different viewpoints, collaborate in interdisciplinary team settings to develop innovative solutions. Some universities such as Carnegie Mellon and Stanford now require students to take a course that develops creating skills before they graduate.

Lehigh's office of creative inquiry provides multiple opportunities for students to participate in project based learning projects throughout an academic year especially over summer. This office [24] supports a wide range of interdisciplinary initiatives that help students and faculty pursue new intellectual, creative and artistic pathways that lead to transformative new innovations, expressions and questions. One specific activity it organizes is the summer Mountaintop project experience. Mountaintop projects [37] are interdisciplinary deep dives where faculty, students, and external partners come together to explore a topic that they are passionate about, typically a project that creates new innovations with societal impacts. For example, in 2019, two professors from College of Education, Prof A. Bodzin and Prof T. Hammond partnered with Prof David Anasstasio from the Earth & Environmental Department to do an immersive virtual reality Lehigh River Watershed project. The project designed, developed and tested an immersive virtual reality application for STEM education to promote engagement and learning about spatial watershed features and environmental issues in the Lehigh River watershed. Team members learn Unity programming skills and developed immersive games for learning. Another project led by Prof Lori Hertz, a bioengineering professor, is related to fighting the malnutrition problem in Sierra Leone. Students designed several nutrition-dense foods at Lehigh which were then prepared and tested in Sierra Leone. The team consisting of students from bioengineering, financial engineering, psychology and health, medicine & society students work together to improve the recipes, investigate methods of preservation and packaging, analyze the products for nutrient levels and shelf-life and create a business plan on how to deliver such products at low cost to the populations in Sierra Leone that can benefit from such food products.

Engineering graduates have long been expected to have complex problem solving skills. Real life problems often encompass different aspects from technical to socio-economical to environmental. Any proposed solution needs to take into consideration various factors, e.g., scientific, financial cost effectiveness, etc. Often such factors are interdependent and trade-offs need to be made between ideal or practical yet affordable solutions. Developing creative minds at the early stage of their training help to build their confidence and cultivate better judgements while evaluating different solutions.

In the past, we typically arrange for engineering students to go to companies for internships where they can learn how to apply the knowledge they learn in class to real life problems in industries. However, internships need not just happen within companies. Practicing engineers can form non-profit organizations with support from the federal or state agencies to solve problems faced in different communities. For example, a rural community may need innovative solutions how to improve its agricultural productivity. Engineers can team up with engineering students to study the environment in that community, e.g., soil composition, weather to determine the type of crops the community can plant, how smart irrigation system can be deployed to ensure the crops are well irrigated, and how affordable technology can be designed to ensure the crops can be harvested efficiently and delivered to the right food markets. Another example is in the healthcare domain. Healthcare services may not be freely available in rural communities. Thus, engineering students can be charged with designing a smartphone application that allows residents in such rural communities to be seen by doctors far away and drones can be used to deliver medicines quicker to hard-to-reach areas.

4.3 Creating Intelligent Educational Tools for Personalized Learning

Typically students in a class come from different background. Thus, traditional classrooms with rigid class syllabus may not be suitable for all of them. In addition, in recent years, computing related majors such as computer science education has become very popular because young people realize that it helps to prepare them for better job opportunities. Universities are facing challenges to meet such increasing demand. Massive open online courses (MOCC) have been introduced to address this challenge. Such courses indirectly help students in countries which may not be that fortunate to have teachers with the right expertise to teach more advanced science topics.

However, there are challenges for teaching an effective MOCC class with diverse students' background. In 2016, Computing Community Consortium organized a workshop which brought together researchers developing educational tools based on technologies such as logical reasoning and machine learning, researchers in education, researchers with human computer interaction (HCI) and cognitive psychology expertize to brainstorm on what can be done to produce intelligent education tools which facilitate personalized learning. A copy of their report can be found in [25]. This author summarizes their findings in subsequent paragraphs for such findings help Malaysian educators see how they can develop innovative computer-aided solutions to provide personalized learning experience in big MOCC classes in Malaysia.

Recent technology advancements provide exciting opportunities to create more intelligent educational tools that can transform the manner in which students learn [25]. First, tutoring tools utilizing natural language processing, data analytics and logical reasoning have been created for automatic students' assessment, personalized instruction which includes targeted feedback and adaptive content generation for different groups of students with varying learning styles. Affordable cloud computing services have facilitated the large scale deployment of educational tools for data sharing and experimentation. Malaysian educators may want to explore if some of these

automated tutoring tools are publicly available and customize them to suit Malaysian local learning environments or develop similar tools themselves.

