

VOLUME II



**GLOBAL WOMEN
ENGINEERING
LEADERS**

SHARE THEIR
JOURNEYS TO
PROFESSIONAL
SUCCESS

**International Federation of
Engineering Education Societies
Global Engineering Deans Council**

RISING TO THE TOP

GLOBAL WOMEN ENGINEERING
LEADERS SHARE THEIR JOURNEYS TO
PROFESSIONAL SUCCESS

VOLUME II

-

INTERNATIONAL FEDERATION OF
ENGINEERING EDUCATION SOCIETIES
&
GLOBAL ENGINEERING DEANS COUNCIL



**International Federation of
Engineering Education Societies**



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INTRODUCTION

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OĞUZHAN ÖZTÜRK

Chief Technology Officer, *Arçelik*



Extraordinary times create extraordinary solutions that disrupt the global norms and mindsets. Going through the COVID-19 pandemic, we have especially witnessed the increased urge and necessity for open innovation, bringing academicians, universities, institutions, start-ups and companies from multiple sectors and disciplines together in a network of unprecedented interaction. Women's abilities in collaborative networking, creating value, welcoming change and coping with crisis have strengthened females' role and leadership in fundamental,

applied and experimental research organizations. The struggle to find a vaccine for the virus has reinforced the importance of fundamental sciences, creating opportunities for fields where women researchers are exceptionally powerful.

Whether remotely working from home or personally working in laboratories and offices, women researchers and engineers have also shown superb social skills in maintaining work-life balance and fulfilling their professional and maternal responsibilities simultaneously. This period has been specifically difficult as the children and all the members of the family are at home. I can wholeheartedly say that women's contribution to the well-being of our planet has been globally recognized and appreciated during the pandemic and hope that the stories of women engineering leaders shared in this book will inspire more women to pursue careers that will create a world of difference.

A special thank you goes out to our sponsors, without whom this great initiative would not be possible.



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INTRODUCTION

COORDINATING COMMITTEE MEMBERS

SOMA CHAKRABARTI
ŞIRIN TEKINAY

The first volume of the book “Rising to the Top” was published in 2019. Since then, we have had numerous occasions when young women engineers came to us and said that how much hope and dreams the book and each one of its chapters brought to them. That was beyond gratifying. It meant a lot to all of us who were involved in the making of Rising to the Top and searching for women engineering leaders’ journeys -- their stories. We realized that our work did not end there. In fact, it just started.

We identified 22 more women engineering leaders from different countries from all different corners of the world– from Hong Kong to Bahrain to Poland to Myanmar to Estonia – and invited them to write their journeys for this new volume. They did. They wrote their life stories, their struggles, their challenges, their aspirations, and triumphs for the world to know. Each one of their journeys is different yet, once again, the common thread of overcoming challenges and realization of dreams is palpable. Each is an inspiration itself. Each will encourage little girls to succeed as an engineering leader.

We present this new volume – with the first forms a compilation of journeys of 54 global women engineering leaders --to you with the hope that

it brings as much joy to you as it has brought to us. We are humbled to have ushered this book through its journey from conception to materialization to share it with you. It has been a true labor of our love.

We will be completely remiss if we forget to thank the man behind this book – our very own Professor Hans J. Hoyer. His untiring effort in giving life to the book was contagious. We also would like to thank Bonnie Munday for her marvelous editing and to Alik Pappas for coordinating the project.

Enjoy!

You are holding in your hands a collection of journeys taken by different women from all the different continents, women from backgrounds and environments that differ in more ways than can be counted, including culturally, educationally, ethnically, and generationally. What weaves the collection together is that the authors are engineering leaders, mostly from academia, and several from industry, who have “made it” or are role models.

At least, that was the initial idea: to have women engineering leaders from around the world contribute to this project by sharing their personal journeys. We ended up with not just that, but much more.

It started with candid conversations initiated by Prof. Hans-Jürgen Hoyer, Secretary General of the International Federation of Engineering Education Societies (IFEES) and Executive Secretary of the Global Engineering Deans Council (GEDC). He had become inspired after reading a piece written by Tagwa Musa, of Sudan, about her journey in academia (a piece he had requested). This led to those candid conversations with women engineering leaders, including ourselves, about the possibility of

doing this project, and it came to fruition when he sent out invitations to contribute to this book. Prof. Hoyer has been the thrust behind this exciting project that depicts colorful life journeys of women engineering leaders spanning the world.

We needed little, if any, motivation to share the stories of paths trodden. Diversity is critical—especially gender diversity in engineering in different cultural contexts—and it is what the world needs now. We need all the innovations, all the solutions, all the designs, all the creativity of all the people of our planet to achieve the vision of ensuring “continuation of life on the planet, making our world more sustainable, secure, healthy, and joyful.” We are thrilled to be a part of and to present this compilation of authentic stories generously shared by exceptional colleagues who are all hoping to inspire others in every corner of the world. The stories open windows into the lives of women in various cultures and backgrounds, providing a wider world view towards understanding what it takes to study and work in engineering in distinct settings. It seems we have all gone against the grain, swam upstream, and jumped over hurdles, at least in parts of our journeys.

However, this isn’t all that binds the book together. It is simply beautiful to find that the contributions end on a positive, encouraging, hopeful—even cheerful—note. Perseverance and grace run as common threads through this book, as part of implicit or explicit advice to be taken away, despite numerous challenges faced. Various cultural contexts depict resilience among all the authors, who smashed the stereotype of the “weaker” gender while contributing to the engineering world in their

own unique ways. Through the different sections, fight after fight, success after success, there is an air of modesty, unpretentious humility. Despite all obstacles, there is no resentment, no animosity; rather, simply gratefulness.

These journeys were not taken alone. Indeed, the leaders had to overcome often imposed and seemingly insurmountable difficulties. However, as Sushma Kulkarni noted, with the right mentoring, self-aspiration, and confidence, women educators can definitely occupy top leadership positions. But the positions often bring challenges; as Tagwa Ahmed Musa writes, a woman in such a position will typically be exposed to many tests. Some will describe her as an iron woman, while others refuse to accept her leadership role and assume that she is too weak and soft to be a leader. Often, family members, parents, and especially fathers played important roles in the authors' early lives. Adriana Cecilia Pérez Pino, Soma Chakrabarti, Tânia Cristina D'Agostini Bueno, Dawn Bonfield, Jenna Carpenter, Archana Mantri, Theresa Mkandawire, Khairiyah Mohd Yusof, and Naadiya Moosajee write how a little encouragement from their fathers in their childhoods made all the difference, helping them grow and flourish in engineering.

Often these leaders appreciated the roles of inspiring mentors throughout their journeys toward the top. Thus, many have taken on the role of mentor to young girls and women who want to be, or are, engineers. Renata Tull, Jesennia del Pilar Cárdenas Cobo, Şirin Tekinay, Brenda Discher, Lueny Morell, and Marlene Kanga vividly describe how their mentors contributed to their journeys and why they mentor others to help them continue their own.

None of the authors see themselves as being at the end of their journeys, or at the top of the mountain. There is still endless work ahead. In fact, it turns out, we view our journeys as a continuum: even though most of us were the originators—the first, the pioneer, or the outlier—we prefer to think of our life’s labor as a flag to put into the hands of upcoming generations of women and men who will enjoy a more inclusive, diverse world in peace.

As leaders of three engineering associations, we have been privileged to see the changes over the years in the lives of women engineers, especially in developing nations. Over these years, we have tried our best to mentor, encourage, and help young women to become top engineers. Hopefully, these narratives will touch and open the hearts of young women towards engineering as a calling, a way they can contribute to making the world a better place. We have enjoyed reading the journeys of our fellow authors, each one being unique yet somehow connected in intangible ways. We hope you will find this book as enjoyable as we do, and that you will share these valuable stories with your friends, colleagues, and especially the younger women following in your footsteps.

JOURNEY 1

TOGETHER, WE ARE STRONGER

VALERIE AGBERAGBA

*Head, Renewable Energy
Niger Delta Power Holding Company*

NIGERIA

Becoming an engineer and getting involved in the activities of my professional organization have guided me in achieving much, both personally and professionally. Reading engineering was not in my plans when I was growing up but, looking back now, I would not have done better in any other profession. My story, therefore, is one of two paths: my experience with respect to my career, and my involvement in engineering professional activities.

I was born in Edo State in southern Nigeria to educated parents who wanted the best for their children. I had my early education up to the

advanced level in the state system, and I was well guided in subject-interest in my secondary school; I loved science subjects but was not a fan of further mathematics—which ruled out engineering from my list of course options.

Growing up, I thought that medicine was the only field that saved lives, the only one that made life better for people. So I had a strong desire to read medicine and become a doctor who would save lives. As my second option, I chose pharmacy. How fate played with me! I ended up in engineering, and am still thankful to God for that. You see, I tried to

ABOUT THE AUTHOR



Valerie Ifueko Agberagba is a graduate of Metallurgical & Materials Engineering. She worked as a Quality Control Engineer for almost 20 years in the Federal Capital City of Abuja, Nigeria and was part of the project team for many monumental building in the Capital City. She was appointed in 2010 to work in the Presidential TaskForce on Power. The TaskForce was to drive the Power Reform programme of the Power Sector and the Privatisation of the government owned Power Utilities. Valerie, presently is the Head of the Renewable Energy Department at the Niger Delta Power Holding

Company, Nigeria. Valerie Agberagba is a Past President of the Association of Professional Women Engineers of Nigeria. She served as Vice President of the Nigerian Society of Engineers and just completed her four year term as Vice President, World Federation of Engineering Organizations(WFEO) and Chair of the Committee for Women in Engineering of the Organization. She also served in the same capacity for the Federation of African Engineering Organizations. She is a recipient of the Royal Academy of Engineering, UK Grant through the African Catalyst Project, Phase I in 2018 to lead a research on the Statistical data for women in Science & Engineering in three African Countries. This has since been completed. She is the Founder and Executive Director of a mentoring organization Science Engineering and Technology Network (SciEtech). Valerie, in addition to her work continuously advocates gender balance and mentoring in the workplace and is passionate about building the next generation of Engineers & Scientist.

get into medical school twice and was unsuccessful. On my third attempt, I tried getting into biochemistry, with the intention of changing after admission into the university. But this was not to be, as I was admitted to mining and metallurgical engineering.

I accepted reluctantly, with the hope of changing my course the following year, as I had waited three years to get into medical school. However, discussions with my course adviser and the head of the department helped me to understand the relevance that engineering had to what I truly desired in life: to save lives and ensure a safe and conducive living environment. I then got so excited about engineering, and thereafter made up my mind to continue with it, thus gradually falling in love with further mathematics. Engineering was not considered a “girls” course, so being in the class for mining and metallurgical engineering was worse—it was even more male-oriented. There were only two females in the class, so after my first year, when the department was split into two, I chose the metallurgical and material engineering option: to many, this was considered a “more feminine” engineering discipline.

Studying engineering over five years of university was interesting. Being the only girl in my class, I had to learn to get comfortable in the midst of my male course mates, and they were always ready to help—especially with my engineering drawing, on which I spent long hours and still wasn’t able to finish my assignments, especially in fluid mechanics. I became a

bit more outspoken in school and found myself nominated in year three to contest for the position of vice-president of the students' union. This was my first taste of leadership and I learned that not all issues needed to be resolved with confrontation; some can easily be resolved by simple appeals and diplomacy. Through this position I was able to make a difference in the attitude of the school towards students' welfare. Our tenure was, however, shortened as student unions were abolished in universities across Nigeria: the students' continuous confrontation of government and school authorities was causing so much unrest in schools. In a way I was relieved; student unions were indeed becoming too confrontational.

The issue of sexual harassment in universities was a very minor one at the time—plus, I was ignorant and naïve. As such I was not prepared for the experience I had in my fourth year of university. One of my lecturers called me to his office to check my results, and showed me a score of 17 percent. He then said, “You must use what you have to get what you want. Think about it and let me know.” I was shocked. He knew that failing this course meant I would need to take an extra semester in the university, and I guess he thought I would be desperate, and succumb to his request. But I confided in some course mates who were very protective, and I avoided going anywhere near the faculty until the results were out and we could challenge it. When the results were released, I saw I had received a D. I was able to leave for my internship immediately; I never saw the lecturer

again, until I graduated.

While I was in school, some companies came to try to recruit young graduates as interns. We took their tests and I was successful, and therefore was invited for a second interview with one of them. The company was in another state, and we had to travel about four hours to take the test.

During the company tour they took us on, I realized there was discrimination in terms of the job assignment to female engineers. The tour guide said to us, “We do not assign women to the production plant.” In fact, the only female engineer in the organization was in the administrative office. The tour guide insinuated that if I was taken, I would be posted to the laboratory because of my discipline. This made me lose interest in the organization; there was no way for me to determine the extent of discrimination in this workplace.

I therefore focused on working in the steel industry, and was confident that those currently under construction would all have been in full operation before my graduation. Unfortunately, that was not the case, and hence my dream of a job in the steel industry was dashed. I carried out my compulsory one-year national service in a bank and was not employed after it was over. I later got a job as a quality control engineer and gradually fell into the routine of a regular job in the civil engineering environment. Though I enjoyed my job, my life trajectory changed—I had to learn more about what was expected and build a career as a quality control engineer.

New environment, new life, new plans!

It was a good start. I was part of the project staff in the engineering department of a government organization, the federal capital development authority in Abuja. It was not a permanent job with the organization but a role working on a designated project as a quality control engineer. I was nervous as the environment was entirely not where I had planned to be. Working in a civil engineering environment as a quality control engineer? What will be expected of me? I had to read a lot to get prepared. I was the only female and the youngest on both the supervisory technical and the contractor team, and I had to learn to be comfortable in their midst while also proving myself to be strong.

To work in a quality control unit meant having a very high level of discipline and honesty. Thank God for my upbringing and cultivation of good character. I had to learn to be very thorough in checking materials, paying attention to details and developing a high level of honesty and integrity. I also learned very good work ethics from the beginning of my career. My boss was emphatic about proper documentation of all site activities, and I developed this using a daily site report book, which I submitted for review at the end of every week. These traits have helped me through my career and life experience.

As the only female technical personnel—and very young—there were times I felt intimidated by very senior engineers from among the

contractors and consultants, but I learned to be strong and to stand on my convictions.

I did, however, experience bullying from the site workers. I presume they felt I was too young to give them instructions on how to do things right, and one day, I was splashed all over with concrete after giving an order to stop casting due to a failed slump test (concrete workability). It was awful, and I had to be driven home by their site engineer to change my clothes. But this did not deter me from carrying out my job with utmost seriousness. I got my letter of permanent employment before the project was completed and moved to the head office to work.

There were very few female engineers among my colleagues in the engineering department, and we soon became friends and helped each other at work. They were all civil engineers and I got to learn a lot from them to the extent that I was assumed by many male engineers to be a civil engineer, since I could comfortably hold conversations and carry out civil jobs. Sometimes I stood in for my colleagues at site inspections when they were unavailable.

I soon began attending meetings of the engineering professional association, the Nigerian Society of Engineers (NSE). Within a year of attendance, at the election, I was called to assist the secretary, and this developed into me contesting for elective posts through the years, serving in the state branch in different capacities. My service to the society earned

me a Presidential Merit Award in 2001. (I had to travel to receive the award personally, and I remember that at the time, I was eight months pregnant with my second child.) I was happy that my services were acknowledged even at the national level of the society. I later served as vice president at the national level of the NSE and was the first female to serve for three years consecutively as thus. I was to later vie for the apex position of president of the society twice, but I didn't get it.

I would say it was a great experience, and the support from men was overwhelming. I learned some lessons: that engineering is still perceived in strong terms as a man's world, even among the male engineers, and that women should control their actions and not allow men to use them against one another. One other area that we as women need to work on is encouraging those who were unable to make it to the top to support others in their aspiration to get there. If the glass ceiling is going to be shattered, women must support women.

I took my professional examination for membership and registration after four years of post- graduate experience. In 1997, I got married and started my family.

While we were members of the NSE, five female engineers including myself formed the Abuja Chapter of the Association of Professional Women Engineers of Nigeria (APWEN Abuja). The chair was a senior female engineer who was very accommodating and helped us all in building self-confidence,

boldness, and tolerance to marginalization in the work environment. She is an example of a female engineer greatly discriminated against but who continued to be excellent at her work. I later became the second chair of the association. By that time, the marginalization of women in assignment and promotions had become very obvious in a growing number of engineering workplaces.

One issue that was of concern to APWEN Abuja was the fact that in the NSE, female engineers were always called upon to handle social activities like birthdays, serving refreshments, and playing the hostesses. This had to be addressed as we saw it as very derogatory. The men do the engineering (technical) and the women did the entertainment; it was a terrible perspective. Funnily enough, I saw this happening in some other African countries I visited years later and I always had to share our experience and encourage the women engineers to stand up against it. I also had discussions with the presidents of the local professional institutions.

This trend, we are glad to note, is now almost non-existent except for where the women themselves have opted to remain in such circumstances for reasons of their own. With our activities and good media coverage, the number of women in the chapter has increased as membership drives were a key point in our program. And getting the women to be part of APWEN was not an easy task. Different reasons were given for not wanting to be part of women's group. However, with our professional development

training sessions and the fact that we were getting support from prominent organizations meant that more women began to join the network.

Programs attracting more girls to engineering were planned as the level of awareness of engineering as a course for girls was very low. We concentrated on secondary schools at that time because we thought that was the point in which to get girls to study science with the view of opting for a career in engineering. However, research and findings show that reaching out to girls earlier in life helps them to appreciate the effect of science and engineering all around them. Hence, some years later we started focusing on children of primary school age.

In 2006, I became president of the Association of Professional Women Engineers in Nigeria. This was a big task and as I had decided that getting involved in these professional institutions would not be disruptive to my job, I had to develop more skills, work harder, and learn to balance my time without neglecting my family responsibilities. I knew I had to excel in my job if I was to follow up with my team on the issues of barriers for women engineers, and I prepared myself for this.

The APWEN website was launched during my investiture as president and this helped in growing our global and national visibility within the engineering family with good media awareness on the need to have more female engineers in the engineering workforce. A vision acronym was developed for APWEN and this helped in redefining our course of focus

and growth. In our drive to get more females into engineering, APWEN established a relationship with the departments of engineering in some universities and began to launch the student chapters, categorized now as collegiate members.

I undertook a documentary film on the state of engineering workshops and laboratories and presented it to industries in order to bring industry intervention and collaboration to academia. The documentary portrayed the reality of the situation in these workshops and laboratories, where most of the equipment was obsolete and the student-to-equipment ratio was very high.

This meant some students never had a chance to be part of workshop practices or the practical work done in the laboratory. Though not much was achieved, efforts are still being made to close the industry-academia gap. Professional development was enhanced and women engineers were encouraged through professional development courses and workshops to present papers at engineering conferences. This was one way of emphasizing we are all engineers. I believe if we are to stop being used for social activities, then we must be active participants in technical matters. I am glad that in the past few years the number of women participating as speakers in conferences have increased.

As president of APWEN, there were two important international workshops I participated in that brought out the best in me and set a path

for my later activities. I was invited to participate in the workshops by UNESCO at the national stakeholders' forum for the Reform of the Nigerian Science, Technology and Innovation System both in Paris and Nigeria. I was also afforded the opportunity to lead a number of female engineers to attend a Colloquium for Women in STEM in Tunis. The outcome of this meeting helped in the creation of the Women in Engineering (WIE) Committee of the World Federation of Engineering Organizations (WFEO). Countries had to nominate members to the newly created WIE committee and I was nominated as one of the three representatives from Nigeria.

Through my years in the WFEO/WIE Committee, I gained and developed a lot of skills and experiences on leadership and advocacy. Having been president of APWEN in Nigeria and relating with women across the globe, I've observed that our problems are the same, in different degrees, and so workable solutions from different countries could be adopted and modified to suit the culture and environment. It was easy to work with other women to determine our focus and activities continentally. The spirit of teamwork was encouraging. I was honored when there was an opportunity to have another chair of the committee and that most of the women from different countries and continents deemed me fit to lead them. I also automatically assumed the position of chair of women in engineering in the Federation of African Engineering Organizations (FAEO) and was able to have two successful continental conferences for women engineers.

It was an interesting four years of learning, educating, creating, and renewing strategies that will advance the course of women who enter the engineering profession. It is with a sense of humility and pride that I can affirm that the last four years of the committee were very productive. These years featured workshops, regional conferences, and meetings declaring to change the narrative and work with men and other disciplines to achieve our goals and vision. They featured more participation in committees and presentation of technical papers in our conferences, and greatly improved our visibility within WFEO. I was also, through a Royal Academy grant, able to carry out research on statistical data for women in science and engineering with the pilot in three African countries: Nigeria, Rwanda, and Malawi. Thanks to this research, we have realized that the absence of role models is the main cause of low entry of girls into engineering in Africa. Therefore, this should be given the attention and support it really needs. I have also taken this up personally as an agenda item in my work through my mentoring organization, Science, Engineering and Technology Network, or “SciEtech.”

However, I have come to realize that we need to work on some areas of our relationship with each other: Women need to learn to support other women and encourage each other to actualize their goals.

While my activity in continental and global engineering forums was ongoing, I made sure that though I was diligent in my workplace, I

used my personal leave, and I delegated assignments as and when necessary. I was glad to have been nominated to be part of the presidential Task Force on Power to drive reform of the Nigerian power sector; it gave me the opportunity to work with a team of policy experts, professionals, and technocrats determined to make a success of reform. At this point, I moved away from working as a quality control engineer and moved fully to the power sector.

It is sad that there is still some discrimination in the workplace despite all the activities around diversity and inclusion. Having completed my four years as chair of WIE/WFEO, I have taken a break from active professional association participation to focus on my new assignment heading the renewable energy department in my organization. We are determined to assist the government in actualizing its plans to increase the percent of renewables in the Nigerian energy mix.

I do, however, still play my advisory role in APWEN and other continental organizations and am glad to see great strides being made daily by women engineers. My campaign for this period is #womensupportwomen#. Please, join in the campaign, wherever you are! All for one, and one for all!

JOURNEY 2

SECRETS OF SUCCESS: BALANCE AND SELF DISCIPLINE

RAIDA AL-ALAWI

Director of Technology Development, BFG International

BAHRAIN

My life started almost 55 years ago when my parents took a three-month trip from their home in Bahrain for their summer vacation in Al-Najaf, Iraq: I was born there, the third youngest of 13 kids in my family. Even though my father did not finish high school and my mother did not attend school at all, education was highly regarded in our household, and my parents encouraged my siblings and me to achieve success through contests and competitions. We were constantly striving to advance ourselves and be exceptional.

My father has always supported equality and never differentiated between girls and boys in our family. He consistently highlighted the importance of education and its impact, how it makes us better citizens, enriches our lives, and improves our community. My father, as well as my

siblings, are some of the greatest influences in my life and have instilled in me a lifelong love for learning that started when I was a girl.

My favorite subject has always been mathematics, as it is based on logic. My enjoyment for it only increased and during my final year of high school, I received the highest score in the subject nationwide. This passion led me to select engineering for my undergraduate studies. My eldest brother, Jameel, who was Bahrain's undersecretary for the Ministry of Electricity and Water at that time, inspired me to be an electrical engineer; he himself

ABOUT THE AUTHOR



Raida Al-Alawi received her PhD in Computational Intelligence from Brunel University in London, her MSc in Computer Engineering from the University of London, and her BSc in Electrical Engineering from Kuwait University. Before joining BFG International in 2019 as a Director of Technology Development, she was Dean of Student Affairs at Ahlia University in Bahrain; previous to Ahlia, she was an Associate Professor in the Department of Electrical and Electronics Engineering at the University of Bahrain (UOB), and Chairperson

of its Department of Computer Engineering. Dr. Al-Alawi's honors and awards include the UOB Certificate of Excellence in Teaching, HRH Princess Sabeeka bint Ibrahim Al Khalifa Outstanding Academic Women Pioneers Award, and the GCC Engineering Union Award for Pioneers in Engineering. She is active in international societies, such as IEEE, ENNS, ACM, FAE, AETDEW and chairs the ICT committee of the Federation of Arab Engineers. She's on the board of the Bahrain Society of Engineers. Having conducted information technology consultancy projects, Dr. Al-Alawi is a referee for international electronics and computer-engineering journals. She has been on the organizing and technical committees of many conferences and workshops. Her research and teaching interests lie in machine learning, computer vision, embedded systems, reconfigurable logic, wireless sensor networks, and computational intelligence.

had studied mechanical engineering. Back then, in the 1980s, engineering was male dominated, with very few females entering the field. Bahrain's society during those times was much more conservative, and women who did pursue higher education studied medicine, science, nursing, arts, or business to enter a career in stereotypically female fields such as teaching, nursing, or secretarial work. Despite engineering being an atypical choice of career for a woman to pursue, I did not face any objections or barriers to entering the field.

The next chapter of my life began when I travelled to Kuwait to pursue my Bachelor of Science in Electrical Engineering, offered by the College of Engineering at Kuwait University. During my four and a half years of study there, female engineering students were far outnumbered by their male counterparts; I was one of four female engineers out of around 50 students studying electrical engineering. None of the courses I enrolled in were taught by a female professor. Nevertheless, I stayed motivated, strived for success, and excelled in the program. As the courses became more advanced, I started to acquire the logical and critical analysis skills needed to be successful in electrical engineering. By my final year, I decided to pursue further studies in computer engineering, as I felt it satisfied my intellectual curiosity and ambitions to engage myself in research about the latest trends and emerging technologies. So when I was offered a job as a system programmer by Batelco (Bahrain Telecommunication Company)

upon graduating, I accepted. I was one of two Bahraini engineers working at Batelco, and the other was my direct senior manager. Even though the job was interesting and offered a great opportunity to move up the job ladder, my true ambition was to earn a PhD and become a professor.

To further my aspirations, I sought employment at the University of Bahrain (UOB), and worked as a graduate assistant in the physics department teaching laboratory sessions; this work would entitle me to a scholarship to continue my postgraduate studies (I was only 20 then, and many of the students I was teaching were my age). Shortly after joining UOB, I got engaged to my colleague, Shawqi Al-Dallal. He had joined the physics department as an assistant professor a year prior, and was an inspiration to me; plus, he was encouraging, understanding, and fully supportive of my career ambitions. That has always been a key factor in my career progression.

After that, my life became driven not only by my career, but also by my family. My husband and I started to plan our lives together and agreed that I would pursue my Master's degree and PhD, have three or four children, and eventually move to our own house. One of my goals was to have children early in life while pursuing my career; I felt that not having a big age gap between me and my children would allow me to connect better with them and strengthen our relationship.

Nine months after joining UOB, I received a scholarship to attain

my Master's in digital systems at King's College, London. I completed my degree in one year, attaining the highest overall grades among the 28 students in the program, and then returned to teaching at UOB. I also got married, and another new chapter began when I had my first child, Aseel. Having a baby while working at the university didn't deter my enthusiasm to pursue a PhD, and while looking after her, I started applying to universities in the UK, hoping to join a research group aligned with my interests. I got accepted into four programs, and chose Brunel University west of London. I would be studying the functionality, training and topological constraints of weightless neural networks (WNN).

Many factors went into the decision to attend Brunel, besides the field of studies available and the prestige of the university. That's because my husband and I decided that I'd go live abroad with my daughter, who was eight months old at the time, but my husband would stay in Bahrain; we did not want to put his career on hold while I pursued my PhD. So in making my choice of which UK school to attend, I had to consider factors such as the availability of daycare close to the university, ease of transportation, and the availability of reasonably sized (and priced) accommodations. I received a scholarship from the British Council and found a family-friendly apartment not far from the university.

Living in London for three years while I did my PhD at Brunel was financially challenging, as the scholarship barely covered my daughter's

daycare fees and the utility bills. The rest of our living expenses—the apartment, car, and daily expenses—were covered by me and my husband. Balancing being a first-time mother and living abroad while conducting PhD research proved to be the most challenging task I have ever undertaken. Time management was crucial: I had to be efficient and prioritize my tasks. On one hand, I had to find time for all the activities associated with my research: spending hours researching in the library, developing neural network simulator software, training and testing the software, and collaborating with my research group. On the other hand, I had to dedicate time to my daughter's daily schedule and her needs: dropping her off and picking her up from daycare on time, feeding her, playing and reading with her, and putting her to bed.

To balance these responsibilities, I set a strict deadline for every task within my research and worked late hours to ensure that all my duties were done. In this way, I was able to make my daily schedule predictable and manageable. These habitual behaviors paid off. Parenting alone while working on my PhD was a big challenge, but it was never a hindrance to achieving my goals. In fact, due to this balance and self-regulation, I was able to spend quality time with my daughter in the midst of completing my PhD, and I always viewed this experience positively and looked at the bright side of things. In fact, it was a joyful time, as I got to spend quality time with my daughter and we did many activities together, especially during weekends,

which tightened the bond between us. The situation actually motivated me to work harder to complete my PhD on time. But it was wonderful when my husband eventually came to join us in London to spend a sabbatical year at Imperial College, London. Having him around was a huge relief, as we could divide our parental responsibilities. My experience of living abroad with my husband and daughter was transformative and enjoyable; his support and encouragement kept me motivated and enabled me to complete my thesis on time. By then, I was pregnant with my second child.

We returned to Bahrain and I requested a transfer to the department of electrical engineering, since it was more closely related to my field of study and my research interests. At that time, I was the only female Bahraini professor in the college of engineering. Shortly after my return to work, I gave birth to my second daughter, Hadeel, and took two months maternity leave. In the beginning, managing my time between my newborn, my toddler, and my work was overwhelming. But my husband and I balanced our tasks, and our baby stayed with my mother-in-law, who babysat her, while Aseel attended school. When Hadeel turned nine months old, we enrolled her in a daycare centre near our home.

The first years in academia are usually the hardest and most challenging. At this stage, teaching is the most demanding task compared to other academic responsibilities such as research and administrative work. I had new courses every semester, which required me to put in

extra hours in order to plan and develop the course material. Effective time management is a key factor for success during this stage, as I had to balance work and family responsibilities. Once again, I prioritized my daily tasks and set boundaries between work and family time. And by the time I finally learned how to have an acceptable work-life balance, I had my third daughter, Mayse! And a few years later, my fourth child, a son we named Wessam, came along.

I was once more faced with the increasing challenges of work-life balance. My job's duties increased, and I started to hold major roles and responsibilities at the department, college, and university levels. Nevertheless, my main efforts were directed toward teaching and supervising students' projects. In my department, I was responsible for teaching computer engineering courses. This field has always been rapidly evolving, so I had to continuously keep myself up to date in the field, and I'd frequently update course curriculums to keep them current. My commitment to the profession and to teaching was highly praised by my students and my colleagues, and I was bestowed the Presidential Award and the Deanship of Engineering Award for Excellence in Teaching.

As an academic, I always wanted to be an excellent lecturer and an exceptional researcher. By then, I had published a few papers, but was not heavily engaged in research. To be the researcher I envisioned becoming, I would need continued momentum and would have to devote quality time to

carrying out research and publishing research works in reputable journals. But this just wasn't going to be possible. So I decided to make research a lower priority in order to fulfill my teaching, administrative, and family duties. This had a direct impact on my career, delaying my progression.

But when my son reached school age, I once again had more time for my profession, and I created a plan to get promoted to associate professor. I was determined to achieve my goal, so I started prioritizing research and setting aside a daily "undistracted time" for research; I worked on this both while I was at the university and late at night, after my children went to sleep. Besides research, I also attended conferences and published articles in international journals. Then I was appointed chairperson of the department of computer engineering. And so, thanks to hard work and extra effort, I was able to fulfill the requirements for promotion to associate professor.

Despite the male-dominated environment of the department of electrical engineering, I felt comfortable, accepted, respected, and appreciated by my colleagues, and I did not experience inequality or gender issues; after all, I'd been recognized and rewarded for my work. Having said that, I did notice some inequality when it came to leadership positions, as men were instinctively selected with the belief they could better handle it; their female counterparts have to work much harder to earn these positions. Another form of inequality comes up, too, in terms of academic promotion, which is of course based on the candidate's contribution to four important streams:

teaching, research, university service, and community service. The problem is with community service, because that can be very difficult for women to achieve since they are usually the primary caregivers of their children. Personally, this is the stream that I struggled to meet when I decided to apply for a promotion.

Working at a university is dynamic; you meet new students every year, teach a different course every semester, conduct research in a new field, and do administrative work with different teams. I am always fascinated by technology and innovations and this is reflected in the different projects that I supervise and implement with my students. For me, the most satisfying and enjoyable part of teaching was seeing the accomplishments of graduated former students.

As a student, and then as an educator, I have been fortunate to witness the transformation of education and the way each generation perceives it over those decades. The major changes I've witnessed are mostly related to students—for example, the increase in the number of female students entering engineering during my academic life is staggering, having risen from five percent to almost 50 percent. Also, when I joined the university, the teaching model was based on a one-size-fits-all model, rather than adapted to students' individual learning needs. The levels of examinations were much higher, and it was mostly the students' responsibility to attain the course's required level. However, increasing tuition fees and living

expenses worldwide now force many students to have part-time jobs, which inevitably conflicts with classroom schedules. This situation presents a major obstacle in higher education institutions (HEIs) and their instructors. It greatly influences our teaching methodologies, which increasingly rely on customized learning and flexible delivery to meet the challenge of having a diverse student body.

The role of technology and the internet has also been a big development; this has played a major part in changing students' learning behaviors and the delivery of teaching material. Students are less reliant on their instructor, course textbooks, and physical library resources. Access to the internet has introduced a wealth of information and study materials online, which has affected the methods and resources used for teaching.

Over the past two decades, there has been increased awareness of the importance of quality in teaching. Accreditation bodies, quality assurance agencies, ranking agencies, and higher education regulatory bodies are more commonly using graduation rates as key performance indicators that influence a HEI's sustainability. This has very much influenced the way we deliver our courses and has imposed an extra administrative load on the teaching and learning process. Being a program evaluator for the Accreditation Board for Engineering and Technology (ABET), as well as a reviewer with the Oman Academic Accreditation Authority (OAAA) and Bahrain's Education and Training Quality Authority (BQA), affected the

way I delivered courses; they became more student-centered, and focused on them attaining the program's educational objectives.

After three decades of serving at the University of Bahrain, I got an offer from Ahlia University, a leading and pioneering private university in Bahrain, to serve as dean of student affairs, which I accepted. For me, it was a role that represented a gateway to new horizons in the academic experience: a sensitive, complex, and crucial role requiring me to be immersed in routine administrative activities as well as key strategic and planning committees across the campus. My experience in ABET accreditation and regional program reviews was fully utilized in assisting different departments with their program reviews and accreditation. I acted as the connecting link between students, faculty, and university leadership. Despite the broad experience I gained and the friendly environment I enjoyed at Ahlia University, the role shifted me away from my personal academic goals, something I hadn't planned or envisioned. After three years of work there, I sensed that my administrative involvement was not likely to decrease.

I have always enjoyed collaborating with the industry and this was reflected in many of the projects I conducted and supervised; I was always looking for an opportunity to capitalize on my years of experience in academia to have practical experience. As a member of the organizing committee of the First International Conference on the Fourth Industrial Revolution, I came to know about BFG International's Industry 4.0 project. Its aim is

to harness cutting-edge technologies to bring BFG International into the fourth industrial revolution. I was always fascinated by the uniqueness of this Bahrain-based manufacturer as a leading multinational engineering and manufacturing organization. It has encountered tremendous growth in its innovative line of products during the past three decades—mainly due to the deep insight and the futuristic vision of its group chairman, Dr. Samer Aljishi, who put great emphasis on acquiring in-house R&D capabilities to deliver breakthrough levels of performance and durability in its manufacturing process. I felt that an opportunity to work at BFG would be excellent, and appropriately suited to my academic skills and curiosity.

So, like most things in my life, I sought to challenge myself to reach this goal, and was successful. In 2019, I joined the BFG Industry 4.0 team as the director of technology development, where my computer-engineering teaching experience and my research skills could have practical outcomes. At BFG, I became engaged in many projects that involve manufacturing innovative solutions and products. One of my assigned duties is to develop and build strategic partnerships with research labs and HEIs. Additionally, I am in charge of attracting young engineers and scientists to BFG and upgrading their skills through the deployment of Industry 4.0 technologies onto the manufacturing floor.

A major difference I have experienced between industry and academia is the ease of getting resources once a project has been approved.

The scope of the projects that I am involved in at BFG is wider and more open compared to the projects we conducted in academia. However, working in industry has its downside. Unlike in academia, where research is driven by the faculty's own interests, projects in the corporate world are tightly linked to market needs, and are therefore driven and imposed by the firm's policies. This can create an impediment to intellectual freedom and limits to personal initiatives.

Joining professional organizations and helping organize professional activities have proved to be valuable in building my career. It all started when I joined the Institute of Electrical and Electronics Engineers (IEEE) and the Bahrain Society of Engineers (BSE) as a student member while studying for my BSc. During postgraduate studies, I joined the International Neural Network Society (INNS) and became involved in the technical committees of the conferences it organized. When I joined the electrical engineering department, I established the first IEEE student branch at the University of Bahrain.

My major contributions to professional societies flourished when my children grew up and I had more time to serve the engineering community. I became a board member of the Bahrain Society of Engineers (BSE) and, regionally, I chaired the ICT committee of the Federation of Arab Engineers (FAE). I have been involved in several regional and international conferences and workshops, and was nominated by IEEE to serve as a program evaluator

for the Accreditation Board for Engineering and Technology (ABET), USA. Furthermore, I have been engaged as a program reviewer for the Bahrain Education and Training Quality Authority (BQA) and the Oman Academic Accreditation Authority (OAAA). These activities enabled me to develop a strong professional network and be exposed to various academic environments that allow me to gain different perspectives for my professional career. Out of all these activities, the one I enjoy most is the review and the evaluation of international engineering programs. This gives me the chance to visit different universities internationally and gain exposure to different academic systems, cultures, and practices that reinforce my experience.

Despite my heavy involvement in my career, I have a vibrant and happy personal and family life. My career success was never a detriment to my health or my family responsibilities. My husband and I always believed that the best investment in our lives is to be devoted to our children's education; hence, a major part of our income was allocated to their education. They all joined one of the best private schools in Bahrain, then attended top international universities: my eldest daughter, Aseel, joined the University of Waterloo in Canada; Hadeel attended the University of Delaware in the United States; Mayse went to the University of Kent in the United Kingdom; and Wessam attended the Royal College of Surgeons in Ireland (RCSI), Bahrain branch. As a mother, I always felt that I am my

children's most important teacher, and was dedicated to supporting them in their learning endeavors.

Our children have always said that they were fortunate to have parents who were both very involved in their academic lives. We spent a lot of time together as a family every day, whether it was through having meals together, sitting together in the living room and conversing, or helping them with their academic commitments. We were able to follow up and assist them in most of their school subjects, especially math, science, and Arabic. Neither my husband nor I ever missed a parent-teacher conference for our four children. We are lucky that our home was in close proximity to the children's school and our workplace, so we were very keen on personally dropping off and picking up our kids to and from school. This daily trip was an enjoyable bonding activity that built a stronger connection between us, our children, and their school.

A major advantage for a family with both parents working in academia is the fact that our vacation is synchronized with school vacations. Thanks to that, we were able to have family vacations, travelling abroad for at least six weeks annually. Those trips allowed us to spend quality time with our children and left us with wonderfully memorable experiences. This enriched their lives as they learned about different cultures and ways of life.

We believe that being close to family and friends is one of the most important elements in our lives. Being part of a close community brings

us happiness and fulfillment. Our extended family is rather large and we have always made sure to stay connected through weekly gatherings and chat groups. We get together every Friday with my side of the family, which has made us very tight knit. It brings us such joy that we have brought together and keep in touch with multiple generations that number more than a hundred people.

To conclude, I would describe myself as a career-driven woman who was able to balance family life with her career, giving the priority to her family whenever needed. I am proud to have made a significant contribution to engineering education and the engineering community both locally and internationally. I have had the privilege of instructing generations of successful engineers who have and will become prominent members in our society. I can only wish such a fulfilling career on anyone entering this profession.

JOURNEY 3

WHERE THEY STAND, WE STAND
OUT

CARLIEN DORCAS BOU-CHEDID

President-Elect

Federation of African Engineering Organisations

GHANA

A variety of factors influenced my decision to become an engineer. For one thing, my father was a civil engineer. At the time that I was born, soon after Ghana's independence from British rule in 1957, the country was going through rapid development, and my father was the chief engineer in the Public Works Department (PWD—the body responsible for overseeing virtually all government projects in the country). So I grew up hearing about many engineering projects, and even had the privilege of visiting some sites with my father. In addition, I was able to witness first-hand my father using his engineering knowledge to solve many real-life problems: for example, building a dam and sprinkler system to irrigate his rice farm, and designing and fabricating toys and

games for my mother's nursery school.

Another reason for my interest in engineering was that I was fascinated by gadgets at home that made life easier, like washing machines, the floor polisher, food blenders, and the like. I was really keen on learning how to actually make such items. Indeed, my chosen profession when I was just four years old was “inventor.” I recall “inventing” a broomstick needle and spending quite some time trying to come up with an invention for plaiting hair. I also recall that when I saw toys that I liked in shops,

ABOUT THE AUTHOR



(Mrs) Carlien Bou-Chedid is an Independent Consulting Structural/Earthquake Engineer and President Elect (2019-2020) of the Federation of African Engineering Organisations (FAEO). She applies engineering to improve lives, especially for the less privileged, and believes that acting with integrity is necessary for leading change. Carlien is founder of Zeno Enterprise, a food manufacturing firm that has operated since 1993. Carlien's 35-year career covers a breadth of activities, including the design, supervision

of construction, and rehabilitation of several structures. She has used her earthquake engineering knowledge to advise on issues related to vulnerability of buildings, and chairs an expert committee advising Ghana's government on earthquake preparedness and response.

She has been involved for several years with the Ghana Institution of Engineers (GhIE), and served as its President in 2017 and 2018. During this period, the GhIE changed its constitution to become more inclusive and admit all classes of engineering practitioners, including craftsmen.

Carlien has been involved in corporate governance, often when the organizations were going through transformations. One example is the Volta River Authority, which was unbundled to allow private-sector participation. Carlien serves on several boards, including the Electricity Company of Ghana and the Council for Scientific and Industrial Research.

my thoughts were not on how to acquire these toys, but rather on how to make similar ones. It was only when I grew older that I realized there was no such profession as “inventor.” So I settled on becoming what I thought was the next best thing: a mechanical engineer.

Another source of inspiration for me in my early years was television. I still recall when TV was introduced in Ghana and we transitioned from watching cartoons in the cinema houses at weekends to an hour or so of children’s television programs each night at home. The ones that impacted me the most were science-fiction based, like Thunderbirds and Flash Gordon. There was also a local production, Young Scientists, which sought to explain scientific concepts to children.

I began my primary education at the Ridge Church school in Accra, the capital of Ghana, and my hometown. It was a Christian school that placed importance on moral uprightness. I had no difficulty with any subjects, perhaps because both my parents were well educated and my mother, who was trained as a teacher, made sure my siblings and I had the kind of educational resources that made things easier for us. I loved to read, and we had a well-stocked library at home; I also visited the children’s library. When it came to mathematics, I had tools like Cuisenaire Rods so that concepts that may otherwise have seemed abstract and difficult to grasp had physical meaning for me.

I believe that it was at Ridge Church school that I began to develop a global outlook on life. Although most students in school were from Ghana,

I also had classmates from the Netherlands, Yugoslavia, England, and India, so I learned to be comfortable with other cultures. I also had my first taste of leadership when I was made assistant head girl in my final year.

I then attended Wesley Girls' High School for my O-levels. It was a boarding school started by the Methodist Church, and was also my mother's alma mater. It was, and still is, considered one of the best schools in the country, and currently accounts for many female firsts, perhaps more so than any other institution in Ghana.

The atmosphere at the time I attended was very competitive, and everyone was expected to achieve. There were many ways in which we were encouraged to excel. Books that were required reading included those about great female role models like Marie Curie, the only person to win Nobel Prizes in two different sciences (namely, physics and chemistry), and Helen Keller, the first deaf and blind person to earn a Bachelor of Arts degree. I recall that what struck me most about these stories was these women's perseverance. Among ourselves as students, we had mantras like, "When they sit, we stand, when they stand, we stand out, and when they stand out, we become the standard." Another was, "The heights reached and kept by great men were not attained by sudden flight, but they, while their companions slept, were toiling upward in the night." There were also the other less-savoury sayings, like, "We are we, and they that come after us are nothing but fish bits." All of these mantras solidified the confidence that we had in our abilities.

It wasn't just academic excellence that was drummed into us at Wesley; we were taught Christian principles in daily assemblies and weekly church services. The school's motto was, "Live pure, speak true, right wrong and follow the King" (the King being Jesus). We hardly ever recited the motto, but we lived it. You were expected to tell the truth, and you did. If for example you were talking during a rest hour and you were questioned, you owned up. You wouldn't even consider doing otherwise. You saw something wrong and you felt it was your duty to correct the wrong.

Perhaps because I am a nonconformist at heart, for my A-levels I chose the newly created sixth-form Science College, part of the Presbyterian boys' secondary school. Although it was a well-equipped school with good facilities and teachers, this move was considered a risky one by many of my friends because the college had yet to prove itself. Plus, I was the only girl in my class of almost 100 boys. I was so shy that I sat in class for two years and got to know only a handful of boys. A few years later, it appears the concept of a mixed sixth form Science College was abandoned—the school reverted to being an all-boys' school. The experiment seems to have worked, however, as the school has subsequently posted exceptional results, especially in science.

I gained admission into the University of Surrey, in Guildford, UK, to study civil engineering in 1980. My older siblings were already in the UK and it was my brother in particular, who was also studying to become a civil engineer, who was instrumental in helping me make the decision

to switch my studies from mechanical engineering to civil engineering. I had also learned from my father that mechanical engineers in Ghana were mostly engaged in maintenance.

In Surrey, the atmosphere was warm and friendly, especially among international students. My civil engineering class was made up of about 200 students, but we were only three girls. The other two were from Malaysia and Singapore. Again, I rarely interacted with the boys in class.

I loved subjects like fluids, hydrology and structural analysis, and design, because I could easily see how I could use the knowledge I was acquiring. I did well in maths because the approach to solving problems was systematic and logical. Of all the subjects I studied, however, computer programming was by far my greatest love. I could spend hours behind the computer and not get tired. I undertook a computing project in hydrology and stayed on after my degree for a year to work in the computing department. But I could not be persuaded to change focus and branch into computer programming as a profession.

I returned to Ghana near the end of 1985 to work with the Architectural and Engineering Services Corporation (AESC). AESC had been carved out of the PWD, the organization that for many years was headed by my father. AESC was set up to be consultants to the government of Ghana at a time when the concept of a private consultancy practice was very much in its infancy. Salaries were quite low, but it was an excellent training ground for a fresh graduate engineer as there was a constant stream

of projects. I benefited immensely from the mentoring of senior engineers and clerks of works who had worked under my father in PWD and were only too willing to show me the ropes. Interestingly, they included some expatriate engineers: one from India, another from the Philippines (both men), and a woman from the USSR. I was thus not the only female engineer.

I learned from one of my mentors that drawings and calculations for all previous projects handled by PWD were stored in the archives and could be accessed by staff. So, whenever I came across a type of structure that I had not dealt with before, I just paid a visit to the archives, where the man in charge was often so pleased to have the rare visitor that he would go out of his way to assist. Also, whenever I ran into difficulties, especially of a practical nature, I only had to wait until I got home to discuss it with my father or my siblings—two brothers and a sister who had by now also all graduated as engineers. The following day, I would return with the benefit of a wealth of experience and a solution to the problem.

There were a number of incidents that marked my time at AESC and helped to shape me. The draftsmen in AESL—yes, all male—were in general much older and more experienced than I was, and in dealing with them I would often take the trouble to carefully explain the reasons for any instructions I was giving. This approach earned me their friendship and respect. On one occasion, however, a senior engineer instructed a draftsman to make what he called corrections to my drawings. I questioned the basis for these changes, and he was forced to admit that there was no real need

for them. It was apparently something he had done in the past to younger engineers, and he had often gone unchallenged. I believe the intention was to intimidate and make us seem less competent to the draftsmen.

In another incident, I found myself the subject of controversy when some staff questioned why public funds had been used to sponsor me for a short course in soil dynamics, a course that introduced me to some concepts in earthquake engineering. I believe it was because I was young and female. Tensions were diffused when the chief executive called a meeting of all staff to explain the process used for my selection. He went further and read all the submissions made, leaving those present with little doubt that I deserved to have been selected.

I gained in stature in the eyes of some colleagues after a client's architect refused to accept my amendments to their design for a standard building type. The AESC was going to supervise some of the buildings while the client was to supervise the rest, so the client went ahead with their own plans instead of mine. It so happened that one of their structures, which was directly behind our offices, collapsed during construction. They then surreptitiously sent workers to my sites to obtain copies of my drawings from the contractors.

I eventually got to use my knowledge of computer programming when I was required to work out the dimensions for cutting marble that was being imported to cover an important national monument. In writing the program, I was so pleased that I was finally able to apply some of the

math I had learned to derive an equation to approximate a curve.

I also came to appreciate the importance of documentation when a fence wall that had been my project collapsed in a rainstorm. Thank goodness that, on the advice of the clerk of works on the project at the time I was working on the design, I had carefully documented my objections to the wall being constructed without the drainage problem in the area being addressed. The incident was declared a natural disaster by authorities—who had failed to act on my advice.

My involvement with the Ghana Institution of Engineers (GhIE) came early in my career. My father was a past president of the institution and I therefore understood its importance and participated in GhIE events. I took the professional examination at a time when other colleagues did not see its importance. I found myself defending my work against a panel that included a senior engineer from the AESC. This engineer had tried to dissuade me from going ahead with the concept I used for one of the projects I was presenting. I refused to be intimidated by his questions, instead responding in a relaxed and friendly manner. I also focused on convincing the other panel members with my answers. I was successful in the examination and became the first Ghanaian female to become a full member of GhIE.

I was later persuaded to join the GhIE secretariat as director of education and training by a new executive secretary who challenged me to join, and to implement the measures I was proposing to him for the

training of young engineers. My new boss, the executive secretary, was a very hard-working man who was very results-oriented, and I learned a lot from him. He set about systematically training me to understand the workings of the institution. I had to read all the old files and attend council and committee meetings. He explained to me the measures he had taken to stop the institution from operating like an exclusive club: he ensured it was constantly holding evening lectures, seminars, and other events, and that they were advertised on the radio and in the newspapers. The effect was that practically every day, one would hear or read about the institution. In addition, we were regularly communicating with members through letters, newsletters, and journals. All of these measures went a long way towards raising the profile of the GhIE, and membership grew.

My boss at GhIE was a great advocate for the profession. We undertook career counselling and guidance tours of secondary schools in a number of regions, during which he spoke passionately to the students about engineering. I also had an opportunity to speak, and I dispelled myths about females' capability to become engineers. These tours gave us an opportunity to learn first-hand from students and staff about a new educational system that was being implemented by the government. I realized that some students would be prevented from entering universities to study engineering simply because they could not include maths in the combination of subjects they were selecting.

My boss encouraged me to deliver my findings during an evening

lecture on the topic, which I did to a small audience. Quite unknown to us, there was a newspaper reporter present and he did a full back-page article in the Saturday edition of a national daily. The headline he gave to the article suggested that engineers were critical of the government's educational reforms. The effect was dramatic. The phone did not stop ringing on Monday morning as people called in to congratulate us for saying something that others had been unable to say. This was at a time in Ghana when the country was ruled by a military government and we had what was termed a "culture of silence." Emboldened by the reactions, we quickly followed up the lecture with a letter to the Ministry of Education pointing out the flaws we had found. To his credit, the minister responded by thanking us for our observation. Eventually the necessary changes were made. This incident really brought home to me the power of the GhIE.

My boss eventually resigned, leaving me to act as executive secretary for about a year until a new appointment was made. I did not apply for the position as I felt I would be considered too young and therefore would not be given the respect the position deserved. I eventually left the institution to get back into engineering practice.

Around the time I left, I heard about a new Master's degree course in earthquake engineering from a lecturer of the Imperial College in London who gave a talk at GhIE. I was fascinated that such a course existed, and I instinctively knew that this was what I wanted to do. My husband, who was as ever my greatest cheerleader, offered to pay for the course. This

was a real sacrifice on his part, as it meant he would be alone for around a year as I travelled to the UK with my daughter; he wouldn't be able to leave his job as head of procurement for an automobile company. So our nine-year-old accompanied me to London, where she was able to live with my cousin's family and attend the school where my cousin taught.

We were a small class from different countries. I was much older than everyone else, but they were very friendly and we all got on quite well. Although the course was not easy, I enjoyed it and I believe my years of practical experience helped. I was fortunate to have as my project supervisor a world-renowned seismologist, Professor Nicholas Ambraseys, whose particular expertise was in the historical study of earthquakes. I was looking at reducing seismic risk in Ghana, and Professor Ambraseys had done a lot of work on the West African region. I benefited from a wealth of knowledge that he passed on to me.

On my return to Ghana, I worked as an independent consulting engineer but was soon persuaded to return to the GhIE secretariat, this time as acting executive secretary. The institution was not in a very good position financially, but it had assets. I generated a lot of income for it by renting out facilities on its premises as well as its bus. I also generated income from regular seminars. After only one year in office, the institution was in a much better financial position and I was confirmed as the executive secretary.

I set about trying to make the GhIE more open and friendly, especially

to younger engineers, technicians, and technologists. I kept an open-door policy and members would often walk in to talk about their issues. I began the formal registration of students and encouraged their participation in GhIE events. I supported Women in Engineering (WiNE) groups in the institutions, and a program that sought sponsorship for one female each year to attend a leadership program in France. I communicated regularly with members and their organizations and ensured that I responded promptly to all correspondence. I also organized evening lectures, seminars, and conferences, which were all well publicized by the press. These measures helped increase the visibility of the institution and led to an increase in membership.

Soon after I re-joined, I attended a conference in Tunisia where I learned about the World Federation of Engineering Organizations (WFEO) and its African counterpart, the Federation of African Engineering Organisations (FAEO). I immediately recognized its importance and set about ensuring that Ghana renewed its membership in the WFEO. It took a much greater effort, however, to get the FAEO back up and running. I had to work with my counterpart in Nigeria and, later, a number of other African countries in order to revive the African body. In the meantime, Ghana came together with Nigeria and Sierra Leone and signed a memorandum of understanding, agreeing to attend each other's annual conferences and share ideas.

One of the key things I achieved at the GhIE was to obtain funding for a project advocating the passage of an Engineering Council Bill. The funding enabled the GhIE to engage members and the public nationwide. By the end of the exercise it became obvious that the law needed to be redrafted to include the regulation of all within the engineering family, from craftsmen to technicians, technologists, professional engineers, contractors, consultants, manufacturers, fabricators, and even vendors.

Many were concerned because they did not know of any similar laws. I got around their difficulties by showing them the Nigerian law, which included all classes of engineering practitioner. During this process I realized that my willingness to “stand out” and “become the standard” was not shared by everyone. I eventually left the GhIE about a year after my contract expired. The bill was passed into law soon after I left.

I maintained my involvement with the GhIE and served on its council. I later ran for president—and succeeded in becoming the first female to occupy that position. The length of time I had spent working in the GhIE secretariat meant that many members already knew me. I was very touched by the support I received, especially from colleagues who were female engineering practitioners.

My one-year term as president was indeed very eventful. I hosted many events, conferences, and meetings. We made important declarations on national issues like the illegal small-scale mining being undertaken by

foreigners, which was polluting important water sources and devastating the environment. I was satisfied to note that our recommendations for a ban and re-education of locals on safe mining practices was taken seriously.

I continued our participation in international meetings and was able to boost our influence by increasing the number of delegates from Ghana participating in these meetings. And so, when the position of president of the FAEO came up for consideration, I was nominated and unanimously supported for the position by all other countries present. I hence became the first female to have the honor of being appointed to serve as president of the FAEO, a position that will also see me serving on the executive council of the WFEO.

Looking back on my life, I believe I have had a much easier path to leadership and success than most females in engineering. I was fortunate to be brought up by parents who instilled in me confidence as well as strong Christian principles of honesty, service, and a belief that I should strive to leave the world a better place than I found it. I was blessed to have attended schools that reinforced these beliefs. And I had siblings who are all engineers with whom I could share experiences.

On my journey, I have encountered more champions than detractors. Indeed, if there were detractors, I would not have recognized them. I am eternally grateful that I married a man who was very encouraging, ever-prepared to make sacrifices, and so proud of my achievements. I have

been lucky too that my daughter, in spite of the many inconveniences that she has had to put up with, continues to offer her support. And most importantly, I am grateful to God for His guiding hand that has always been a part of my life.

JOURNEY 4

NEVER STOP REACHING FOR THE TOP

BARBARA CHAN

*Professor, Biomedical Engineering Programme,
Department of Mechanical Engineering; Associate Dean,
Graduate School, The University of Hong Kong*

HONG KONG

I believe the main reason why Christopher Chao, the dean of engineering at HKU, and Hans Hoyer, the publisher of this book, invited me to contribute to this new volume of *Rising to the Top* is that I am the first and only female full professor in the faculty of engineering at HKU in history. Because of this unique fact, I have been sitting on different committees for gender diversity; for several years, I've been on the Promotion and Tenure Panel of the faculty, and I must say I am happy to see that there are more female full professors in the pipeline than ever—a rising trend!

When I was young, I dreamed of becoming an athlete (I was on the track-and-field team, inspired by my father who was an amateur athlete; he was a weightlifter!), a scientist (I admired the first female Nobel Laureate, physicist Marie Curie), an artist (after joining a drawing club), a kindergarten

teacher (I attended boarding kindergarten and from Monday to Friday, the teachers were my whole world), and so on. Becoming an engineer never crossed my mind, although I found it surprising, and interesting, that my mother was an engineer. She worked for a semiconductor company, specializing in quality control of water. I could not figure out the logic, because she was a graduate in microbiology. I therefore concluded that career development can be quite random.

In my pre-college years, I was amazed by all the science subjects, and was particularly interested in understanding the mechanism of life, so I

ABOUT THE AUTHOR



Barbara Chan has 25 years of research experience in biomaterials, cell, and tissue engineering. She obtained her Bachelor's degree in Biochemistry and PhD degree in Surgical Science from the Chinese University of Hong Kong, and her post-doctoral experience in Laser Medicine at Massachusetts General Hospital, USA. She joined the University of Hong Kong in 2003 and has been a key member of its Biomedical Engineering program. Barbara established the Tissue Engineering Laboratory with the vision to improve quality of life by

bioengineering biomaterials and stem-cell based tissues for personalized therapies for diseased tissues.

Barbara became the first female full professor in the history of HKU's Faculty of Engineering in 2016. Since 2016 she has been on the Research Project Assessment Panel (Electronics) under the Innovation and Technology Commission, and in 2017 was appointed by the local government to the Task Force on Regulations of the Advanced Therapeutic Products (ATPs).

Barbara has been on editorial boards for peer-reviewed journals, and has been Associate Editor for Biomaterials, one of the field's top journals. Together with her business partner, and a few PhD students and post-doctoral fellows, Barbara co-founded a technology startup that develops cartilage tissue-engineering therapies in Hong Kong.

chose to study biochemistry. I was amazed by the hierarchical organization of life and the complexity of the inter-regulated biochemical reactions, the “spider-web-like” complex signaling pathways with hundreds of biomolecules under each and every action of a cell—for example, breaking down sugars for nutrition.

But instead of going on to discover the mystery of life and its underlying mechanism, at the very end of my college life I decided to work on something closer to applications. My final-year project was about anabolic steroids, which are hormones that stimulate muscle-building and boost physical performance. These drugs have been used to treat delayed growth but can also be abused to manipulate athlete performance during competitions. This project triggered my strong interest in doing something closer to the clinical end. I gave up the idea of investigating the molecular mechanisms of cellular calcium signaling in cells and decided to join a sports medicine center at the Chinese University of Hong Kong.

Over the next five years, I so enjoyed working with and learning from surgeons and clinicians as they knew exactly what the unmet needs in modern medicine were, and they also knew the inadequacies of existing treatments. I was bombarded with a lot of tough questions that directly pointed to important medical conditions. For my PhD, I chose to answer one of these questions: how to accelerate healing at the patellar ligament donor site after surgical repair for anterior cruciate ligament (ACL) ruptures in high-impact injuries that occur in sports such as soccer. Such knee injuries are very common yet very difficult to treat. I was inspired to

focus on this thanks to a sports medicine project in my final year, and I had really enjoyed working at the sports medicine center.

I found that gaining a better understanding of the molecular and cellular mechanisms of tissue healing, which I learned in my undergraduate program, did help me to design new approaches to accelerate tissue healing. The first hurdle to overcome was handling those big hairy lab rats and operating on their ligament. Starting from my own horrified screams during intra-peritoneal (the membranes lining the abdomen) injection of anesthetics, to a record-breaking 24 operations per day, it's clear that overcoming my own weaknesses is what doing a PhD is all about.

My PhD work also gave me the opportunity to try out a multidisciplinary approach in accelerating ligament healing. In order to retain the growth factors in the local defect site, I started to try in situ gelation of hydrogel materials that entrap growth factors for controlled release after implantation. In order to evaluate the functional properties of the healing tissues, in addition to the traditional biochemical, histological, and molecular biology characterization, I had to know their biomechanical properties—hence the need to study the stress-strain relationship in soft tissues such as ligaments and tendons. Most, if not all, biological processes are multifactorial, so the ligament healing problem is no different.

Seeking answers and help from people with different disciplines, including biomechanics and material scientists, was the right approach. I started to believe that any impactful question needs answers and solutions from multiple disciplines—and that is where I came to know the term

“multidisciplinary.” Toughening one’s own character and sharpening one’s analytical, organizational, argumentation, and people skills are the best gifts of a PhD, over and above the research degree itself. These first-hand experiences became important assets for me to share with my PhD students when they face challenges and difficulties.

I’ve always been proud of myself for seizing every single summer holiday period to get paid jobs and volunteer work as soon as I reached the minimum age of employment, 15. I took many different roles: sales staff and cashier in a stationery store; sales and warehouse worker in fashion stores; secretary in a leather goods company; shipping clerk in a shipping company; warden in a hostel for the mentally challenged; substitute teacher in a middle school; student helper in a cultural center; and more. I loved those experiences because they gave me totally different perspectives than the school environment, and were opportunities to interact with people of different backgrounds and with different stories. It was a chance to better understand how a society works, and to understand what matters in different industries. It was also a way to discover my own strengths and weaknesses, and to understand that every dollar earned is precious. I always encourage my students to do summer jobs or internships in other industries during their undergraduate and even postgraduate years, as you never know when these experiences might become relevant and useful for your future.

I experienced a time of soul-searching in 1999, shortly after graduation. Doing my PhD was indeed physically and mentally demanding,

so I decided to take a short break to buy some time and space before taking the next step. I actually had a lot of choices. For one thing, I thought about becoming a hospital biostatistician because I had a diploma in epidemiology and biostatistics, and I liked data analysis. Ultimately, I joined the newly established Innovation and Technology Commission (ITC), a government funding agency supporting universities/institutions and industries to develop applied and translational research-based innovations and technologies. I helped in the evaluation of hundreds of research grant proposals from universities/institutions and at least 200 business proposals from startup companies. But I soon found that I was really absorbed in the technologies mentioned in the proposals. So, I took extra time to read a lot about the technologies, and I incorporated my own ideas and even tried to impose them on the proposers. Not only that, I started to feel an eagerness to run experiments, rather than just read and talk about technologies.

That feeling drove me to offer myself as a volunteer in a research lab at the University of Hong Kong. My supervisor at the ITC had told me that I should consider going back to research, because, he said, every time we discussed those proposals, I started babbling about new ideas, and my eyes sparkled. After about a year of soul-searching, I realized that I still enjoyed rolling up my sleeves and doing the dirty work far more than I enjoyed crossing my arms and commenting on others' work. I therefore decided to go back to R&D.

I started my postdoctoral fellowship (PDF) training in the year 2000 in a multidisciplinary laser medicine lab in the Massachusetts General

Hospital in Boston. We were working on the development of laser-based biosurgical techniques for sutureless repair of soft tissues such as tendons, ligaments, nerves, and skin. It was an eye-opening and unique experience. I worked in a multidisciplinary environment with more than 200 researchers from diversified backgrounds, including everything from chemists to dermatologists, from oncologists to optical engineers, from physicists to ophthalmologists, from molecular biologists to orthopedic surgeons, and more. That was the most stimulating and inspiring research environment I ever experienced.

Among many intra- and inter-institutional exchange activities, I most enjoyed the monthly gathering hosted in a big conference hall, where I met people from different backgrounds other than researchers, including government officials on regulations, patent lawyers, company executives, venture capitalists, etc. These experiences helped me to understand that solving a biomedical problem is complex and intrinsically multidisciplinary.

One shocking experience that accelerated and motivated me to commit to tissue engineering research even to this day was a visit to Dr. Robert Sheridan at Shriners Hospital across the street. I was working on a skin-grafting project in which a visible laser together with a photosensitizer were used to enhance intimate tissue, bonding the graft and the host tissue. Dr. Sheridan asked me to join his operation session on a fourth-degree burn case, a four-year-old girl whose stepparent had set her on fire. It was a devastating situation. The majority of her skin was badly burnt. He told me that they had to use all available options, including immunologically

matched allograft from donors, temporary dressings from both animal and synthetic sources, and tissue-engineered skin, which has very limited availability in this case because there was very little healthy skin left. A small piece of healthy skin from the girl was sent to a company in Cambridge, near Boston, for isolation, expansion, and growth. When it grew into a circular shape around 10 centimeters in diameter, this tissue-engineered skin was sent back to the operation theatre for grafting.

He mentioned that tissue-engineered skin has live cells and is therefore “taken” by the hostile wound easier and faster than all other grafts, particularly at a location where the wound bed is not flat. That was also the reason why that tissue-engineered skin was grafted from the girl’s kneecap. “Taken” means that the engineered skin can be successfully integrated with the host’s wound bed and gain enough vascularization that the patient’s blood supply can reach the engineered tissue. It’s a strong indicator for graft survival.

However, Dr. Sheridan told me that the girl did not have much healthy skin left for harvesting skin cells to derive that tissue-engineered skin. Staring at the girl, he commented: “If the company can grow more and larger tissue-engineered skin in a shorter period of time, that would be good...” That day, I made up my mind to commit to tissue-engineering R&D.

But life does not always go as planned. I learned on a call with my mother that my dad had been rapidly losing weight. A strong and overwhelming feeling told me to go home, and I rushed back to Hong Kong. Shortly after I returned, we got the news that my dad had been diagnosed

with stage IV colon cancer.

Over the following year or so, I had the best time with my dad. He enjoyed listening to my innovative ideas and I tried to explain my research in layman's terms. He had always been so supportive when I decided to continue my career in research and development, and when I was in Boston he often mailed me newspaper clippings of all sorts of biotechnology-related news. During that final year, we also talked about music, technology, religion, and so much more. Basically, we enjoyed every moment of life.

Meantime, I worked briefly at a biotech company in Hong Kong before joining the biomedical engineering program at the Hong Kong University. Witnessing my father's declining health, and seeing failure after failure of several chemotherapies after his resection surgery, I started to think about personalized tumoroid chemotherapy screening models. These are currently being developed in my lab, to help clinicians make better-informed decisions on which chemotherapy to use, so as to minimize the unnecessary damage brought about by the ineffective chemotherapies in cancer patients.

The tissue engineering lab at HKU (called TEL@HKU) was officially established in 2004, with the vision defined as developing personalized medical therapies for patients with tissue dysfunctions via tissue-engineering approaches. The TEL@HKU team has members from many different backgrounds, including applied chemistry, nanotechnology,

physiology, mechanical engineering, radiology, molecular biology, biomedical engineering, etc. With a truly multidisciplinary group, we have developed platform technologies enabling the fabrication of engineered tissues. For example, the advantages of having both a biologist, who understands the structural composition and its functional significance in native tissues, and a material scientist, who has the capability to manipulate the self-assembled polymerization of biomaterials, gives us the unique opportunity to develop a matrix microencapsulation technology that entraps living cells in nanomaterials in 3D configuration.

We are also interested in understanding the basic mechanisms of how cells interact with their microenvironment, particularly the extracellular matrix and their mechanical properties, as we believe that basic science work always generates useful knowledge to enable engineers to utilize informed, rational design in our approach to scaffolds and tissue-engineering. For example, we found that immobilization of fibronectin into the collagen matrix stimulated the formation of elongated and mature cell-matrix adhesions in stem cells, and allowed them to differentiate into bone cells. This knowledge helped us to define the matrix composition of the scaffolds for bone tissue engineering.

The ultimate goal of our lab is to engineer complex tissues with multiple cell types and biomaterials for replacement of defective tissues. Examples include osteochondral tissues for patients with cartilage injuries

in joint diseases, and bone-ligament tissues for patients with ruptured ACLs in sports injuries. Collaborating with the end user of our tissue-engineering technologies—that is, orthopedic surgeons—we are able to design the engineered tissues with practical considerations, such as the fact that rigid bony anchorage ends are necessary for rapid integration of the engineered soft tissues with the host tissues.

In the past 10 years, built on more than \$16 million in funding, via at least seven projects and 17 research papers, two technology platforms, seven issued patents, and four generations of technologies, we have developed a complex engineered osteochondral tissue and demonstrated promising and sustained regeneration outcomes that are favorably comparable to the clinical gold standard (autografting). After completing preclinical animal models with exciting outcomes and a human cadaver study testing the feasibility of implanting the tissues via minimally invasive arthroscopy procedure, we are now working with our collaborating orthopedic surgeons, industry partners, and local regulators on a first-in-human (FIH) clinical study to establish the safety profile of the engineered tissues. Although our journey toward clinical application of the engineered osteochondral tissues in regenerating damaged cartilage in joint diseases still has a long way to go as we are still facing a lot of challenges, we are making progress every day and are getting closer and closer to the clinical end.

Lifelong learning is a core value and quality of professional engineers.

Because I am a Chartered Engineer and Chartered Scientist, it is my professional responsibility to engage in lifelong learning and continuous improvement in the profession. This is particularly useful if one is working on innovations and technologies, because the advancement of technologies changes rapidly and we need to be at the forefront of knowledge and information. For example, before we plan for any clinical studies, I first need to understand the emerging regulatory requirements of tissue-engineering products in different countries and regions. The process of extensively reading these materials, together with attending workshops on regulatory requirements of medical products, as well as visiting the regulatory agents in selected regions, has helped me to figure out the most suitable product classification during the regulatory process in that region.

This knowledge became very useful when, for example, I was invited by the government to be a panel member on the task force for advanced therapeutic products (ATPs) regulation. Another example: Our engineered osteochondral tissues are classified as ATPs, which are regulated as drugs, and hence it's a must that the tissues are compliant with good manufacturing practice (GMP). However, ATPs are new to Hong Kong and we do not even have qualified personnel for this kind of product. I therefore have to study local pharmaceutical law, GMP manufacturing theories and practice, and register as qualified personnel for ATPs together with three members of our technical team. While I was reviewing the lecture notes to prepare for

the pharmaceutical law exam, side by side with my 10-year-old-son who was preparing his Grade 6 assessment, I felt like a student again. It was a good feeling, as I enjoy learning.

As a female professor, scientist, and engineer, I have faced the same number of challenges during my career development as men. But as a mother, I have the opportunity to enjoy a few more “big prizes.” One is pregnancy, a process of experiencing a miracle, while motherhood is a process of self-discovery. In terms of knowledge, researchers understand what happens to the fertilized egg during pregnancy. But only female researchers, including me, have the privilege of enjoying the first-hand experience of pregnancy and motherhood. When my son was stretching his arms and legs inside my tummy, I felt fulfilled. Upon the first sight of my son, when the doctor brought him to me and my husband, I felt “completeness.” Seeing my son fall asleep with a mouthful of milk, I enjoyed “contentment.” These are wonderful feelings, exclusive to women.

The only real challenge of being a mother and an academic was that I needed to rush home to feed my son on every working day for more than two years. I was quite lucky because the nature of my work is relatively flexible and it’s only a 15-minute journey from my office to my home. However, for colleagues who share offices and labs and need to commute between work and home, such as my female PDFs, this can be a problem. I used to open up my own office to accommodate my female postdoctoral fellows

for milk pumping. A more accommodating university campus is necessary.

I am glad to see that our university has installed baby-care rooms in recent years. Moreover, mothers spending more time with babies and toddlers is extremely important for their healthy development and growth. Some of my female PDFs had to face the decision to quit their research career. So several years ago, I began flexible arrangements for my female members. For example, one PDF worked from home whenever there was no scheduled experiment. Another example: when a PDF returned to work with her little girl, my office became her playroom.

Compared to the Western world, institutions and companies in Hong Kong are not family-friendly enough, as they do not have at-work nurseries for team members to take care of their young children, and working-from-home is not common. I feel that the world of academics need to be more innovative in finding ways to help female researchers. We must give women the help they need to truly rise to the top.

JOURNEY 5

DEVELOPING A LIFE,
DEVELOPING A COUNTRY

MARIA TERESA DALENZ ZAPATA

President, Enterprises Federation, Sucre

BOLIVIA

I was born in Oruro, a small city at a high elevation on the Bolivian Altiplano. My dad was an industrial miner, but sadly he died young, leaving the family—I have two sisters and a brother—with very little. Typical of women in my country at that time, my mother hadn't had a chance to study or to have a career, so we all took small jobs in order to put food on the table.

I liked to help my mother at home and that made her happy. She was always so proud of me, and had high expectations for my future, as I was usually the best student in my school. I attended primary and secondary school at an all-girls' establishment called Jesus Maria, and was good at all subjects. I graduated at the top of my class, obtaining the baccalaureate in humanities. But my mother wasn't very supportive of my wish to study

engineering; it's just not what girls pursued. I only knew that I wanted to be different, even if my family or friends didn't agree with my decision. For me it was simple: I liked mathematics and physics, and I wasn't afraid of being the only girl in anything. I wanted to be recognized as a brave woman and a capable one. So I put all my trust in myself when I decided to be an engineer. And I have never regretted it.

I did realize that engineering would be a difficult field for a woman to enter. The other girls I knew were preparing themselves to get married or studying to be teachers; they thought I was crazy to imagine myself doing

ABOUT THE AUTHOR



Maria Teresa Dalenz Zapata graduated as a Civil Engineer in the 1970s from the prestigious National School of Engineering (ENI) of Bolivia. She was the only female student in the entire university. In 1990, she earned her diploma in construction management from the University of Chile, and in 2003 achieved her Master's degree in foreign trade at Andina Simón Bolívar University. In 1986, her dream of having her own company became reality when she founded the construction firm MATERSA. Today, it has around

100 workers. Over the decades, Maria Teresa has led building projects in Bolivia that have included schools, institutions, and sports facilities. Two of her most memorable projects are Engineer's House in 2007 in Sucre (Bolivia's constitutional capital) and, in 2016, the Bolivian Judicial Forum, Sucre's biggest and most modern building. She has been an active participant in the Pan-American Union of Engineers Associations (UPADI) since 2004, becoming its President in 2014, the first Bolivian engineer to reach this position. Maria Teresa has committed herself to helping Bolivians in need: she has built two kindergartens for disadvantaged children, and heads a foundation called Amazonia, which is dedicated to educating and housing children living in extreme poverty.

“rough” work with men, away from the city; they couldn’t believe I would want to wear work boots and dirty clothes, and not constantly attend to my family and children “like all women do.”

In 1972, without moral support from my peers—but without hesitation, either—I began my higher education at the prestigious National School of Engineering (FNI), where I studied civil engineering. I was the only woman student in the entire university. I got accustomed to being surrounded by males, and became friends with many of them; most of the guys simply didn’t care about gender or other prejudices at that time. But institutional prejudices existed. After I graduated and married a man who was an economist, I used to assist at the university while I continued my studies. This was when I was in my early 20s, and when I became pregnant with my son, I had to play some tricks with my clothing so that no one realized I was pregnant.

What made things even more difficult was that I did not have the support of my husband at all. My sister used to care for my kids when I was out studying or working, because in my culture, and in many around the world, watching the kids is something many husbands won’t do. The only way it was possible for me to keep pursuing my studies was if I continued to be responsible for the cooking, the cleaning, and attending to my husband.

However, I did not allow that to be a barrier: I became the first woman in Bolivia to obtain a degree in civil engineering. That was in 1980,

and by then I had three sons. (I received recognition for this milestone in my country's history during the celebration of FNI's 100th anniversary in 2016.)

My biggest dream was to work for myself by starting my own business. To my mind, that was the easiest way to succeed as a woman, a mother, a wife, and an engineer. This dream came true in 1986, when I created an enterprise called MATERSA, a one-person construction company I founded with capital earned in a successful public transport enterprise that my husband and I had built some years before. I worked alone because my husband didn't understand engineering and I had no other support at that time. (We later divorced.) It was stressful and complicated, but my children were my inspiration to keep working at it. And when you do something you love, your efforts don't feel like work at all.

In 1990, I earned my diploma in construction management at the University of Chile, and after gaining more work experience, in 2003 I got my Master's degree in foreign trade at Andina Simón Bolívar University, a credential I needed if I was going to be able to do business with other countries. In Bolivia, while we have a lot of raw materials, we don't produce a lot of materials. So in order to reduce costs, I wanted to import construction goods.

After spending time in the working world, I realized that enterprises either closed down or lost money because of a reliance on outside service providers—for example, carpentry—so I decided to build a company that

offered a variety of services in order to keep costs down. My business had its own carpentry, mechanical, and farrier branches.

My company is now 30 years old and has approximately 100 workers. I'm the general supervisor and am still active in the company. But my two older sons and my daughter-in-law are responsible for this enterprise that has grown in all its branches, and that has led to us starting other successful businesses, including two hotels and a hostel.

Throughout the process of growing my company, I have built important infrastructure works not only in my local area of Sucre, but all over the country. I've worked with mayors, governments, and ministries, as well as cooperated with both international and Bolivian institutions. All of this work has been achieved by participating in national and international tenders, which are governed under the state procurement system for goods and services. I've always presented my work proposals with a strict relationship between quality and cost, and executed each project in a respectable manner and to the satisfaction of the contracting entity. For all of the works that I won, I had to insist—insist without hesitation or shame—on high standards. I stuck to my values even when men were working against me and saying I wasn't capable, or that my enterprise wasn't capable. And I'm still insisting today. After all these years I still get frustrated when somehow, or because of someone, I don't win. But I love what I do, and I know I'm not alone now. So I continue to stand tall.

My objective has been to develop my enterprise and my country at the same time. We always obtained top-quality equipment, machinery, and, above all, very capable engineers who have worked supportively, helping us avoid many of the difficulties that can arise during any construction work. Most of the projects have been the construction of buildings and roads, because in Bolivia not all roads are paved. I also had the opportunity to build schools and institutions for the people of my country, as well as a dental faculty, schools, and sports facilities.

A memorable project my enterprise built was Engineer's House in 2007, a beautiful 2,500-square-meter modern building with all the amenities to best serve our affiliates. It had been a dream of Sucre's engineers to have one place where all the engineering institutions could be located; we didn't have a physical building. My company built it, saving money and reducing costs, even giving away some materials. I built it like it was my own house. My colleagues thanked me by naming its principal auditorium in my honor. I also didn't take a profit for myself on this project, and for that I was recognized by the municipal government with its Maximum Award, "in recognition of the services provided in honor of Marshal Antonio Jose de Sucre (the liberator of South America)." I received this in 2007 at the House of Freedom in the presence of some of Bolivia's most important dignitaries, on the anniversary of the liberation of Sucre.

The Bolivian Judicial Forum, completed in 2016, was one of the

most special that my enterprise was involved in. It's the biggest and most modern building in Sucre. My company led this job, working in association with other companies. I was so happy to have the opportunity, and I feel I left a little part of my heart in this building. I was fortunate to work with some family members, too, including my brother who is a mining engineer; he helped me with my studies when I was younger. I also worked with my three sons, my brother-in-law, and many others.

With the creation of MATERSA, I was able to work closely with the institution that brings together the builders in my department—the Departmental Chamber of Construction (CADECO)—and after years of active participation in meetings and on boards, my colleagues put the fate of this institution into a woman's hands for the first time when I became CADECO's president in 1998. It meant so much that my colleagues had such confidence in my abilities, and as president, I always sought to serve my country.

Eventually I had another opportunity, when I ran for the presidency of the National Society of Engineers (SIB) of my local chapter, and won—becoming the first woman to achieve this position. After my term (2012-2013), my colleagues asked me to represent them on SIB's board of directors. In my role there, I began work to become the highest representative of engineers of all specialties in Bolivia, an objective that I achieved. The election results showed I had the support of the majority in becoming the first woman in

my country to hold the position of president of SIB for all of Bolivia in 2013. I was honored to have the opportunity to be an ambassador for all Bolivian engineers; I thank the engineers who chose me for the trust they placed on me. As a result of honest, tireless work, I had the pleasure of getting so much in return from many SIB members, including recognition of many aspects of my work. However, I must say that the greatest recognition has always been the affection they have shown me.

And I must mention another milestone of MATERSA: we constructed Engineer's Square, in the heart of the city of Sucre. It was inaugurated on the 200th anniversary of the department where Sucre is located, Chuquisaca, in 2016.

I've had the opportunity to make international connections with engineering colleagues for the past couple of decades, starting in 2004 when I participated in the Pan-American Union of Engineers Associations (UPADI). This organizations includes engineering associations from countries in North America, Central America, the Caribbean, and South America. I've attended events in Mexico City, Aruba, the United States, Costa Rica, Brazil, Puerto Rico, Cuba, Colombia, Honduras, and Panama. All of this travel gave me the opportunity not only to make new friends and connections, but to see life through a wider lens, and to understand more clearly the power of engineering in the world.

In August 2014 we organized the XXIV UPADI convention held

in Santa Cruz, Bolivia's largest city. This included the Technical Congress, UPADI Assembly, and the development of an Assembly of the UPADI Academy, so it meant a large number of professionals from across Bolivia participated. At this convention I presented myself as a nominee for president of UPADI. Because I had participated for 10 years at all the assemblies and conventions, and thanks to the support of the representatives of many different countries, I was favored in the election. This was a real honor: I was the first Bolivian engineer to assume this position. Later, when I was sworn in, I gave an emotional address, thanking God and the engineering world for the opportunity to become a leader.

This position led to even more experiences and connections, as the position led me further afield: to engineering conventions in Singapore, Japan, Italy, and Mexico, among others. (A particularly memorable event was the World Congress of Cost Engineering and Project Management, held in 2015 in Brazil, where I had the honor of being recognized as Personality of the Year, a distinction offered to me by the Brazilian Institute of Cost Engineering.) For all of these travels, I had to leave my work and my family, but the experiences have been invaluable: I had to improve my abilities to communicate, to reach out to people. This provided me with more self-confidence to talk to people in a different language, English.

I feel that the best thing to do when you're successful is to help people in need, so with the Rotary Club of Sucre, an organization dedicated

to service, I had the opportunity to construct two kindergartens for disadvantaged children in 2006 and 2012. Both infrastructures were given to the local municipality for commissioning. For the construction of these infrastructures I received recognition for dedication and altruism. Then, in 2009, my life underwent a radical change when I received the opportunity to take charge of Amazonia, an Spanish foundation dedicated to helping children living in extreme poverty. In Sucre, the foundation has two beautiful projects dedicated to housing children whose living conditions are really poor; the households provide these children with everything they need to be able to develop properly, take care of their health, education, and well-being. These homes are in my care and I consider myself the mother of all these children, which is why I work tirelessly to arrange for their care and to ensure that they are not lacking anything.

Recently, we managed to build a new home for children in collaboration with the Spanish members of the foundation. That, along with my experience in the field of construction, means that we now have a more comfortable and suitable place to house them. We also have an objective to help meet the needs of the many women who must go out to work without having any childcare help, since they are single mothers and are unable to afford a babysitter. So, with the help of the foundation, we built a nursery in order to take care of their babies for free. It is very fulfilling to be able to do this work, to help the children of my country in

any way I can and to watch them succeed. Nowadays we have more than 100 children between the ages of seven and 16 in our institutions, children whom I hope are heading toward a better future.

I think back to the first time I had the opportunity to lead an institution full of men, and I remember the beautiful feeling; it was an experience full of emotions. It spurred me to go after my dreams—even big ones. Not just for self-satisfaction, but also to show to the world that women are, undeniably, just as capable as men. Life has taught me that no triumph is by chance, nothing “just happens”; you succeed after a lot of effort and work. Life has also shown me that you succeed when you help other people, with all your heart, achieve their success.

In the most important years of my career and life, back when I was just starting out, I was told I should get married and serve my home. So I did. I had to live in a male home with three little boys, all of us following the rules of their dad—a man who wasn’t a good companion for any of us. I was the one who cooked, cleaned, prepared my boys for school, worked, and studied, all at the same time. I was told to just be nice, be considerate to the men around me. I did everything I was told, redoubled my efforts, and reduced my sleeping hours. But I was strong enough to go after my dreams, and doing so gave me my freedom. All that work, all those sleepless nights, all of it to serve others. Yet I do not regret anything I had to go through. Because it has made me the woman I am now.

I have three sons and one daughter, and they are all engineers. Today, I realize that I am an inspiration for some young women, and every time I have the opportunity to address them I tell them: “If you don’t see a difference between genders, nobody can make you feel different or that you are less. The capacity you show is what talks for you and defends you if any person wants to make you feel you are not good enough.” I tell them that all the friends I had during university and at work were men, and some of them have become like family to me. They have never treated me differently or made me feel less capable—for the simple reason that I have never felt different or less capable.

I would like to conclude with a quote from Dr. Deepak Chopra: “Everyone has a purpose in life... a unique gift or special talent to give to others. And when we blend this unique talent with service to others, we experience the ecstasy and exultation of our own spirit, which is the ultimate goal of all goals.”

Today more than ever I put my faith in these words, for it is that spirit of serving others that make most of my days, and all of my activities, truly joyful.