An example of an educational tool that can provide personalized learning is the AutoProf [26] which was developed to help students in a large introduction to programming course. Rather than having instructors grade students' programming assignments, this tool can execute a student's program on a properly chosen set of test inputs and then use the logical reasoning module to synthesize a variant of the student's program that works correctly if the student's submission does not work [25]. AutoProf then highlighted the lines of codes that need to be changed and provide hints to students on how to fix them. This tool has been shown to be effective by MIT researchers in its introductory programming course.

In addition, one can develop learning analytics tools utilizing machine learning to help students and instructors keep track of the learning progress and recommends the next best learning activity for a student based on his/her progress to date. For example, a tool described in [27] provides personalized predictions of a student's comprehension and predict his/her grade in the class. If a student's performance in a class is low, then he/she is referred to e-Tutor, an AI system [28] which provides personalized remedial help for the student.

Furthermore, researchers in Natural Language Processing (NLP) and HCI are developing tools and techniques which allow students to interact naturally in their personalized learning environments [25]. For example, NLP-based applications have been created to automatically generate factual-based questions in new subject matters, support group discussions of reasoning tasks and automatic grading of essays. Educational games involving virtual reality technology can also be developed to help motivate students to learn new concepts. Visual interactions are used in some programming tools to help students see what happens when a program executes different lines of codes, e.g. Python Tutor [29]. One can also solicit help from cognitive science researchers to identify effective education tools for personalized learning. Such researchers can deploy technologies to monitor if students are attentive or engaged in classes. They can also design experiments to evaluate what types of interventions are more effective in improving learning outcomes.

4.4 Creative Inquiry Activities Led by Industries and Professional Bodies

4.4.1 State/National Level Competitions

Industries and Professional Bodies can help to promote creativities through activities that they organize. For example, annual state and national robotic competitions at primary, high school and college levels can be organized to encourage our young generation to produce innovative solutions that are useful to society. For example, designing a low cost smart wheelchair that allows seniors with disabilities to be able to live more independent lives.

To promote data science related research, data mining related challenges such as those organized by Kaggle can be organized. Hospitals can pool together their healthcare data and professional bodies can organize a healthcare data mining challenge. For example, Amyotrophic Lateral Sclerosis (ALS) is a fatal neurodegenerative disease with significant heterogeneity that leads to muscle weakness and gradually impacts patients' body functions leading to eventual death. Though the average survival is 35 years from the onset of symptoms, ALS survival is markedly variable ranging from several months to over a decade. Because of this heterogeneity, ALS clinical trials typically require large number of participants with clinicians spending much time on analyzing the survival patterns and hence such a process is highly inefficient. Thus, the DREAM ALS Stratification Prize4Life [30] challenge was organized to better understand patients' profiles and seek mathematical tools to predict the ALS progression so that personalized ALS treatments can be given to ALS patients. The main goal of the challenge is to forecast disease progression more accurately based on 3 months data of that patient.

Similarly, Kaggle often organizes competitions in different business sectors where data mining researchers/students from all over the world can design models that address a particular topic and compete for a monetary award. For example, there is a Jane Street Market Prediction [31] competition in October that lasted 3 months where different data mining teams submit a model that can predict the financial markets. Such competition is organized to find a useful data mining model that can help to ensure that products would remain at "fair values", not undervalued or overpriced. Developing such a model is very challenging. Each team is given market data from a major global stock exchange and will develop their own quantitative trading model to maximize returns. Such competitions often motivate data mining researchers to come up with better techniques in a fun way. Another example is the multiple autonomous driving related challenges organized by companies such as Baidu Apolloscape [32]. Lyft [33] where multiple autonomous driving datasets are shared by these companies for researchers develop deep learning models for object detection, tracking and trajectory prediction tasks. Leaderboards for different tasks are created so that data mining researchers can boast about how good their developed models perform. Another site with similar ideas is the Kitti Benchmark Suite [34].

4.4.2 Partnership with Top Tech Companies & Non-Profit Organizations

Industrial engineers and researchers should play more active roles in shaping the curriculum at universities and technical colleges since they are more aware of what additional skills new graduates need to have in order to be effective at their workplace. Advisory councils with industry members and university alumni need to be formed at universities to provide constant feedback to universities on how they can improve their academic programs.