JOURNEY 6

COMMITMENT AND LEADERSHIP: LIFELONG LESSONS

STEPHANIE FARRELL

*Interim Dean, Henry M. Rowan College of Engineering,
Rowan University, New Jersey*

UNITED STATES

The rhythmic sound of water lapping against the side of a pool is part of the soundtrack of my childhood, the scenes of which often took place in natatoriums and swim clubs. I was not a “natural,” but I started swimming young; I was 6 when I joined my first competitive team in my hometown in northern New Jersey. Why? Simple: I enjoyed swimming. But that’s how something that becomes a defining life force starts for many people—almost without purpose.

I do not think passion comes to us at full speed. We test the waters, try things out. But after we find it, we somehow know it. It just feels right. And that was swimming for me, especially team swimming. I loved being part of the team; some of my best life-long friends were on that team. Swimming has been a part of me for every formative day of my life. I always

felt sad when the season ended, the pool closed for another winter, and thoughts turned to the academic year. This might be the point when one might expect me to talk about having another passion—academics. But that would not be true; while I've always considered myself a good student and a hard worker, my mind was more often on swimming than learning.

My childhood in the suburban town of Chatham was idyllic. I was the only child of devoted parents, both of whom were deeply interested in the humanities. My father had a Master's in music theory and my mother a degree from the American Academy of the Dramatic Arts. (Even today, at age 90, she performs in the drama club at her retirement home; she never

ABOUT THE AUTHOR



Stephanie Farrell is Interim Dean of the Henry M. Rowan College of Engineering and Professor and Founding Chair of the Experiential Engineering Education Department (ExEEd) at Rowan University in the United States. She was a founding faculty member of the Department of Chemical Engineering at Rowan, joining the faculty in 1998. Dr. Farrell has been recognized nationally and internationally for contributions to engineering education through her work in experiential learning and promoting diversity

and inclusion, and has been awarded more than US\$7 million to support her research. She has led major institutional change projects at Rowan and nationally to promote participation of underserved groups in STEM. Dr. Farrell was the 2014-2015 Fulbright Scholar in Engineering Education at Dublin Institute of Technology (Ireland). She has been an active member of the American Society of Engineering Education (ASEE) and is an elected Fellow. Her several ASEE awards include the National Outstanding Teaching Medal and the Quinn Award for experiential learning. She was awarded Honoris Causa in Engineering Education from the Internationale Gesellschaft für Ingenieulpädagogik (IGIP), and has received that society's highest honor, the Nikola Tesla Golden Chain for achievements in engineering pedagogy.

lost her commitment to the arts.) Somehow, from their array of abilities in writing, painting, acting, and music, they managed to produce a daughter who wanted to be a chemical engineer and an academic! It was from them that I learned about not just finding passion but also the value of making a commitment to it. As all parents know, when their child commits to a sport like swimming, it's a commitment for everybody in the family. My mom or dad drove me to every swim meet, every practice, and made sure I never had a reason to shirk my commitments.

By the time I was 9 or 10, I started swimming for the local YMCA because they had year-round swim teams. It was my swimming home for the next decade. By the time I was in my early teens I practiced every day. Girls' and boys' practices were on alternating days—I did both—and I also did the daily morning sessions for adults. Is there a fine line between obsession and passion? Perhaps. I enjoyed getting better the harder I practiced. Looking back, I'm not sure I was aware of being focused and determined to become a top swimmer. It was simply that I felt I had to work hard and carry through on my commitment and meet my goals. One of those goals was to compete in national meets, and I achieved it, winning races at many of our team meets, breaking records, and swimming at the nationals in each of my four years of secondary school, though I never won a medal at that meet. Relays and team wins were particularly exhilarating; as I said, I loved contributing to the team, to something bigger, and was thrilled just to make it to that level.

I earned a place on the swim team at the University of Pennsylvania (Penn), and again, while I was not a champion swimmer there either, I was competitive. The team schedule was relentless; several times a week we started before dawn, practicing on average more than three hours a day, including weekends. I'm proud I was able to keep my commitment to the team while also doing a degree in chemical engineering, one of the most demanding curriculums. After more than a decade and a half of competitive swimming, one thing was clear: while I may not have been the best swimmer, I could achieve meaningful goals through focus and dogged persistence.

Of course, this lesson would prove to be invaluable in my academic life. In high school I found joy in studying history, languages, and literature, and I envisioned a liberal arts education, like my parents had had. It came as a surprise to me when one day my chemistry teacher, Mr. Desantis, asked if I had ever considered studying engineering. In my family there wasn't a single scientist or engineer, and I really didn't know what engineering was! But he got me thinking. I was excited by the idea of designing things for the betterment of society. I also heard that engineering studies were very difficult and that very few women chose it. The challenge appealed to me—I could tackle something difficult, something unique in my family and unusual for women. I still wouldn't really know what engineering was for many years, but I knew this was a new path that I could make all my own.

People often reacted strangely when I mentioned that I was studying chemical engineering, which amused me at first, but quickly became

tiresome as I realized their surprise was always based on assumptions of what an engineer looks like, and who should be an engineer: engineers were supposed to be white men. These comments came mostly from people outside the discipline, but it stung a little deeper when I once received this message from a professor. Overwhelmingly, I have found support within my discipline, but if there is one thing that will raise my hackles and set my jaw in determination, it is telling me I can't do something just because of who I am.

At Penn, I loved chemical engineering. It was exciting to learn how things worked, the science that could explain everyday observations, the math that could be used to model or predict observations and solve problems. However, as I entered my senior year, I did not feel drawn to a career in the chemical process industry or any of the other traditional paths I knew about. Then, that year I took a bioengineering elective course that caught my interest; I wanted to be part of solving major society societal challenges, to be part of something, well, bigger.

After graduation (and the end of my competitive swimming career) I worked on a WHO-funded project developing a needleless injector for measles vaccination with a goal of worldwide measles eradication. The principal investigator was Benjamin Rubin, who is credited with saving more than 130 million lives for inventing the bifurcated needle used in smallpox eradication. At that time measles remained one of the leading causes of death among young children, even though a safe and cost-effective vaccine was available. I truly felt I was contributing to something important,

and it got me thinking about graduate school. I had watched several of my classmates at Penn go on to pursue PhDs, but I always saw them as much smarter than I was. I will forever be grateful for Penn Professor Eduardo Glandt for giving me great advice on finding the graduate programs that were right for me. It was Eduardo's sincere interest in my career goals and his guidance that opened my eyes to an academic path I never would have considered.

Ultimately, I joined Dr. Kamalesh Sirkar's lab at Stevens Institute of Technology in New Jersey and worked on a project that aligned with my biomedical interests—drug delivery using microporous membranes, which resulted in a shared patent for a novel drug-delivery method. Kam encouraged me to explore opportunities outside my main research project, and during my first summer at Stevens, I had my first solo teaching experience in a program for high-school girls to explore careers in STEM fields. I wanted to teach them through a fun, relatable project, and I chose to teach them about the process of making beer. It was a big hit with the girls and revealed to me my new passion: teaching and experiential learning. When Kam got a position on the faculty at NJIT, I also went to continue my graduate research under his supervision.

Throughout grad school I sought opportunities to teach—through summer programs, as a teaching assistant, as an adjunct instructor. I wanted undergraduate teaching to be part of my career. However, some of my mentors cautioned against it, believing it could harm my future tenure and mobility. When Susan Montgomery from the University of

Michigan came to give a seminar on learning styles during my final year, I was surprised and excited to discover there was such a thing as engineering education research. That was when I first heard of the American Society for Engineering Education (ASEE), which would become a major influence in my academic career. Along with my good friend Ann Marie Flynn, from my chemical engineering department, I attended ASEE's annual conference in Washington DC. It was like discovering a whole new world! We attended talks on chemical engineering education, covering innovative ways to teach energy balances and thermodynamics, and process control. Something changed for us both: we had discovered a community of scholars with common interests and passions. I suddenly saw a career pursuing biomedical research and developing innovative ways to teach engineering. Maybe I could even combine them.

It was around that time when I met the man who is now my husband of 25 years, Peter Cole. I knew right away that he was "the one." Peter's profession as a software developer allowed for a lot of flexibility in his work location, so when I finished my PhD that year, I accepted a position as assistant professor at Louisiana Tech University (LA Tech). But after two years, I had a unique opportunity to help build a chemical engineering program in a new engineering college at Rowan University in New Jersey. The vision of the founding dean and chairs was to pioneer an innovative, hands-on, student-centered program. I was delighted to become

a founding faculty member; it was a dream job. This position also brought us closer to home, a priority because my father had been diagnosed with Parkinson's disease.

Our founding department chair, C. Stewart Slater, is a mentor and role model for me, and a great leader. He built a collaborative department in which every individual was valued and rewarded for their contributions. He was always looking for opportunities to support my growth at Rowan, increase my visibility in chemical engineering education, and recognize my accomplishments. The strong support he gave all his faculty helped shape my perspective on the type of leader I wanted to become. Stew introduced me to a network of leaders in chemical engineering education and helped me get involved in professional service activities including ASEE. We worked together closely for 21 years until his retirement in 2020.

Then came one of the most significant moments of my life. In November 2004, I sat in the car with my husband in the airport parking lot at Philadelphia International Airport holding an envelope. I had just arrived from a meeting in Texas, where I had woken up at 3 a.m. to catch the first flight home to share this moment with him. We opened the envelope and saw a photo of our baby daughter for the first time. We instantly fell in love with Lei Qingying, born November 12, 2003; the description read, "she has a ready smile." We traveled to China in December to meet and hold our daughter for the first time. She was remarkably easygoing, with

an infectious giggle and big twinkly eyes. She was always smiling. It was a very happy beginning for our family.

Within a couple of months, however, we realized something was wrong. My daughter's story is hers to tell, but I will share some of the work-life challenges that we faced as a family. We consulted with medical specialists at Children's Hospital in Philadelphia over several weeks while our daughter endured countless blood tests and other diagnostics. Her condition was ultimately not life-threatening, and we had a happy ending, but first we had a difficult journey over several years. She was unable to attend day care, so we had caregiving responsibilities around the clock, including throughout the night. Peter and I adjusted our work schedules to squeeze in short work shifts and take turns caring for Phoebe, whom we nicknamed "PQ." We throttled back our careers, making sacrifices every parent would make. Meanwhile, my dad's condition worsened, and he died in 2006. We were thankful that PQ's smile brought him joy in his last years.

Throughout this difficult period, there was always a fear in the back of my mind that my career could slip away. After about five years, Phoebe improved, and the medical appointments became less frequent. Finally, we could refocus somewhat on other things. I had lost some of my career momentum, and would have to rebuild. I wasn't sure how I'd do that.

A timely opportunity that helped me get back on track was when I was invited to be a NETI Fellow. I had previously attended the

renowned National Effective Teaching Institute workshop and found it to be transformative. NETI leaders Rich Felder, Rebecca Brent, and Jim Stice became instant role models and supporters as I envisioned ways to make an impact on engineering education. In my role as NETI Fellow, I co-facilitated NETI workshops and took a leading role on project-based learning. It led to new opportunities to lead teaching workshops around the world. The interest that Rich and Rebecca showed in me was just what I needed to regain my confidence, get back in the game, and get inspired to impact engineering education.

My service to ASEE also helped keep my career on track. Despite family matters, I had successfully served as chair of the Mid-Atlantic Section, and was then elected to the board as Zone Chair. During my first term, another unique opportunity came my way when Hans Hoyer, director of international programs at ASEE and secretary general of the International Federation of Engineering Education Societies (IFEES), invited me, as an ASEE Board member, to visit Kazakhstan to “explore opportunities for collaboration.” I didn’t fully understand what that meant, but I suspected there would be potential to build collaborations to benefit ASEE, Rowan, and engineering education. Three weeks later, I gave a commencement speech at the East Kazakhstan Technical University in Ust-Kamenogorsk. This serendipitous invitation to Central Asia resulted in years of collaborations and partnerships working with institutions in Kazakhstan on academic

mobility and international accreditation. At Rowan we hosted more than a dozen Kazakh graduate scholars in chemical engineering and chemistry, and currently we have a PhD student I first met when he was an undergrad at Al-Farabi Kazakh National University in Almaty, Kazakhstan.

Over the next several years, my network grew and I became more involved in IFEEES. This dynamic and collaborative group connects the world's engineering education societies to improve engineering education worldwide. Working with international colleagues was enriching, and expanded my view of engineering education. It also provided me the opportunity to meet more inspiring educators, who, like Rich Felder, became mentors and hugely influenced my career. When I was elected to the executive committee and served as vice-president for engineering education, I focused mainly on faculty development and effective teaching, and got the chance to travel to some 25 countries to exchange ideas.

In 2004 came a major step in formalizing engineering education as an academic discipline: when Purdue University in Indiana established the first doctoral program in the world. Soon after, other programs were developed at universities across the United States and around the world. A new generation of researchers was being trained in qualitative, quantitative, and mixed methods research in engineering education. I had an upcoming sabbatical, and that seemed like the ideal time to retool my skills by learning these research methods and collaborating across education

and social-science boundaries so that I could contribute to this emerging discipline. I was awarded the position of Fulbright Scholar in Engineering Education for 2014-2015 at the Dublin Institute of Technology (then DIT; now TU Dublin), and the following summer, I along with my husband, 10-year-old daughter, and 85-year-old mother flew to Dublin to spend the year in Ireland.

At DIT, my research focused on spatial skills in engineering that are strongly linked with success in STEM fields. Spatial-skill development is influenced by academic and nonacademic experiences throughout childhood and into adulthood, and spatial ability varies across race, gender, socioeconomic status, and culture—disadvantaging groups already underrepresented in STEM fields. I started to think more about diversity and making engineering more inclusive to those who have not had the same advantages and have experienced hostility in the engineering community. (Interestingly, my husband, who was earning a Master's in computer science, developed a training system to improve spatial skills. We have been collaborating on spatial skills research ever since.)

Meanwhile, Rowan's engineering program continued to grow in number and status, and with a new administration, the institution soon embraced a research mission with a great emphasis on growing a graduate program. Along with others, I was concerned about the impact on our traditional strength of undergraduate education. I also saw the opportunity

to develop a synergy among graduate education, research, and undergraduate teaching. I proposed forming a Department of Experiential Engineering Education (ExEEd) to serve as the caretaker of the undergraduate mission in the first two years of engineering. I became ExEEd's founding chair in 2016. ExEEd serves more than 600 undergraduates annually through an innovative, hands-on curriculum. Our faculty and students thrive in this collaborative environment: we have transformed our clinics into rigorous, inclusive courses that emphasize engineering in the broader context. We've received numerous research grants, graduated our first MSc student in 2018, and accepted our first PhD students the following year. I loved the direction ExEEd was heading and was very happy with the amazing and diverse team we had built.

It was around this time that I received a jolt: the headline of a letter from an ASEE member published in Prism magazine read, "Is All Diversity Good?" The suggestion that diversity is a bad thing instantly caught my attention. The letter rebuked a previous article in Prism that positively featured diversity in gender identity and sexual orientation through the stories of LGBTQ+ individuals in engineering. The letter, written by a male academic, asserted well-known homophobic myths by making dubious links between cause and effect. He asserted, "We would do well to teach the truth about the homosexual/lesbian/bisexual/transgender lifestyle." But I knew his truth was far from reality. This letter opened up a conversation

and a wider realization that bias against LGBTQ+ individuals is prevalent in STEM. Despite decades of efforts to broaden participation in STEM for women and other minorities, LGBTQ+ engineers have generally been left out of those attempts.

I am proud of ASEE's response to that letter, led by the diversity committee. We agreed with its final point—"we would do well to teach the truth"—and we embraced that challenge. Education is a crucial part of any successful effort to create inclusion and broaden participation. We launched an educational program called Safe Zone LGBTQ+ Ally Training, and with support from several engineering deans, we ran 12 workshops at the annual ASEE conference in 2014. In an effort to continue the success of this program, I wrote a proposal and was awarded the first-ever National Science Foundation (NSF) grant to broaden participation of LGBTQ+ students and faculty in engineering—a milestone for diversity in NSF history. I have secured funding for a second project to build on the original. It's a research-education/advocacy initiative that has created a visible network of some 1,300 allies through Safe Zone training, and has grown to a virtual community of practice with more than 50 active members who are advancing LGBTQ+ inclusion. The research has generated new knowledge about LGBTQ+ inclusion in STEM and the role of the community in the development of change agents. To broaden the impact of this work, we have partnered with organizations such as the American Institute of Chemical

Engineers, IFEEES, and others to offer Safe Zone training and best practices for inclusion in their membership.

After 20 years serving ASEE, which I've always considered my primary professional society, I was honored to be elected its president; my one-year term started in 2018. Since it's a short term, I had to quickly define a reasonable, achievable agenda. Issues I wanted to address included: How can we serve members better? Who are we serving well, and who are we not serving well? I wanted to involve members in these conversations and seek input from underserved groups. Roundtables were arranged, with interested representatives from groups including military veterans, LGBTQ+, low-income first-generation persons, persons with disabilities, graduate students, and non-tenure-track faculty (NTT).

These created a series of actionable recommendations for ASEE to better serve each group. For example, over my career I'd seen how NTT faculty—even the label smacks of deficit thinking—had been marginalized in many departments. We renamed it the more affirming “Professional Track Faculty.” Despite being trusted with the great responsibility of the education of our undergraduate students, professional-track faculty are often underpaid, undervalued, and don't have shared governance. Yet their professional development is essential to institutional missions and the education of the next generation of engineers. ASEE started a campaign to elevate their status, to include them in national faculty salary and profile

surveys, and to advance best practices and policies for their employment; the aim was to change perceptions and policies that have hampered recognition of their contributions. It is hard to bring about large institutional change and open minds to new ways of thinking in just one year, but I am proud that we opened dialogues and made progress for many underserved groups.

I was in my third year as department chair for ExEEd when our dean became provost and asked me to serve as interim dean. I started in July 2019. I embraced the opportunity to lead the college that had been my home for 20 years. Times were good—the college had experienced steady growth in research funding, established a new PhD program, and seen rapid growth in enrollment. We had great momentum. I wanted to continue supporting my longtime passion for engineering education and I felt it was the right time to look at other strategic areas— international programs, interdisciplinary collaboration, and diversity, equity, and inclusion—that would support our mission and advance engineering education.

But things do not always unfold as we expect. The world changed in the spring of 2020 when the COVID-19 pandemic brought upheaval and created significant challenges within higher education. As cases spiked in New Jersey—one of the states hit hard early in the pandemic—universities were shut, and students left campus at spring break and were not allowed to return. Rowan, like so many institutions around the globe, scrambled to transition to online learning to finish the spring semester. Labs were

hibernated, and budgets were frozen. The daily life of a dean became mired in myriad details in uncharted territory. Even as the pandemic rages on, we are leading the university through the crisis surrounded by uncertainty—about the trajectory of the pandemic, the financial forecast, enrollments, and how immigration rules will impact our international students.

I have tried to define a leadership style that takes a people-first approach by using empathy and compassion while considering how decisions affect those with privilege and the disadvantaged. I know that to lead as dean I must rely on the knowledge and skill of others who are more experienced. I have nurtured networks both inside and outside the university. For example, I have found other deans at Rowan to be very supportive and collaborative, and we have developed common approaches to planning and problem solving. A network of engineering deans from ASEE has also been very valuable. By involving stakeholders, I've created solutions that truly serve the needs of people in the college. My hope is that with values-centered leadership I can help maintain security and stability.

A crisis can change normal operations, but it does not change values! I hope to think beyond the crisis, and develop a vision for a robust and thriving college post pandemic. It's important we resist being trapped in daily tasks and failing to look beyond the crisis. The pandemic is disrupting every aspect of the status quo, and our success depends on our agility—and our ability to accelerate the change necessary to keep higher

education relevant.

I often think back to my days in the pool, the need for commitment to the team, the need to be diligent and consistent in both effort and dedication, and the importance of working toward a goal. Though I'm well into my career, these lessons, and those I learned from my parents, are still guiding me and paying off even as I encounter new, unexpected challenges.

JOURNEY 7

VERSATILITY IS CRUCIAL FOR SUCCESS

IRENE CAMPOS GÓMEZ

Minister of Housing and Human Settlements

COSTA RICA

I am a civil engineer who graduated from the Universidad de Costa Rica with a Master's degree in environmental engineering from Ghent University in Belgium. Professionally speaking, environmental engineering is one of my greatest passions: It perfectly combines infrastructure development, communities, and the environment, which are all considerations that must be taken into account to have sustainable development. Through this engineering perspective, the economic, social, and environmental variables are easy to understand.

I have been Minister of Housing and Human Settlements in Costa Rica since 2018; my four-year term is to end in 2021. This is my second time in this position, as I previously occupied this office during President Laura

Chinchilla Miranda's administration in 2010. This second opportunity to be a minister has given me great satisfaction as I am working with a very committed team at the ministry. This has enabled us to work on new and innovative ways of tackling informal settlements, and the problem of housing in my country in general.

I was born in San Jose, Costa Rica, and raised in a small town called San Rafael de Oreamuno, in the province of Cartago. While my hometown is located close to an urban center, I consider it to have been rural, located as it is on the slopes of the Irazú volcano, an agricultural and livestock

ABOUT THE AUTHOR



Irene Campos Gómez, a civil engineer, graduated from the Universidad de Costa Rica in 1988. In 1992 she obtained a Master's degree in Environmental Sanitation from the University of Ghent in Belgium. Since 2018, she has been Minister of Housing and Human Settlements in the government of Mr. Carlos Alvarado Quesada, a position she held in the administration of Mrs. Laura Chinchilla Miranda from 2010 to 2012. She is a professor in the Faculty of Engineering at UCR.

When Irene Campos was elected President of the Unión Panamericana de Asociaciones de Ingenieros (UPADI) in 2009, she became the first woman to hold this position. She led UPADI until 2013, and during her tenure, promoted professional mobility, young engineers, anti-corruption, and gender equality. She also supported the Think in America initiative: In Costa Rica, the Colegio Federado de Ingenieros y de Arquitectos undertook this project and today, it's planning strategic infrastructure that contributes to Costa Rica's energy, transportation, and land-management sectors. Irene Campos currently chairs UPADI's Advisory Council.

In October 2019, she was appointed as President of MINURVI—the entity for coordination and intergovernmental cooperation of Latin American and Caribbean countries—in the area of sustainable development of human settlements.

area. I grew up close to agricultural activities—my maternal grandfather was both a teacher and a dairy farmer—but when I was growing up, he dedicated himself more to farming. For these reasons I have a very close affinity to everything related to agriculture, nature, and the value of the land; not only are these things treasured childhood memories, to this day they have a very special place in my heart.

After attending Jesús Jiménez elementary school in Cartago, I went to Calasanz high school in San Jose. This is a school run by Piarist priests who, though they practice very strict and rigorous discipline, they also taught students about social service. In fact, they had a night school especially for young people who had problems attending high school, and gave full scholarships to these students. This was a time of great learning, and I had the opportunity not only to prepare myself for an academic future but also to learn about many social skills, including how to collaborate with others, be empathic, and stand together.

I graduated, and then was accepted to do post-secondary studies at the Universidad de Costa Rica. This is a public university with a reputation for high standards both nationally and internationally. I had thought I would study architecture—it was one of my first options—but, sometimes life surprises you, and for reasons I cannot explain, I decided to study civil engineering. And when I took the environmental engineering courses, that's when I knew my vocation: I thought to myself, "This is my real passion. It's

what I want to do professionally.”

From a family perspective, I have always had the support of my parents, and of those close to me, in whatever I chose to do as a profession; engineering was never considered by them to be something only for men. I was fortunate in my family history, because although my grandmother hadn’t had the chance for an education—she did not even complete her secondary education.—she nevertheless made sure that her daughters (my aunt and my mother) not only finished their secondary education, but also pursued a university degree. My mother even earned university degrees in addition to the one that eventually led to her first career as an elementary school teacher. This truly shows my family’s interest in and commitment to the educational development of all family members.

Speaking of my profession, I must say that environmental engineering is very special in that it is multidisciplinary and requires working collaboratively with other professionals in different areas, including biology, sociology, and, of course, engineering. That is, it requires basic sciences, applied sciences, and definitely good communication and comprehension skills. These skills have truly been valuable in my professional life, as empathy and understanding have permitted me to think outside my paradigm and place myself in others’ shoes so that I can really understand their personal needs when facing a specific situation. These skills have been key in my career when I have worked as a manager and when I have been in political

positions.

Being in environmental engineering presented an interesting challenge. I obtained my degree in 1992, the same year that the third meeting of the United Nations on environmental issues was held in Rio de Janeiro, Brazil. The outcome was the famous Rio Declaration that outlined 21 principles around the environment and development (for example, sustainable development, and using instruments like environmental impact assessments). So of course when I graduated from civil engineering in 1992—a profession traditionally focused on building, infrastructure design, and construction—specializing in development and the environment was considered very top-of-mind and innovative, not only in Costa Rica but around the world.

From that point of view, it has been difficult to date to reconcile environmental interests and the vision of sustainable development with civil engineering. In my opinion, today's generations are clearer on this, but it has represented a challenge throughout my professional practice. Definitely it is a challenge that I have been passionate about. I have always worked with the conviction that sustainable development is what the country needs, and of course what the whole world needs, too.

My first job after graduating from the university was at the Instituto Costarricense de Electricidad (ICE), the institute that provides electricity and telecommunications in Costa Rica. There I had the opportunity to

work with impressive professionals in engineering whom I consider today to be my mentors. They enriched my experience and knowledge. I had the chance to work in different areas, and there was one area in particular where I worked with the private sector in the development of renewable private hydroelectric projects. It was a very meaningful experience as I had the opportunity to understand the professional practice from the private sector's point of view, and not only from the government perspective. The experience proved to me that private and government alliances can work together to achieve great national goals.

My profession has given me the opportunity to occupy varied positions. Each place I have worked has helped me grow in all aspects. In 2002 I became president of the Colegio Federado de Ingenieros y de Arquitectos, a Costa Rican professional organization that brings together all engineers and architects and regulates the practice of both professions. I had the professional challenge of leading this important organization for two years. I say "challenge" because engineering is a profession that is undoubtedly dominated by men, and this is truly a challenge when it comes to leadership, because women simply have a different leadership style. It's neither better nor worse than that of men; it is simply different.

There is a long-held presumption about male leadership: that it should be strong and authoritarian. Women, on the other hand, tend to practice a more conciliatory leadership, listening to and accepting more

opinions from the people around them. This, in my opinion, is what makes the leadership styles of men and women so different.

As I mentioned, it was quite a gratifying experience to be in that position and therefore be able to see that the female leadership style motivated engineering and architecture professionals, and in fact was key in the execution of different important projects for the organization.

In 2009, I was the first woman elected president of the Pan American Association of Engineering Societies (UPADI) for a four-year term. Indeed, this was a very special experience for me that began with the election process itself. There were two candidates: a Mexican engineer and myself. It was a very interesting fight from the electoral point of view, since a man and a woman were competing. For some members of the assembly, the fact that one of the candidates was a woman was important—a big step forward—and for others the prospect of a woman president was simply not the leadership they wanted. Yet, I was elected—though it was a very tight race in which I won the presidency by just a few votes. I knew I'd have a challenge to win over those who didn't want a female leader.

But things went well. I must say that being the president of UPADI for a period of four years enabled me not only to work with high-level professionals around the world and learn more about the engineering reality of their countries, but it also enabled me to carry out several projects that had Pan American impact. The organization's management now had a

different twist, not only because of the leadership I practiced as president but also because of the important support given by the Colegio Federado de Ingenieros y de Arquitectos de Costa Rica that served as UPADI headquarters during this time.

I had to think long and deeply before accepting the post of Minister of Housing and Human Settlements in 2018. The main reason was that, from a political point of view, the party that won the presidential election was one to which I really did not belong. So I was struck by the fact that, despite this, they asked me to join their cabinet.

We had a lot of discussions before I accepted. We talked about the objectives and goals that were set for this area and we totally agreed on many points. This motivated me to accept the post and I have been able to carry out a series of public policies thanks in part to the government's political will. I have been lucky to have a very committed team.

Knowing that God puts us into situations that call us to participate helped me take the decision to accept the position of minister. It is not common that for a second time I was being given the opportunity to be a minister of state. So, I decided that I would once again work hard with the team to carry out pending tasks and achieve our goals.

While working as my country's Minister of Housing and Human Settlements, in a government of consensus where the priorities and main goals are to do what is best for the country—not so common in the world

today—I have found support in cabinet. Together with other ministers we work very hard to find different ways to safeguard the health and well-being of the Costa Rican people, and we are working especially hard to get the country through the COVID-19 pandemic. Together, we are striving to find a way to keep our ship afloat, and to stay as safe as we can from the economic consequences of this situation.

Undoubtedly, when one starts a career in civil engineering, particularly in my case, one doesn't really know what practicing it professionally will actually be like. One of the reasons is that engineering education tends to be more oriented to technical teaching—yet, if you really think about it, civil engineering is a very social profession. Everything you design, everything you build, will benefit society. Whether it's a road, aqueduct, or house, it is done to benefit a nation, a community, a family, or an individual.

When you get to understand how this profession is linked with people and society, you realize there are many ways in which you as an engineer can contribute to the community. Helping create political policy is one of many ways we can contribute: by applying a technical point of view. Indeed, the career opportunities I've had have been endless, and they have allowed me to grow and mature, to face life's problems, including personal ones, with much more ease and strength.

I would definitely encourage any woman to become an engineer,

particularly a civil engineer. And because I am so passionate about my career, I would take it one step further: I invite her to become an environmental engineer.

JOURNEY 8

BECOMING AN AGENT OF CHANGE

JUN DONGOL HADA

*Senior Programme Officer, Swiss Agency for
Development and Cooperation (SDC)*

NEPAL

I believe that everyone is born with a purpose in life on this earth. I chose to be who I am and to do what I am doing, both professionally and personally. In my work with the development organization Swiss Agency for Development and Cooperation (SDC), I manage a very important portfolio focused on rural transport infrastructure and the development of roads and bridges in Nepal. Access is very important for all of us, but especially to the people of Nepal, which is a mountainous nation; access, thanks to transport infrastructure, provides opportunities and information, and allows us to further progress in life and contribute positively not only to the community we live in but to the nation and the world we belong to. When I say that today I am professionally content

compared to many Nepali women scientists and engineers, I truly feel that I achieved this only through my continuous hard work and perseverance.

Looking back to when I was growing up in Kathmandu in the 1970s and '80s, I realize I was extremely shy and naïve. I was an average student until I was in senior school. I think my elder siblings and their ambitions had a positive influence on me; my elder sister, for example, knew from her early childhood that she wanted to become a doctor. She did reach

ABOUT THE AUTHOR



Jun Dongol Hada's background is architecture and urban planning, but for almost 20 years she has worked as a rural and urban planning development professional in Nepal. She is involved in transport-sector development, particularly on rural roads and bridges. Her work has also focused on alternative and non-motorized transport, renewable and clean energy, and urban environmental services.

Jun has worked with national and international development organizations, including the United Nations Development Programme (UNDP) and Practical Action Nepal (a United Kingdom based NGO), in the capacities of Programme Specialist and Programme Team Leader.

Jun has consulted with multilateral and bilateral development organizations—such as the World Bank, World Health Organization, Asian Development Bank, and the Department for International Development—in various capacities. She has been active with networks including the International Forum for Rural Transport and Development, Nepal Forum for Rural Transport and Development, Clean Air Asia Network, Indoor Air Pollution, and Health Forum Nepal. With them, she has worked in policy advocacy and knowledge sharing on issues related to these areas.

Jun is a founding member of Women in Science and Engineering (WISE) Nepal. She has been passionate about narrowing Nepal's gender gap in STEM education and careers.

that goal, and she specialized in gynecology, but unfortunately, she didn't live long enough to achieve more success. My elder brother, who is now a well-known architect in my country, also knew from childhood that he wanted to become an engineer. As for my younger brother, he was always attracted to big engines and machines like fire trucks, and ever since he was a kid he was focused on becoming a pilot. He is now a senior captain who flies for a renowned commercial airline – Buddha Air in Nepal.

It was only me who never had a focus for what to be when I grew up. Although my mother wanted me to become an advocate or a lawyer, I was never interested in this area. I was never good at making arguments assertively. I grew up playing marbles, seven stones, badminton, table tennis, wheel and stick, and skipping ropes with my brothers outdoors. I never had a Barbie doll to play with when I was a child. My parents raised the four of us under a great deal of hardship. My dad, a civil engineer, was the only income earner while my mother was a homemaker. Both of my parents strongly believed in investing in the education of their children, so they supported us in every way they could by sacrificing their own happiness. While growing up, in addition to doing our regular school work, my sister and I were also required to help our mother in household chores including cooking, washing dishes, laundry, and house cleaning, while our brothers were free to play and do whatever they liked. Being born a boy is much more privileged in Nepalese society, and my own house was not

an exception at the time.

My academic mediocrity changed once I went to senior school: suddenly, the pressure in school and at home rose, especially because both my elders always ranked high in their classes. This really changed me, and I began to study more and work harder. It wasn't long before I was one of the top five in the class, which encouraged me to achieve more. I was encouraged by my maternal aunt, who was a family doctor and later became a specialist in gynecology; she was very focused on what she wanted to do in life, and I always looked up to her. She dedicated most of her career in service to the people of Nepal, and spent a few years in Nigeria in the late 1970s with my maternal grand aunt (who is an anesthetist) in the World Health Organization's resident missions. These women were my role models when I was growing up: not only were they doctors, they were independent women earning their own money, helping support the families, and most importantly, they were highly respected. Their discussion about their work used to fascinate me.

While in senior school, aside from studies and regular classes, I kept up my hobby of singing. I was in the chorus for the group of dancers competing in high-school competitions; I'd often entertain fellow students and friends by singing in school programs. I was also into spelling bees, winning many competitions; in high school. I even won a medal from the late Queen of Nepal for winning in the spelling contest. As for high school

academics, in Nepal we do the school leaving certificate (SLC) examination given by the National Education Board before entering a higher level of secondary school (grades 11 and 12). This is the moment when you are set on your life path: when it's determined what stream of education you will pursue further.

I was not sure what I would be studying until the day the results of the SLC exam were announced. Unexpectedly, I stood as one of the top three students among all girls nationwide, and my name was announced on the radio on the 7 a.m. morning news! My father was away on one of his work sites, so he missed the news broadcast, but the rest of us at home heard it. Back then, although we had a radio, we did not even have a telephone in our home—only a few elites owned them—so there was no way of letting my father know of the results.

I was just relieved that I didn't have to check the thousands of serial numbers published in *The Rising Nepal*, a government-owned, government-run paper, to find out if I passed or failed. When my father came home at midday, he brought home the newspaper with the long lists spanning 20 sheets so he could check whether I passed the exam. So when my mother excitedly told him of my results, he was overwhelmed. Soon after, my school requested that I go there because journalists were waiting to interview me about the results. I wasn't prepared, but of course, I went to meet my teachers to thank them, as well as to meet the media. One asked me what I

would like to become in the future, and that question was a turning point. I quickly searched for an answer: I flashed back to my mother telling me to become a lawyer, which I was never into. Then I recalled that there were already two generations of women doctors and professors in my family, with some, such as my sister, still in the making. So, I immediately thought I should become something different: an engineer—the first female engineer in the entire family, including both my father’s and my mother’s side. “I’ll pursue engineering,” I told the journalist, and that was published in the news the next day.

Well, from then onwards, I was determined to become an engineer. I was offered a scholastic honor by the Queen Mother at the Royal Palace along with the two other girls who came first and second. I took the science stream with physics and mathematics as majors, and got a scholarship for one of the most prestigious science colleges in Nepal. However, I did not much like the subjects once I started studying them; I didn’t like the way we were being taught, as students weren’t allowed to learn the practical ways of applying the theories in everyday life. The teaching was basically a one-way street: giving notes to the students plus model questions, and students mocking up the notes and practicing the model questions, rather than learning the real fun of science and math. There was little, or no, interaction between the professors and students.

So I decided to take a BSc in architecture in the Philippines. I

enjoyed my studies, and always strived to get good results through hard work and many hours of research. Back then, there was no internet, and we relied heavily on the library and archives for our research. During my final year, I spent a few months doing an internship at a Philippine-based architectural firm to learn detailed drawings of buildings and how they are practically executed at sites.

I returned to Nepal and started my first job as a project architect at the firm of one of the most prominent architects in Nepal, Tom Crees. I learned a lot from my boss, who became a mentor, pushing me to my limits in bringing the best creations with attention to detail. For me, architecture is about playing with the natural environment and human scales to create social harmony. I later joined my brother's architectural firm to learn more about the different functions of an architect, from drafting drawings on the table to meeting clients, presenting ideas, laying out the building for the contractor, supervising contractors' work, checking lines and levels, measuring works and workmanship, and problem-solving at sites. It was all very exciting. But architects were not paid well then, though it's now better than it used to be. I realized that works of art and architecture are not highly valued, and I thought that with such a low pay-scale, it would be difficult to sustain life in the long run. So I decided to do post-graduate studies at the Asian Institute of Technology (AIT) in Thailand to study urban planning in the School of Environment, Resources and Development

where I received a NORAD (Norwegian Government) scholarship.

Coming from an architecture background, I was interested in studying city structures and the blueprints of exotic utopian cityscapes and designs. To my dismay, the curriculum was very interdisciplinary, covering statistics, economics, human settlements, and urban planning. It was more the study of policy planning than spatial planning. But I became interested in learning why some policies fail while others succeed, and how decisions are made and implemented. I came to realize that because many policy decisions are highly political, they have to be strongly backed by sound financial, economic, environmental, and technological rationale if they are to benefit people. That's where engineers, planners, scientists, and technologists have roles: to either support or not support the political vision. Sometimes political leaders listen to these rationales, and sometimes they do not. Policies either succeed or fail depending on what kind of political leadership your city and your nation has.

At AIT I made many new friends from across Asia, all of whom were very concerned about how their politicians were running their countries and their economies. There was so much to learn, so much we could share among our countries. In South Asian countries in particular, political instability and corruption were major reasons behind the region's low economic development compared with East Asian and Southeast Asian countries. At that time, in late 1990s, countries like China, Korea, Vietnam,

Taiwan, Malaysia, and Thailand were already on their way to becoming the economic giants of Asia, whereas most of the South Asian countries were under-developed, fighting extreme poverty and dealing with their own internal conflicts.

During my final year, a group of about 12 of us got financial support to visit Malaysia, Hong Kong, and Singapore on a study tour. Having grown up in a landlocked country and having not flown anywhere except for India, Thailand, and the Philippines, I was so impressed by the transport network that connected the three countries by both sea and land. That was my first experience travelling by train, which I consider one of the most efficient public mass transportation systems because it connects thousands of people socially and economically. The mixed-land-use systems in Malaysia and the stricter land-use systems in Hong Kong and Singapore really made me think about what it takes to make things work for the people to better a nation as a whole. The ways that urban policies are put into practice in these countries are unbelievable. We saw how urban fabrics worked harmoniously, from low-income settlements, to street vendors, to the high-end central business districts merchandising branded goods and high-end services in all three of these countries. How they managed to integrate poor families in the city is amazing.

Fascinated by studying the countries' economic development policies, I became very interested in being a development practitioner. Soon after

getting my master's degree, I returned to Nepal and applied for a job at the United Nations Development Programme(UNDP), and was offered one based in Tansen Municipality to assist with the technical advisory services related to urban-economic and social-development plan formulation and implementation. Tansen is several hours away from Kathmandu by land transportation, and about three hours away by a combination of land and air transportation. It had been only a month since I had married my love (who is also a civil engineer by profession, and now works as an international disaster-management expert), and already I had to leave my home city, my new husband, and my family for this job. Yet it was a very important opportunity for me.

In the beginning it was quite difficult for a young woman under 30 to live in a small city, renting a room alone. My courage, determination and focus on work really helped me deliver in my role as an advisor to the municipality. It was an enriching experience for me to learn about how the local government in Nepal works. It was my first time working with politically elected leaders—ward members, chairs, and the mayor. I learned from them how to interact and how to do public speaking; my job required frequent public consultations, meetings, hearings, and interactions, since we were promoting participatory planning and decision-making processes. I had to manage a team of nine people. Being a young-woman boss who had to manage several men about the same age or older was at times challenging.

I learned about the importance of teamwork—giving them space, listening to them, having empathy—while at the same time, sticking to my principles and maintaining integrity, which has always helped me hold my head high. I never knew how powerful a mayor is in a municipality, and how important the mayor is in the development of a city. Nevertheless, there were also difficult times dealing with political pressures. I learned to stand by my principles, which sometimes did not please everyone.

Though the program was running well, I had to leave my job after a year and a half due to a family health issue; I had to choose between the health and well-being of my husband and his mother over my career. I chose the former and left this very interesting job. My husband and I took his mother to Delhi, India, for the treatment. After her recovery, I started looking for a new job. Initially it was very difficult as I had little more than one year of work experience. However, I didn't give up; I applied to every possible job vacancy announcement related to what I wanted: a career in development.

Finally, I was offered a job as a human settlement specialist in a team of urban planners, economists, environmentalists, and social development specialists to work on a city development strategy for Metropolitan Kathmandu. The project was funded by the World Bank. This gave me the chance to work very independently while still on a team of both young and senior experts. I learned to value the opinions and experiences of

senior experts, and I realized it is not the academic degree that makes the professional; it is the practical work experience that one gains over the years that grooms someone into competency.

In the meantime, I had a baby boy, and that put my career temporarily in the back seat. I took a year-long break to look after my son, who was born with congenital pneumonia and a clot in his brain due to hypoxia, had to be admitted to the neonatal intensive care unit for 14 days after his birth. Because of his lower immunity, I needed to be with him throughout his infancy. During this period, I took up mainly home-based assignments as a consultant. I did work for development partner organizations like the World Health Organization, Action Aid, and the Nepal branch of CARE, the international non-government organization (NGO); this required only minimum field work, allowing me to attend to my child. After a year, when I stopped breastfeeding, I began a regular job again with UNDP, working on different development projects. I have been lucky to have a very supportive husband who understands my work demands and was always ready to take over the family-care burden when needed. This allowed me to travel to the field without any hesitation and to move forward on my career path.

Along the way, I got a very important breakthrough: I was offered a team leader position to manage the infrastructure program for the International Technology Development Group (ITDG, now called Practical

Action), one of the most esteemed international charity organizations of the United Kingdom. I took over the leadership of the infrastructure program with a team of three project managers, all of them men, who were in charge of small projects in the areas of transport, renewable energy, and air pollution mitigation. I knew it was odd for these men, and in the beginning, I could sense they were waiting to see me fail; they probably had not accepted that a woman leader would manage them.

Against all odds, and in a very challenging environment without much support from my fellow team members in senior management—all of whom were men—I became a successful fundraiser by diversifying the program, and I grew the infrastructure portfolio from an annual budget of GBP50,000 to half a million GBP annually. I had more than seven project managers (including one woman, at my insistence, for more inclusivity) and 25 project officers and assistants across the country within a tenure of five years. I received a Global Leadership Award (presented by the Partnership on Clean Indoor Air, supported by the United States Environmental Protection Agency) on behalf of the team for our evidence-based, research works on indoor air pollution, health, and household energy.