In Malaysia, we already have internship opportunities for engineering students. Such industry attachment in industry is important for it allows students to gain hands-on experience in applying the knowledge they learnt in classes. However, there are more industry sectors can do. The industry in different sectors can help to shape new programs that can meet their needs. For example, Boston University recently introduced a MS in Robotics & Autonomous Systems program where students can finish their degree in 2-3 semesters. Robotics & Autonomous systems have become a part of everyday life and an exponential job growth in multiple areas, e.g., medicine or transportation, are anticipated. Paid internship placements with industry partners is part of that MS program. Students complete advanced course

work and gain hands-on experience through paid internships. The all-rounded educational plan allows them to be ready to face challenges in real jobs upon graduation.

Besides exposing students to how engineers solve real problems, faculty members who educate students need to gain similar experience too. What is less common in Malaysia is to grant faculty members a sabbatical year or one semester to work at industry research laboratories so that faculty members can sharpen their knowledge and bring back more exciting and relevant topics to teach in their classes. Intel and Motorola used to have R&D departments in Malaysia and I hope they still have such departments. University administrators should have communications with them to see how to create new sabbatical leave opportunities for faculty at their R&D departments. A recent 2019 news article also highlighted the AI Park that Malaysia Ministry of Education (MoE) has spearheaded with partnership with SenseTime. SenseTime is a fast growing artificial intelligence related company with many talented engineers. If the Ministry of Education can strike a deal with SenseTime to provide internship opportunities for both engineering students and faculty, it will definitely help to jump start the artificial intelligence education and research among Malaysian universities.

Aside from internship opportunities, industry researchers and engineers are encouraged to give technical talks at universities so that students can be exposed to technical problems that practicing engineers deal with at work and solutions that they come up with. Having constant communications between the industry, professors and students at higher education helps to ensure that universities can produce graduates who can contribute to the industry immediately after they graduate.

Typically research partnerships between academia and industry can produce innovative solutions faster. A recent example at Lehigh during the pandemic period shows how useful such collaborations can be. A recent innovation was created by an ECE professor, Prof Nelson Tansu and his research team at Lehigh working together with his industry partner during the pandemic. In mid March, Prof Tansu were asked to find a safe and effective way to extend its existing supply of personal protection equipment (PPE) especially the N95 masks for their medical professionals by Dr. Christopher Roscher, an anesthesiologist at St Luke's University Health Network. Dr. Roscher was interested in exploring the use of UV light for PPE decontamination. Prof. Tansu and his colleagues collaborated with Dr. Roscher via Zoom meetings, phone calls and hundreds of emails and text messages. The collaborative team completed an initial prototype and installed it at St Luke in fewer than 3 weeks. They called their invention "Bug Zapper" [35]. In addition, industry researches are often short-term but during the process of solving short-term problems, industry researchers may identify longer-term problems that they need to solve. Thus, having MoE provide some research grant opportunities where industry and faculty can apply to work together will definitely help to promote innovations in Malaysia.

Besides government partnering with universities, this author hopes that philanthropists in Malaysia can also play important roles in shaping the future of young Malaysian engineers. There are many successful businessmen and business ladies in Malaysia. The hope is that they can collaborate to form a non-profit organization similar to the Gates Foundation that can give young or vulnerable population in Malaysia opportunities to have better lives through deploying affordable technology solutions. For example, the Gates Foundation [36] often work with partners worldwide to tackle critical problems in five program areas, namely (i) Global Health Division aims to reduce health inequities, (ii) Global Development Division focuses on improving delivering health products and services to the world's poorest communities, (iii) Global Growth & Opportunities division focuses on creating and scaling market-based innovations to stimulate inclusive and sustainable economic growth, (iv) the United States Division works to improve US high school and postsecondary education and support vulnerable children and families in Washington State, and (v) the Global Policy & Advocacy Division seeks to build strategic relationships and policy that can help advice their work. Non-profit organizations in Malaysia may not be able to replicate all the activities but having a few activities that incentivize young Malaysia engineers to come up with affordable technology solutions to solve local/regional problems will go a long way in encouraging them to come up with innovative solutions.

5.0 CONCLUDING REMARKS

In this paper, the author first shared her own research journey from industry to academia and from Malaysia to United States. She shared some testimonies about how she overcame some obstacles in life to become an effective researcher. Subsequently, she shared some of the factors that if young researchers can adopt to help them to become more effective researchers. Last but not least, she shared some of her thoughts on what educators, university administrators, Ministry of Education, engineering professional bodies and industry experts can collectively do to promote innovative thinking among young Malaysian engineers. ■

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