I travelled across Nepal to the rural and urban areas for project-monitoring, consultations, training, and capacity development to work with partners, and I really enjoyed it. I also travelled across different continents and countries for cross-learning, policy dialogue, and advocacy

with development partners. There were multiple fora with like-minded organizations; not only was that good exposure, it was excellent for the purposes of training and knowledge-sharing. I gained a wealth of experience managing diverse programs in the areas of urban environment focusing on water, sanitation and waste management, indoor air pollution and health, renewable energy focusing on micro-hydro, wind and solar power, and rural transport focusing on alternative means of transport systems, such as ropeways, waterways, and bicycle-based modes of transport. These exciting areas have introduced me to many people in many different countries.

Because of having a science and technology background, I was always results-oriented and focused on delivery. I was among the founding members of fora like the Nepal Forum for Rural Transport and Development (NFRTD) and the Indoor Air Pollution and Health Forum Nepal (IAPHF-N). Because of the works of these organizations, Nepal has made good progress in curbing indoor air pollution in rural households with the introduction and scaling up of cleaner and more efficient cook stoves. But there is still a long way to go to promote cleaner and more sustainable transport systems and engineered roads in the rural areas of Nepal.

Thanks to my engagement in NFRTD, I probably got noticed among the key stakeholders working in the transport sector, especially since there are very few women engineers and professionals involved in the sector even now. I was called by a friend to check out a vacancy announcement at the

SDC for managing the rural transport portfolio. I thought it would be a leap forward to go from working in an international NGO to working with a bilateral donor and a very trusted development partner of the Nepali government. I applied and competed for the position against many other promising men and women candidates. I was selected, and started the job in late 2009.

So, after working for about five years with Practical Action, I had a new beginning: working directly for the government of Nepal to assist in rural transport and development programs and policies on behalf of the Swiss government. I was not new to the stakeholders, including my government counterparts and others from our key development partners, including the Department for International Development/United Kingdom, the Asian Development Bank, the World Bank, and the Japan International Cooperation Agency.

It has been a wonderful and stirring association with SDC for more than 10 years to have assisted in building more than 4,000 kilometers of engineered roads, more than 8,500 footbridges, and more than 350 bridges across the country in those years. It is so elevating to have worked closely with hundreds of engineers and technicians, who, in this sector, are mostly men. I had to travel frequently across the country for missions—and never have I felt that I was underestimated or treated differently just for being a woman. One of the reasons for this is because SDC has a very strict human

resources policy for treating men and women equally, and there is zero tolerance for any sort of discrimination. This was extremely important if an organization is really walking the talk of eliminating discrimination and promoting inclusion. Strength in diversity and inclusion is what I embraced from SDC's values.

Realizing how low the representation of women engineers is in the transport sector in Nepal, with the support of my line manager, I worked with my project managers to start internship/traineeship programs for new women engineering graduates to promote them in this sector. Since 2009, we have trained more than 65 young female engineers in roads and bridge engineering. I am so proud to see that many of these young women engineers have received better opportunities outside of the country for jobs and for further studies, and some have joined the government of Nepal's civil service. We have also retained some of them for our projects at SDC, where they help our teams with the design and execution of roads and bridges.

Around 2013, I was introduced by my former Practical Action boss to the members of Women in Science and Engineering in India (WISE India). Since then, I have known the International Network of Women Engineers and Scientists (INWES) and its regional networks via the Asia-Pacific Nations' Network (APNN). I believe in the values and objectives INWES and APNN. Therefore, as part of the INWES-APNN, I together with the members from India went on to form national chapters in South

Asia with member countries from Nepal, Bangladesh, and Sri Lanka. I started up Women in Science and Engineering in Nepal (WISE Nepal) with a vision to bring together women scientists and engineers here to promote more women entering science, technology, engineering, and mathematics (STEM) education and careers. WISE Nepal is an institutional member of INWES and APNN. It works both at the grassroots by counselling and orienting students in making the right education choices, and at the policy level by removing barriers that hinder women to stay in, and progress in, STEM professions. With continued pressure from WISE Nepal and its allies, especially the United Nations Office for Project Services (UNOPS) and the United Nations World Food Programme (UNWFP), the Nepal Engineers Association (NEA)—a Nepali professional organization for engineers—has formed a Women Engineers Subcommittee (WES) to work closely on the issues of gender inequality in the engineering profession. Together, we pivoted our engagements to bring in more role models to share their stories and successes in order to inspire and encourage more women in this field.

Of course, 2020 has been a very challenging year because of the situation brought about by the global pandemic. It has heavily impacted not only our physical health but our mental health, and the social and economic well-being of men and women alike. However, it has also created an important opportunity for all of us: to adapt our way of doing things, and to continue delivering results despite working remotely. Definitely,

scientific communities all around the world will soon bring the solutions needed to end the negative impacts of this pandemic.

I hope my mother and sister are still watching from the stars above and blessing me as I climb up these ladders of professional successes and act as an agent for change in our society.

My last message to all young women out there is this: Believe in yourselves, and know your north star. You can rise to the top.

JOURNEY 9

A SERENDIPITOUS JOURNEY

MASOUMEH NASIRI KENARI

Professor, Electrical Engineering Department,
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IRAN

The position I find myself in is the result of a multitude of opportunities and challenges that have come my way, as well as a series of seemingly fortunate and unfortunate events. Something that has stayed constant in helping me throughout my life's journey, however, has been my independence, persistence, and self-motivation.

I was born and raised in a small city, Fereydunkenar, in the north of Iran close to the Caspian Sea. Mine was a caring and traditional family, with me being the second eldest of six children: five girls and one boy. Although my parents had completed only elementary school education, they were very passionate about their children's education, especially that of their girls. My father had a peculiar ability in math and had a business

of his own, while my mother, a housewife, loved reading.

One summer day when I was around age five, I was playing at a neighbor's house. My little friend's aunt was giving a reading and writing test to a first-grade child, age seven. I was listening, and I asked if I could take the test too. She accepted with a mix of amusement and curiosity and gave me a paper and pencil. When I scored full marks, she was so excited that she ran to my house to tell my mother. At night, when my father heard the story, he decided to enroll me in first grade even though I was not due to start school until age seven. This was no easy feat since, at that time,

ABOUT THE AUTHOR



Dr. Masoumeh Nasiri-Kenari is a Professor of Electrical Engineering at Sharif University of Technology (SUT) in Tehran, Iran. She received her B.S. and M.S. from Isfahan University of Technology, Iran, and her PhD from the University of Utah, United States, in 1994. In 2001, she founded the Wireless Research Laboratory in the Electrical Engineering Department to coordinate wireless communications research. From 1999 to 2001, Dr. Nasiri-Kenari was a Co-Director of the Advanced Communications Research Laboratory, Iran Telecommunication Research Center. She was

Director of the Advanced Communications Research Institute (ACRI), Director of the National Center of Excellence in Communications Science, and Vice-President of Graduate Studies Affairs in SUT's Electrical Engineering Department. She currently serves on the department's faculty recruitment committee. Dr. Nasiri-Kenari is the recipient of several awards, including SUT's Distinguished Researcher Award and Distinguished Lecturer Award, Distinguished Scientist of Mazandaran Province, and Distinguished Professor in Engineering from the Iranian Academy of Science. She was chair of IEEE Women in Engineering (WIE)-Iran Section from 2012 to 2016. She's currently a member of the WIE Task Group of the Iranian Academy of Science and a member of the Iranian National Science Foundation (INSF) Engineering Committee/Workgroup.

there were no private schools in my hometown or in neighboring cities; there was only one public elementary school for girls, and one for boys.

So my father took me to another city to make the arrangements. On our way, while holding my hand, he told me that he was trying to send me to school early so that I would grow up to be a doctor, a gynecologist. I was terrified by the prospect, as my perception of a doctor was someone who administered injections. But I said nothing.

And so it was that I started school at the same time as my older sister. She was much taller than me and whenever she didn't get good grades, she was often told by teachers that she should learn from me—obviously, child psychology had no place in our small town! Despite the unpleasant comments, my relationship with my sister remained strong. In fact, she was one of my regular “pupils,” along with my other siblings, cousins, and neighbor's children, as I helped them prepare for exams. During elementary and then middle school, I demonstrated a special ability in mathematics and problem solving that was much admired by my teachers. Solving difficult problems became my hobby and even won me a pen as an award from the Chair of Education in our region. The Chairman's pen and his kind words made me deeply excited and proud.

In my first year of high school, I had to decide which field I wanted to pursue. Out of the three available options, I selected math and physics, knowing that I would be unable to enter medical school with a diploma

in math and physics. I didn't share with my father the reasons for my choice; I just told him that getting a diploma in math and physics was more challenging and only the very good students had selected this field. And this was actually true at that time. I had to travel to another city for high school, which was an hour-long bus journey. I remember thinking about geometry, arithmetic, and calculus problems on that bus. Solving a problem in my head brought a world of excitement to me, a world that was mine alone to cherish.

All of the children in my family had chores and responsibilities. I was tasked with washing the dishes, which suited me well: I immersed myself in problem solving while I immersed the dishes in soap bubbles. This was a fantastically peaceful time, only broken when I had a eureka moment, at which point I'd drop the dishes and start dancing.

I was much inspired by my high-school physics and math teachers who told me that I could easily enter any university in any field of study. "But," they asked hesitantly, "will your father let you study engineering?" The question played on other people's minds, too. I wanted to enter a course in engineering because my perception of the subject was one that entailed creativity and challenge. At the time, a course in computer engineering had just been launched in two top engineering universities in the country. I loved the challenge of a new field, and thought this could be my best choice.

None of my cousins, other family members, or acquaintances had

ever been to university. Your result on the national university entrance exam determines the university and course that you are eligible to apply for, and I achieved a high score. This brought a smile to my father's face that I will never forget. He was, in fact, very happy for me to study engineering and even happier to know that I was the first among both boys and girls in my town to enter engineering school. Much to my delight, I gained admission to computer engineering at my first choice, Isfahan University of Technology in central Iran. It would be my first time living away from home.

But this was 1979, and change was in the air in Iran: My stay there lasted only two months, due to the start of the Iranian Revolution. Universities closed, and I had to go home. They did open up again a few months later and I returned to the beautiful Isfahan campus where I enjoyed campus life and felt very much alive. However, in the second year of my undergraduate degree, all universities were once again closed—this time for two years, due to a so-called cultural revolution. This period was devastating, especially for students like me in small cities like Fereydunkenar, without any entertainment, sport clubs, theatres, foreign language education centers, music classes, or any prospect of employment. My only entertainment was reading (my love of reading was instilled in me by my mother, and it's something I have carried through life), visiting family and friends, and of course, strolling along the coast of the Caspian Sea.

During the university closures, I suffered from anxiety, which

manifested itself as pain in parts of my body. I later found out that many of my university peers had had the same experience. At the time, being a young female significantly limited my life choices; in my hometown, people expected a young woman to get married unless they had good reasons for not doing so. I did not want to settle down; I was at an age when I was keen to explore the world around me. And even though my father looked forward to his daughters getting married, he was a very open-minded man. In contrast to most people in my hometown, he never forced his children to do something against their wishes, even when he thought it was best for them. I keep referring to my father rather than my mother because in the environment where I grew up, all decisions were made by the man of the house. This is, of course, quite different nowadays.

Universities did finally open again, and along with that came the promise of renewed friendships. Because there was talk of cancelling the computer engineering course, I changed my field to electronics engineering. It seemed challenging; I didn't have particular knowledge of the field. At that time, students selected their field of study mostly based on how competitive and prestigious the field was, and not based on their interests and abilities. In the last two years of my undergraduate degree, when I was taking specialized courses, I achieved high grades thanks to my interest in the subjects and dedication to attending the lectures. I had never envisaged continuing my education beyond a BSc degree, but my professors

encouraged me to learn new specialized subjects, and I decided to study for my MSc. I started the postgraduate program in Isfahan University of Technology in electrical engineering/communications systems. My interest in communications came about during my undergraduate studies thanks to the mathematical nature of the subject. I finished my MSc degree in a year-and-a-half, though it was expected to take at least a year longer.

I loved my time at university, beyond what I studied. I had the rare opportunity to take multiple trips around Iran with fellow students. Following graduation, I was immediately hired by Isfahan university as a faculty member. My time at university was not all plain sailing, however. I encountered many obstacles and experienced various unfortunate events, one of which I will mention here. I got engaged a few months before my graduation and my fiancé decided to travel to the United States to work. Our agreement was that I would join him after he found a good job. When he did, I applied for and was admitted to a PhD program in electrical engineering at Princeton University. During the 18 months it took for me to apply for a program and receive the necessary travel documents, I lectured at the university. And when all the arrangements were made, I bought a one-way ticket.

However, just two weeks before my trip, our engagement was broken, and I was devastated. This engagement was not a family arrangement; it was something that I had wanted. The idea of studying for a PhD had initially

come about to facilitate my emigration to the U.S. to join my fiancé. Now, I had to revisit the decision to move. In the end I decided to go, to make a fresh start in the U.S.; my father agreed with my decision. When I arrived at the airport in New York, I immediately bought a ticket to Salt Lake City, where my eldest sister lived with her family. I started my PhD at the University of Utah; my admission to Princeton secured me a place there. I completed my doctorate after four years.

Living and studying in the United States had a significant positive impact on my life. I had the opportunity to interact with students and people of diverse cultural backgrounds, which helped me to develop a more mature and open-minded view of the world. This time was a real breakthrough in my life, an opportunity that came out of an unfortunate event. During my studies I took several trips to different states, either to attend scientific conferences or simply to see them. These trips opened my eyes to the diverse landscape of this vast continent.

After finishing my PhD in 1994, I returned to Iran and applied for faculty positions in three of the most prestigious universities. All offered me positions; one department even contacted me to tell me they had never had a female faculty member, and that they were very interested in hiring me because of my expertise. I chose to join the electrical engineering department at Sharif University of Technology in Tehran.

I was the only female faculty among about 50 in our department,

and remained so for over 20 years. The department was not biased against women; there simply weren't good female applicants. (Things have changed since then, and some five female faculty members have been hired just in the last six years.) My male colleagues were very supportive when I first started, and that continued. The environment was very friendly in my group—the communications group, the largest in our department. I soon became its director, and then the first chair of the center of excellence in communications; these centers of excellence are awarded by the Ministry of Higher Education to universities excelling in a particular field of science or engineering.

Since joining Sharif, I have been engaged in various educational, research, and administrative activities both there and in the Iranian scientific community at large. Some highlights include developing several undergraduate and graduate courses in our department, including an educational undergraduate lab. I also taught a graduate course at Mashad University for two years due to the university's lack of staff. I served as the chair of the electrical engineering graduate committee for four years, during which we made several substantial changes to our regulations to improve the quality of our graduate studies and to boost the scientific code of ethics.

I also founded a research laboratory in 1997 at Sharif and a test lab on base stations of mobile communications in 2009. In any given time, an

average of 15 graduate students are working on their MSc and PhD theses in my research lab. I have initiated research in several cutting-edge fields, including molecular communications for nano networks, for which I was awarded an international research chair by Iran National Science Foundation (INSF). In this research area, molecules are used as information carriers for wireless communications among nano devices. It can have applications in various areas, such as drug delivery inside the body, environment monitoring, Lab on Chip, and so on.

I have been offered many administrative roles, but have only selected the ones that I felt I could make effective contributions to; I have steered away from sitting on committees where I could not envisage having a constructive role. In all the positions that I have held up until now, my one guiding rule has been that quality should in no way be sacrificed for quantity. I have always tried my best to adjust and modify the regulations with a view to improving output quality.

Something that I have really enjoyed has been helping promote the status of women in engineering (WIE). I was not aware of such activities in scientific societies until the chair of IEEE-Iran branch asked me to serve as the chair of IEEE WIE. I asked if I could have a week to think about it, for I always believed that we could not separate men and women in science. So I read about the committee and similar activities that have taken place around the world. I also did some research on the history of women in

science and engineering. It was instructive to learn what such committees stood for and what important objectives they served. I realized that if I got involved, I would have a lot of work on my hands. I plunged in.

WIE's most important objective is to diversify the field, something I have deeply believed in both during my studies and in my career. As a communications systems engineer, I have known the meaning and importance of diversity from a very different perspective; without diversity, no efficient communication is possible. Much improvement is needed in science and engineering in terms of the under-representation of women. Women's contributions are essential since science and technology are truly engines of social and economic development. Women's participation and presence increases creativity and innovation in science, technology, and industry, where a full spectrum of solutions is explored.

In the history of women in engineering, two breakthrough movements are recognized. The first was during World War 2, at a time when industry encountered a shortage of engineers and technicians because men were being dispatched to war. Because of this need, industry took steps to encourage women to be involved in science and engineering. This push from industry forced universities to open doors to more women. The second intensive movement in the 1990s to encourage women to enter the fields of engineering and technology was not due to industry or market demand but for the sake of diversity. This movement has been taken up by

scientific and academic societies, which have realized that despite doors being open to women, very few take part in these fields, and that women's role in engineering and technology is insubstantial.

Technology affects daily life regardless of the gender, and it promises improved living standards. Yet it could also have negative side effects, including on our health and the environment. So it is society's obligation to encourage women to take part in the field for the sake of humanity; they make up half of society, and they can no longer sit aside. Significant presence of women can bring diverse talents to the field, which ultimately drives innovation for the benefit of humanity.

When I accepted to chair the WIE committee of IEEE, I did an initial field investigation to examine how much awareness there was among scientific communities in Iran about the committee and its objectives. I asked my colleagues at Sharif what they thought about the WIE committee. Strangely enough, none of them knew what "WIE" stood for. They imagined it to be a women's cooperative guild inside IEEE to support women's rights. One of them, an active member of IEEE, told me that it was ridiculous that such a committee even existed in IEEE (and he even asked whether the male members of IEEE should organize a Men In Engineering—MIE—committee).

At that point, I decided my first task would be to raise awareness of WIE and its objectives in our community. I invited colleagues from different engineering universities to become members; three male colleagues were

also invited. We defined our scope of interest and a two-year plan based on promoting the effective and competent presence of women in the area of technology and engineering science in our country, especially in electrical and computer engineering. Our priority was to actively participate in all important national conferences in order to introduce the committee and its objectives and improve networking among women in engineering.

We launched several successful panels, that I moderated, on opportunities and challenges for women in engineering; the panelists were among successful women and men from academia and industry. More than 100 people attended some of the panels, and they brought up some challenging and important questions. As part of the two-year plan I also gave talks, one of which was at the largest electrical engineering conference in Iran. After that particular talk, one male colleague who had known me for 20 years said to me, “You should run for president!”

The committee’s other main objective was to include more female students in our joint meetings; much effort was expended on this. For example, we had several meetings with the Iran Vice Presidency for Women and Family Affairs to discuss the problems and challenges that our female students faced, while proposing solutions and guidance. The committee actively participated in annual gatherings of the student branch of IEEE. We also launched networking events among female faculty of electrical engineering departments in different Iran universities. We tried to identify

and make connections with similar committees in other Iranian scientific societies, one of which was Women In Physics.

In 2015, following a talk I gave at the Iran Academy of Science (IAS), a working group in Women in Engineering was established in IAS; I have the privilege of being a member. We have done a considerable amount of work there, including an IAS project, “The Status of Women In Engineering in Iran: Academic, Research, and Administrative.” And, with the help of some students, we have collected a significant amount of data from different sectors. This has helped us to provide guidelines to improve the status of WIE in Iran. In this project, we further compared the status of Iranian women in engineering with Australia as well as countries in Asia and Europe. The results of our findings were presented in a meeting in the general council of IAS-Engineering branch: We had found that while the presence of women in undergraduate and graduate engineering studies is comparable with European countries (about 25-30 percent), their presence in leadership positions, decision making, and scientific committees is low, and is similar to many other Asian, and perhaps some European, countries.

To take practical steps towards enhancing the status of women in science and technology, in 2019 we launched the Women’s Council in Science and Technology in IAS, and identified and invited some successful and active women from different academic, research, industry, administrative, and entrepreneurial backgrounds. Our main objective is to identify and

reduce the barriers to women's progress in academia, research, and industry. To this end, we have itemized a one-year' work list, which we review in our monthly meetings.

Looking back, I was not a particularly studious student, but tried to have an active presence in class and to manage my time well. Perhaps because of this I had much more free time for other activities than my classmates, spanning from high school all the way to the end of my PhD. During my career, I soon learned that no matter how busy I am with different projects and administrative duties, I should always put some time aside for myself. My love of novels and non-fiction books continues, although this has given way to mostly audio books. I have always tried to incorporate regular exercise into my daily routine, and because I have always loved traveling, I take the opportunity to explore the world when attending conferences in exciting new places.

And here's something that's been really important for me to stick to: I try to not accept more than two scientific and industrial projects at any one time, so that quality is not compromised—I avoid taking on anything in which I feel I can't be effective. In fact, that's the advice I give my students and young colleagues, so that they don't have to have too many plates spinning at the same time. My other advice to them has been to believe in their potential, and appreciate their own qualities.

Importantly, I emphasize time and again that they should not be

afraid to be women. There is no need to act like our male colleagues in order to get better recognition in a male-dominated engineering environment. Inner satisfaction and personal fulfillment would ultimately mean that women would not need to prove themselves, and that there will eventually come a time when we are recognized by those who appreciate good and honest work.

I did end up getting married, in case you are wondering. My husband is a psychiatrist. We have often had long discussions about the differences between women and men, their behaviors and approaches to life. Some of these differences are meaningful, for sure, and there are debates on whether the differences are innate, learned, or both. What really matters is not these debates, but that men and women should collectively use their diverse and complementary talents to innovate and develop new technology for the benefit of humanity. To reach this goal, we all have an obligation to assist in the recruitment and retention of women in technical and engineering fields. The time is now.

JOURNEY 10

TWISTS, TURNS—AND NO REGRETS

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Before I started writing this chapter, I worried about whether I am an adequate person for this task. I thought that my story is simply not interesting enough. I am not an active feminist. I think that I am an ordinary woman, mother, wife, and researcher in the field of engineering. For me, each day is a fight for a better tomorrow and for new challenges.

Now that I am looking back on my academic life, I feel I should answer some questions I have for myself. What stage of my career am I at? If I could do things again, would I do them the same way? What would I like to do in the future? It is very difficult to answer these questions,

because I could certainly have done some things differently and, likely, better—although I do not regret what I have done, even when it has brought me sadness and disappointment. After many years of gaining experience, I have explained to myself that all situations make me stronger and better prepared to take on the next task.

I was born in 1976 in an industrial city in the eastern part of Poland, where I attended a small primary school in the countryside. I liked this school very much and performed well there, and although I was not a genius, I had no problems as I was competent at all subjects. That is why I found it difficult to choose the path I should follow in secondary

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Aneta Magdziarz has an undergraduate degree in Chemistry from the Jagiellonian University and a PhD in Metallurgy from the AGH University of Science and Technology (Cracow, Poland). After receiving the PhD in 2005, she began her professional career at AGH as a lecturer of graduate and undergraduate courses in general chemistry, corrosion, and environmental protection. In addition, she was a researcher in the field of energy. In 2018, she reached the position of professor.

Aneta conducts research as Principal Investigator both on national and international projects involving thermal conversion of renewable fuels (e.g., torrefaction, hydrothermal carbonization, pyrolysis, and gasification), ash chemistry, and high-temperature corrosion. She is a leader in the Chemistry of Combustion Processes group at AGH University. Aneta has established cooperation with many universities, including Canada, China, Germany, Sweden, Austria, and the United Kingdom, and has participated in many international scholarships. She is the author and co-author of more than 150 publications, which are cited in many studies. She is a Board Member of the Polish Combustion Institute and a member of the Combustion Institute in Pittsburgh, United States.

school. Fortunately, I chose biology and chemistry. In some ways, I wish I had chosen mathematics, because during subsequent education I felt that I should have had a better understanding of the subject.

My studies in secondary school focused on biology and chemistry because I wanted to pursue medicine. Unfortunately, my original plans were never fulfilled. I passed the exam, but I did not have high enough grades to get into a medical school. I remember that day very well. It was the first big disappointment of my adult life. It took some time but, finally, I came to the understanding that studying medicine was not to be and that I would have to accept that. Instead, I discovered that my score was high enough to study chemistry at Jagiellonian University in Krakow. It was a prestigious course, but I felt from the beginning that it just wasn't for me. I did not particularly like chemistry; it was not my passion. But I had no other choice. I wanted to study in Krakow—it's a beautiful, historic place full of tourists, artists from all over the world, and students—and so I made the decision to go there to study chemistry.

From my current perspective, I can say that it was a good decision. I studied at the oldest and most prestigious university in Poland that was also well-known in Europe. It gave me some advantages for the future. However, it was not easy at the beginning. I had moved from a small city to a big one, which was quite a transition for me. I lived in a dormitory together with three other girls in one room. But it was an amazing time!

Everything was new: New friends, new life, and a new way of studying.

I had to be careful not to enjoy the experience too much, though, as I had to focus on studying. I was scared at first and scarcely able to face new and adverse situations. Studying at the faculty of chemistry was really difficult; I was afraid I would not make it. My university experience was a time of hard work and discipline. I remember the first time I went into a typical inorganic chemistry laboratory and I had to do experiments by myself within a predetermined time. I did not know how to start, because I had never used laboratory glass before. But it all worked out, and I finished my course and obtained a master's degree in chemistry in two specialities: analytical chemistry and forensic chemistry. The year was 2000 and it was a success. I still have respect for all my professors and the staff. Each time I visit the chemistry building it has the same smell and the same atmosphere as when I was a student. Even now, I can feel the excitement, the shivers going up and down my back.

I did experience a major life event during those studies: In 1998, after my third year, I got married and gave birth to my first son. Well, life writes different stories. My parents were not happy. I decided not to take a break in my studies. Michael was born in July and I started the new academic year in October. It was not easy; my husband, son, and I lived in student housing, in a small studio apartment, although it was very close to campus. But I would not have done it any other way. I do not know why,

but I wanted to prove to everyone that I could do it. And I did. I knew that I had to be as good as my colleagues in our group (most of them were women and each wanted to be the best). Of course, we helped each other to some degree, but I had to learn a lot on my own.

I think that in this period I learned and studied more than during any other time in my education. I wanted to show that it is possible to study and to be a mother. I have to thank my parents, especially my Mum, who helped me then and help me now. Mum looked after my sons (a second son came along). They have spent summer and winter holidays with her, as well as other free time. They love spending time at my parents' home because there is clean air, lots of space, a forest, and freedom—it's the opposite of living in a big city like Krakow. I hope they will always remember what my Mum has done for them. I think that my sons are lucky to have had the opportunity to grow up with their grandparents (and even with a great-granddad) and now they have respect for older people.

After graduating with my master's, I wanted to do a PhD but not at Jagiellonian University. My husband, who studied at the AGH University of Science and Technology, also in Krakow, graduated in material science two years before I finished my degrees in 2000, so I knew something about AGH. It is a more typical engineering/technical university compared to Jagiellonian University. I decided to apply for doctoral studies, and I was easily accepted. This marked the start of 20 years of association with

AGH that continues to this day. During my doctoral studies, I focused on chemical processes in metallurgy and material science. I remember that time very well. I was the youngest in our group, but I was still treated like an employee, an equal researcher. Unfortunately, at that time there were neither new research ideas pursued in the department nor opportunities to go abroad. After a while, this stagnation started to trouble me. I wanted to go higher and further and develop myself.

The first brave decision I made was to apply for a scholarship to Cambridge University in the United Kingdom. I was successful. It was my first solo journey abroad, and I was there for three months. It was not possible at that time to go home and visit my family, whom I missed terribly; my husband had to work in Poland and my Mum looked after my sons. However, this visit to Cambridge was the first significant point in my career as a scientist. From that moment I started taking an interest in environmental protection and combustion science. Two years later, I visited Cambridge University for the second time; I was the only person to receive this kind of scholarship twice.

I completed and defended my PhD thesis without problems. I recall the words of my professor: “It was nice and elegant.” This was a compliment indeed, because everybody was afraid of this professor, and he was the “ultimate authority.”

After the defence of my doctor’s thesis I was really happy.

Unfortunately, or fortunately, depending on one's point of view, I had a break of only one week, as I was offered the position of assistant professor in a Department of Heat Engineering and Environment Protection at AGH. It was a great distinction. However, it was a very stressful time because I had to prepare lectures on four new subjects within a few days. All concerned fields of environmental protection and thermal science. I was at the beginning of my academic career, I was new in the department, and I did not know anyone. It was not easy. I could focus only on pedagogy and on delivering my lectures. This was a true "school-of-life" experience: I was left alone and was expected to somehow know what to do, without any help, instructions, or someone to guide me. I would never wish such a situation on any young person. Fortunately, it happened many years ago, and now, as a supervisor, I try to help and instruct my PhD students. I hope they are satisfied. They know they can always come and ask me for help, suggestions, and support. Now I can say that teaching brings a lot of satisfaction and supports both the development and progress of students. Being with young people makes you feel younger, because students have boundless energy and different ways of thinking about the world.

The next several years at the university went fast and were varied. I had established my academic credentials, and was slowly moving forward. I was up and then I was down, but after many years I could not give up. I applied for many projects for young scientists and was always wanting to do

something new. It was not easy, and not all of my experiences of academic life have been positive. Many times I have been underestimated and not considered an equal partner because I am a woman. When I gave birth to my second son, I heard that I would not be able to do my duties as well as my male colleagues. I remember that just one month after my son was born, I had lectures to attend to. And when I had the opportunity to go on a scholarship, when my son was six months old, our senior administrator stated that it would not be possible. Five years went by without any meaningful university support, and I had to do everything related to the scholarship myself. I had to wait. But I knew that I could do it.

And the wait was worth it: The most significant and impactful event in my academic and private life was my stay in Toronto, Canada. In 2014, I spent three months at York University working with my colleague, Janusz Koziński. It was another long visit away without my family. I was lucky I had the support of my husband. I need to say here that he has never opposed my ideas and travels to many places around the world. My younger son (he was 6 at the time) stayed with my Mum; he thought that he was having a long vacation, which made me happy. In the meantime, my older son visited me in Toronto and for him it was a trip of a lifetime.

For me, being in Toronto was a fantastic opportunity and a creative time. I remember it now with some emotion, but at the beginning I encountered all possible administrative problems. However, I solved all

of them because people there were very helpful and friendly. During my stay in Toronto I met a lot of interesting people. I could see how Western universities work, and everything for me was fascinating. This trip had also a significant impact on my scientific career. I attended many meetings and events and visited many places in Canada. Janusz and his wife, Roma, showed me real “Toronto life.” For me it was almost like a flight to the moon. I would like to thank them for showing me so many new opportunities and, most importantly, that I could believe in myself. I have never forgotten Roma’s words when I felt afraid before attending an official meeting and dinner with important people: “Remember, you are here because you have earned this with all your hard work. You have to be confident; you are not here by chance.” I have never forgotten these words, and sometimes I repeat them to put me in a better mood.

After I came back, I was full of new, positive energy, and new ideas. I felt more confident, and I thought that I could do more. This good energy helped me to focus on writing the habilitation thesis. In the Polish university system this is the level between a PhD and a full professor. The habilitation stage is obligatory if one wants to advance one’s research and an academic career. The year 2016 was a time of working very hard; I spent all holidays in the office and the laboratory, but it was worth it. My habilitation was on risks, both corrosive and operational, occurring during the combustion process of renewable fuels, particularly biomass and sewage

sludge. I investigated the formation mechanisms of ash deposits and the interaction between particular components of ash during the fouling and slagging processes. Since then I have investigated different aspects of solid renewable fuels, their thermal conversion processes, and their impact on the environment. I obtained positive reviews of my academic achievements and, in 2019, I was offered a position of professor at the university. I can say that from that moment on, several positive changes occurred at the university and my position became more stable and more significant.

I should mention that during my academic career I have established meaningful cooperation with many European universities. It was not a “grand plan”; actually, I do not know how it happened. From one conference to another I have gotten to know more people working in the field of combustion science. When I interact with my friends at conferences and while preparing and implementing a project, I am really glad and proud that they want to work with me. And let me point out that most of them are men. There are only a few women in this field.

On the other hand, and this may sound somewhat controversial, I have observed that some female researchers just cannot work together. I know that gender is not critical here. I think it's purely about competition. Regrettably, some women are more jealous than men and they do not always control their emotions. I do not know of any research group in engineering that consists solely of women. Why? You will have to find the

answer yourself. But I do know this: I believe that women should support each other, not compete with one another. Such competition doesn't help when women still have so much to overcome, so much we can work towards together. Yes, the world has changed dramatically within the last 30 years, especially in Poland, and I live quite a different life from my mother or grandmother. Women do have more opportunities/ But unfortunately, we still have a problem with women not making it to the top.

Engineers, including women, make some of the biggest advances in society. They solve issues such as global warming, novel design, and implementation of new technology that changes our lives and creates things that make our lives easier and better. To create something new, we need diverse groups, not overly homogenous groups. The relatively small number of women in engineering does not allow for the creation and expansion of new things relevant to our gender. Engineering requires a high level of skill and a specific mindset. Clearly, women have plenty to offer to different aspects of engineering.

For some time now, I have been trying to create a comprehensive research group. My aim is to be the leader of an interdisciplinary group consisting of young, open-minded, people-oriented, and responsible scientists who can work together with colleagues from a variety of fields and embrace different points of view. The group would provide new solutions and work hard at enhancing modern education in engineering and science

for the future. Young scientists need passion, perspective, professionalism, and integrity. They should embrace emotional intelligence and creativity. A close friend of mine recently reminded me about an African proverb with some words of wisdom: “If you want to go fast, travel alone; if you want to go far, go together.” I am trying to implement these words in my own academic milieu. In another 10 years I will be able to tell you if I have been successful.

My job is challenging, but it gives me great satisfaction. I know that I have to feel that it has meaning. I want to make choices that are successful. It’s important to me to be recognized for my accomplishments. Women try to be perfect, but we should really make an effort to take more chances. Men are brave, jumping in headfirst and not caring much about the consequences. I’m sure this is probably their nature, and not so much in women’s nature, and so it will be difficult to change.

When I am tired, I wonder if it is worth working so hard. Sometimes I say that it would be better to stay at home and take care of my family, but my husband says that it is not possible, because it’s in my nature to be doing something all the time, to always be looking for new activities in all areas: at work, at home, and with the family. I am working from home now due to Covid-19 and am finding that I cannot stand still. I have to do something at home: clean, iron, plant flowers, etc. Last week, one older professor said to me on a call: “You are in a hurry all the time! Maybe you

should stop and ‘smell the roses.’” It is true, but I don’t think it’s possible for me to stop. I have too many things to do, and not enough time.

Sometimes, people tell me that I am too young for some position or other, and I answer that it is true, but I have a lot of experience in both my private and my professional life. Some friends say that I have an alpha-male personality, that I am an optimist, and maybe that’s true. But I have to confess: inside, I feel like a pessimist. I often do not believe in the success of my projects, and maybe that is why I do not always get what I want. Fortunately, when I am disappointed after some sort of failure, my husband tells me, “Stop being sad; next time it will be better. This will only make you stronger and you will have gained more experience.”

At this moment, I am glad that I have got to where I am today. All my successes have been achieved thanks to my hard work and the support of my family. I am proud of my sons and they say they are proud of me. I should say I am a happy woman, and it is true; I am in the middle of my life both personally and professionally.

And still, all the time my mind is creating new ideas. It does not matter that it will probably be very difficult to realize them, but it is not possible to live without dreams. If I work hard and want something passionately, I know that it can be achieved. That’s why I believe that the most exciting things are yet to come.

JOURNEY 11

THE TWISTS AND TURNS OF A STEM CAREER

GAIL MATTSON

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UNITED STATES

A couple of years ago, I was asked to give a talk at Stony Brook University in New York state to a group of young women pursuing STEM careers at a workshop entitled, “Girl Power in STEM: Press For Change!” Like many women in STEM careers whom I have met over the years, my career has taken many twists and turns in order to get around shut doors and denied opportunities, and to overcome disappointments. I shared with the group at Stony Brook how I progressed from college to where I am today, and used a graphic of just how convoluted a path it was, with redirections, accepting the second choice, going back to school, and taking advantage of unique circumstances.

Several of the aspiring students who spoke with me afterwards said my story was eye-opening as it helped them to see that there is never

one blueprint for the path to success. You simply have to make a start, not get discouraged, be open to new possibilities, and trust that you will learn along the way how to make your success your own. Luckily, I also had the strong support of both of my parents and could draw on the perseverance they instilled in me.

Let me start from my beginning. I fondly remember spending hours in my grandparents' basement where they lived in Prairie Village, Kansas, in the 1950s building all sorts of things with my father's old Erector Set, and reading National Geographic magazines. These activities inspired me to want to work either in construction like my grandfather or become an archeologist.

ABOUT THE AUTHOR



Gail Mattson is President of the International Network of Women Engineers and Scientists (INWES), a global network that advocates for women in Science, Technology, Engineering, and Mathematics. Its members include women in STEM organizations, corporations, universities, and institutions, representing more than 250,000 people from 60 countries around the world.

A registered professional engineer in seven states, a Certified Hazardous Materials Manager and Project Management Professional, Gail has more than 40 years' experience in environmental engineering, safety, radiological control, project management, business development, and corporate relations. She has a BS in Chemistry and Biology and received her MSE in Environmental Engineering from the University of Washington.

Gail was the FY01 President of the Society of Women Engineers, and has also served in various regional and national positions with the American Society of Civil Engineers, the American Association for the Advancement of Science, the Academy of Certified Hazardous Materials Managers, and Girl Scouts of the USA.

The eldest of five siblings, in grade school and junior high I was good at math, and especially science; I was “that nerdy student” who was always asking the science teacher questions and wanting to perform other experiments. I had to get permission from my parents to enter the school science fair, as I was just in fourth grade and the majority of the entries were from boys in the fifth and sixth grades. Luckily, my parents were very supportive and made sure that I had all the materials and information I needed to prepare my diagram about the human eye, and eye diseases and ailments. I was interested in the subject as I was very near-sighted as a child and had to wear glasses with thick lenses. To the amazement of my classmates, I won the third-place ribbon!

Obviously, at that age I was self-conscious and often teased about wearing glasses, so I was always trying to figure out how to “fix my eyes.” The thick glasses also got in my way; I was a “tomboy” who loved exploring in the woods, climbing trees, catching frogs in the creeks, and swimming. As soon as I found out about contact lenses at age 12, I insisted on going to the eye doctor to get them. He was very reluctant to put them on active child my age, but I was determined and suffered through the pain and tears to get accustomed to the original rigid plastic lenses that were available in the early 1960s.

My mother had worked as a medical lab technician in several hospitals during World War II, and finally obtained her degree in biology from Baker

University in Kansas in 1948, shortly before I was born. I definitely got some of my perseverance from my mother. To graduate from college, she had to pass the advanced biology class, but the professor, Dr. Boyd did not believe women should be obtaining degrees in science—and he gave her a failing grade the first time she took the class, even though she knew the material. Not to be deterred, she took the class again, ignored the mean looks and discouraging remarks, passed all the tests and completed all of the experiments. The professor reluctantly gave her a D so she could graduate. Years later when I applied to Baker University, I received—ironically—the Dr. Boyd Memorial Scholarship in Biology, which covered my tuition for all four years. When my mother found out I had received this specific scholarship named for that professor, she laughed so hard she started crying. Obviously, I was now obliged to study hard to ensure I earned As in all of my science classes! As a result, I graduated with honors in 1973 with a dual major in chemistry and biology.

My father was a petroleum engineer and after I graduated from high school in 1969, he went through considerable effort to get me a summer job working at Bechtel, an international engineering design and construction company in San Francisco. He himself had worked there for more than 10 years as a project manager on new pipeline projects around the world. Even though I applied for an engineering technician position that first summer, the human resources department insisted that I take

the “required typing test” for all female applicants. So instead of typing the designated paragraphs for the test, I typed an explanation as to why, as an engineering technician, it did not make sense for me to take the typing test but that instead I should be tested on how fast I could use a calculator and slide rule to answer math problems. Believe it or not, I “passed” the typing test and got the job. I worked for Bechtel on the design of nuclear power plants the following four summers while in college.

After earning my undergraduate degree, I originally applied to medical school at four universities in California, made it through the selection process to on-campus interviews at all four—and then in one week received rejection letters from every one of them. I was obviously disappointed but not surprised, based on the comments I had heard while going through the interview process: “You are too good looking to be taken seriously as a doctor,” “Too bad you are not a minority; we already have enough white women.” “We have fewer diversity slots this year as we are required to take so many veterans who served in medical units in Vietnam.”

So, I went back to my boss at Bechtel in San Francisco where I was working that summer and asked for a full-time position as an engineering technician. Over the next year Bechtel put me through rigorous training courses to become a cost/schedule engineer, and performed cost-engineering work for the construction and start-up of nuclear power plants. I also dated a lot of engineers—and then met Peter, a newly graduated civil engineer

whom I married the following year.

I was still determined to obtain a graduate degree, so I applied and got accepted at the University of California, Berkeley, to study organic chemistry, with the idea of applying again for medical school. But then my husband got the opportunity in 1975 for a very good promotion to work for Bechtel in Canada, so we moved to Fort McMurray, Alberta, in Canada, for three years to work on the Syncrude Tar Sands project. They found a position for me as a field-cost engineer. It was while working on this construction project in the wilderness that I became aware of the environmental impacts of our project and started researching on my own what we could have done differently.

In 1978, we were transferred by Bechtel to the Jubail Industrial Complex in Saudi Arabia for another three-year assignment on a huge construction project. Initially, I was assigned as a cost/schedule engineer, but after the religious uprising in neighboring Iran, I was not able to continue working in a man's job. We decided, for the sake of my husband's career, to stay on the project. So to fill my time, I became a lifeguard at the women's swimming pool, served as a travel agent escorting tours to 10 countries over the next two years, established USA Girl Scout troops for the American girls in the industrial complex, and then applied to graduate school.

I was accepted in 1980 at the University of Washington in Seattle to study environmental engineering; I was one of only three women in

the graduate program at that time. I loved the course work, especially that related to the emerging environmental fields and laws. But I also had to enroll at the same time in undergraduate courses in civil engineering, which meant I had to plan out my schedule really well. Why? To deal with the inconvenience of having to walk across the street to the Student Union building several times a day, as there were no women's restrooms in the civil engineering building.

The week after receiving my Master's degree in engineering, I accepted a position as an environmental engineer with Ebasco Environmental in Seattle. Over the next three years I worked on a number of exciting environmental projects throughout the Pacific Northwest and Alaska that included researching and authoring environmental impact statements for new construction projects, investigating groundwater and surface water contamination from industrial plants, and designing municipal landfills and remediation of Superfund sites.

Then I hit a career roadblock: I was passed over for an opportunity to manage a major remediation project for which I performed the initial conceptual design and was a major contributor to the winning proposal. Senior management was concerned that the client would be "uncomfortable" with a woman managing the project and that I would have to work in another state, away from my husband.

After that, I knew I had to be the author of my own success. I started

my consulting company, Mattson Environmental Engineering, in Seattle in 1986. My certified woman-owned small business provided environmental engineering services to a number of clients, and I became so busy that I actually had to turn down some projects. One important thing I learned was to always have a Plan B in case things do not work out as anticipated, so I have maintained this consulting business throughout my career. Several times, when I had a gap of a few months between projects or jobs, I have been able to work as an independent consultant and expand my network of contacts.

Perhaps Ebasco Environmental regretted passing me over when they did, because in 1987 they approached me with a new opportunity I couldn't resist. The company encouraged me to work for them again, this time in Chicago. They wanted me to start up a new office for the company and manage a major contract with the United States Environmental Protection Agency (USEPA). It was something I was excited to do, and it enabled me to try my hand at business development by winning contracts over the next four years with several state environmental agencies and private industry.

After a brief stint turning around a contract for the USEPA in New York, I relocated with Ebasco Environmental to Oak Ridge, Tennessee, in 1992. My job was to manage the group of 12 project managers on this new contract to address environmental issues at the US Department of Energy (USDOE) sites, including remediation of radioactive releases to

the environment and the appropriate storage, treatment, and disposal of radioactive waste. All of this drew on my earlier experience working on the design of nuclear power plants. After four years I was promoted to assistant vice president of engineering where I managed a \$16-million budget and 60 professionals.

At the beginning of 2000, I accepted a position with Bechtel Jacobs Company as the Program Manager for the USDOE Reservation Cleanup/Waste Management Project with a \$250 million per year budget, 15 subcontractors and responsibility for management of the facilities and treatment systems for storage, treatment, and disposal of hazardous and radioactive waste. Then in 2004, I led the proposal effort to secure the role as the “first ever” small-business contractor to take over a prime environmental management contract at a USDOE site, this one in Portsmouth, Ohio. In 2006, I returned to Tennessee to accept the position of vice president of engineering with a company designated by the US Small Business Administration as a small woman-owned disadvantaged business. It provides these services to the USDOE across the country: nuclear engineering; environmental, safety and health (ES&H); and quality and waste-management. Four years later I was recruited by another small business to revitalize its environmental consulting company as chief operating officer.

In 2014, I was hired by Brookhaven National Laboratory to fill the position of associate laboratory director, ES&H, located on Long

Island, New York, with direct supervision of three division directors with 140 employees and an annual budget of \$31 million. I was responsible for occupational safety and health, environmental protection, and waste management at the lab's 5,300-acre site, ensuring compliance with federal, state, and local regulations that protect the lab's 3,000 employees, the public, and the environment. This past January, I accepted a position as senior ES&H associate with Longenecker & Associates, LLC, a small woman-owned business and USDOE contractor, and moved to Santa Fe, New Mexico, to be closer to my immediate and extended family, who all live in the western United States.

There are two things that have definitely assisted me throughout my career and helped provide opportunities to give back and find balance in a demanding professional career: being active in professional associations, and volunteering where you have a passion. One of the most rewarding aspects of my career in STEM has been my involvement with the Society of Women Engineers (SWE). Originally, when I was working at Bechtel as an engineering technician, I was told that I could not join the SWE as I did not have an engineering degree. But I joined 10 years later while in graduate school, and became active in its professional section in Seattle after I graduated. My involvement with SWE continued when I moved to Chicago; I organized professional development sessions, eventually working on the planning committee for its national convention in 1993.

After I relocated to Tennessee, I was elected to several officer positions in the Smoky Mountain Section, then joined SWE's national membership committee, eventually becoming its chair.

After being elected to the national board of directors, I served as regional director of the southeast, VP of membership, chair of strategic planning—and then was elected president, to serve in the year 2000. That meant I had the honor of overseeing the planning and celebration of SWE's 50th anniversary. It was founded in 1950, the year I was born, by a number of courageous women who had performed critical technical jobs during World War II and were determined they would not “be sent home to cook and have babies” but instead be recognized for, and allowed to continue to perform, engineering work.

While working at the national level in membership, one of the changes I championed was developing different categories of membership so that SWE could encourage women who were earning degrees in junior colleges and/or working as engineering technicians, and obtain support from women and men as associates who wanted to support the objectives of SWE. During my presidency, I relocated the national SWE headquarters and outsourced major functions to achieve significant cost savings for funding new programs, leading to significant growth in membership and national convention attendance. I have effectively utilized many of the management skills that I learned while in SWE as a volunteer, such as strategic planning

and financial operations, as I advanced in my professional career.

Another group I was involved in that has been really rewarding is the International Network of Women Engineers and Scientists (INWES), in which I've filled many roles over the years starting back in 2003. INWES is a not-for-profit global organization that aims to “build a better future worldwide through full and effective participation of women and girls in all aspects of Science, Technology, Engineering, and Mathematics.” From 2018 to 2020, I have served on the board of directors as president, updating numerous support functions and operations for the board meetings, membership, financial operations, and communications via the website, newsletter, email, and virtual platforms. I've also worked to improve the operations of the regional networks, update the policy manual, and increase the presence of INWES in critical international platforms such as the UN Women and WFEO events.

And I want to briefly mention an organization that has been close to my heart since my childhood, the Girl Scouts of the USA. I am a proud “Life Member,” having started as a Brownie in first grade, achieving first class as a Senior, working as camp counselor, and serving as a Girl Scout leader in several locations in the United States and overseas. I was on the national board of directors from 2005 to 2008. Part of my role was expanding and updating programming focused on STEM, consolidating more than 300 councils down to about 100 in order to better deliver programs and more

effectively use resources, and initiating new interface projects with the World Association of Girl Guides and Girl Scouts to improve international relations and collaborations. I believe strongly in this organization as it was instrumental in providing me with leadership skills as I was growing up and opening my eyes to numerous opportunities for careers and the importance of lifelong service.

In closing, I want to make a few suggestions for achieving success in STEM careers, which can be so rewarding:

- Be open to multiple opportunities
- Commit to continuous learning
- Gain skills through volunteering
- Be willing to take a chance
- Learn from your disappointments and failures and move on
- Consider relocation; it opens up the world and your future
- Find what excites you and/or is fulfilling

Finally, know that only you can manage your career. With all the opportunities in STEM, you really can write your own ticket.

JOURNEY 12

UNCERTAIN ROADS TO MY DESTINY

REINE ESSOBMADJE MBANG

CEO, Evolving Consulting

CAMEROON

I have often acknowledged the fact that life is full of promise for those who faithfully believe, and unexpected paths will lead you to your destiny. Failures, changes, success... all can help you achieve what you were meant for.

I am an engineer in the field of network and telecommunications, and the CEO of Evolving Consulting, a firm specializing in digital transformation. Born and raised in Yaoundé, Cameroon, in a family of six children, as the eldest child it was always my duty to lead the way and be a role model for my siblings. My father was so fond of, and proud of, his four daughters. A teacher by training, he always pushed us far in our studies, and encouraged autonomy and free expression—but with great discipline. Respect and academic success were two values we should never compromise.

As far back as I can remember, I had always aimed for a career in science. More specifically, I wanted to be a doctor: a professor of neurology. I was a brilliant student, thus benefiting from free computer sciences training when I was in 11th grade; this introductory session was reserved for the best students.

After secondary school, I left Cameroon in 1997 at the age of 17 to attend the Henri Mondor Faculty of Medicine in Paris, France. I spent two years there, unfortunately without succeeding both times I attempted my first-year studies. Only 80 students of 700 could be promoted to second year, and I wasn't one of them. It was my first confrontation with true, comprehensive failure. The difficulty of adapting to life in France, along

ABOUT THE AUTHOR



Reine Essobmadje holds a Global Executive MBA from IE Business School Spain, with an additional program in Ethics and Corporate Governance from Singapore Management University. She is an engineer by training, graduating with her Master's degree in sciences in 2004 from ECE Paris (where she is in the school's Hall of Fame), and did an additional program in Management at Stafford University in the United Kingdom. Reine is very active in several organizations related to her area

of interests, which include women in STEM, entrepreneurship, and more. She is President of the Digital Economy Committee and is on the board of the Cameroonian Business Council, or GICAM. Prior to joining the GICAM board, she was on the board of AIR e-GO (the West Parisian Business Council). Reine is also the Cameroonian Ambassador of Women In Africa and a Co-Founder of Digital Coalition. In August 2020, IE Business School recognized Reine with its EPIC "Women Inspiring Women" award (EPIC stands for Extraordinary People Inspiring the IE Community). She is founder of Evolving Consulting, a firm in Cameroon and France specializing in digital transformation in Europe and Africa. It has been operating since 2009.

with the harshness of the training, left me morally exhausted. But despite all of that, what I gained from the experience was a phenomenal capacity for work.

All things happen for a reason, and better things were just around the corner. I owe my rebirth to a woman for whom I used to babysit while I was a student in France. I remember in 1999 when, in despair after not being accepted to second year, I went to see her. She asked me, “Reine, how do you see yourself in 15 years?” I replied, “Briefcase in my hand while travelling.” I don’t know where that vision came from; it was simply out of the blue. But some 10 years later, this would become a reality. The conversation was the trigger that immediately pushed me towards another path: I decided I wanted to become a telecommunications engineer.

I remember that my father travelled from Cameroon to France to be with me when I started those studies. He wanted to make sure that I was doing well, that I had chosen a good career path, and that I was ready to start again. I wore the scars of my two years of failure in medicine, but I was ready to write a new chapter in my life.

If I was aiming for an engineering degree, I must admit that I felt it was out of the question to re-engage myself in a long course five years in length. I could not wait that long to get my first university diploma; for some reason, it was of critical importance that I do not take five years to get my first diploma after leaving high school. So, I opted for a two-step process: First, an advanced technician’s certificate in industrial data processing, which I could obtain after two years in Paris. Second, I

would get an engineering diploma, a Master's of Science in network and telecommunications, after an additional three years in Paris.

The industrial computer science course for a holder of a high school diploma with a major in sciences was a nightmare. I did not have the proper academic background. Most of the students came from industrial technical courses (or STI in French). Thus, they had the basic knowledge for these courses. My first supervised assignment was a disaster: three points out of 20. The whole class laughed. Two girls—I was one of the two—were simply lost in a boys' stream, and they reminded us of it at every opportunity. My low grade was deserved, because I hadn't understood much. But nevertheless, I was already prepared to face those difficulties. And after a few sessions of hard work in the library, including reviewing my 12th-grade student STI courses, I became the best student in my class. The boys were amazed at such determination from someone whom they must have seen as a little African girl lost among a group of white boys.

A passion for digital technology was born of this experience. It's a passion that I didn't suspect I'd ever have, but it is constant and is still evolving even to this day.

The engineering portion of my education went much more smoothly, and I graduated in 2004. After some professional experiences in France from 2004 to 2008, during which I managed various projects, I decided to set up my own business at the end of 2008. The reason? I have always defined myself as a professional misfit; you know, one of those people who always needs to create a new project, to embrace a new professional adventure.

It's the kind of environment that I finally created in Evolving Consulting, my firm. I prefer it to jumping from one company to another.

Evolving Consulting is a digital creative space in which I evolve from telecoms to applications through the network and infrastructures with a glimpse of strategy. I can talk about cybersecurity, digital transformation, or telecom regulation. I wanted my company to make what I actually am—an insatiable consultant, always eager for innovation and disruption—a reality. But, Evolving Consulting is first and foremost the story of my reconciliation with Africa, and also the revelation to myself of my deep attachment to the continent.

You see, at the beginning of my professional career, I systematically refused any position in Africa. I just wasn't interested in moving back at all. And so, when I set up my firm, it seemed natural that I would put my knowledge to work by helping with digital transformation in Africa. This was my second professional rebirth.

A life is the sum of several steps that lead us to various renaissances. A professional path, despite common thinking, is not only getting a diploma (in my case an engineering diploma) and working in an engineering field; it's about the people you meet, the choices you make, and the events that shape your future. No matter whether these things are positive or negative in nature, if they are successes or failures, it is about the way you leverage them to move forward. For me, jumping into entrepreneurship has been a wonderful journey.

Trust me: being a women entrepreneur in technology in Africa

embodies resilience. It means stretching yourself until you survive.

The creation of Evolving Consulting has not transformed me into a leader. Instead, right from the beginning, I saw myself more as a consultant and an engineer. I tried to do everything myself. In fact, I'm learning how to delegate and trust others to do better than me.

I also learned that leadership was a necessity to scale up my business. Three years after I started my entrepreneurial journey, I decided to acquire missing competencies in order to better manage my company and projects. Thus, in 2012 I went back to school for an executive MBA (EMBA) program. I applied to IE Business School in Spain and took an additional program in ethics and corporate governance from Singapore Management University, because I had been facing some difficulties in running my business due to poor governance and corruption.

My EMBA experience strengthened my management skills and gave me a 360-degree view of all aspects of running a business. As an international consultant, I am also better when I am performing my own projects. Being a French-speaking person, I think I did gain a lot in improving my English. But I believe the most benefit lies in the entrepreneurship and relationship skills I learned. In fact, during my EMBA in 2013, we had a venture day in Shanghai; my team was awarded third prize in entrepreneurship.

I have come to realize that lifelong learning is the key to success—and entrepreneurship is a type of school that lasts a lifetime. Through the ups and down, I have learned to stretch myself into various stages of resilience. Running a business in a field dominated by mostly white males

is not easy. I did not look like the boss. I started my business at age 29 and was quite young looking. Working in a technical environment—I am engineer in network and telecommunications—dominated by older white men certainly did not put me at an advantage. Customers did not expect a young woman to be the boss behind the company that won the tenders. I had to build trust and a strong reputation through high-quality work. In other words, I had to prove that I had a right to be there!

I recall an incident after we won a big project for a government ministry. At the official launch, the minister was there, and when the managing director was called on to say a few words, I stood—but the officials approached a man they assumed was the MD (he was in fact one of my experts). Although I tried to step in, I was ignored. After all, the minister wanted to talk to the boss first! And then someone had to explain to him, indicating towards me, “*She is the boss lady.*”

But I wasn’t really offended; taking offense is not something I am used to. Thus, this kind of situation was just one of those funny moments in life.

For leaders, handling employees in various countries is not easy; we expect everyone to work at the same pace as us. It’s difficult for managers to handle under-performing employees but doing so is part of being a leader—you must deal with such issues, although I am still working on it. It is very important to remain human despite all kinds of pressure.

So, what does rising to the top really mean? It is very difficult for women to boast about their professional accomplishments; it's probably an inherent social bias on our part. So in thinking about the concept of rising to the top, I have a meaningful perspective that I'd like to share: To me, rising to the top means reflecting on your path, starting from ground zero and all the way to where you are standing right now. Through the past 12 years of my entrepreneurial life, rising to the top has been as simple as challenging yourself to reach the next level while making a positive impact on the people around you.

Sustainability is not a just a buzzword for me; it has true meaning. My interest in sustainability began when I launched Evolving Consulting. Behind my company's name was this idea of growing up and taking digital transformation projects to the next level. In addition, our motto is "Tomorrow's technologies solutions," meaning that the goal is sustainability in a world of technological evolution and competition. It was in our DNA since the very beginning.

When I started this adventure, I had envisioned myself as a consultant. It's taken me a long time to drop the consultant clothes and wear the manager and leader clothes. I must admit: this process is ongoing. But that is probably in the character of most engineers; it's probably the reason why even if we are at the foundation of innovation, we are not the economic leaders we should be. If you add to that being a young black

woman, there are even more biases, because we reflect what others see through their own lens.

I have found that a key character trait of a person rising to the top is that they build on every failure and success to keep evolving. Despite what others think or say, you have to hold your dream tight until it becomes a reality. I have always believed in these words of Peter Drucker: “The best way to predict the future is to create it.”

Another essential? Getting rid of negative feedback in business, in entrepreneurship and in life. Most of the time, you are the one believer in your project and its success. Even if people like to think that they are very kind, often their automatic reaction to a new business idea you have will be negative. As an entrepreneur, you have to fight this attitude, which comes from your customers, from strangers, and even from those close to you. In fact, making sure you maintain your own sustainability in this adventure lies in your capacity to believe in yourself.

Five years ago, I wrote what I call an Entrepreneur’s Alphabet and put it on my Linked In profile (I have also included it at the end of this chapter). Its purpose is for women to share, especially with other women, their secrets to success. In it, I describe all the essential characteristics required to reach success—based on the animal world. For example, “N” is as follows: “Regenerate like a **Newt**. Destruction happens. People will recall your capacity to build over the ruins.” The point is that failure is part of

the learning process; it's an honest exploration of fear, failures, personal limitation, and the mechanisms to growth and improving ourselves.

Rising to the top is all about that. We are never too old to learn. It is a lifelong process that is productive only when we are able to look at ourselves with honesty and integrity in order to examine what needs to change—and fix it. But moreover, it's about treating others with compassion and having the desire to make them better than we are.

For certain people, the definition of success is running a million- or billion-dollar business. But to me, it is simply moving from A to B with joy and satisfaction. Success is as simple as finding the right innovative solution for a customer or helping a young engineer along her career path. I admit that sometimes it is winning tenders over recognized brands. But most of the time, it is doing my job for a satisfied customer.

Whatever way you define success, without passion it means nothing. And sharing is caring. One of my other passions is to attract and retain women in STEM fields. For me, it was a natural attraction. Although I had many questions, due to the absence of a role model, I did manage to receive mentoring from other women. So you see, while the attraction may be easy, staying there can be tricky.

Sharing my experiences is probably what gives me the greatest satisfaction. The NGO that I created and head up, called Digital Coalition, has launched several programs around digital, coding and girls in information

and communication technology, or ICT. WoMenTor is one program that is very close to my heart. We have paired young aspiring girls in ICT with experienced women and business leaders to help build the next generation of ICT women. This brings to life our motto: “Attract, retain and maintain girls in ICT.”

When it comes to managing my personal and professional life, I have found the work-life balance a major challenge. I don’t think I have yet found the best way to manage both, but I am trying to be more organized, more focused. I am working toward predefined objectives. Tasks and agenda management are the keys to success. And sometimes you have to say No to customers.

The downside of having passion for your work is that it can sometimes negatively affect your personal relationships. I am always looking for guidance from older engineers so that I can learn how they managed it, and then I try to apply their advice.

I also want to share that being involved in committees can be so rewarding. Back in 2017, I was requested to chair the committee of digital economy for the most prestigious business council in Cameroon. And one year later, I joined the business council as a board member. Back then, I was the youngest female and member.

Today, in the private sector I am one of the faces of digital transformation. It’s a recognition of an expertise built patiently, seriously,

and with passion and love for tech-related issues. It is truly a pleasure to serve and advise government and the private sector on strategic issues.

As it has for everyone on earth, Covid-19 has not only shaken our lives, it has put a big spotlight on technology. This year has been a busy period for me, but reflecting on 2020, I have learned that those who have a lot must also give a lot. We have a great responsibility to use technology for good, and ethically...to keep technology human, and not focused on profit only. It is our responsibility, as we are quickly moving activities online, to make sure that the tech environment is comfortable and safe for all—especially for the elderly, women, and children—and that it is not exclusive (i.e., not reporting our biases on algorithms).

In August 2020 I was honoured to win the EPIC Award from IE Business School in the category “Women Inspiring Women.” EPIC stands for Extraordinary People Inspiring the IE Community. It comprises these five categories:

- **Business impact.** Experienced executives who transform the companies and organizations where they work by putting into practice the values acquired at IE.
- **Creators.** Entrepreneurs who tell us their story of founding and scaling their businesses, ultimately turning ideas into reality.
- **Human success.** A step beyond personal and professional achievements to mobilize society through social impact.

- **Women Inspiring Women.** Women who live the value of diversity by helping other women achieve their aspirations and by creating a solid platform for gender equality.
- **Young and Ambitious Minds.** Young professionals who apply the learnings acquired during their IE experience in their alumni life by transforming society with disruptive business models.

The recognition was the kind of magic moment that reminded me how much I've achieved, and allowed me to appreciate these accomplishments—while looking to what still needs to be done. It is a message, not only to me but to my sisters out there, that we are constantly evolving, and that we are like mountains: several peaks, where one doesn't have to obscure the others. Take the time to enjoy your successes and be proud of yourself.

I will leave you with some tips for making your way to the top, found in my Entrepreneur's Alphabet:

A Act like an **Ant**. Management is about financial decision-making. An ant has the savvy entrepreneurial character traits needed for the 21st-century economy.

B Be like a **Bee**. A bee doesn't ask permission to gather the best nectar; it flies until it has found the most suitable stuff, because the best nectar will lead to the best final product. Stop only when you spot it.

C Endure like a **Camel**. A camel can survive without water for 10 months! Entrepreneurial life is mostly about scarcity of money, time, or any kind

of resources. Get ready to survive in the desert. The best is yet to come!

D Act like a **Duck**. Negativity is all around. People will try to discourage you; let the negativity flow off you like water off a duck's back.

E Envision like an **Eagle**. Have a futuristic mindset in order to break through with disruptive solutions and innovative ideas.

F Be a noisy **Fly**. Never underestimate a small beginning; it doesn't mean you can't be noisy. Make your presence known.

G Get ready to grow like a **Giraffe**. Never say you are too small for a particular partner or investor. Billion-dollar businesses always start small but are ready to expand quickly and without limits.

H Remain **Human**. Entrepreneurship should never dehumanize you. Relationships are key to your growth.

I Jump high like an **Impala**. Business is about scalability. No progress means failure.

J Endure like a **Jackal**. Endurance is key to entrepreneurial business, so stay strong and do not neglect your health.

K Sleep like a **Koala**. Getting enough sleep will give you the strength you need to endure (see J above). But it's essential to plan your resting time. Staying focused on work is key to your success.

L Be as resilient as a **Lobster**. A business's longevity reflects its leader's determination to make things happen. Longevity promotes trust.

M Be as calm as a **Molly Fish**. Self-control is key to your business and

reflects your maturity.

N Regenerate like a **Newt**. Destruction happens. People will recall your capacity to build over the ruins.

O Be as efficient as an **Oyster**. Your capacity to work and be efficient under pressure will project confidence and lead to new business opportunities.

P Show off like a **Peacock**. Good and efficient communication will reveal your talents to the world. You must be seen!

Q Be happy like a **Quokka**. A positive attitude will help you to make trails through the long grass!

R Be strong, loyal, and self-assured like a **Rottweiler**. Business will bring investors and partners. Loyalty will turn them into friends. Strength and self-assurance will make them life-long business partners.

S Be as sly as a **Snake**. We live in a tough world. Like in poker, do not show all your cards.

T Do as **Termites** do. Work hard and cherish your team.

U Be a migrant like an **Umbrella Bird**. Move until you find a suitable location for your business.

V Avoid the **Viper's** tongue. Nice words reflect a good heart and are likely to attract people.

W Defend your area like a **Wolf**. Competition is tough. Mark and protect your territories with the help of your pack—your ecosystem of partners.

X Get the **X-factor**. Innovate and differentiate yourself to survive.

Y Be curious like a **Yorkshire terrier**. You must be ready to live an entrepreneurial adventure.

Z Be unique like a **Zebra**. Your patterns should bring something new and unique to the world.

JOURNEY 13

BEING A WOMAN, BEING A PROFESSIONAL: OUR GIFTS ARE MANY

ELISA MARÍA RUIZ NAVAS

*Professor, Vice-Dean of International Affairs and Cooperation,
Director of Engineering Programs in Carlos III of Madrid*

SPAIN

I am grateful for the opportunity to participate in this project, where great stories of great women are told. Rising to the Top is a really inspiring and engaging title, and even though, when I look at my personal life and my professional career, I do not consider myself to have reached the top just yet, I do recognize myself rising. I have achieved many smaller goals, all of which bring me closer every day to that great TOP for which we are all striving!

This is how I see myself: swimming out to sea, diving...trying to always look ahead, and beyond. Have you seen the movie Finding Nemo? Besides having the same bad memory as Dory, I have adopted her slogan: “Keep swimming.” When you move forward, deepening and growing as a person, as a woman, as an engineer, and as a teacher, you acquire an inner

attitude—one that you accept in your heart, and make your own. Eventually, this attitude is what configures and defines you.

That is why I consider myself privileged to be able to participate and to be allowed, albeit as a minor figure, to enter among the great women featured in this book. Undoubtedly, the people in these pages—women dedicated to engineering and science who surpass me both in merit and experience—are already transforming the world. And on top of all this, we are also experiencing a historic moment; I never thought I would be

ABOUT THE AUTHOR



Elisa Ruiz-Navas is a PhD in Mining Engineering, Universidad Politécnica de Madrid. She joined the Universidad Carlos III de Madrid as a researcher in 1999, and has since developed her research and teaching with the Materials Science and Engineering Department. A Full Professor, Elisa has lectured 23 different courses, all related to Materials Science. Her main research areas are light alloys for automotive and biomedical applications—aluminum and titanium alloys, MMCs, and TiAl intermetallics—and different

synthesis, processing, and characterization routes (e.g., advanced powder metallurgy, mechanical alloying, and additive manufacturing). Most of Elisa's research has involved international collaboration. She has made more than 80 contributions to international journals, co-authored more than 90 contributions at international conferences, and participated in more than 50 research projects with the financial support of the European Union and Spanish Ministry of Science and Innovation. Her curriculum vitae reflects her interest in collaboration with industry. Since 2004, she has been Director of LACTE (Technical Assistance for Companies Laboratory) in the Network of Laboratories of the Government of Madrid. In 2009 she was appointed Deputy Director of International Relations and Academic Exchange until 2012, when she was appointed Deputy Director of International Relations and Cooperation.

writing this and sharing my story in the midst of a global pandemic, in conditions as adverse as those of COVID-19.

I was born in Madrid, Spain, the middle of three sisters in a middle-class family. Neither of my parents studied beyond primary school. Their family situation and the social circumstances of the times they lived in did not make it easy. I have to thank them for their generosity, and for giving me the opportunity to study. More importantly, they offered me numerous development opportunities not only in academic studies, but also for my personal growth, and for the great treasure of the transcendent dimension: faith.

At no time was I expected to help with the family business (my parents were merchants in family shops). With their support, I studied at a neighborhood school, and then had the opportunity to study a six-year engineering degree, after which my parents continued to support me to study for a doctorate. So it's thanks to them that I am a doctor of mining engineering.

Looking back is an exercise that allows you to identify all those people, events, and experiences that make up the tapestry of your life, one full of multiple colors and shades without which you and I would not be who we are. In this great adventure that is life, my main companion has been Alberto, my husband. We form a great team, at first as students, then later in professional life, and of course in our personal lives. With him I

have discovered that difference is a complement, a way of enrichment and fulfillment. He has been my great support and engine at every stage of the journey, in bad times, when facing personal and professional difficulties, and in good times, in each success achieved. Without a doubt, he brings out the best in me, and he helps me to be what I am called to be: the best version of myself.

Growing up in western Europe in the 1990s, I never met a woman who was not able to study what she wanted. I firmly believe that we are a very fortunate generation of women because in Europe, specifically in Spain, and even more particularly in Madrid, the majority of women of my generation had the opportunity to study thanks to an education system that was free or affordable. It is true that there are some exceptions, but there are numerous support measures and scholarship possibilities that make it easier for most of us to study. In addition, there were no obstacles to women studying scientific or technological degrees. We are truly lucky. This real opportunity that has been given to us should serve as an incentive to give the best of ourselves always, especially when we compare ourselves with women in disadvantaged situations.

Although I chose to be an engineer without being very sure it's what I wanted to do, to this day I must say that being a mining engineer has been a great adventure. In Spain, mining has been very important throughout much of its history, and for a long time was one of the critical

factors in the country's gross domestic product. We have copper, iron, and coal mines, among others. It is true that it was difficult to become a mining engineer because in the past it was forbidden for a woman even to enter a mine: It was considered bad luck. So it was in this context that I started a career in mining engineering.

I wanted to be an engineer because it seemed like a wonderful career that offered the opportunity to continue learning. Discovering the wonder of nature through geology, or internal perfection and the ultimate order that is hidden in minerals, has been an open window to delve deeper into the knowledge of things—to ponder with amazement and gratitude the greatness and beauty that surrounds us. To this day, it seems impossible that we can contemplate materials through techniques such as scanning electron microscopy or electrical transmission microscopy and not be surprised by them, not marvel and have more and more desire to learn, and not have more desire to discover what lies beyond. Engineering opens the mind and invites us to explore unknown and unfathomable terrain.

In my mining engineering class there were five females in a class of approximately 100. This was a formidable challenge. However, despite having to climb three floors to go to the only ladies' bathroom, this was never an impediment. Since that time I have learned to work hand in hand with wonderful people, and to do it regardless of whether they are men or women. I believe that being in that minority environment has allowed

me to develop the ability to not discriminate between people but rather to try to take advantage of and value the capabilities and contributions of those next to me, regardless of gender.

After finishing my degree in mining engineering and doing a doctorate in metallurgy and mineralurgy at the Polytechnic University of Madrid, I moved to University Carlos III of Madrid (UC3M) as research staff. It's one of Madrid's public universities, and is medium-sized , with about 18,000 students across three different campuses: social sciences and humanities; engineering; and postgraduate. The UC3M is a young university, and is one of QS World University Ranking's "top 50 under 50" (it is among the 50 best of universities less than 50 years old). It is dynamic and has a marked international focus; it has the largest selection of bilingual studies and the greatest mobility of students in Spain, as many of them travel abroad through exchange programs.

Among the activities that I have undertaken in recent years, and that has given me the most satisfaction, is helping to promote the university by, for example, giving scientific and technological talks in schools. In that environment I have seen first-hand young people's dreams, worries, and concerns. I have witnessed the decline in interest in pursuing technical careers among high school students—especially among girls. It is really a shame, since it has taken a lot of effort to gain visibility and see ourselves as an involved and active part of the world of science and technology.

Approximately 4,000 students are enrolled at UC3M each year, of which around 1,800 are women. Having a faculty of engineering in the university explains why there are fewer women in the total. And there is a clear difference in the choice of studies between women and men: only 16 percent of women choose degrees from the Higher Polytechnic School, and only 10 percent of men choose degrees from the Faculty of Humanities, Communication and Documentation. My work as vice-dean for international relations, and the fact that I've travelled and come to know other universities and engineering faculties, have allowed me to conclude that this is the general situation throughout western Europe.

Universities and technological centers are making titanic efforts to demonstrate the importance of fostering scientific and technological development. Institutions such as the European Society for Engineering Education (SEFI) or the Global Engineering Deans Council (GEDC), being aware of this, have for years been summoning deans of engineering universities to work together to develop engineering curriculum so that it responds more and more to the real needs of a society in constant change. We must also take into account important aspects such as sustainability and integration. In these institutions, women engineers have a key role to play, and how we are accepted and valued is of vital importance. We really have a lot to contribute. Recent events—namely, COVID-19—have demonstrated the importance of new communication technologies, and

the great support they have provided. The lockdown would not have been the same without them because, among other things, they have allowed us to bring some humanity to tragedy (for example, many elderly people in nursing homes were able to say their last goodbyes to family members via care workers' smartphones).

At UC3M, female teachers make up 33 percent of the total. Despite the fact that the number of women professors is only around 22 percent, it is still above the average for Spanish universities. It is true that the numbers are much lower if we focus on the Polytechnic School, where in several departments the number of women teachers is less than 20 percent.

My participation in enhancing UC3M's Second Equality Plan has made me even more aware of this situation and has allowed me to deepen my analysis of it and reach a very important diagnosis: the glass ceiling that prevents women from being promoted in our university occurs between the ages of 30 and 39—so it's directly attributed to motherhood. This is a phenomenon that I understand perfectly well.

I still smile when I remember the day I received a call from the dean of the university asking me to be Vice-Dean of International Relations. How good his words sounded: "Yes, Elisa, I know that you are pregnant... and that it is not your first." That was an understatement: It was my fourth! Alberto and I are parents of five children (Maria, Rodrigo, Teresa, Santiago and Isabel). How important it is to support women who want

to work and have families; it's a way of integrating the aspects of life that, far from limiting our performance, enrich us, empower us, and allow us to develop other abilities! We cannot, we must not, backtrack. We are called to a fulfillment that exceeds what we are capable of seeing in the short term, and that takes courage.

I'm so grateful to my dean and other colleagues for trusting me. Because accompanying each professional milestone, Alberto and I received personal gifts, the most important of which is the gift of each one of our children. We formed a wonderful family, and not without difficulties, obviously. But we created in our family a place where we learn to grow together, to come out of ourselves, and to relate to others in a way that's equal, respectful, and accepting of the specific needs of each individual.

At UC3M I have been fortunate to be part of the materials science and engineering department, where I started teaching shortly after I joined. I have more than 20 years of teaching experience in degrees and in subjects related to materials science, mainly in mechanical engineering and industrial engineering. I love being a teacher. This is especially significant for the moment in which we are living. The COVID-19 pandemic has put the whole world in a situation that we would never have imagined. I think that all of us have been living through a moment in time that has put us out of joint, taking us all out of our comfort zones, and not just in the area of technology. This pandemic has put us in touch with both human

weakness and human greatness. I believe that during this time we have all felt vulnerable, and have had the opportunity to change our priorities and take on tasks and responsibilities that help us be useful to others. I think that in this situation, we engineers have a great responsibility and a lot to say.

Being a teacher in these circumstances is especially difficult. One day you are teaching classes on campus and the next you find yourself looking for a place from which to teach by “bringing” all your students into your home, into your privacy. And on a platform that you have never used before. In Spain the situation has been especially serious; with total lockdown, we were unable to leave our homes and we were subject to police control for more than two months, and a state of emergency for three months in total. But it has also been an opportunity to give the best of oneself. For me, it’s a gift to have the time to write these words and contribute to this book.

It was a beautiful experience to meet, virtually, the students, with all their difficulties and fears, in each class. Some have themselves been sick, others have been isolated with relatives, and yet others have been significantly bereaved. This situation has brought us face to face with the reality of what humanity is capable of: greatness and mediocrity. It has brought us eyeball to eyeball with a mirror that we normally avoid looking into, especially those who move in the scientific and technological fields; it’s the mirror of human fragility but at the same time it’s the mirror of human dignity and of all the greatness that humanity is capable of when

our objective is dedication to serving others.

We have seen it in the healthcare world, but I believe that we must step forward too, bringing out the best in ourselves, accompanying our students in this situation, walking with them through the shifting quicksand of our times, and helping them face a very uncertain future. In these days of reflection, thanks to the gift of stopping to write this chapter, I constantly ask myself what it will be like to relax restrictions and be presented with a “new normal,” as the politicians have designated it. I wonder if I want that... and I wonder what it implies for us.

“Woman, engineer, mother of five children.” Six words that define me and that speak of my two closely linked worlds: the personal and the professional. Lockdown and the pandemic have presented me with a great personal and professional challenge. It has put us to the test, bringing out our best selves. Women and professionals. Putting into play all those skills that we have acquired, the ability to work, to manage resources, multitasking... like being in a circus with many rings. Whom of us has not felt like this?

Reconciling personal and professional life is a great challenge for women in general because we feel constantly under scrutiny, trying to meet expectations imposed both from outside and within. We feel we have to be the best in fields as diverse and as complex as motherhood, family, and business or, in my case, university. And while this is wonderful, we find that on many occasions we are neither the mother nor the wife nor the

professional that we would like to be. We spend our lives doing a balancing act, and a lot of data reflect this; for example, at UC3M women make up 57 percent of service and administration personnel, and only 17 percent of men telework.

For me, day to day life is always a question of coping and improving. In this great tapestry that is life there are colors and events that are very difficult to accept. Three years ago, unfortunately, and in just one week, Alberto was diagnosed with cancer and, although I know that I will meet him again, and that his soul lives on, I lost him.

During lockdown, getting five children to attend their classes and do their homework online while I also had to teach online—without enough devices...attending all the meetings and seeing the students...and making it all compatible with the housework—has confirmed for me that the greatest battle is within us. As women, engineers, and mothers, we have a lot to say. Being a mother enables us to do many tasks, makes it easier for us to acquire a series of skills and competencies that otherwise we might not have achieved. The pandemic, like all other times, has put us to the test.

Yet I have to say that it has been a gift for me to be able to continue teaching and supporting my students. Perhaps motherhood has made it possible for me to see the weakness, fear, and frustration in my students and has allowed me to accept, support, and accompany them in these months that have been so difficult. At the same time, being an engineer and having

acquired a series of management skills and resources has made it possible for me throughout these months to make all these tasks manageable. In fact, I have also been participating in large-scale projects related to the COVID-19 virus; for example, as an expert consultant in materials for the development of cleaning and disinfection equipment that has been distributed around the world. And all this was done from the borrowed bedroom of one of my children. Isn't that just wonderful?

My children have experienced with me that the freedom of the heart is not constrained by the physical barriers of your house, that we can do a lot no matter what our physical circumstances. "Those who have a 'why' to live can bear with almost any 'how,'" as Viktor Frankl said.

I am proud to be an engineer, to be a woman, to be a mother...it shows, doesn't it? If you are young and you are reading this, I say: Wake up, get up! You have many gifts; you have been given so much. Don't waste them. There is a long way to go, a lot of life to live, and so much to do.

JOURNEY 14

MY LIFE AMONG, AND FOR, ENGINEERS

TATIANA POLYAKOVA

*Head of the Foreign Languages Department, Moscow Automobile
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RUSSIA

I must say that during my journey from early childhood to today, I have been lucky to have only one stop, and four transfers: from home to school; from school to university; from university to MADI (Moscow Automobile and Road Construction State Technical University); a short detour to Moscow State Linguistic University (to do research and defend my first dissertation); and back to MADI to continue educating future engineers.

I was born in Moscow in 1955. My father was a historian by education, and an economist and a translator and interpreter of French by profession. He was a person of encyclopedic knowledge. My mother was an English teacher by education and a translator of English by profession. Being an only child, I had a lot of adult relatives who had a dramatic influence on me.

Of course, in this article I cannot mention all the people who influenced me during my childhood and youth, but I am sure that every grown-up we meet shares their perspective of life and the world around us. I will share that one of the most important of those influences was my grandmother (my mother's mother). I spent a lot of time with her—a fairly typical situation in Soviet families during that time in history, if both working parents were lucky enough to have their own parents willing to help care for their children. In fact, grandparents often ended up as the primary caregivers to their grandchildren. As with most of the Soviet

ABOUT THE AUTHOR



Tatiana Polyakova holds a Degree of Candidate in Pedagogical Sciences (PhD equivalent) and a Degree of Doctor of Pedagogical Sciences. Since 1995, she has been Head of the Foreign Languages Department at Moscow Automobile and Road Construction State Technical University (MADI). She is the author and co-author of two monographs on engineering pedagogy, more than 30 textbooks and manuals for teaching English at engineering universities, and more than 80 scientific articles on the problems of teaching English for specific purposes (ESP) and engineering education. Since becoming a member of the International Society for Engineering Pedagogy (IGIP) in 1998, she has held several roles, including serving on its Executive Committee, and the role of Vice President. She is also on the board of the Russian Association of Linguistics Educators, and is a member of the editorial board for the periodicals *Pedagogy* and *International Journal for Engineering Pedagogy*. She was executive editor of IGIP's journal, *Report*. Tatiana Polyakova has received several awards, including: the title of "Honored Worker of Higher Education of Russia"; the RF Transport Ministry's Jubilee Badge, "200th Anniversary of Transport Education"; the title of Ing.-Paed IGIP; and the 2019 Adolf Melezinek Meritorious Service Award.

people who had lived through the perils of the revolution and the war, my grandmother's life had been incredibly hard, but she was an amazingly creative and positive woman. Quite often, I watched her find a way out of critical situations. This has served me well in my own life; I have always tried not to panic but to concentrate on solving a problem. Also, both my mother and my grandfather were crazy about reading and passed on their passion to me, so I managed to read a lot of world classics as I was growing up.

As a schoolgirl I attended an experimental school under the auspices of the State Academy of Pedagogical Sciences. The curriculum included advanced courses in physics, chemistry and biology. My parents had no idea about this; they chose it just because of its close proximity to our home. Incidentally, I was quite good at these subjects, so no one paid much attention to my academic achievements. However, my father did spend time introducing me to two things that help me now. First, he showed me the logic of presenting facts and proving arguments. Second, he gave me interesting puzzles to solve. He told me it was a hobby of sorts, and that helpful friends and colleagues always supplied him with fresh ones. I was fascinated. Then one day my mother told me that the puzzles had come from the book "Mathematical Brain Teasers" that my father was hiding on the upper bookshelf! That killed the joy, but I had already acquired a taste for solving problems, and that has been crucial to my success. By the way,

I still have this book.

Women in the Soviet Union always had a very active role. From the start, the Soviet Union promoted the idea of equality of sexes; equal education and professional employment opportunities became a reality for Soviet women. Mothers of my friends were doctors, translators, teachers, editors, engineers—you name it. In fact, sometimes, they were more successful and advanced than their husbands. Naturally, I wanted to become a successful professional, although I am not sure I had an ambition to climb the career ladder *per se*.

I spent my summers at my uncle's country home, or *dacha*. My uncle, a famous biologist and a member of the Science Academy, introduced me to the amazing world of plants. Together we explored the local forest and water flora. In the end, I decided I was an expert on plants and set my mind on becoming a biologist. Alas, I turned out to be a disaster at preparing onion slides for the microscope—I simply could not slice them thin enough to allow their structure to be visible—and thus my biological career was nipped in the bud. In the meantime, my parents quietly nudged me toward linguistic education. I cannot say it was a heartbreak for me, so I happily switched to English, spending a lot of time delving into it. I decided to enter Moscow Institute of Foreign Languages, at that time the most prestigious foreign languages school.

The competition was fierce, and I failed to get accepted. It was a

shock. A disaster. I was nowhere, in limbo, while all of my friends were starting a new life, attending lectures, taking exams, meeting new people. My frustration was complete. I am glad to report that as of today it has been the only truly painful stop on my journey. I decided to make another attempt the following year and, if I failed, to try for the Faculty of Economics at—ironically—MADI, and become an English-speaking economist.

The next year, 1973, I was successful. I entered the English Language Faculty of Moscow State Pedagogical Institute, and so began my university career. I wanted to become a translator like my parents were, but from the 1960s to the 1980s, only a couple of highly privileged Moscow colleges could boast the translator/interpreter faculties. Therefore, the common approach, especially for girls, was to enter foreign languages faculties of pedagogical colleges or institutes, as they were called in those days.

In Russia, foreign languages teaching was fairly advanced, and students were able to reach a high level of communicative competence. In the 1990s, foreign visitors to Russian universities were surprised to learn that most of their Russian interpreters had never communicated with native speakers and had never been outside the Soviet Union.

But in my first year at the university I was greatly disappointed and disillusioned. There were no brainteasers, no challenges, only phonetic drills, memorizing rhymes and poems, pronouncing tongue twisters. Should I leave? But I did not have enough courage for that. So, I made up

my mind to stick around because no matter where you were, I thought, it was possible to find something interesting to do.

I didn't much care for the courses on pedagogy and methods of teaching. I was determined to become a translator. My favorite subject was English grammar because it was logical, precise and closer to mathematics. It was easy for me to study; I graduated with honors.

But in my final year, I realized that I actually did not want to be a translator after all. The idea of interpreting and translating somebody else's thoughts and concepts, and of sitting in the office from "nine to five" was not close to my heart at all. However, my education allowed me to become an English teacher, work at university, do scientific research, and, yes, enjoy some brainteasers.

In 1978, I got a job at MADI but only as a secretary, because there were no teaching positions available. Neither my family nor my fiancé supported me in this step, since this job did not require a diploma with honors.. That two-year period was not easy, but it was not a stop: it got me closer to academia, and in fact a few months after my secretarial debut, when I began teaching part time, I immediately realized that I was perfectly carved out for this work. I found it exciting to invent and structure exercises, define their succession, invent games, motivate students, and, finally, crown all these efforts with the ultimate success: to see the students able to speak and read!

MADI's department of foreign languages used advanced teaching methods. I was quickly catching up on technical English, trying to understand technologies of road, bridge, and tunnel construction, the workings of internal combustion and diesel engines. I was incredibly fortunate to meet a remarkable person, Elena Sinyavskaya, the head of the department. There are people who are blessed with a talent of an artist or a composer, and Elena's calling was to be a fantastically talented academic manager. For 40 years she successfully led a team of about 100 teachers. Women did not dominate the department, because all the teachers were women. Teaching, medicine, history, and economics were careers for which the competition was mainly among the representatives of the "weaker sex."

However, for a long time, up to the 1980s, Elena was the only woman among the heads of MADI's departments; a technical university, it was male-dominated by far. Our university was famous for its highly qualified and well-educated professors, many of whom were well-known scientists, and even art connoisseurs. They had very good manners, and female colleagues enjoyed their gallantry as much as the men appreciated women's scientific achievements and, yes, their beauty.

At that time, in the 1970s, I was interested in the foreign-language teaching method developed by Georgi Lozanov, a Bulgarian scientist, neurologist, psychiatrist, psychologist, and educator. This method was known as "suggestopedia" or "the Accelerated Learning Method." Only

recently have I learned that it was certified by UNESCO as “the most cultural, integral, and effective learning method.” In the Soviet Union, a method called Activation of Learners’ Reserves was promoted by Galina Kitaygorodskaya, a professor at Moscow State University. During the course, the surroundings and atmosphere in the classroom are of vital importance to make students feel comfortable and confident. For the same reason each learner is given a new name, a new identity to hide behind. Using various techniques, such as art and music, specially trained teachers help learners to overcome a language barrier, acquire confidence, and memorize more than 200 new words per session. The results were fantastic: in the shortest time, people began communicating, albeit with quite a few grammatical mistakes.

To my great surprise and joy, two MADI teachers practiced this method. I attended their classes and immediately decided to take a four-month special professional development course for teachers. The rest, as they say, is history. For more than 15 years I taught accelerated courses of English and Russian to engineering students and engineers. The “teach communication by communication” approach influenced my work and convinced me that further research was necessary to find the answers to the questions I had.

In 1979, I married Vladimir Polyakov. We were a typical “high-school sweethearts” couple. He became an engineer, a brilliant researcher, and a

scientist. His field of research was and still is the construction of high-speed rail. Our conversations always help me to understand more deeply the very essence of engineering. My husband's erudition, good memory, and inexhaustible curiosity allow him to guess the meaning of words in many foreign languages. As for me, I enjoy inventing optimal technologies, so we joke that in our family he is the linguist and I am the engineer.

When we married, he was at the start of his career, and I thought it would be a good idea for him to do his PhD before I did mine. To my mind, a family is happier when a man sees himself as the leader. I typed the first draft of his dissertation and it showed me how complicated engineering was. Helping him gave me a chance at least to learn engineering terminology in Russian.

In 1983, I took the exams and was enrolled in the postgraduate program in linguo-didactic competence at Moscow State Linguistic University. I wanted my research to focus on how to improve teaching foreign languages at engineering universities as I was determined to return to MADL.

At that time, the purpose of teaching a foreign language to future engineers was limited to developing reading skills. There were reliable methods for applying a number of reading strategies, but the results were far from excellent. To be aware of the world's technical achievements, an engineer had to be able to read foreign texts in the library. My thought

was that an engineer was too busy for that and only researched foreign texts when he had to solve a technical problem, a solution to which was not available from Russian sources. I presented an engineer not as a reader-researcher but a consumer of information. As such, they needed help in effectively sifting through various sources of information. To improve their reading skills, I suggested the “situational approach”: imitating a typical professional reading environment in the classroom.

A survey proved my hypothesis. While working on my thesis, I had a lot of debates with my husband, and if he had not been an engineer my dissertation would have been different. In 1987 I defended the dissertation and received my Degree of Candidate of Pedagogical Sciences (PhD equivalent).

In 1987 I returned to MADI, tired of the problems of teaching reading skills, and gladly accepted Elena Sinyavskaya’s offer to be a co-author of a nationally published English textbook. I was responsible for the section on teaching oral speech. The textbook was a success. A year later, I was appointed head of the English section, the largest section in our foreign languages department, and started a management career in education.

Then, in 1991, our son was born. Dmitry grew up to take after his father and now represents the fourth generation of engineers in the Polyakov family. He is a 21st -century engineer and his vision of the profession is fresh and innovative—a great help for me as an educator.

In Russia, the terms of maternity leave are quite different from most other countries. A woman can leave work two months before the baby's birth, with her salary paid out for those two months, as well as for two months after she gives birth. A mother may then stay at home with her baby for three years with guaranteed return to previous employment. I chose to take this leave, and used the time to write a book.

Those were early days after the fall of the Soviet Union. The initial flow of foreign goods brought personal computers to Russia. Some of my friends, German- and French-speaking engineers, turned to me to recommend to them an English textbook on the basic computer terminology of Disk Operating System (DOS). I could not find anything on this topic—so I decided to create such a book myself.

I felt elated breaking traditional rules of teaching methods. I had a clear understanding that this new, emerging class of business engineers had little or no time to spare on lengthy learning processes. I knew I had to write a very pragmatic textbook to help them effectively use DOS commands, understand information about errors, and grasp the gist of instructions. To achieve that, I selected particular grammar structures, drew pictures illustrating the commands, used etymological expressions in Russian that could be easily associated with English terms and help learners to remember them—and so much more. I had a lot of fun writing it (and my friends were happy to finally have such a book!). A Moscow

publishing house got interested, and published *English for Dialogue with a Personal Computer* in 1992. The book saw four subsequent editions, in 1997, 2001, 2002, and 2003, despite DOS losing its relevance well before that. The textbook was incredibly popular.

In 1995, I was elected as head of MADI's foreign languages department. The 1990s were times of serious economic difficulties in Russia. Our salaries were not paid regularly; younger, promising teachers were leaving the department; and I had to manage the people who were older than me, my former mentors.

We had to stop our local "brain drain" at a time when there was a growing demand for studying foreign languages. In 1995, my colleagues and I started foreign language courses for our students and in 1999 launched the *Translator in Professional Communication* program. It met with great opposition from academia. Firstly, linguistic universities vehemently objected to the implementation of this program at technical universities, claiming that only they had enough resources to produce marketable technical translators. On the other hand, there was opposition from technical university teachers because they did not believe in the viability of our project. I, however, managed to convince my colleagues that only a technical university was able to train a qualified translator of technical literature in the area of airfield construction, automobile service, etc. I am proud to report that for the past 21 years, numerous students and engineers

have received additional qualifications as translators and work successfully in the industry.

In 1998, together with Elena Sinyavskaya, we produced a new, updated and improved issue of our textbook English for Engineers, and to this day it is used in many engineering universities all over the country.

Also in 1998, MADI hosted the 27 th International Symposium, and our department was responsible for translation and interpretation. Since then I have been an active member of the International Society for Engineering Pedagogy (IGIP). I was a member of the organizing committee of IGIP's 37th symposium, also held at MADI, and am a regular speaker at IGIP conferences. Since 2009, I have been the chair of the IGIP working group on language and humanities in engineering education. I took over from Robert Ruprecht, a Swiss teacher and a magnificent speaker. From 2005 to 2012, I was the executive editor of Report, IGIP's official journal. In 2010, I was elected as an IGIP executive committee member, and since 2014 I have been IGIP vice president. In 2015, along with MADI's rector and the president of IGIP's Russian monitoring committee, Viacheslav Prikhodko, I published IGIP: The Past, Present and Future, a book we hoped would help to disseminate engineering pedagogy ideas in Russia. It was awarded an international prize.

Communicating with engineers from various countries was important both for my practical pedagogical work and for research. In

IGIP I met people who played an important role in my professional career. Firstly is Adolf Melezinek, the founder of IGIP and the Klagenfurt School of Engineering Pedagogy. And then there is Michael Auer, a computer scientist and engineering educator, the vice rector of Carinthia University of Applied Sciences. He was also president of IGIP, and of the International Federation of Engineering Education Societies (IFEES), the International Association of Online Engineering (IAOE), and other prominent societies. He is editor-in-chief of some international scientific journals. Because of his international work and high profile, Michael Auer has been the driving force behind IGIP's active participation in and contribution to the development of engineering pedagogy.

In 2008, I met another person who has devoted his life to developing engineering education: Hans Jürgen Hoyer, IFEES general secretary and the executive secretary of the Global Engineering Dean's Council (GEDC). GEDC was created in Paris on May 9, 2008; there is a photo on the GEDC website taken just after signing the Paris Declaration of a multinational group of leaders in engineering education from prestigious institutions. Among them, you can find me. Even though I was there as an interpreter, I was honored to have been present at this historical moment. I am proud also that among the 12 translations of the Paris Declaration in the Inaugural Statement of the GEDC brochure, there is a Russian version done by me.

From 2007 to 2009 MADI was a coordinator of the Tempus project,

“Innovative language curricula for technical universities.” The consortium included six engineering universities: the University of Klagenfurt (Austria), Linköping University (Sweden), and four Russian universities: MADI, Moscow State Agri-Engineering University, Tambov State Technical University, and National University of Science and Technology “MISIS.” I headed the working group responsible for preparing teaching materials. It was at that time when the Bologna Process was in full swing. One of its action lines is promoting academic mobility of students and teachers. The aim was to create teaching materials for three target groups of learners—such as engineering students, lecturers, and administrators—that could help them prepare for studying or working in European universities. The idea was to teach them English as a means of international communication and to work out one common course book for all the target groups, and a manual for each of them to take into consideration for their specific needs.

We had a team of excellent teachers who accepted the concept even though nobody truly believed in it. The result of this outstanding cooperation was English for Academic Mobility, a set of five books. The series with a CD was published in 2013 and was awarded the 2015 University Book national prize. It was a fascinating experience and the project was possible only through the team effort of an exceptional group of leading international educators.

In 2011, I successfully defended my doctorate thesis, 16 years after

my husband had done his own. In Russia, we have a system of candidacy (PhD) and doctorate degrees. My research work focused on a large-scale professional survey in order to narrow down and define engineering needs in foreign languages. The idea was that they are constantly changing. An engineering university must be in a position to offer a fast response via new programs for life-long foreign language learning constituting a flexible diversified system of foreign language training. My thesis provided the concept and diversifying technology of professional life-long foreign language training in engineering education. My work expanded from linguistic issues to the history of engineering education in Russia, as well as global trends of its development.

In 2012, my contribution to MADI's strategic development plan was a proposal to compile a series of concise terminology dictionaries for our students and teaching staff. I showed that it was a vital tool during the education process because it provided carefully selected basic terminology for each university discipline. Together with our technical specialists we published 17 bilingual and three language dictionaries, among them Transportation Tunnels, Automobile Roads, Automobile Services and others. The one called Bridges was edited by my husband and co-authored by my son!

In 2017, together with Kirghiz State University of Construction, Transport and Architecture, MADI compiled five Russian-Kirghiz concise

terminology dictionaries. Their publication was financed by the Russian World fund. In 2019, MADI was awarded the International University Book prize for the best joint project.

Now, I am busy compiling IGIP's multilanguage glossary on engineering pedagogy and my dream is to see it available on IGIP's website: the English version with its translation into the languages of IGIP National Sections. I am almost finished with the English and Russian versions, and I hope the other languages will follow.

I think I am lucky that in my work I have always enjoyed the support of my mentors and my colleagues: the teachers in the department of foreign languages. And in my family life, I have been blessed with my two loving and much-loved boys: my husband and my son, my rock-solid home base.

Besides my work, I love dancing, cooking—my friends say I am good at it—and knitting. I adore country music and detective stories. My favorite flower is the hydrangea; I cannot resist planting yet another one each summer in the garden at my dacha, and I enjoy watching them grow and blossom.

On my professional journey I have always been accompanied by engineers, and that brings me to these conclusions. Engineering thought is a key driver in human development. Engineers apply theoretical knowledge to create practical things that do not exist in nature and which become indispensable to people. From the Egyptian pyramids to the first Roman

aqueduct and Via Appia antica, the oldest surviving highway (both constructed in 312 BC), to the magnificent medieval cathedrals of Europe—where designing and constructing sustained roofs demanded a true genius of engineering thought—and transatlantic liners, airplanes, automobiles, mobile phones, the internet... every day, we live in and use the products of knowledge and practical skills of engineers.

The involvement of more and more women in engineering will bring harmony into the profession. Role models include architect Zaha Hadid and her breathtaking building designs, her success and outstanding achievement, which have opened doors to aspiring young women architects and construction engineers. For centuries, women have been destined to preserve their homes and nourish their children. In engineering careers, women focused on the problems of ethics in engineering. Environmental protection and sustainable development were just about the only areas open to them. No longer!

The journeys of women engineers show that often there are changes in their careers caused by various circumstances. It is important not to be frustrated but to welcome the change that can give a new positive impulse and show the world from a new angle. It is possible to find something stimulating everywhere.

There is no problem in life that cannot be solved. I always remember Scarlett O'Hara in *Gone With The Wind*: If you have no money to buy a

dress and no proper fabric to make it, use the curtains and hold your head up high. But don't forget to wear gloves to hide the rough hands worked to the bone!

It is important to spend more time with young people, be it our children or our students, sharing our experiences and our knowledge, teaching them things that will help them in their life. To some extent, in doing so you may influence their life journey. I know that's been true for me: Every day I feel the influence of people I grew up with, studied with, people I met at work, and people I am working with now.

JOURNEY 15

ON OBSTACLES, AND THE RESILIENCE OF WOMEN

ARIUNBOLOR PURVEE

*Professor, German Mongolian Institute for Resources and
Technology, and Associate Professor, Mongolian University of
Science and Technology*

MONGOLIA

My career path—starting from when I got a job sweeping up the parking lot at the Chinggis Khan Airport during high school through to today, serving as professor of engineering at the German-Mongolian Institute of Technology—seems like it has always been strewn with obstacles. But because of who I am, and how I was raised, I stayed true to myself, and nothing has been able to stop me from achieving my goals.

I grew up in the 1970s and '80s in socialist Mongolia on the outskirts of Ulaanbaatar, Mongolia's capital city, during the period just before the fall of the Soviet Union. We lived in a ger district (these can be explained as "tent cities"; gers, or yurts, are a sort of tent) that flanked the city for miles on either side. Ger districts consist primarily of herder families who

moved there because they could no longer sustain their nomadic lifestyle. This is the case for my parents; they moved to the capital to secure jobs. Even today, in ger districts there are no ready connections to sewer, water, or electricity services, nor is there easy physical access to hospitals, schools, or jobs.

My father was trained as an electrical technician and was selected to serve as a district leader in the Communist Party, and my mother worked in the shoe factory as a stitcher. My parents had six children; I was the third-born. My mother had to return to her work 45 days after giving

ABOUT THE AUTHOR



Dr. Ariunbolor Purvee is a leading scientist and engineer contributing to engineering education and research in Mongolia. She is a Professor of Electrical Engineering at the German-Mongolian Institute for Resources and Technology in Mongolia.

Dr. Purvee was one of the first students to graduate with an MA degree from the Mongolian University of Science and Technology (MUST; formerly the Polytechnic Institute) after the country's Socialist period ended.

Since 1993, Dr. Purvee has taught engineering courses while serving on the MUST faculty, bringing the research experience she gained abroad—in India, Korea, and the United States—to the next generation of Mongolian engineers. Her academic work has been published in textbooks, manuals, and papers. She holds 10 copyrights, two trademarks, and one patent.

Her most profound social impact, however, occurred when she became the Founding Director and President of the non-profit Woman in Science, Technology, Engineering, and Mathematics (WSTEM) in Mongolia. As an active member of the International Network of Women Scientists and Engineers, she understood the potential benefits of promoting women in science and technology in her country. Her vision is to provide the proper guidance and training to enable women to assume leadership roles in Mongolia.

birth, so the elder siblings helped to raise us younger ones. We grew up in the proud glow of our grandmother's accomplishments: The government had honored her with the Labor Hero medal, which was very difficult to receive in that time period. She received the medal for having raised more camels than the government had planned. (Apparently, one of her "tricks of the trade" was to sleep on an iron box; the metal would transmit ground vibrations very well, and she would awaken if predators like wolves were approaching her camels during the night, allowing her to chase them away before they attacked.) As a result of her prestigious award, she was able to serve as a member of the People's Great Hural (Parliament) for 18 years. Her medal always had the place of honor in our household. When I was growing up, it was a sort of subliminal source of inspiration for me, a symbol that a woman could achieve great things.

I was always good at math in grade school, but only achieved competitive success once we realized I needed glasses. After that, I managed to begin winning places in math Olympiads at higher and higher levels, ultimately placing first in my school district and 15th in the country. As in all former Soviet Socialist states, upon graduation from high school at the end of the 10th grade, students take national exams to determine if they can study in university and if so, which major they will study. Each university has specific test-result requirements for matriculation, as well as government-set quotas for each field of study, a practice that continues

to this day. At that time, there was also an opportunity to study in East Germany to become an airline stewardess, and I had my heart set on that; it seemed so glamorous and exciting! But my father, seeing first-hand the opportunities available in Mongolia's rapidly developing society, insisted I apply to study as an electrical engineer.

I sat for the Mongolian University of Science and Technology (MUST) entrance exams. But I was cocky and not terribly motivated; after all, it wasn't my first choice of a career. The exam ended with three math questions and I dashed off the answers in under five minutes, then left, confident in my proven math abilities. But I got only one of them right, which lowered my score dramatically. However, I had done just well enough to take the last place—just above the so-called “red line.”

I had learned my first lesson: never take an opportunity for granted. This near miss made me study very hard during my first year, and I won first place in the university's Olympiads. I had wanted to transfer to the popular IT technology and programming major at the end of my first year but the dean in charge did not give me permission. He said he didn't want to lose yet another good student from the mining and electrical engineering department, and so I graduated with this major. It was to be another 18 years before I could return to my IT programming interests.

I began working in the mining industry as an electrical engineer, but was invited back to MUST to study in its new MA degree program

because of my excellent grades. It was Mongolia's very first MA degree program, drawing from the top students graduated from each of the universities. When I received my MA diploma, I saw from the number stamped on it that I was only the fifth student to have completed an MA degree from Mongolia! I was asked by MUST to teach in the mining and electrical engineering department, which I wanted to do—and would do for the next 28 years—but first, I was required to pass a Russian language exam, as was anyone who taught at a university. This was in the early 1990s, just after the fall of the Soviet Union; Mongolia was still in transition to independence, so regulations from the socialist period were retained. The language of tuition was Mongolian, but it was assumed we would be accessing information, texts, and teaching materials that were published in Russian. I studied Russian very hard that summer, and somehow managed to pass the exam. To this day, I still make use of my knowledge of Russian.

I entered the PhD program at MUST in the late 1990s, but there were not enough faculty holding PhDs to help supervise the PhD students' research, nor were there any real research facilities, equipment, or materials. Although I was never directly asked for bribes, it was generally the expectation that PhD students needed to give money to the professor to obtain their degree. For all of these reasons, I decided to obtain my research training abroad: I had received a TWAS Award, a scholarship that allowed me to go to India, where I conducted my online condition-

monitoring research (this involves the monitoring of the operation of motors, and other mechanical equipment, to determine any faults). I was also able to learn English while there, which has truly helped me in my career. After completing my research abroad, I brought the research field of online condition monitoring to Mongolia. After defending my PhD at MUST, I received a one-year post-doctoral fellowship for advanced research training at the University of Seoul, in Korea. Upon completion, I returned to my academic life at MUST.

It was at an International conference of women scientists and engineers in 2011 in Australia, organized by Marlene Kanga (whose journey was detailed in the first edition of this book), where I was first introduced to the idea of networks of women as a potential force for personal and societal development. The panel theme had to do with the status of women in STEM fields from a variety of Asia- Pacific countries. People were surprised when I presented the information about Mongolia because the numbers were so high: Statistics show that there are many more women than men in higher education of Mongolia. It was news to me that our statistics were in any way remarkable, so upon returning to Mongolia I told others about our apparent success in this area. It was then that we decided to form an organization of Mongolian women in STEM fields, to take our place among this broader network.

I had to make two attempts, as the first one was a disaster. I'll share

what happened. After that conference in 2011, I called upon women working for higher positions, such as heads of research departments and those holding PhDs from the Mongolian University of Science and Technology, to build the new Association of Mongolian Women Scientists. At our first meeting at the end of 2011, more than 100 women scientists attended. We had a sponsor, the Sergen Mandalt Corporation—and I was shocked that the founding women wanted to share the money. I did not agree with this idea; I wanted to focus on a program that encouraged and motivated young women in STEM based on the good experiences of women in STEM from other countries. Plus, I wanted to include Mongolian women engineers in the association. Meanwhile, there was a parliamentary election underway, and a new election law required a certain quota of women candidates. There was no shortage of women wanting to run, but they lacked a platform. So when they learned of our new organization, with its focus on women in STEM, these candidates were attracted to it in droves. At first, I interpreted their enthusiasm as genuine interest in the start-up organization. But once they became members, they took it over completely: the voting and membership rules, the finances, and ultimately my leadership position. I was voted out as president of the very organization I had just founded, and I was crushed. I was in deep shock. I left, knowing that I could and should do better for women in STEM fields in Mongolia.

In 2012, after the organization fell apart, I started again and founded

the Mongolian Association of Women in Science, Technology, Engineering, and Mathematics. This time I began by inviting known scholars, women with similar goals, to recommend women in STEM fields whom we could invite. I met with two men to discuss the non-profit organization because I worked with men professors and engineers and I taught male students for many years. One of these men was one of the oldest professors in Mongolia, famous in the mining technology sector, and the other was one of my country's most famous singers.

We grew slowly and deliberately over the next eight years, to the point where we have membership in every province in Mongolia and a steady financial base. We have programs for accomplished women scholars, programs for scholars in development, programs for young girls (in a past/present/future framework), and work-experience programs. We hosted a major international conference of women in STEM in Mongolia. We also give achievement awards to women who have contributed to STEM fields; we annually select and subsidize young women scholars to attend summer STEM camp in Korea; we invite groups of high-school girls to observe women working in STEM fields; and we organize many other activities. For these efforts, our organization has been selected to help oversee and provide advice for an international conference of women engineers and scientists to be held in 2023.

I've found that perseverance is essential not only professionally, but

personally: I now want to share with you my experience of breaking free from an abusive husband, as I hope it could be helpful for other women reading this.

When I was a young woman and first introduced my boyfriend to my mom and dad, my dad told me, “He is not for you; he will not be a husband who can take care of you.” But I did not listen, and my adult life with this man started. I was not happy; I felt that something was very wrong with this relationship. But by now I had a son, and so I endured the problems. Many years passed, and our relationship grew worse; he wasn’t supportive of my career, and was verbally abusive to me and to my son. Still, it was a deep shock when he left us in 2004 to live with another woman, and they had a daughter together. It was tough to get over that. But in 2006, I had the opportunity from the World Academy of Science(TWAS) to become a PhD scholar, and I went to India. I studied very hard. I completed the PhD research and returned to my country. My husband then asked me if he could return to our family, to be a father to our son; I agreed, for my son’s sake. But then the problems resumed, and he started hitting me. Each time, it was worse than the time before.

In 2015, I saw a possible opportunity to go away with my son and become free of my husband: I was fortunate to have been invited to serve as a visiting professor in the department of mining engineering at the University of Alaska, Fairbanks, for a few semesters, to teach and conduct

research there—and for the final semester, I could take my son.

But when my husband found out, he insisted on coming with us. I was crushed, but I couldn't see how to stop him. And, I hoped that maybe he would change. He got his US visa and the three of us—my son was now 15—flew to Los Angeles. But my husband started to beat me soon after we arrived. It was at the Metro station at 11 p.m.; I had heard that in the United States, police would immediately come help in a situation like this, but nobody came. With my son, I ran away from my husband and became lost in the huge city. Many homeless people who slept in the street were calling to me. I was so afraid that all I could do was stand under a big tree with my son. I had the address of a friend, but could remember only part of it; in the morning, I began to ask passersby if they knew where the street was, and eventually I found my friend's apartment. Then my son and I went to Alaska. My husband didn't search for us; he returned to Mongolia (I have not seen him again since that day).

Now I knew I had to remain free of him forever, but I had a hard time in Alaska. The wife of the professor who hosted us said, "You are a different person. What has happened to you?" I told her everything, and she was so supportive; she helped me get over it. Even the professor told me, "He is just a tumor. A tumor makes you hurt. Then when it's removed, you feel pain, just like after surgery, but after some time you will be okay. You are lucky he is not a cancer that has spread even further."

There were obstacles, but upon my return to Mongolia, facing personal, financial, and career threats, I was able to eventually break free and become my own person. I kept very busy teaching courses and organizing the 2015 international conference of women engineers and scientists from Asia-Pacific countries. And the money I earned in the United States was my big opportunity to truly be an independent person. I was able to get a mortgage, with which I bought the apartment I'm living in now.

It's not always easy; a few years ago I saw on Facebook that my former husband was celebrating the birth of a new baby. But I have since met a new guy, a mining engineer. We now live together and have our own apartment. He is caring and supportive of my success; we make a good team.

My story isn't over yet. But it's far enough along that I can make some observations and offer some advice to younger women entering this profession:

- First, operate with an open mind and an open heart; it's better than the alternative. Despite all of the trouble I have gotten into with my naiveté, I have learned from my mistakes and somehow found the strength to remain open—to new people, new opportunities, and new ideas.
- Second, never give up. If an idea or a plan was worth having in the first place, then it is worth fighting for and overcoming all barriers to its success. I was determined to make my

undergraduate studies a success, despite my less-than-stellar start. There were many times I thought it impossible to complete my PhD research, but I eventually found a way to get it done. I was determined that my son, as well as my sister's daughter, whom I helped raise, should have the best education; that meant having them study abroad, so I worked three jobs to make it happen. I overcame the humiliation and shame of having my new women's organization taken away by coming back to organize one that was stronger, better, more sophisticated, and more stable.

- Third, believe in the resilience that women and girls possess. I was a kid from the ger districts, who grew up without financial advantage or connections. All I had were parents who guided me, an inspirational grandmother, and a positive outlook on life. And yet somehow, it was enough.

We all possess an inner core of strength that gets us through and over both the avoidable and unavoidable situations in life. Find and tap into that core, and there is nothing that can stop you from achieving your goals.

JOURNEY 16

THE WORLD NEEDS WOMEN ENGINEERS

NIRANJANIE RATNAYAKE

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SRI LANKA

Gender stereotyping has been an ongoing practice in both the developed and the developing world since time immemorial. While some conservative cultures strictly enforce a differentiation between males and females in education, employment, and social freedom, stereotyping is still apparent—even in more liberal cultures—from the day a child is born. For example:

- Girls are dressed in pink dresses with bows and ribbons, expected to play with dolls, and are seen to be timid and weak. Boys are dressed in blue, expected to play with trucks and trains, and are often complimented for being tough and rough.
- Boys should fix things while girls need things fixed. As girls grow up, they are expected to be beautiful, graceful, soft-spoken,

and cultured, whereas boys should be handsome, outspoken, and strong.

- Boys are expected to be strong in science and mathematics, and girls strong in the arts.
- Even if girls do get into science, they may study medicine or biological sciences, but rarely engineering. Boys will become surgeons, engineers, and pilots, whereas girls will stay at home as housewives or take up jobs like nurses, primary teachers, or

ABOUT THE AUTHOR



Niranjani Ratnayake is an Emeritus Professor of the University of Moratuwa, the title awarded on her retirement from service as a Senior Professor in Civil Engineering. Her field of specialization is Environmental Engineering. In 2002, she was promoted to the post of Professor, thus becoming the first ever female Professor in any field of Engineering in the Sri Lankan University system. She was the President of the Institution of Engineers, Sri Lanka (IESL) for the session

2017/2018, considered as the highest position an engineer can achieve in his/her Professional career. In its history of 113 years, this is the second time that a female became President. She served as the founder Chairperson of the Women Engineers' Forum and Chairperson of the Civil Engineering Sectional Committee of the IESL. She has won several prestigious national Awards, including a Presidential Award for Research and the Zonta Woman of Achievement Award in Engineering and IT. IESL recognized her by awarding the Outstanding Engineering Education Award of Excellence. She is also the President Elect of the Institution of Environmental Professionals, Sri Lanka (IEPSL) which is a gathering of Professionals of all disciplines committed to the common goal of a clean planet and sustainable development.

secretaries. If they do become doctors, they are expected to select to practice in what are perceived as the less-challenging specialities. This is the typical stereotyping of roles given to boys and girls by society.

Let me quote Nilupuli Andrahennadi, a young Sri Lankan who has successfully broken the barrier of this gender stereotyping and risen to be a pilot in our national carrier, Sri Lankan Airlines. She has said that the stereotyping of some jobs as male-dominated won't go away, but that, "It is our choice as women to break these stereotypes and achieve the goals we set for ourselves." "Our career paths should not depend on gender," she adds, "but on our passion, skills, talents and dedication." I couldn't agree more.

We become engineers because we get excited about solving problems and making things happen, by design. It's been said before, but it's worth repeating: Engineers change the world. We improve human life by catering to the needs of society, providing solutions to facilitate everything from basic human necessities such as shelter, food, water, transportation, clothing, and medical equipment to fancy excesses like Trevisas and Lamborghinis. We help advance cultures through providing platforms for entertainment and communication. We conceptualize, design, and implement solutions.

We also design and implement others' concepts, collaborating with architects, doctors, and scientists to create buildings, medical equipment, and laboratories. Engineers at NASA are working hand in hand with

astronauts right now, designing and implementing their concepts for space travel to another planet! This list is endless. Without engineers, these concepts would remain merely ideas.

I do not see being a woman as a handicap for being an engineer. Gaining the right skills and having the passion for what you do are the important factors to being successful as a female in engineering—though, as many of us have learned, being a female in a male-dominated field is, apparently, inconvenient to many people.

To illustrate this social dilemma, I'd like to draw your attention to an interesting quote I once came across, although I can't recall the source: "Female engineers have been termed double stereotype breakers; that is, we break the stereotype for a 'good woman' as well as that for a 'good engineer.'"

Females bring something to a team that would be lacking were this an all-male society. Recently I saw the movie *The Female Brain*, which was so amazing that it led me to download and read the book, on which the movie is based, by the American neuropsychiatrist Dr. Louann Brizendine. Here are a few passages:

- "Male brains are larger by about 9 percent, even after correcting for body size. In the nineteenth century, scientists took this to mean that women had less mental capacity than men. Women and men, however, have the same number of brain cells. The cells are just packed more densely in women—cinched corset-

like into a smaller skull.”

- “New tools, such as positron-emission tomography (PET) and functional magnetic resonance imaging (fMRI) scans, now allow us to see inside the human brain in real time, while it’s solving problems, producing words, retrieving memories, noticing facial expressions, establishing trust, falling in love, listening to babies cry, and feeling depression, fear, and anxiety.
- “The male and female brains process stimuli, hear, see, ‘sense,’ and gauge what others are feeling in different ways.... In the brain centers for language and hearing, for example, women have 11 percent more neurons than men. The principal hub of both emotion and memory formation—the hippocampus—is also larger in the female brain, as is the brain circuitry for language and observing emotions in others. This means that women are, on average, better at expressing emotions and remembering the details of emotional events.”

The film also made an interesting point, along the lines that the “female” characteristics of being emotional, sensitive, and hypervigilant—qualities stereotypically considered as weaknesses—are actually strengths. For example, it’s a good thing that we are hard-wired to identify danger.

It’s not only our brains that are different: it was with some astonishment that the world learned, just 25 years ago, that women’s heart

disease manifests itself differently than men's does!

But rather than dwelling on our differences, the time has come to embrace the unique qualities women have to offer. The benefits of female participation in fields like product design are being recognized now. A recent article by Sue Williams published on Inc.com, entitled “Why we need women in STEM,” describes this advantage. She says, “As more women enter the fields of STEM, we are seeing the difference a women’s perspective makes. For instance, engineer Surbhi Sarna of nVision is developing a technology to detect ovarian cancer and tube blockages, which would improve a century-old procedure that is painful to the patient.... Amy Sheng, a mom and bioengineer, is working on CellScope, which allows parents to use a smartphone attachment to diagnose children’s ear infections. Leah Sparks and Katherine Bellevin have created Due Date Plus, a smartphone-enabled maternity program.”

These are products that improve people’s quality of life, and they are products that men probably would never have dreamed up. Another aspect of development that female engineers are contributing to, in a significant way, is in the social and environmental aspects of engineering works. As referred to in the earlier quote about the “female brain,” women more acutely sense threats to safety and security, which can positively contribute to the implementation of projects. This factor is finally being recognized in the developed world.

You do not have to be a “tomboy” to become a good engineer. In fact, during my career of 43 years as an academic at the University of Moratuwa, I have seen very few girls who wanted to look like boys or act like boys. Gaining the right skills and having the passion for what you do, and the confidence to take up challenges put in your path, are the important factors to be successful as a female in engineering.

I write this as a professor emeritus in civil engineering of the University of Moratuwa, the leading faculty of engineering in Sri Lanka, as well as a recent president of the Institution of Engineers, Sri Lanka (IESL), the Apex professional body for engineers in Sri Lanka. I was the first female to achieve this combination, being the first female professor of engineering in the country and the second female president of IESL in its history of 114 years. But I am hopeful that I am merely at the start of a long line of many more to come.

Personally, I have been lucky in being able to balance my career and family life because I had the support of both my own parents and my parents-in-law. I also think that being an academic has had its plus points as a career choice, as it has allowed me to spend more time at home. I am invariably working until about midnight, as I bring my work home, but being home has meant being available for the children when they have needed me, so that is a big advantage. I did not take up any administrative posts until the children were grown up, and although I didn’t have to pass up

any promotions, I did not rush into them, either. Even though my husband and I have the same number of years of service at the university, he became a professor about five years earlier than I did. But that is fine with me.

I must admit I am what I am today because of my parents. The biggest influence in my life was my father. He was a simple person, always cheerful, and he loved to quote from the books he had read and poems he had learned during his school days at a leading Catholic school in his hometown. But my mother was the one who “knew” that their children should be educated and sent to the best schools possible, and later, to university.

I am also grateful to the support that my husband, Professor Lakshman Ratnayake, has extended to me whenever I needed it. But perhaps the most important role he has played in my career is allowing me to reach my heights on my own, without interfering with my academic and professional work.

When I was studying for the national examination that would qualify me for university admission, becoming an engineer was just a dream. I was quite good in mathematics, but not so good in remembering botanical and zoological names in biology, so I chose to get into the mathematics stream at the advanced levels. Having attended two all-girls national schools during my primary and secondary education, I was trained to do what is right, and not care too much about what others say. I never felt disadvantaged

by being a girl. I do not think it ever occurred to me at that time that I was entering a “man’s” vocation.

This was the era when science and technology were gaining popularity even among the ordinary people, with breakthroughs in astronomy and space travel; people were walking on the moon. USSR cosmonauts Yuri Gagarin and Valentina Tereshkova were household names, even though I come from a very ordinary family in Sri Lanka and had access to only the radio and the newspapers. Apollo 11 was launched when I was in the advanced level class. The movie based on Sir Arthur C. Clarke’s novel, 2001: A Space Odyssey, was breaking box office records. I remember reading everything I could lay my hands on about space travel at that time. I also feel it was natural that I should have been interested in science as, being the youngest in a family of three, my older brother studied physical science and my sister, dental surgery, both at the University of Peradeniya.

I guess the defining moment in my choice of a career came not on the day the advanced level results were released and I learned that I was selected for engineering (along with five other girls in my class), but when a letter came from the University of Colombo offering me a substantial scholarship if I gave up engineering and joined their physical science program. I knew then that I did not want to give up, at any cost, my opportunity to do engineering.

There were only 12 girls in the batch of 150 engineering students

when I entered university in October 1969. (We were called in jest “The Dirty Dozen,” after the movie.) There were four first classes when we graduated in 1974: one in electrical engineering, two in mechanical engineering and one first class in civil engineering—mine! This was out of a batch of about 120 civil engineering students! More importantly, one of the mechanical engineering first classes was also obtained by a female: Indira Arulpragasam (now Samarasekera), who served two terms as president of the University of Alberta, Canada! I did not feel any competitiveness between the girls and boys as far as the academic work was concerned. I worked with the conviction that if you study well, and do your work well, you get good results.

I do not believe it is difficult for a woman to create a niche for herself in a male-dominated field. I feel that being a woman has not held me back from anything that I wanted to do in my career. Of course, sometimes our brains must compensate for what we miss in brawn. I tell our female students that they cannot afford to be mediocre; employers will select a mediocre male over a mediocre female, but they will hesitate to take a mediocre male when there is an excellent female engineer.

We did a study among the female engineers of the IESL in 2017. Incidentally, we had a total current membership of 15,500, all qualified engineers, out of which 2,290 were female engineers—about 15 percent. The numbers have increased since then, but the percentage of female engineers remains about the same.

Our questionnaire went to all the female engineers, out of whom about 20 percent responded. The majority, 88 percent, are working full-time in the government or private sector, and 25 percent have postgraduate qualifications, too. We got some revealing statistics from that survey, and we need to take some initiatives to improve the lot of women engineers. I do not want to bore you with numbers, but here are some, just to give an idea about the situation:

- Although 88 percent think, “Engineering is not a man’s world,” 91 percent agree that the ratio of men to women is imbalanced in the sector in general.
- 71 percent say that women face more opposition in leadership roles than men.
- 77 percent say that some men do not feel comfortable with having to report to women.
- 54 percent feel that female engineers have to work harder than their male counterparts to get ahead in their workplace.
- While only 48 percent say that having more females in leadership positions in the workplace encourage them to succeed more, 71 percent say having a mentor (male or female) helped them to succeed.
- 61 percent think that there was (or will be) a time in their engineering career when they must choose between family and

career; of those, 52 percent chose/will choose family.

- 72 percent think they can perform better if/because they have post-graduate qualifications.
- Of the 52 percent who want to pursue postgraduate studies (MSc/PhD, etc.), 64 percent prefer to do that in Sri Lanka on a part-time basis, mainly due to family responsibilities.

So we can see that although in Sri Lanka there does not seem to be any barrier to women studying engineering (the current university intakes being totally impartial to gender), when it comes to the workplace and home, there may be barriers that have to be overcome to rise to the top. After all, three quarters feel that male employees resent having to report to female bosses, and more than half feel that they have to work harder than their male counterparts to get ahead in their workplaces. On the positive side, most of these women engineers are doing very well in their careers, as they have chosen to do engineering rather than just go along with the wave.

At the IESL, we formed the Women Engineers' Forum (WEF) in 2002, of which I was the founder chairperson. The objective of forming WEF was to strengthen women engineers of the IESL to play an active role in its endeavors to improve people's quality of life. Our mission was to utilize the total potential of women engineers for all progressive activities of the IESL by developing a greater bond among members while enhancing their professional competency. We conduct professional development programs,

lectures, and seminars on diverse topics, and social and corporate social responsibility (CSR) projects. Although at the beginning there appeared to be some resentment among the male engineers about the establishment of the WEF, I believe we have proved that this is not a move to break away from the mainstream, but an attempt to get the female engineers more involved in IESL activities.

In this day and age, when the world has started to realize that participation of women can provide ideas and added value that could be lacking in an all-male boardroom, we find that the governing council of the IESL (where decisions related to the profession are being made), comprising 32 members, had either one or no female members in many years. Even though female engineers do voluntarily participate actively in IESL sectional committees and standing committees, women's representation on the IESL council is difficult to sustain. However, there are a number of capable women engineers who are willing to actively engage in IESL activities but are reluctant to contest at the council elections with their male colleagues, where it is generally felt that the competition is not on a level playing field.

WEF is trying hard to pass a resolution to consider allocating at least two seats to female engineers, although there is opposition from male as well as some female engineers to this proposal, alluding to the fact that females should not be given special favors. It is rather disheartening

to see that some do not want to acknowledge the benefits of diversity in the decision-making process, while some others say that since there is no restriction for females to contest for the posts, there is no need to change the status quo; they give examples of myself and a few others who did contest under the present setup. I consider it as one of my missions to see that more capable female engineers get onto the council and become president of IESL.

The advice I would like to offer young women who are considering a career in a male-dominated industry is simple: Don't think about it too much. Men and women may have differences in the way we think and act, but if you have the passion for engineering, and if you are prepared to work at it, you can achieve excellence. I believe that once you have achieved your immediate goal, your options open up, and you get the opportunity to choose what suits you best—because by then, you will have a clearer idea of what you really want in life, and will make the best choice. Life is all about making the right choices. But don't be afraid to make mistakes; there are many ways to achieve what you want. While some may be tougher than others, not trying takes you nowhere.

I will leave you with this statement by Stacey DelVecchio, past president of the Society of Women Engineers in the United States. It nicely sums up the sentiment most of us women engineers feel at work as well as when we meet people socially: “I wish people would stop being impressed

by the fact that I'm a woman engineer. We want it to be normal to see beautiful, social, intelligent women out there that are engineers."

JOURNEY 17

ENGINEERING PEDAGOGY: I DID IT MY WAY

TIIA RÜÜTMANN

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ESTONIA

I was born in the capital of Estonia, Tallinn, a fabulous medieval Nordic-Baltic city with a rich history and tales about Vikings, kings, queens, and medieval merchants. Tallinn Old Town never fails to amaze with its historic charm, cobblestone streets, gabled houses, churches, and squares; it looks like something out of a fairy tale. By the way, the Estonian people are quite special; they have always understood the value of nature, education, culture, freedom, and independence.

I was an only child and thus surrounded with the love and care of my parents. My father was a civil engineer and my mother had studied finance. My parents valued good education, literature, arts, and music, and I started to read books at the age of six. From an early age I was encouraged

to discuss different topics: nature, books, paintings, and films. My parents always respected my opinions and tried to answer my endless questions. My father's words, "No one can ever take away your education and the competencies you have acquired," have guided me throughout my life.

My father was my first teacher; he taught me mathematics and science using real-world examples. I began to love mathematics; it was exciting, challenging and always fun—for example, I learned multiplication while jumping with a rope. Unfortunately, many students then and today consider mathematics too difficult; they are afraid of giving wrong answers.

ABOUT THE AUTHOR



Tiia Rüttnann is a Senior Lecturer and Head of the Estonian Centre for Engineering Pedagogy in the Department of Mechanical and Industrial Engineering at Tallinn University of Technology, Estonia. She's a visiting professor at Peter the Great Polytechnic University in St. Petersburg, Russia. Tiia graduated as Diploma Engineer in chemical engineering and cybernetics in 1982, and received her MSc in chemical engineering in 1992. She defended her PhD in education at the University of Hradec Králové, Czech Republic, in

2007. She is on the Executive Committee of the International Society for Engineering Pedagogy (IGIP) and is President of its International Monitoring Committee. Tiia is also a member of several other engineering and education organizations. She has authored and co-authored more than 90 peer-reviewed articles, written several book chapters, and published a handbook on engineering pedagogy science and STEM didactics in 2019. Tiia has delivered workshops on engineering pedagogy in Europe, Russia, Brazil, Mexico, China, and Argentina, and has participated in 18 research projects, coordinating five of them. Her fields of expertise are engineering pedagogical sciences: effective teaching of engineering, STREAM pedagogy (university didactics, laboratory didactics, e-learning didactics), innovative methodologies, as well as course and curriculum design in engineering education.

However, without self-confidence and metacognition, one can never learn from their mistakes and, therefore, will never improve her/himself, or become smarter.

Thanks to my parents and a good high-school education at Tallinn English College, I was interested in both STEM and languages. At the same time, I finished music school at the age of 15. While taking piano and singing classes, I developed a love for classical music, associating it with mathematics, emotions, and feelings. I still remember interesting discussions between my father and me while we walked home from the opera house. Although I did not become a musician, that love for music has remained with me forever, and my children have inherited it as a family tradition.

However, in high school, I came to understand that science and mathematics were closest to my heart. My father and I often repaired our family car together, and so I started to like engineering and technology, because it showed me how and why things actually work. It is always challenging and exciting to solve problems, as it teaches analysis, something that requires critical, logical, and technical thinking. My motto became, “If a problem can be formulated, it can also be solved in some way.” Solving different problems has made me more observant and quite independent at drawing my own conclusions, but also more persistent at discovering my own mistakes.

My sunny and happy world collapsed one day when I was 15 years

old—the day my father died of a heart attack. Everything was suddenly black and white. Nevertheless, life went on and the pain gradually decreased. I am forever grateful to my mother, who supported me in every possible way, even though she herself was also going through a really difficult time. Thanks to her, I never had to worry about my future—she supported my studies in every possible way. We helped each other out. Still, the lack of my father's support was painful; it was a feeling that would be with me forever.

To my great fortune, the teachers in my school were excellent and sparked my interest in STEM, keeping me motivated to learn, helping me to discover something new every day. They helped students notice logical structures and patterns, to build connections, learn with comprehension, doubt, build hypotheses, and investigate. They taught us to defend our views and opinions. Thanks to my teachers and, of course, to my father, I decided to become an engineer.

Following the family tradition, I went to university after finishing high school. I passed my college graduation exams with distinction, and accordingly had to take only two of five entrance exams to get admitted to university. I decided to study engineering at Tallinn University of Technology (TalTech) in 1977 and chose chemical engineering and cybernetics as my specialty. It allowed me to combine chemistry with programming to design industrial equipment and technologies, understand the nature of chemical processes, and become acquainted with their application in the

chemical industry. However, it was a really demanding program of studies that required great effort. At the same time, it was a very useful period as I learned to see problems and find field-specific solutions to them, work in teams, and make both individual and collective decisions.

It felt great to be a student of a highly recognized technical university. TalTech was then and still is one of the best universities in the country, making me even more proud to be studying there. Everything sparked my interest immediately: attractive learning environments, labs, new subjects, and, of course, new friendships that last to this day.

There were always more male students at TalTech, especially in the field of engineering. There were 20 students in our student group and only five of us were female. We were a united and effective team that always supported each other and never left anyone behind. We competed hard, and this always paved the way forward. However, we had to work hard and prove ourselves, because in those days it was taken for granted that boys are better at mathematics and engineering. Still, I loved the process of learning, solving real-life problems, finding multiple solutions, working in labs, and writing projects.

I graduated from university as a diploma engineer after five years of studies in 1982 with cum laude. I had the highest grades in all passed subjects and I defended my diploma thesis, “Purification of Industrial Wastewater from Nitric Compounds,” with honors. Our team used the

process of ozonation in water purification and we reached perfect results when we turned brownish and smelly wastewater into clean, clear, drinkable water. I am grateful to my supervisors Professor Enno Siirde and Professor Rein Munter who enhanced my motivation, by giving me the confidence and courage to dream of further studies and continued learning.

After graduation, I had the chance to apply for a job as senior laboratory assistant in the department of chemical technology at TalTech. I became one of four women colleagues in the department.

My career took its first turn when I realized how much I enjoyed teaching. The first courses I taught in chemical engineering were laboratory classes on water purification and the analysis of fuels and lubricants. Right from the first classes I held, I understood that I lacked the pedagogical skills - the knowledge about didactics for teaching engineering. Ever since then, my passion has been to teach well and to learn how to motivate and engage students, considering their individual differences and using diverse methodologies—both traditional and contemporary—in various learning environments that can always be made supportive and rational.

During my first year of employment, I married and started a family. My husband, Jaan, is a medical doctor; he is an otolaryngologist, or ear, nose, and throat (ENT) specialist. In the beginning, it was me who supported my husband's career—he became a hospital chief physician—while I focused on raising our first child while also trying to cope with my job. Then, later, it

was my husband's turn to support my career. I have been lucky—both my husband and my mother have supported me a lot, and they both believed in my aspirations.

Five years after graduation I started on my second Master's studies. The topic of my thesis was "Desodoration of Cocoa Butter with Water Vapor in Counter-Current Vacuum Film Column." It was so intriguing to design a distillation column, study the process of desodoration, and program the process of distillation in the vacuum film column. I was happy to have a wonderful supervisor, Professor Juha Kallas, an excellent example of an engineer with brilliant critical, technical, and systematic thinking. I also had a great opportunity to participate in cooperation with Dresden Technical University in Germany, where my co-supervisor was Professor Karl-Ernst Miltzer.

After defending my thesis, I worked as a researcher in the department of chemical technology at TalTech, participating in numerous research projects, teaching students, and supervising their work in the chemical technology lab.

By that time, I had a son and a daughter, Lauri and Marianne. Some do not understand why a woman wants or needs a career when she has a family life, and why a woman needs a family when she is devoted to her career. I like challenges; I wanted to prove that being a mother and wife does not prevent me from having a successful STEM career. My family is

my stronghold and my support system—and my children are my fan club.

I have thought that if my career had ended there, after my Master's studies, my life would have been different. But everything changed when I made a career turnaround. During my Master's studies, I had to pass a course on didactics of higher education. I enjoyed the course as it provided me with many fresh and interesting ideas for effective teaching of engineering, and I always implemented new knowledge in my teaching as soon as possible. I have been interested in effective teaching for a long period already, and this was my next challenge.

In 2001, the Estonian Centre for Engineering Pedagogy (ECEP) was founded at TalTech. The head of the center, Professor Jüri Vanaveski, offered me the job of assistant head, and I agreed. I have never regretted this decision; in fact, today I realize it was one of the best decisions of my life. I knew very little about effective teaching and engineering pedagogy, so I had a lot to learn, and this is where my international activities began. I participated in international conferences and workshops, and organized several conferences, including IGIP 2006 and IEEE EDUCON2015.

My third child Anna Maria was three years old when I started my job at ECEP, and it was at this time that I also decided to go for my PhD degree. It happened for a reason. The founder of Klagenfurt School of Engineering Pedagogy and the International Society of Engineering Pedagogy (IGIP), Professor Adolf Melezinek, held a workshop at our

university in 2002. We got acquainted, and finding that we had a lot in common, he recommended that I apply for doctoral studies in the field of engineering pedagogy. I discussed this possibility with my family and decided to take the chance.

The only place I could do my PhD in engineering pedagogy was at the University of Hradec Kralove in the Czech Republic. I was admitted in 2003, and Professor Melezinek was not only my supervisor—he became my role model, mentor, teacher, and good friend. I liked his benevolence and empathy, and his ability to create a safe and really supportive learning environment.

I studied via distant learning, with study sessions held in the Czech Republic twice a semester. It was hard to leave a three-year-old daughter and my other children back home with my mother and husband and fly away for two weeks. When I was away, I thought about my kids, and when I was at home, I worried about my studies. I managed to complete my degree in four years, defending my thesis in 2007 on the design of a new curriculum for technical teacher training. I received my PhD in the field of education, majoring in teaching STEM subjects and engineering pedagogy.

My work with IGIP started in 2006. IGIP has been a team of friends, a personal network, and almost a second family for me. We meet at least once a year at IGIP conferences, workshops, and meetings. We stand for a common cause—making the teaching of engineering more effective and

interesting. To that end, we develop practice-oriented curricula for faculty pedagogical training corresponding to the needs of students and employers by improving teaching methodology. IGIP normally organizes annual conferences of engineering pedagogy, and we do encourage the use of media and e-learning for teaching engineering and fostering management training for engineers. IGIP's international monitoring committee (IMC) accredits training centers and curricula of technical universities and universities of applied higher education for effective faculty development, based on prototype curriculum and basic principles of engineering pedagogy science.

I am a co-chair of IGIP's working group on teaching best practices, a member of IGIP's executive committee, and have been president of IGIP's IMC since 2010. I am proud to represent Estonia within IGIP. Since 2018, I have had the title of IGIP senior member, in recognition of my professional standing and for having long-time active membership in IGIP.

Another role model and mentor for me within IGIP is Professor Dana Dobrovská from Czech Technical University in Prague. She has supported, taught, and helped me a lot, always saying that there are too few women in engineering and engineering pedagogy today.

Since 2009, I have been head of the Estonian Centre for Engineering Pedagogy at TalTech and an associate professor. I enjoy working with the faculty and students. I teach courses in engineering pedagogy and STEM didactics, didactics of higher education, laboratory didactics, course design,

and mentoring and coaching for Master's and PhD students and engineering faculty, but also for STEM teachers who participate in the pedagogical courses of continuing education. I have held several international workshops on engineering pedagogy and effective course design in Slovakia, Hungary, Greece, Russia, and all of the Baltic countries. I have supervised Master's and PhD theses, and given keynote speeches at international conferences. In 2018, I received the Meritorious Service Award at the IEEE Education Society's Global Engineering Education conference (EDUCON) for outstanding contribution to EDUCON development.

While I still consider myself an engineer, I have not worked as a “traditional” engineer for a while. I have been a visiting professor at Peter the Great Polytechnical University in St. Petersburg, Russia, and a visiting professor and supervisor in the department of didactics and educational technology at Dubnica nad Váhom in Slovakia. I am also an expert of engineering pedagogy at Vilnius Gediminas Technical University in Lithuania.

One of the accomplishments I am most proud of is the publication of my Handbook on Engineering Pedagogy and STEM Didactics, which I compiled for engineering educators. The first edition was published in 2016 and the second in 2019. This handbook gives an overview of the basics of engineering pedagogy—contemporary didactic models, teaching theories, teaching methodology, principles of assessment, feedback, reflection, and

metacognition. In this handbook for effective engineering teaching, I have used ideas from my PhD thesis and scientific articles, but also the best-known research results from around the world.

In the past 10 years, I have built up and modernized an integrated program for the faculty of continuing pedagogical education in the school of engineering at TalTech. The program follows the recommended long list of skills necessary to thrive the fourth industrial revolution. These skills include complex problem solving, critical thinking and creativity, human resource management and coordinating with others, emotional intelligence, judgement and decision making, service orientation, negotiation, cognitive flexibility, just-in-time knowledge and learning, individualized education, mutual networking, explanation on board and one-shot learning, constant knowledge building, and machine learning.

We usually have two options in our career: either to be a leader or a follower. I decided to be a leader, taking into account the elaborated principles of engineering pedagogy science and developing new ideas for contemporary and effective teaching of engineering.

Since my university studies, my support network has mostly consisted of men. This continued during my work at TalTech, where the majority of my colleagues are still men. I value their friendship; they believe in me and support my ideas and choices. This supportive network has widened and grown every year; they have cheered me along my journey, and I am ever

so grateful to them. I have to say, feminist debates have not been an issue in Estonia until recently; people have been and still are usually objective and achievement oriented.

As a woman engineer, I have been at the leading edge of the change. I was the first woman introducing the principles of engineering pedagogy in Estonia. At first, I felt active distrust towards me; it was not easy in the beginning. I have even experienced some persecution, bullying, and often envy at work. Dissenting opinions arose from disparity of schools of classical pedagogy and engineering pedagogy, classical didactics, and STEM didactics. Not all the principles of classical pedagogy and didactics are suitable for effective teaching of engineering. Today I understand that a wealth of knowledge, skills, personal values, and experience are the factors that determine a person's real value, along with attitude, communication, and behavior. Unavoidable prerequisites are self-development, self-regulation, lots of learning, and hard work. However, I have experienced support, appreciation, acknowledgement, respect, and positive feedback from my students and colleagues. Engineering pedagogy has been recognized and widely used in Estonia and it continues to evolve.

The fact is that addressing challenges makes you stronger—and I have become stronger. I always try to give my best, I do things from my heart, I share my knowledge with my students and colleagues, and I always try to create a positive, supportive atmosphere. My role as an engineering

educator is to assist each and every student in developing his or her own potential and learning styles. I try to set a good professional example and respect my students, a legacy of my supervisor, Professor Melezinek.

I am very happy that my contribution has been acknowledged in Estonia. In 2018, I became a lecturer at TalTech's school of engineering, and received excellent feedback from students on my teaching. In 2019, I was a nominee for Estonia's Teacher of the Year, and received a letter of gratitude from Estonia's Minister of Education and Science for my long and successful career training engineering educators and STEM teachers. This has been an honor and a high recognition, and I am deeply grateful—and highly motivated—to continue on this path.

We need engineers like never before. Engineers continue to be at the forefront of shaping our world in the 21st century. My generation has experienced an unbelievably rapid set of developments and innovations in the field of engineering and technology—from radios and then television to microchips, smartphones, computers, the internet, the internet of things, virtual reality, and artificial intelligence, to name but a few. Today, there are objects and services in our lives that we could not even have dreamed of 50 years ago. This is a valuable experience that has helped us to cope and solve complex problems in ambiguous situations, as critical and technical thinking come to rescue. There is a need to move towards higher quality and innovation in engineering education.

Engineering is often considered a man's world. The stereotypes still exist. I often hear comments like, "You do not look like an engineer," or "I wouldn't have believed you are an engineer." Estimation of STEM knowledge and skills does not depend on gender. Girls' interest in engineering must be encouraged by parents, teachers, personal networks, and mentors. The more we have women in engineering, the more we have the role models for girls selecting their future profession. Women bring sustainability, security for tomorrow, and mutual respect to the field of engineering. We must not be afraid of making mistakes; we must be able to learn from our mistakes, turning them into strengths and opportunities. Emotional intelligence, empathy, respect for others and oneself, persistence, education, knowledge, continuous learning, a good mentor, faith in oneself, confidence, and wide experience—these are the basics of women's success.

My biggest thanks go to my family for their everlasting support, for their faith in my endeavors and for their constant love. My husband and three children are my closest support network. We are able to contribute to our professional work with the greatest efficiency only if we find a point of support in our family.

Different roles and positions have challenged me during my career, constantly giving me something important to learn at each level. I have had the privilege to do what I love to do: teach my students, preparing them for an academic career. I value and love my students, I believe in their

abilities to be successful and creative. It keeps a smile on my face and gives me strength and energy to move forward. I am happy that I have always followed my principles. I am thankful for the challenges, opportunities, inspirations, difficulties, and lessons learned during my career.

To summarize it all, I would like to share with you the way I try to look at life: If you always face the sun, the shadows will stay behind you. We need to keep moving forward, with our heads up and our backs straight. That helps ensure we never stop dreaming and achieving...

JOURNEY 18

BREAKING THE GLASS CEILING: JOURNEY OF A FEMALE ENGINEER

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UNITED ARAB EMIRATES

Being the first-born child to my parents gave me the opportunity to observe the phases of their career paths. My early childhood and schooling in the 1980s was in Ithaca, in upstate New York, where my father was finishing his PhD in civil engineering at Cornell University. My mother was doing her undergraduate studies at that time at a nearby college, and I still remember accompanying her to the college to spend the day in its colorful daycare center. Then our family (including my three younger siblings) lived in several places; my father's career took us elsewhere in the United States, Canada, Syria (where my parents are originally from), and the United Arab Emirates. My experience of the diversity of these places gave me a wider and a deeper perspective. It has

shaped the way I think, my life goals, and the way that I am affected by society.

As a child, I didn't dream of becoming an engineer. I only knew I wanted to be someone who could positively impact society and help humanity, so, for a young girl, the obvious career choice was physician. Yet even back then I was a natural engineer; I would investigate basic stuff—like empty tissue boxes, toilet paper rolls, egg cartons, empty jars, lollipop sticks—and turn them into a project. My grandfather, whom I always thought of as a visionary, God bless his soul, predicted that I would

ABOUT THE AUTHOR



Dr. Reem Sabouni is an Associate Professor at the ABET-accredited Abu Dhabi University (ADU) and has authored several publications in the fields of geotechnical and structural engineering. She is also Coordinator of Student Enrollment and Success for the College of Engineering, ADU. Prior to joining ADU, Dr. Sabouni was Chair of the Civil Engineering Department and Director of University Laboratories at ALHOSN University (also ABET-accredited). She is a member of several prominent engineering societies, including the

ASCE, fib, and CSCE. She is a founding member of the fib-UAE Chapter and is its Chair of Women Engineers. In March 2020, Dr. Sabouni was elected President of the ASCE-UAE Section. Dr. Sabouni acquired her PhD and Master's degrees in Civil Engineering from Western University in Canada. She was the first researcher in North America to conduct full-scale tests on circular precast concrete manholes in a controlled laboratory environment. These tests were conducted in the Large Scale Geotechnical Testing Facility at Western University and in collaboration with the Ontario Concrete Pipe Association. Dr. Sabouni received several Canadian awards and research scholarships, and the Excellence Award from H.H. Sheikha Fatima Bint Mubarak for ranking first in UAE University's Class of 2002.

become an engineer when I was around eight and I proudly showed him the suspended bridge I'd made of egg cartoons, sticks, and ropes. I was very happy that I could make it stable by installing supports that stretched between two tables set about a meter apart. I even put small cars on it. I still remember how proud he sounded when he praised my work. I know now that these foundational childhood lessons taught me about balance and equilibrium, important concepts in engineering.

My parents always supported and encouraged me to reach to my potential in all aspects, and as a child I was not only among the top students academically, I was also involved in sports, including basketball, and drawing clubs. I have never felt that my parents expected less of me or my two sisters compared to their expectations of my brother. If anything, they had to put more effort into supporting their girls to help us overcome the barriers that we faced with our chosen careers: one sister is an associate professor in chemical engineering; my brother recently got his PhD in electrical engineering; and my youngest sister just finished her MBA.

I had mixed gender schooling before high school, but I believe that being in an all-female high school, in Al Ain in the UAE, made it easier to concentrate on my studies and develop skills in all aspects. Al Ain in the late 1990s was a small, quiet city—it has grown so much since then—and is home to the country's main government university, the United Arab Emirates University (UAEU). The fact that my high school teachers came

from different nationalities and backgrounds made my learning experience even more fruitful as I was exposed to their different ways of thinking, including their perspectives about female careers. They emphasized the importance for both male and female students of excelling in science. To help us reach maximum potential, distinguished students were grouped into one class during our final year to expose us to a higher level of scientific problem-solving.

Having high grades in all subjects made deciding what to study at university difficult, though I still wanted to have a positive impact on society. I started asking about what kind of careers were linked to the subjects I most enjoyed. Physics and math were top of the list, followed by other science topics. I concluded I should become an engineer, despite knowing that few of my female friends would choose that path. With my parents' support, I began my studies for a bachelor's degree in engineering.

The challenge was that a very limited number of females were admitted to the College of Engineering at UAEU (among the first ABET-accredited universities in the region). So I was keener than ever to get the best high-school score I could. My hard work paid off, and I was admitted. Being among the few females in the College of Engineering brought out my best; I felt a moral responsibility to prove to society that a female can be a distinguished scholar of engineering and can have a successful engineering career.

Before you can take the first year of common engineering courses, you first must finish the University General Requirement. I tried to pass as many challenge exams as possible, which would allow me to start my general engineering courses sooner. One of the challenge exams was Visual Basic Programming. I had no prior education on this, and the university allowed only students with A+ marks in their first General Requirement Computer course to take the challenge exam. My course instructors told me it would be a waste of time to attempt this exam. But my father told me that with my analytical skills, I could pass it if I put my mind to it.

So, I spent the next two weeks going through a book on the subject, solving example after example. I passed! During my first engineering lab, the head of the unit came to speak with the course instructor, who pointed at me on my station. The head came over, introduced himself, and told me I was one of two students (both named Reem, coincidentally) who passed the challenge exam out of 4,000 students in the General Requirement Unit—and he wanted to know how I managed it. He knew that the standard curricula in UAE high schools did not cover programming. When I told him I studied on my own, he was surprised. This experience gave me huge confidence that with hard work, I can pass any obstacle.

After finishing my first year, it was time to decide on a specialty. At the time, not all engineering specialties were open to females: mechanical engineering was not, and civil engineering had only recently been opened

for female students, with very few admitted. Yet by now I knew that the applications I enjoyed most related to civil engineering. Plus, I liked that it was involved in all aspects of civilization, from buildings to roads, to water supplies and environmental applications. I knew it was male-dominated (and it still is), so it was not an easy decision to specialize in civil engineering but, again with the support of my parents, I submitted my application, and was accepted.

The courses were enjoyable, and I always made the Dean's list, allowing me to take a higher course load than my colleagues. I ranked first in class when I graduated after four-and-a-half years, which was exceptionally fast; the program was five years long at the time.

My first experience as a civil engineer was during my industrial training, which is mandatory the year before graduation. I was lucky to have my internship at a well-reputed British company in Abu Dhabi called Hyder Consulting Middle East. The office portion of my internship went very smoothly; everyone in the office was very respectful, and my supervisor, a female structural engineer, was very supportive. The company had many female employees, but most were secretaries or receptionists. At first my supervisor gave me old projects, and when she felt confident enough, gave me some of her current work. I finished all my tasks quickly, as I was determined to benefit as much as I could; my father told me internships are a unique chance to work as an engineer yet still have the benefit of

being a student, so you can ask questions without being judged. To this day, that advice is the first I give to my internship students.

One of the tasks I worked on was designing the roof of an underground pumping station that required several roof openings, and my supervisor wanted to get the optimum sizes and orientations of these openings. The only way to do that was through numerical modeling of options and comparing their performance. But I hadn't taken any such courses, so after work I studied program manuals. With the help of my supervisor I came up with the best roof option and my justification for it. She was very happy with it, and then told me, "Now comes the hard part." I'd need to present my work to the head of the design unit and convince him of my conclusion. At the meeting, the head asked in detail about everything in my report, but I was prepared, and at the end he told me, "Good job. Your report is approved." I learned a lot from this, as it made me look deeper into assignments over the rest of my university courses.

Even though the company had agreed to include a site-visit component of my program, it was a struggle for them to fulfill as they are a consultant company and their site engineers are continuously moving among projects. I ended up wearing the safety shoes and helmet they provided within the site offices, reviewing documents. It wasn't quite the experience I was looking for. But the main reason females don't go into civil engineering is fear of working on the sites, and I felt that unless I faced

this fear, I wouldn't be a successful civil engineer—and the best time to do it is in the controlled environment of an internship. I was determined to find a way to get some site experience.

My best friend was doing her own internship in Al Ain, working under my uncle's supervision. A senior engineer, he was struggling to give her office tasks, as most of his work is on sites. After convincing my friend that site work would give us a unique experience, I convinced my uncle to have us accompany him on his site visits for one week. I was so excited to put on my safety shoes and helmet, and will never forget the first time I entered the construction site with my friend: the whole place seemed to go still as we walked across it. The male workers were not used to seeing female engineering inspectors on site. But the experience taught me how to overcome the anxiety of entering an entirely male environment, and exposed me to unique projects. (One in particular I remember was inspecting the construction of a frame for a school gym that was more than an eight meters high and 10 meters wide. We went up to the top on the scaffolding to do the inspection.) Even though there are now more female civil engineers in the UAE, on site they are still not common. I always recommend female students get part of their training on a site.

Upon my graduation a year later (I was first in class), I was offered a full-time time engineer position at Hyder. I accepted, because even though I planned to obtain my Master's and PhD, it would be several months

before I would get responses to several graduate programs I applied to in Canada. Working with Hyder, I was able to get industrial experience before entering academia, and though my time there was short, it gave me a wider perspective of civil engineering. For example, one design task I have contributed to, under the supervision of project managers, was to reevaluate the stormwater system of Kuwait City, a project valued at more than \$4 million.

My female engineer colleagues and I quickly established good collegial relationships (and we are still in touch), and during an office redesign I convinced management to allocate the women's offices in one area. After we settled into our new location, the head of the redesign toured the new space. When he came to our all-female area, he looked at me and said with a big smile, "Now we have a women's engineering section."

Many friends and some extended family members did not understand why I would leave a good job to commit to at least a six-year journey to get a PhD degree. My father has a PhD, so my parents knew how hard this path is. But they also knew that it meant a lot to me; they were very supportive. I got acceptance letters from several Canadian universities, most with scholarships, and after discussion with my parents, I decided to go to the Western University in London, Ontario; it's a relatively quiet city, and my parents had a house there. I also chose Western because it was famous for its Geotechnical Research Centre. I began graduate studies in

the civil and environmental engineering department in fall 2002, with my mind set on a president's scholarship—I felt I had to prove to everyone that I was up to the challenge.

As I began taking my courses, I wanted as much knowledge as possible. I was not shy to ask questions in class and I was active in after-class discussion groups. I got very high marks and began building a reputation among my fellow graduate students, of whom very few were female—only four out of about 80. It stayed that way throughout my graduate studies. This wasn't unexpected, and it was no problem; we were very respected by our male colleagues. There was only one negative I recall: When the weather became cold, a couple of the male students complained that since more than 70 males had one washroom facility versus just four females for ours, both washrooms should be unisex. But the idea went nowhere; most of the male students felt it would be a violation of their female colleagues' privacy.

On top of being a research assistant I was also a teaching assistant, which became one of the tasks I enjoyed most. Female civil engineers, after all, can encourage younger female students to enter civil engineering. In engineering in general it was around 30 percent female students, and even less in civil engineering. I had always assumed these low numbers at UAEU were due to local culture, so I was somewhat surprised to see that Canada had the same issue. My university wanted to improve this percentage in part by allocating female teaching assistants in first-year courses; this made me

feel even more driven to obtain my PhD, as it would increase the chances that females would enter engineering, and civil engineering in particular.

While I was concentrating on my courses and my Master's research, something unexpected happened: I met my future husband. I began to notice that one of my colleagues was in attendance at most of the after-class study groups I belonged to. Samer didn't seem very involved in the discussion, yet he managed to be in many of the places that I went to on campus. At first I thought it was a coincidence, and then I convinced myself that he must want to be around me because he was also of Syrian origin—of all the graduate students in civil engineering, there were only three of us with that background. We became friends—and then he proposed to me. With close friends and family in attendance, we got married in Canada later that year. At the time, we were both still doing our Master's studies (my husband was a year ahead of me).

We finished our degrees; in fact, I went into my Master's defense just a couple of weeks before giving birth to my son! On top of attaining two scholarships (the President's Scholarship for Graduate Study and the Ontario Graduate scholarship), I was awarded the prestigious Milos Novak Memorial Award from the Geotechnical Research Centre at Western University for my thesis work.

With a baby, new family commitments, and my husband starting his PhD studies, it would not be easy for me to begin my own PhD studies.

My faculty advisor said that if I wanted to begin right away, I could work on my comprehensive exam and PhD proposal with minimum attendance on campus for the first semester until our son, Eyad, was old enough to go to daycare. My husband and I decided this would allow us both to finish our PhDs as close as possible to each other.

Looking back, I think we were very brave, as it was not easy. With my husband's hands full with his own PhD work and preparing for his comprehensive exams, it was hard for him to give me a hand, but later, when our son was old enough to go to daycare, it was slightly easier. With time management (and less sleep!), I managed to pass my comprehensive exams and was ready to begin my PhD thesis work.

I remember getting an email from my PhD supervisor calling me for a meeting to discuss a PhD topic for me to work on. We had already been having conversations on topics I was interested in, but this time it was different: He wanted me to lead a research project funded by industry, a project that meant I'd be applying for an NSERC Industrial Postgraduate Scholarship (IPS). The project, funded by the Concrete Pipe Association, was testing full-scale precast concrete manholes in the newly constructed geotechnical testing facility at Western University. This was an important project and, in addition, was physically massive, so I was surprised by his proposal because he had a large group of male graduate students, several of whom were still deciding on their PhD topics. Without even thinking,

I asked, “Why pick me instead of one of your male students?” After all, it’s a big advantage for any graduate student to have their thesis project part of an NSERC IPS. He smiled and told me, “On top of your technical background, I know that females are better at paying attention to details, and you in particular are.” He told me not to worry about project’s scale, as the lab was equipped with a large crane for lifting the big components and that he would be assigning interim male students to help with any heavy lifting needed for the smaller components. He gave me a couple of days to think about it and to discuss with my family whether I wanted to apply for the NSERC IPS scholarship. My husband encouraged me to take it, even knowing it meant I’d need to spend a lot of time in the lab and with the companies involved. Since his own thesis had an extensive experimental component, we worked out logistics to allow us both to work around our son’s daycare hours.

Even though the couple of years after that were very hectic for us as a family, I gained unique technical experience. The new \$1-million facility allows for full-scale geotechnical testing of infrastructure components, and I was the first to operate it. That necessitated running a small construction site equipped with monitoring instrumentation. I learned how to use the indoor crane that lifted the full-scale concrete manhole specimens. I was in continuous contact with the companies that delivered the samples and I arranged for access for the huge trucks to unload the tested parts

in the lab. The project also required about 20 tons of soil to be installed and compacted each time we installed a specimen, and then disposed of when preparing for another specimen. I worked with trucking and slinger companies for delivering the soil, with contractors for installing the specimens according to code, and with specialty contracting companies to uninstall the specimens. I was in my safety shoes and helmet most days during the experimental portion.

Working with so many people was not easy at first. Once, I called for a meeting with a company, and when the men arrived they approached the oldest of my male colleagues and began asking him questions. My colleague stopped them, pointed to me and told them, “You should speak with the boss of this project.” They looked really surprised. But when everyone realized I knew what steps were needed, what equipment should be used, and the installation procedures, things went smoothly. I finished the program on schedule, followed it with an extensive numerical model, and obtained my PhD. I felt proud to be the first researcher in North America to conduct full-scale tests on these manholes in a laboratory environment.

My husband had also obtained his PhD, so we were done with this hard but fruitful chapter of our lives. It was time to move on. This was at the end of 2008, the peak of the economic crisis, and it was almost impossible to get a good job offer in Canada. So we secured jobs in the UAE. I became an assistant professor in civil engineering at ALHOSN University (AHU)

in Abu Dhabi. When I joined, there was a handful of female students in the department among more than 150 male students. As the course offerings at that time were gender segregated, the university was struggling to keep the department open for female admission. To encourage more females to pursue engineering studies I organized a “Women in Engineering” event, and we managed to secure one of the most prestigious women engineers in the UAE as a speaker: Fatima Al Jaber, chief operating officer of one of the country’s largest engineering companies. We also had as a speaker the UAE representative of the United Nations Development Programme at that time, Dr. Khalid Alloush. I also spoke at this event, sharing female engineers’ success stories as well as my PhD experience.

The event was a success, attracting a large audience from inside and outside the university as well as good media coverage. Then I took it to the next level by establishing the first professional society under the AHU umbrella that aimed to encourage women to pursue engineering as a profession. I asked Fatima Al Jaber to be founding president and she humbly agreed. With myself as founding vice-president, I led a team of four female engineering faculties and we spent the coming weeks deciding on the society’s name and bylaws. Thus the establishment of the Society of Women Engineering (SOWIE) at AHU University was announced at a press conference in June 2009. The next day, photos were all over the news, even during prime time.

Under the umbrella of SOWIE we managed to get our female engineering faculty and students involved in important activities, including the Arabian World Construction Summit in Abu Dhabi, and we hosted workshops and training activities on campus. Several journalists came to campus to conduct interviews with female engineering faculty and students for engineering-related publications. The students were very excited about how much attention the idea had attracted, and expressed how proud they were to be female engineers. Later, the university established a scholarship covering half of the tuition of 10 females studying engineering—and the first 10 to benefit were civil engineering students. We had several famous women activists, writers, and engineers from around the world deliver talks, and the university and SOWIE arranged many activities. Exposure to such prominent professionals increased my awareness of various aspects of women's empowerment.

On the other hand, being a young faculty member and teaching all-male classes meant there was some pressure on me in the first couple of weeks, until the students became comfortable that I knew what I was doing. There were a couple of funny situations. One morning, I was trying to give a class and the students outside the classroom were noisy, so I went out and told them to quiet down. One of the male students responded that once the faculty member arrives, they would do so. Then I told them that I was the faculty member—and the noise stopped. Another time, the

mother of a student asked for a meeting about her son. When she arrived at my office, she looked so confused, and asked, “Are you Dr. Reem?” When I said yes, she was pleasantly surprised, because, as she put it, I was “a young and beautiful woman!”

During my time at AHU, I participated in the civil engineering department’s obtaining local accreditation as well as ABET, and held a number of positions. I was eventually appointed department chair. And in early 2018 I joined Abu Dhabi University (ADU) as an associate professor in civil engineering.

In 2018 and 2019, I led the joint International Federation of Structural Concrete-UAE Women in Civil Engineering Forum (my initiative), which hosted national and international speakers and panelists and attracted engineering practitioners from different industrial sectors, as well as students. For 2020, I decided to take it to the next level: the Women in Engineering Forum 2020 also had the support of several international and national societies (e.g., ASCE, IEEE, ACI, IStructE, and the Society of Engineers UAE) and featured local and international speakers. This event was to be held virtually in October at ADU in partnership with the Abu Dhabi Municipality.

Through the events I have organized and my work with many organizations, including recently being elected as the UAE section president of the American Society of Civil Engineers (ASCE), I came to learn about

the accomplishments of Robin A. Kemper, president of the ASCE, and Sirin Tekinay, chair of the Global Engineering Deans Council (and the first female dean of a college of engineering in the Arabian Gulf Region). While I am proud of what I have achieved so far in my career, these women have given me even more inspiration and confidence that the sky is limit for female engineers.

JOURNEY 19

THE ENGINEER, THE TRAILBLAZER

LYDIA G. TANSINSIN

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PHILIPPINES

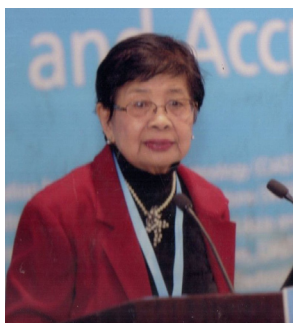
My mother studied home economics; she was from Panay Island. My father was a lawyer from Luzon Island. They met at the University of the Philippines in Manila, and married on Valentine's Day 1932. Together they had eight children: five girls and three boys. I'm the second. With God's grace, all of us graduated from strict Catholic schools and became professionals in various fields: medicine, law, chemistry, accounting, and engineering.

My sisters and I attended the exclusive Holy Ghost College, a school run by conservative German and Filipino nuns (it was near the Spanish-built Malacanang Palace, which became the presidential palace after the Philippines became independent in 1946). After classes, my sisters and I loved to play a game taught to us by our nuns called German Ball,

and we passed around “autograph albums” among classmates, where we recorded our professional ambitions. I proudly wrote that I wanted to be a pharmacist, while others wrote doctor, accountant, and other “feminine” courses. Nobody dreamed of being an engineer; it was considered a tough course and was never mentioned in our girls’ school.

When I was fresh from graduating, my mother accompanied me to enroll at the University of Santo Tomas (UST), the oldest university in the

ABOUT THE AUTHOR



Dr. Lydia Gonzalez Tansinsin, a Chemical Engineer, studied at the University of Santo Tomas and the Tokyo Institute of Technology. She became a Doctor of Science (hc) at Bulacan State University in 1998. Among Dr. Tansinsin’s most recent awards are a Women Engineering Award from the World Federation of Engineering Organizations (WFEO); the Thomasian Engineering Award; the Outstanding Engineer Award from the

Federation of Engineering Institutions, Asia and Pacific (FEIAP); and Outstanding Chemical Engineer of the Professional Regulations Commission (PRC). Earlier in her career, Dr. Tansinsin was Cabinet Assistant Secretary in the Philippines government’s Department of Science and Technology. She was Chair of the APEC Committee on Human Resource Development for Industrial Technology, and represented the Philippines at international events. One major project she directed was the Engineering and Science Education Program with the World Bank and Japanese government; the 1992-1994 loan agreement of US\$80 million went towards improving universities and colleges, supporting faculty members’ doctoral and Master’s degrees, and infrastructure for 100 secondary schools. Dr. Tansinsin is active in the Philippine Technological Council accreditation activities and is Chair of the Accreditation and Certification Board for Engineering and Technology. She supports scholarships for disadvantaged students from the province of Bulacan.

Philippines, established in 1611 (yes, it's older than Harvard University). After we entered the big campus on the way to the main building, I informed my mother I would take up chemical engineering instead of pharmacy. Mother was surprised, and I told her I got the idea when I heard over the radio and read in the newspapers that chemical engineers were needed. She tried to discourage me, saying that father might disapprove, but sensing that I wanted to study chemical engineering, mother relented. Back home, when we told my father I'd enrolled in engineering, he was ambivalent. "I'm not surprised," he said. He told us he had really wanted to become an engineer, being excellent in sciences and mathematics in his school days, but he had to abort his plan because engineering classes were held only in the daytime, and he was a working student. Law classes were held in the evening.

In UST, students graduated from engineering courses after five years, including chemical engineering (BSChE). Core subjects were taught in the evenings as most of the best professors were connected with Philippine industry, which was a blessing. They introduced us to the industrial world because they could relate theories and principles that applied to actual manufacturing practices. In the early 1950s, two things struck me: the minuscule number of women enrolled in engineering, and that all women were taking chemical engineering. In the upper class there were only four women; one of them graduated summa cum laude, besting her male classmates.

I passed the government licensure examination for chemical

engineers as a second placer. I worked for a short time in a pharmaceutical company, and then applied to other establishments. But I was disappointed with their answer: “No vacancies for women.” Most female engineering graduates were restricted to either teaching or laboratory work. Mother saw my predicament and advised me to do three things while searching for employment: pray, take law subjects for self-improvement, and work at father’s law office in Manila.

Our prayers were heard when the government created the National Science and Development Board (NSDB) in the late 1950s. I was accepted on the skeleton force in the early process of its creation. There were two groups, technical and administrative, and since I was an engineer I was assigned to the technical group. In its first few years, the NSDB’s activities focused on streamlining the system to coordinate and promote cooperation in the scientific research and development activities of different government agencies and private enterprises. When it became fully operational, the NSDB formulated plans and programs that prioritized socio-economic development of the country; I was involved with such projects. The “Science Attache” position was created to acquire knowledge on science and technologies from advanced countries including the United States, United Kingdom, Germany, Japan, and Australia.

Later, the NSDB formed a division of education and training to cover science training and scholarships. Initially, it trained high school teachers in science, mathematics, physics, and biology, as educators were

alarmed by the deteriorating quality of science teachers in public schools. NSDB then set up summer training for teachers in cooperation with then Department of Education, Culture, and Sport (DECS). The objective of assuring a quality feeder for the tertiary level and accelerating teachers' improvement was becoming a reality, and would produce more science and engineering students in the future. It would also help the country attain the UNESCO target for the number of students who could become researchers.

While working at NSDB, I was lucky to receive a scholarship from Japan's Ministry of Education to do my Master's degree at the Tokyo Institute of Technology. At that time the students on campus were only males, although in my laboratory there was a female pharmacist laboratory assistant. Finishing my Master's in chemical engineering, specializing in polymerization, was an unforgettable experience, especially to be a student in Japan learning about its culture.

And then I became a multitasker. In 1964 when I reported back to NSDB, I met the new chairman, Dr. Juan S. Salcedo, Jr., and his deputy chairman, Dr. Gregorio Y. Zara, both unknown to me. I was immediately assigned to implement the mandate of Republic Act No. 4086, which had just been approved, to create a financial fund to be paid by textile milling companies in lieu of taxes. I conducted meetings with the mill presidents with the objective of helping the industry upgrade its output. We established a research laboratory, constructing a three-story building at Luneta, Manila. This would be the future home for the NSDB's central

office. I was happy to be part of the project-planning and execution, and our new organization became a full-fledged agency wherein research on different aspects of the textile industry were undertaken.

Next, the NSDB developed an energy project; our unit was assigned this task and I was lead. The project included an intense study by the Philippines' Commission of Volcanology of geothermal steam energy near the Mayon Volcano in southern Luzon Island for electrical power generation. After a successful pilot, I met with the vice-president of the National Power Corporation (NPC) to inform him of the potential of geothermal steam for commercial power, sharing that I had visited the geothermal electric plant in California. But NPC's response was that using geothermal steam to generate power was expensive compared with hydroelectric power and crude oil.

The NSDB was not discouraged and, with New Zealand's expertise, continued to explore more areas with geothermal steam. At least four locations were positively identified.

Then came the 1975 oil crisis, when prices rose from US\$2 per barrel to almost US\$50. The NPC and President Ferdinand Marcos's newly established Department of Energy (DOE), in charge of finding indigenous energy sources, remembered NSDB's geothermal study and gathered all of our information and studies. This allowed the DOE to accelerate the establishment of geothermal electric power plants in the areas already identified by the volcanology commission; it even pirated

some of the commission's personnel. So, everybody was happy. Meanwhile, the NSDB continued its research of "non-conventional" energy sources, which had come to be known as renewable, or "green," energy. With all of these assignments, I was overwhelmed both physically and mentally. But I welcomed the responsibilities; these challenges enriched my knowledge and made me more innovative.

The NSDB planned a number of research activities but had to limit them due to budget constraints; Congress knew that science and technology were crucial for the economy, but they only paid lip service, so the NSDB budget rarely received increases over the years. This hampered science activities, but we tried to source grants from other countries.

As chief of planning and programming, I had to prepare the Philippines' position paper on science and technology for the First International Conference for Science and Technology in Vienna, Austria, in 1978. We gathered data and information from various research institutes and agencies in the Philippines and, along with the Department of Foreign Affairs, NSDB chairman and other colleagues, we presented our position. It was a satisfying undertaking, and we were really proud of our work.

Unfortunately, there was a time when a new deputy minister of the NSDB tried to curtail my attendance at meetings mandated by my division so that he or his consultants could go (and it was reported to me that when committee members asked where my team and I were, he became peeved). Then, he made staff in my division report to him, bypassing me.

Apparently, he wanted to convert the consultants he'd brought into NSDB as employees, replacing us without justification. I did not confront him about this but continued to work in silence, knowing that his idea had absolutely no chance of becoming a reality; after all, we were qualified civil servants and he had no cause to dismiss us. In fact, one of his consultants came to me one day to resign; he apologized for the behavior of his colleagues, saying he could not in good conscience tolerate the activities related to my mandated work.

Despite this, we were able to negotiate with the National Economic Development Authority (NEDA) to include science and technology in its 1980 plan as a separate chapter rather than scattered through the book's chapters. This was to give visibility to science and technology and present its importance to legislators and other government officials, because it would both improve aspects of manufacturing and help in our socio-economic development. Fortunately, NEDA's director agreed. It was the first time science and technology was prominently added to NEDA's plan.

As my work became lighter, I had the opportunity to be actively involved in non-government organizations (NGOs), especially engineering organizations, after office hours. A highlight was becoming the first woman president by election of the Philippine Institute of Chemical Engineers (PICHE) since its establishment in 1939. This enabled me to work for the betterment of chemical engineering, and female chemical engineers, in the Philippines. It included preparing PICHE By-Laws, for example,

to be submitted to the Securities and Exchange Commission that was reportedly forgotten over the years. This work also prepared me for my next important function.

Filipino graduates of engineering courses tended to form different engineering associations; 14, in fact. This was in contrast to other ASEAN countries, which had only one association/institute for all engineering disciplines. When organizers of the Second Convention of Engineering Institutions of South East Asian Nations (2nd CEISEAN) said in the late 1970s they'd like to hold the event in Manila in 1979, but were concerned because we didn't have just one association or institute, I was elected to lead a discussion about forming one integrated body. The outcome was the Philippine Technological Council (PTC), of which I was happy to be named founding chair. PTC members then agreed to accept sponsorship of the 2nd CEISEAN Convention for one year later than originally proposed, in February 1980. I was elected to chair the preparation of the agenda and activities. It included formation of an ASEAN engineering group.

The convention was held at the Philippine Plaza Hotel in Manila. I chaired the meeting with the five ASEAN member countries, which were represented thus: G. M. Tampubolon, president of the Indonesian Institute of Engineers; Wong Kin Hong, president of the Institution of Engineers, Malaysia; Tay Sin Yan, president of the Engineers of Singapore; myself, president of the Philippine Institute of Chemical Engineers; and Dr. Prasom Sthapitanonda, representing the Institute of Engineers of Thailand. Ramon

Hechanova, vice-chairman of the PTC, represented the Philippines. After long discussions, we accepted the constitution and named it the “ASEAN Federation of Engineering Organizations (AFEO).” To quote Tay Sin Yan’s description of the meeting: “There were thorny points of contention and it was largely due to the exercise of an admirably high degree of diplomatic skill on the part of Chairman Tansinsin, and the willingness of everybody else concerned to give and take in the true ASEAN spirit, that the final version of the constitution was agreed to and consensus reached for the establishment of AFEO.” The agreement was formalized in the closing ceremony when all five ASEAN chief delegates signed it, establishing the AFEO on February 6, 1980. It is now 40 years old.

I believe that the most challenging thing I ever undertook was becoming Assistant Secretary (Assistant Minister) of the Department of Science and Technology (DOST)—the successor of the NSDB—in its application for World Bank assistance for the Engineering and Science Education Project (ESEP); the loan we applied for was US\$80 million. DOST proposed that the public and private institutions that were the would-be recipients of the loan would not be required to reimburse the government. The assistance would include: local and foreign scholarships for engineering and science faculty for the tertiary levels, including books and living allowances; training for teachers of science, mathematics, biology, and physics; upgrading of equipment for engineering and science education in 21 selected institutes, plus 100 high schools considered as feeder schools

for tertiary level institutions; and construction of a two-classroom building in high schools for science laboratory classes, complete with the required facilities and books. This is the first time NEDA encountered such a proposal.

To convince them to agree to our no-refund scheme, we had to justify it. DOST remembered the loan taken by the Department of Education, Culture and Sports (DECS) and given to schools under their supervision to upgrade faculty scholarships, equipment, books, and infrastructure. The schools were obligated to repay the government—but no repayments were made because they could not afford to. We wanted to avoid such mistakes, so DOST reminded all the institutions involved in the project that anything that would be done should have the concurrence of both parties, DOST, and the institutions. However, in terms of purchasing books and equipment, the institutions were given the freedom to choose what they needed, provided it was within the budget and urgently needed.

Convincing all sides of the merit of the arrangement was a long process, with documents flying back and forth. But we got it done, and the World Bank was informed that the government would be responsible for paying back the loan. Secretary C. L. Follosco and I attended the meeting at the World Bank headquarters in Washington D.C. to finalize it.

Now, the five-year project needed to be implemented. I went to the budget department for the release of the initial amount, but instead they questioned the project's urgency. We had to visit them frequently, practically begging, until finally they released the money to get the project

operational. Local and foreign scholars had already been working to be accepted to schools they applied to, in anticipation of approval.

There was a lot of pencil pushing and meetings to make the project successful. I was made project director of ESEP on top of everything I was handling. The birth pains of implementing the project, especially the funding, were tremendous and demanding. One could not satisfy everybody; we had to prioritize activities because of budget constraints while coordinating with DOST regional offices to implement the project at local schools.

After putting in place all the World Bank requirements and making it operational, I resigned after only two years of the five assigned to me as project director. I was physically overwhelmed with the volume of work already done and that still needed to be done. The saving grace of the job was that I had a good working relationship with the other officials who were part of creating this project that was a great success.

It has been said that “a clear conscience is the softest pillow.” Fairness, honesty, integrity, and righteousness were the values our parents instilled in our minds for dealing with everybody and at all times, and they constantly reminded us of these. I am happy to have followed these values through the varied work I have done. Here are some examples:

- After the reorganization of the NSDB to the National Science and Technology Authority (NSTA), I was appointed director of special projects with three divisions under my supervision. One day, Minister Emil Q. Javier called me to his office and

informed me I was to supervise NSTA's "grants-in-aid" activities. I promptly responded that this was the job of the Planning Service. But he insisted that he wished me to supervise that activity, which involved financial assistance given to researchers. Thereafter, whenever some officials told me they felt that grants-in-aid should be handled by the Planning Service, my reply was: "Ask the Minister."

- In 1986, another reorganization took place and NSTA's name was changed to the Department of Science and Technology (DOST). I became regional director of Region IV, the largest region in terms of area, with 10 provinces including three islands. It is rich in agriculture, fisheries and minerals. In this position, I had the opportunity to impart to personnel and constituents my knowledge of chemical engineering principles in environmental protection and resources processing. It was important work and I enjoyed it, but I was also well aware that one of the reasons I was assigned to this role was that it removed me from handling the controversial grants-in-aid activities.
- Once, a staff member in my division who was vying for a position told me she was being passed over by the selection group. She was very qualified in terms of education and other traits compared with the other candidate. I questioned the

selection group, and informed its members that they should have consulted with me, as the position was under my supervision. I really put my foot down, insisting a review of the candidates' qualifications. They had assumed that I would not fight for my personnel, that I'd remain quiet because I knew they were influential with top management. Thanks to my actions, they changed their decision.

- Another time I had to stand up for my values when one of my division chiefs told me an honorarium he was supposed to receive was being disallowed. I asked him to gather records of past recipients of the honorarium, and we found that the person disallowing it—who was in a more senior position than both the division chief and me—had himself received a similar honorarium. So I made an appointment with that person. In the presence of him and his assistant, I asked him why he was questioning the honorarium. He replied, “I do not receive any honorarium myself.” I kept quiet while he spoke, and then handed to him the evidence I had collected that proved the contrary. When he saw it, he swirled his chair around, putting his back to me and not saying a word. I left his office. After that, his honorarium was not documented. Some people are unfair, and think that benefits should be applied only to higher ups and

not to be shared with those qualified to receive such benefits.

Before I became the assistant cabinet secretary, I headed a number of projects, including the Balik (Returning) Scientist program, started in 1975 under a presidential decree, and the Scientific Career System Program, created to help prevent migration of scientists to administrative positions. And as a project leader of a local solar-designed collector for the NAST canteen, I had a group of young engineers demonstrate that a locally designed solar panel comprised of wood panels and ordinary black-painted plate glass—local materials—could produce boiling water for the canteen. This was the 1980s, and at that time solar/photovoltaic panels were very expensive. Other projects initiated involves the utilization of electrical power instead of gasoline as fuel for vehicles which was not appreciated and requested the Philippine Atmospheric, Geophysical and Astronomical (PAGASA), to prepare the solar radiation mapping for the whole country to assist researchers in their undertakings.

On top of all of these activities, as acting executive director I had to supervise the daily activities of the Philippine Council for Industry and Engineering Research and Development (PCIERD), one of DOST's four councils, and plan and program its projects for approval. One I introduced was an engineering and industry consortium in the regions to support more engineering projects being undertaken. I encouraged staff to continue with their graduate studies and gave them the time to do so.

When I look back, I see that everything I was doing was a challenge. Despite having limited time for so many activities, I applied time-management skills to help me remain effective and clear-headed to perform the necessary planning and implementation for all the committees and offices that I handled. I enjoyed working at the NSDB, later the NSTA, and lastly DOST, because my work was so varied. Applying my chemical engineering knowledge to managing different activities was not monotonous; I grew intellectually and spiritually. Life was never dull! This must be the reason I stayed for so long. Added to that was my privilege to have the chance to attend local, regional, and international training, and to be a delegate to international conferences. This included involvement in the Asia-Pacific Economic Cooperation (APEC), UNIDO, UNESCO, ASEAN, AAET, and others.

As much as possible, I've tried to extend my good fortune to others. Once, Secretary Follosco informed me he would stop sending researchers/scientists on short training or observation trips, as it was costly and a waste of time for DOST (even though the expenses of the recipient were underwritten by the donor country). His statement surprised me but I recovered my composure, and replied that it was not a waste because the researcher can gain knowledge and exposure in line with his or her expertise, and that it was impossible to monetize such interactions with others working in the same field. I added that researchers/scientists could

add a few days after the training to search for technologies that could be applied readily by DOST or industry in the Philippines, and DOST would pay the expenses for such extensions. He paused for a while, agreed with me, and later prepared a memorandum to all DOST agencies to implement this as a policy. Soon after, a scientist benefitted; after she requested permission to go to Norway for training about paper, she returned with the simple “de-inking technology” that was adapted by the paper industry as it complemented their source of raw materials. The secretary was happy with the outcome of the new policy.

This was probably the reason I was appointed by the president of the Philippines to the position of member and/or chair of the Licensure Examination of the Board of Chemical Engineering in the Professional Regulation Commission; I served for around nine years. Furthermore, my leadership and honesty were proven by my election to professional organizations. I was the first woman head, in its 32 years of existence, of what’s now called the Philippine Association for the Advancement of Science and Technology (PHILAAST). I was also elected president of the Society of Pilipino Accredited Consultants (SPAC); the National Research Council of the Philippines Research Foundation, Inc.; Philippine Association of the Japanese Ministry of Education Scholarship Foundation, Inc. (PHILJAMES); chair of the Philippine Technological Council Women Engineering Network; and the Dangal ng Bulacan Foundation, Inc. This was

aside from my election in other associations/organizations as officer and/or member of the Board of Trustees. I am still active in these organizations.

My leadership and honesty were proven by my election to professional organizations/associations. I was also a part-time faculty member of the University of Santo Tomas, where I taught on Saturdays at the tertiary level for 27 years before my appointment as chair of the Licensure Examination for the Board of Chemical Engineers. After retirement, I was offered the position of professorial lecturer at the University of the Santo Tomas graduate school, which I did until 2018. Even now, I am still giving advice to those preparing their thesis.

I've been retired from DOST since 1998, but I am not tired. I've made myself useful by volunteering with the Philippine Technological Council in accrediting engineering programs in different schools, equivalent to the Washington Accord system, and am chair of the Accreditation and Certification Board for Engineering and Technologist (ACBET). This has meant attending the annual meetings of various professional bodies.

In recognition of my involvement in the different activities, I have received a number of awards, the latest award was given by the World Federation of Engineering Institutions (WFEO-GREE), the 2nd given for Women Engineering, 2019. But the greatest award has been the privilege of receiving the high respect of all my bosses and colleagues in DOST. Many

of them still keep in touch and thank me for my fairness to everybody and for the favors I was able to extend to them within the bounds of love and morality. Furthermore, I thank Our Lord for the guidance in making the right decisions in my undertakings—and, of course, I thank my family for their full support and unconditional love.

JOURNEY 20

A WOMAN ENGINEER IN MYANMAR: MY JOURNEY

KHIN SANDAR TUN

*Vice-President, Federation of Myanmar Engineering Societies,
Yangon*

MYANMAR

I was born in Myanmar in 1967, in a logging town called Pyinmana, which lies roughly between Mandalay to the north and the country's largest city, Yangon, to the south. My father was a government law officer and my mother was a housewife. I was an only child, and my parents lovingly took care of me. My father's job in government took us from one city to another; in all, we lived in five different cities while I was growing up.

My parents wished me to become a doctor, but when I was in high school in Mandalay, one of my father's friends, a civil engineer, told me about the Rangoon Institute of Technology (RIT)—the one and only engineering university in Myanmar at that time. That's how I became interested in engineering. So it was a dream come true when I passed

the matriculation examination and was accepted to join RIT in 1982. Up until around the year 2000, females were limited to just 15 percent of new students. So throughout my engineering-student life I had to work very hard in order to compete with the male students. (Nowadays, there is no limit to the intake of female students; they can join technological universities according to their matriculation examination marks.)

I graduated from RIT in 1991, obtaining my bachelor's degree in electronic engineering. My first step in the profession was working as teaching staff at RIT, when I became an instructor in the department of electronic engineering in March 1992. I was promoted to an assistant

ABOUT THE AUTHOR



Dr. Khin Sandar Tun graduated from Rangoon Institute of Technology in 1991 obtaining Bachelor of Engineering (B.E.) in Electronic Engineering. She also got M.E (Electronic) in 1999 and Ph.D (Electronic) in 2017. She is the first youngest woman Vice President of Federation of Myanmar Engineering Societies and Chairman of Women Engineers Chapter of Federation of Myanmar Engineering societies. She became a member of Myanmar Engineering Society (MES) since it was established in 1995 and put herself in different roles for the prosperity of MES. She is an Associate Professor in West Yangon Technological University. In 28 years of service, She supervised and co-supervised more than 50 research projects. She also designed and constructed her own projects. She was recognized as ASEAN Engineers Register in 2009. She is a Professional Engineer (Electronics). She became ASEAN Chartered Professional Engineer in 2014. She was elected as Honorary Fellow of ASEAN Federation of Engineering Organizations (HON.F.AFEO) and Fellow of ASEAN Academy of Engineering and Technology (HON.F.AAET) in 2018. She is the Chairman of Electronic Working Group and Council Member of Myanmar Engineering Council.

lecturer in 1995.

Then, in 1996, the Ministry of Science and Technology was established, and it opened more than 30 technological universities and colleges across all regions of Myanmar successively. After I obtained my Master's degree in electronic engineering in 1999, I was appointed to the post of lecturer in the department of electronic engineering at RIT (which had by then been renamed Yangon Institute of Technology, or YIT). But then there was a change in the policy around joining the PhD program and hence getting promoted. Whereas previously the promotion policy was based on duration of teaching service, professional abilities, and other factors, the new policy stated that if staff wanted to join the PhD program, they needed to accept the transfer policy—in other words, if I wanted to do my PhD and continue climbing the career ladder, I'd be required to accept a transfer to another technological university, possibly in another city.

This wasn't going to work for me. My parents were elderly, and as I was their only child, I needed to be near them. Plus, Yangon is the best city in Myanmar for healthcare. My husband, a civil engineer whom I had met while in the arts association at RIT in the 1980s, had his work in Yangon, and we had our son by then. So, I would not be able to transfer to another part of the country.

And so, colleagues—and even my former students who started working at the universities some years after I started—were promoted

because they accepted the transfer policy; they climbed to higher positions than me. But although I was not promoted, I always worked hard to improve my teaching; I did a lot of research and I conscientiously carried out all my duties at Yangon Technological University (YTU; it was renamed from YIT). I felt upset about my career, because the people in leadership at that time did not give priority to high-quality teachers who were committed to honest hard work, instead favoring those who accepted the transfer policy.

Then came another policy change, and now promotion to the next level required a PhD. A few years after my father passed away in 2014, I decided to attempt to reach this goal. After I successfully completed my PhD dissertation—"Design and Implementation of Secure Electronic Database Management System for Engineering Education"—in 2017, I was promoted to associate professor, and then in 2018 I was transferred, but fortunately not too far: to West Yangon Technological University (WYTU).

When I carried out my duties at the Federation of Myanmar Engineering Societies (Fed.MES), I also tried hard among mostly male engineers, and I worked in cooperation with engineers not only in academic areas but also in local and international engineering areas. Some male engineers were watching me closely; they didn't have confidence that I could work at the same level as them due to my family duties. I think they doubted I could balance those responsibilities with my academic commitments. When they recognized my service, I was rewarded for working to a high

standard. I was elected to one of eight vice-president positions as well as chair of the Women Engineers Chapter (Fed.MES-WE).

My life falls into three categories: family, academic, and volunteer. In the family category—I have three other family members (my mother, husband, and son) since my father died—I take care of making sure they have their daily meals, that their days are well-organized, and that they are in good health. In the academic area, I prepare my lesson plans, deliver my lectures, demonstrate the practical work to engineering students, and supervise them. And in the non-profit area, I attend seminars and meetings, cooperate with local and international organizations, and organize and encourage the new generation of women engineers. When I have finished my teaching and research, I carry out my duties for Fed.MES.

Sometimes it's a challenge to juggle my time to fulfill my duties in all three of these areas. However, my first priority is always my family, and academics comes second. This means that sometimes I do not sleep as much as I would like, and I have limited leisure time. But for me, it's worth it: I am happy in my work, and especially happy to live the life of a woman engineer. Fortunately, I have a very sweet and loving family who warmly supports me. And it was by balancing my three categories that I achieved a leading role among women engineers in my country, and in the world.

I've been fortunate to have some fulfilling international training.

In 1998, I attended a course offered by the International Atomic Energy Agency on nuclear instrumentation, electronics, and reactor control at Seibersdorf Lab in Austria. I got training in total quality management at the Association for Overseas Technical Scholarship (AOTS) in Jakarta, Indonesia, in 2008. And I received the Erasmus Mundus Action 2 (EMA2) Lotus project scholarship relating to higher education training at Ghent University in Belgium in 2015.

Since I became teaching staff at RIT, I have lectured on a variety of subjects, including electronic engineering circuits, basic electronics, computer science, computer technology, and digital control systems for first-year to sixth-year engineering students. When Government Technical Colleges (GTC) and Government Technological Universities (GTU) were established, I prepared lecture notes on subjects from microprocessors to computer organization design. And I've lectured in Master's and PhD classes at YTU on computer technology, advanced microprocessors, advanced controller systems, and others. In my 28 years of service, I supervised and co-supervised many research projects for Master's and PhD students—from the first batch to the present.

During my academic teaching periods, I also did lots of innovative research that has been very beneficial to my country. One was on the subject of information monitoring systems for airline traffic, which I presented at the International Conference on Science and Engineering (ICSE 2011)

in Yangon. One of my research projects, “Database Management Systems for Teaching Departments,” was published in the International Journal of Engineering Sciences & Research Technology (IJESRT) in 2016. “Web-based Database Management Systems for Teaching Departments” was also printed in the YTU Journal of Engineering in 2017. And I presented “Departmental Database Management Systems” at the Regional Conference on Computer and Information Engineering (RCCIE) in 2016.

As for my involvement in non-profits, I have participated in the Myanmar Engineering Society (MES) since it was founded in 1995. In 2007, I was elected a central committee member, and in 2011 became a central executive member. Then I was voted joint general secretary in 2013 and, in 2016, chair of the women engineers’ chapter, which was established in 2013. It was formed by a group of women engineers from technological universities, the government, and private sectors. Because of my enthusiastic leadership and vision for women engineers, I became the first youngest woman vice-president of the Myanmar Engineering Society (renamed the Federation of Myanmar Engineering Societies in 2019).

In 2013, I gave my first presentation on behalf of the Myanmar chapter of women engineers—“The Vital Role of Myanmar Women Engineers in Engineering Education”—at the 31st Conference of the ASEAN Federation of Engineering Organisations in Indonesia in 2013. I gave the presentation again in Malaysia in 2015 and was then invited to be a speaker at the 2nd

International Conference of Women in Science, Engineering and Technology (WiSET 2018), also held in Malaysia. The Philippine Women Engineers Network invited me to participate in the 3rd Philippine Women Engineers Summit, PSWE3, and in 2019, I presented “The Aspect of Women Engineers in Myanmar” at the World Engineers Convention in 2019 in Australia.

I was recognized on the ASEAN Engineers Register in 2009, and thanks to my initiatives and efforts, I was offered as Honorary Fellow of the ASEAN Federation of Engineering Organizations (AFEO) in 2018. In addition, I was awarded a fellowship with the ASEAN Academy of Engineering and Technology (AAET) in 2018.

I became a professional engineer (electronic) in 2014. I also became an ASEAN Chartered Professional Engineer in 2014. I serve as council member of the Myanmar Engineering Council (MEngC) and chair of the Electronic Working Group, and am a member of the Assessment Committee in MEngC, with responsibility for assessing the applicants for professional engineers, registered senior engineers, and registered engineers. Moreover, I contributed my service as an evaluator in the activities of the Engineering Education Accreditation Committee, which participates in activities like evaluations and reviews for the applied engineering program. And I am getting involved in seminars and workshops about accreditation and engineering education at universities all over Myanmar, to raise awareness about accreditation.

I would like to emphasize the improvement of the Federation of Myanmar Engineering Societies' Women Engineers Chapter (Fed. MES-WE), which I have led from 2016 to present. I have concentrated on growing and strengthening our chapter, and today, we have more members and can extend the network to other chapters of the Fed.MES. The women's chapter became a member of the International Network of Women Engineers and Scientists (INWES) in 2018. I became a member of the committee on women in engineering in the World Federation of Engineering Organizations (WFEO).

Under my leadership, Fed.MES-WE has organized technical and community seminars, training, excursions, technical project competitions for engineering students, and community activities. It has honored at events such as International Women's Day and International Women in Engineering Day. We also cooperated with other international women engineer organizations by participating in conferences, summits, and forums.

Based on these opportunities and experiences, I organized the First Myanmar Women Engineers Summit 2020 (MWES 2020). Held in January 2020 in Yangon, the summit's theme was "Gender, Engineers, and Myanmar." The day included panel discussions. Two sessions were based on sub-themes: "The Role of Women in Engineering to Advance the UN Sustainable Development Goals (SDGs) and Myanmar's Sustainable Development Plan (2018-2030)" and "Taking Challenges as Opportunities by Myanmar

Women Engineers to Stay Ahead in their Professions.” The panellists and moderators were women engineers from the academic, private, and public sectors in various disciplines and engineering areas.

Keynote speeches were given by Marlene Kanga, president of the World Federation of Engineering Organizations (WFEO) (2017-2019), and Chia-Li Wu, chair of the International Network of Women Engineers and Scientists (Asia and Pacific Nations Network) (INWES-APNN). I, too, gave a keynote speech, as chair of Fed.MES-WE.

And in the evening, the gala dinner was held at Novotel Yangon Max. Mr. Aung Myint, president of Fed.MES, delivered the opening speech. Mrs. Si Than, patron of Fed.MES-WE, gave the welcoming remarks.

In total, 453 women engineers attended the summit. They work in different engineering areas, not only in Yangon but in all regions of Myanmar. The summit encouraged and inspired the new generation of women in engineering. It promoted networking and globalization among women in science, engineering, and technology; strengthened the empowerment of women in engineering; and improved participation in meeting the goals of success for Myanmar’s sustainable development plan. All members of our chapter worked so hard and with tireless commitment to ensure the great success of the First Myanmar Women Engineers Summit (MWES 2020).

The report and video message on the summit were published in the World Federation of Engineering Organizations (WFEO) news in March

2020, and news of the summit was also published in the International Network of Women Engineers and Scientists (INWES) newsletter. The video message from my chapter was broadcast live at the World Engineering Day Global Online Celebration UNESCO on March 4, 2020.

I firmly believe that MWES 2020 provided a wonderful summit where the invaluable experiences, insights, and comments of the invited speakers, panellists and participants will be one step toward encouraging women engineers in the profession and improving the wider network of women engineers. Furthermore, the summit was a chance for the world's engineers to notice the women engineers of Myanmar.

After MWES 2020, we participated in a Fed.MED and MEngC World Engineering Day 2020 event. To honour International Women's Day, Fed.MES-WE donated to the Disabled Care Centre, in the Ministry of Social Welfare and Resettlement. When the COVID-19 pandemic began in Myanmar in March 2020, Fed.MES-WE donated 10 lakhs (around US\$750) for fighting and preventing it. Fed.MESS-WE made a second donation of 4 lakhs (around US\$300), again for fighting and preventing COVID-19 and to honor International Women in Engineering Day on June 23, 2020.

During my long journey, I have faced a lot of difficulties in balancing family, work, and my involvement in non-profit organizations. I'm proud that my son, our only child, is clever and has become a front-line medical doctor. A great strength for me is my husband because he always motivates

and encourages me both in my family life and my career. This enables me to stand up again and again after falling down, and has helped me to be a wonderful woman engineer. It has given me the ability to overcome obstacles.

Another strength has been my colleagues in the Women Engineers Chapter, all the committee members at Fed.MES, and my students. I can work with my colleagues with the knowledge that we have the same mindset and can warmly collaborate to achieve our goals for women engineers. My students give love, and in turn I smile whenever they achieve a high position.

Armed with all of these forces of energy, I will continue to improve myself and encourage a new generation of Myanmar women engineers regardless of any difficulties they face. Finally, I want to sincerely thank the presidents and all the central committee members of the Federation of Myanmar Engineering Societies, my colleagues in the Women Engineers Chapter, my students, and all who support and help. And I would especially like to extend heartfelt thanks to my family.

JOURNEY 21

MOVING FROM STRENGTH TO STRENGTH

LORETO VALENZUELA

*Director of College,
Pontificia Universidad Católica de Chile,
Santiago*

CHILE

I am the eldest child of Sergio and Margarita, two engineers who raised me and my two brothers with love, music, games, books, camping trips, and much more. They did such a great job that we were completely unaware if there were any differences, including intellectual ones, between girls and boys; the three of us were equally encouraged to pursue our dreams to be whatever we wanted. Our parents had great expectations of us and encouraged us to reach our highest potential.

Like many kids, I wanted to be everything: a teacher, a doctor, a scientist, a nurse, an engineer, a mother, an actress, a pianist, and more. (Little did I know that I would become several of them: engineer, PhD, professor, scientist, entrepreneur, director, mother and wife!) It was in high school that I decided I wanted to be a combination of scientist, engineer,

and manager, so I decided to pursue engineering studies.

Before I went to college, my family lived and studied in Rancagua, south of Santiago, and I went to a co-ed school. I really loved books, studying, and solving complicated problems, and am grateful for my parents and professors who encouraged me and supported my passion. I also did other things, such as acting classes and piano lessons. In high school, I asked my professors to help me prepare for the entry exams for physics and mathematics. Even though I knew they would be difficult, and that not many of my classmates will be doing them, they agreed to tutor me. When I was accepted at one of the most prestigious universities in Chile to study engineering, my dream was starting to become a reality.

ABOUT THE AUTHOR



Loreto Valenzuela is an Associate Professor in the School of Engineering at Pontificia Universidad Católica de Chile (PUC). She became the first female Director of College at PUC in April 2020, having served as the first female Vice Dean of its School of Engineering from June 2018 to March 2020. Loreto is a Chemical Engineer and earned her Master's of Science from PUC. One day after her graduation in 2002, she started as a Lecturer at the Chemical and Bioprocessing Engineering Department at PUC, just the third female professor at the School of Engineering. After obtaining her PhD in Biomedical Engineering at Rutgers University in the United States, she returned to PUC's School of Engineering as Assistant Professor and developed a research line on biopolymers and biomaterials. In 2018, Loreto founded the spinoff Fishtextend, which is developing a product to extend the shelf life of fresh salmon using only natural ingredients. Several times she has received the "most inspiring teacher in the Chemical and Bioprocessing Engineering Department" award from her students. In 2019 she received the "100 Female Leaders" award from the newspaper El Mercurio and the Chilean organization Mujeres Empresarias.

When I started university in 1995, I realized I had been very lucky: only 13 percent of those studying engineering at Pontificia Universidad Católica de Chile (PUC) were female. We were very supportive of each other and although we were exposed to some sexist comments, the majority of us graduated, and even became professors at various universities.

In my final years of study in chemical engineering, I had a great study group that consisted of five men and five women. Today, we remain very good friends, and we are all successfully working in different fields (and countries). I am so grateful to all of them; we were very supportive of each other. However, during my six years of school and two master's degrees, I had only three female professors: one in chemistry, one in mathematics—and only one in engineering (in chemical engineering), but she was not a tenure track professor.

After finishing my masters at PUC, I applied to a faculty position at the same university, hoping to be considered but with low expectations. To my surprise—and probably also to the surprise of some of my future colleagues—I was accepted. I started as a lecturer in 2002, and became only the second female tenure-track professor at the school. By then, female engineering students made up around 17 percent of all engineering students in a year. When I returned from doing my PhD at Rutgers University in the United States in 2009, another four female professors had joined the faculty—a great increase, but still too little considering the student population and the international standard. Yet I am very proud and happy

that female students entering the school of engineering now make up at least 35 percent of the class each year, and that today, there are more than 20 female professors (though they make up only 13 percent of total faculty). Things have changed at the university, and in Chile, in relation to gender and leadership. But still there is much room to grow.

One of the main reasons I became a professor, besides the passion I have for teaching, is the opportunity to interact with and inspire new generations. From my earliest days as a lecturer (and even as a teaching assistant), I had a very special connection with the students, teaching thermodynamics and discussing with them their goals in life, their motives, and their interests. I did a lot of mentoring, for both male and female undergraduate students. I realized that there is a need for more mentoring for female students, who contacted me to discuss their interests and to learn about me as a person and as a role model. The same happened when new female professors were hired. We created an informal mentoring system among all of us, which is still in place, and it has helped us all in many ways—personally, academically, and professionally. I can't emphasize enough how important mentoring is.

As a researcher I am very passionate about exploring new frontiers, which is why as a chemical engineer I decided to do my PhD on biomedical engineering, in the area of biomaterials, at Rutgers University in New Jersey, as I mentioned earlier. I moved to New Brunswick, New Jersey, where I had a memorable experience both intellectually and personally.

I met great people, such as my advisor Dr. Joachim Kohn and co-advisor Dr. Bozena Michniak. I learned a lot about science, technology, how to bring science and technology to the market, and much more. I also had great teachers; I found one in particular, Dr. Kathryn Uhrich, to be very inspiring. She was a great teacher, scientist, entrepreneur, and role model. Now, she is the dean of the College of Natural and Agricultural Sciences at the University of California, Riverside.

Back in Chile, with a group of colleagues from different disciplines, including civil engineering, chemistry, biology, and medicine, we started meeting to discuss possible collaborations around biomedical engineering and the need to formalize this interdisciplinary area at the university. After a couple of years, two workshops and the support of the dean of engineering, Juan Carlos de la Llera, the biomedical engineering major was created. And with his support as well as that of the deans of biological sciences and medicine, the Institute for Biological and Medical Engineering was formed a couple of years later.

I have had the chance to work on some interesting innovations over the course of my career. One of the outcomes of my research was the development of a formula to extend the shelf life of fresh salmon. Earlier in my assistant professorship I participated in a mission to Stanford University to learn about entrepreneurship. I went there with the objective of learning how to teach innovation and entrepreneurship, and how to innovate in my teaching. But having this potential product in mind, I, along with one of

our team members, went to the Cambridge Innovation Center in Boston to evaluate its potential. As a result, we founded Fishextend as a spinoff of the university. We are currently negotiating with a potential partner to finish the design of the product and scale up its production, with the goal of selling it to aquaculture companies in Chile in the near future and then worldwide. As founder and director of Fishextend, I have learned how to pitch technical solutions to problems to different audiences, and I've been exposed to different interactions, including with potential customers, potential investors, people at the university, and many others. It's truly been an enlightening experience.

In parallel to that, while I was still an assistant professor, Mauricio López, the undergraduate director of the school of engineering, believed in me enough to offer me a new position: Associate Director of Undergraduate Affairs. This role was a nourishing source of knowledge, in which I worked with others, led, and interacted with professors and students. Also, it helped me understand the institution better, as I got to meet many people and listen to students' insights.

I have found that there are innovative ways to reach your goals. Before I became a tenured professor, I asked Professor López and Dean de la Llera to give me a year without administrative work due to the tenure clock. They allowed me to fully focus on my research for that time, without many distractions. I was also lucky that several of my submitted manuscripts were accepted that year. I got the tenure, and became the third female

associate professor at the School of Engineering.

After that, Dean de la Llera invited me to join his team as vice dean. I was not only the first female vice dean, but also the first woman representing the dean at important political venues like the University Council (“Honorable Consejo Superior”). I was and am still very grateful for the honor, and for the trust that was given to me to assume this role. Even though I was not expecting or looking for a political position, I felt I had the dean's faith that I could be an asset for his team and the school of engineering at PUC.

As vice dean, I had the opportunity to interact with students, professionals, alumni, professors, and authorities throughout the university. Being able to discuss projects at a more political stage rather than only at an operative stage allowed me to contribute on a larger scale to different projects, from school internationalization to academic life. One of Dean de la Llera's key projects is called “CARE,” which aims to promote caring more for the community, for societal problems, and doing our best as engineers.

After eight months as vice dean, I was blessed to become a mother, not in the “traditional” way but through adoption. The process took almost three years, and the dean and the school were very generous when I took maternity leave to be able to fully focus on my new role as mother. My original plan was to be a single mother, but luckily I met Marcelo in the meantime, so now we are a happy blended family with my daughter, his three children, and a puppy. The entire process has been a beautiful opportunity

to grow and to give, in a different context. Having a family gives purpose and also limits, and I am very grateful for it. Before, I would wake up every day feeling proud of my job and the way I could impact students and other people's lives. Now, I see my daughter and I realize that the impact I can make can be much more profound. Also, before I met Marcelo, I had to make decisions and carry them out alone; now that I have my partner to discuss them with, it helps me plan better, and has taught me how to really consider the points of view of others and to truly collaborate.

I also learned a key insight that will probably surprise many women who are just beginning in their careers: When I was starting out, I thought that achieving a balance of work and personal life was simply not possible if you wanted to succeed in your career. But I have found that it's exactly the opposite: Allocating time to play, rest, talk, enjoy life, and be with my family has given me such energy and focus that I can achieve even more at work—in less time.

A couple of years ago, when I returned to work after maternity leave, I was almost fully focused on the GEDC conference that took place in Santiago in October 2019. We ran a very successful conference that took place just two days after Chile's *estallido social* (social crisis) ended. My team was superb. I am very proud of Isabel, Macarena, Ana María, Sofía, Soledad, María, Muriel, Gloria, María José, Gabriela, Amanda, and others. We were flexible, caring, brave, and strong. We received only positive comments and feedback from attendees, which included more than 200

deans and authorities from schools of engineering from all over the world.

In March 2020 I was, once again, surprised by a new invitation. This time it was from the university's president, Ignacio Sanchez, who invited me to become the new director of the bachelor of general studies at the university, a position I assumed in lockdown due to the Covid-19 pandemic. Leading a new team, almost fully female (23 women and one man), by video calls and email—without being able to meet with the students—was not easy. However, in a few short months we made progress, starting new projects and of course supporting our students and staff to study and work from home in these times. I am blessed by a great, very committed, and warm team, and a collaborative and welcoming university. I look forward to the day when we are able to come back to the campus and truly meet with the students, and pursue new challenges such as internationalization and the incorporation of a new faculty.

I will end with some words of wisdom, a few things that I have learned throughout my journey, which I feel is just starting:

- Believe in yourself.
- Find your strengths and cultivate them.
- Improve your weaknesses without focusing too much on them.
- Follow your dreams and find the right people to join you.
- Build strong teams and relationships.
- Ask for help, be helpful to others, and collaborate.
- Thank and acknowledge others' impact on your life.

- Be generous with your abilities and time.
- Build—and keep—strong relationships.
- And finally: Learn from others, because everyone, from professors to students, is a potential teacher.

JOURNEY 22

ENGINEERING WITHOUT BORDERS

LIDIA ZAKOWSKA

*Professor on Transport Engineering at
Cracow University of Technology*

POLAND

My story starts in Cracow, Poland, where I was born in the late 1950s. Cracow is one of the most charming cities in Europe, with a long history, rich culture, and the famous Jagiellonian University, where Nicolaus Copernicus studied astronomy before his great discovery that the planets revolve around the sun. Growing up in a family with diverse talents and interests—my mother, Dzi, was a philosopher and art historian who taught at secondary school, and my father, Edi, was an economist who was passionate about art, music, and cars—my four siblings and I had the chance to develop many talents. Although Russian was the first, and obligatory, foreign language at schools in Poland until my country gained independence from the Soviet Union, I also began private lessons

in English when I was a little girl. I did gymnastics and played piano. I enjoyed it, although I remember I did not have much free time to meet my friends and play outside.

I also liked painting, art and architecture, and travelling—passions inherited from my parents, who took the family out every Sunday to visit museums, castles, and old churches. I spent summer holidays sightseeing with my parents and my sister Jola around the countries we were allowed to visit: those on our side of the iron curtain, including Romania and Bulgaria. My father would drive the entire time, and he used to joke: “My

ABOUT THE AUTHOR



Lidia Zakowska, PhD, is a Professor of Transport Engineering in Cracow University of Technology's Civil Engineering Faculty. Her international research concentrates on engineering for sustainable development; mobility and accessibility of transport users; equity in transportation; environmental protection and climate change; safety studies in road transport; visualization in transportation; seniors' mobility; and quality of life. The author of more than 100 research publications, Lidia is on the Editorial

Boards of prominent international journals. She is a Founding member of the WIE (Woman in Engineering) Standing Committee at the World Federation of Engineering Associations (WFEO), an active member of INWES Europe, and past President of the Polish Association of Engineers and Technicians of Transportation, among other leadership roles. A founding member of WIE Network at Cracow University of Technology, she works for the equality of women engineers in their career development. As secretary general of the WOMENVAI platform, Lidia is engaged in bringing new technologies to environmental problems. She believes that adapting to climate change is possible at the local and international level. The planet can be sustainable if engineers and scientists, men and women, work together with policymakers and industry on large, innovative projects with advanced 21st-century technologies.

young drivers are growing.” These experiences gave me my curiosity and my need to discover the world, and I credit my parents for that.

As I grew up, it became clear that both my mother and father wanted me to fulfill their own dreams that they had lost when they were young: my father had wanted to be a lawyer, and my mom dreamed of studying medicine. But then the Second World War came, and universities were closed. When it ended, my father had to go to work, as his own father had died in the war and he had to help care for his mother and two younger sisters. As for my mother, she also had to help her family earn money for food, but was able to study art history while working; there would have been no time to work if she had studied medicine. Because I was generally clever and always had very good marks at school, my parents suggested that I could become either a doctor or a lawyer. But I was fascinated with buildings, art, architecture, cities, and design, so I chose to go to a technical university. Initially I considered architecture, but in the entrance tests I had more success in civil engineering than in drawing, so I decided to study road and bridge construction.

I began university in 1975 and I remember those early academic years as a time of learning not only engineering but also about diversity and equality. For the first time in my young life, I faced strong resistance to female students at the start of their engineering paths—beginning with the inauguration lecture by one of the older professors. He addressed us

thus: “Welcome all men, our future engineers...I also see some women here who came to catch a husband...do it fast so you can leave this engineering school and not distract your male colleagues from studying.” This address was received by most of the male students as a good joke. However, our small group of female students knew that we would have to work harder than the boys to prove ourselves.

Another lesson I learned was accepting diversity in our one-language, one-nation society. Polish students were not used to different cultures, so I often heard jokes about the handful of African and Arabian fellow students; they were seldom included in our social group. But I began to have conversations with these international students, and I realized that they were very nice, passionate, and hardworking guys who needed more understanding and help from us locals to cross the cultural barriers. I did what I could to help them break those barriers, but I had also made a valuable discovery for myself: that despite different cultures, religions, or carnations, we are all equal.

In my first year, I met my future husband, who was also a freshman in engineering. We fell in love and married soon after, when I got pregnant. We both were 20 years old, and if not for the help of our parents, we would probably have been forced to drop out of university and work. My mother did an especially wonderful thing for me: she left her job for four years and, together with my father, took care of my little son and us until we

completed our Master's degrees. This was an outstanding investment my parents had made in their next generation's education, something I more fully understood much later. I know now that my mother was my first, and the most important, mentor of my career.

During summer and study breaks, I had an impressive part-time job to earn some money to buy clothes for my baby, among other things: travelling as a tour guide. I got my international guide's license at the student tour office, Almatour. This was a coveted job, because at that time, before independence, even if you were able to get a Polish passport for private travel, it didn't really belong to you as a citizen; it belonged to the state. So this special passport from Almatour was my gateway to experiencing unknown cultures and lifestyles. I went on cruises of the Baltic Sea from St. Petersburg to Sweden and Finland, visited Georgia and Armenia on Black Sea cruises, and even went to North Africa and parts of Europe on cruises around the Mediterranean Sea. As always, it was the architectural monuments and modern engineering constructions that were my main objects of adoration—but I also discovered that real-life cultures, meeting people, conversation, and exchanging ideas were even more exciting. Usually, what is forbidden or restricted is the thing that's most desired. Young people in Poland at that time were dreaming of democracy, freedom of choice and travel, as well as equality and respect for all. Having these things were essential for my generation; we grew up in the Communist

regime, where some careers were inaccessible unless you belonged to the Polish Communist party (known as PZPR).

Apart from studying engineering and working as a guide, in my last year of study I got the chance to go to Sweden for two months of student practice with the International Association for the Exchange of Students for Technical Experience (IAESTE). This was in the 1980s, at the time of the Solidarity movement in Poland. Strikes were happening, and Polish sea transport between the port of Swinoujście and Ystad in southern Sweden were shut, and I could not get to Sweden by boat. So I went by train to Trelleborg, my practice destination. This, my first individual work as an engineering student in Sweden, was for a huge international company called Trelleborg AB. The experience was so empowering that I never again had doubts that I could contribute to modern engineering development. In the top management of the company was a female engineer who was not only wise but also elegant, beautiful, open to diversity, and respected by all. She was the best example of what we ourselves as women could achieve.

But just a few weeks after my return home from Sweden, reality came crashing down when, on December 13, 1981, Poland came under martial law. I and my whole country faced a lack of freedom of voice, movement, democracy, and equality. There was only terror for the next few years.

As a young civil engineer, I was ready to start my academic career, and was invited by two professors to work in their institutes at Cracow

University of Technology. I chose the Institute of Mathematics, in the descriptive geometry section—one of the very few engineering fields that was dealing with spatial imagination and creativity. This section was connected to the faculty of architecture, and it was also my desire to be involved in creative, interdisciplinary research comprised of engineering along with human aspects, not just traditional mathematical modelling. But after passing the qualification exams, I first had to work for nine months as a construction engineer at the large state engineering/designing office for steel construction. This was because martial law required that I work for the state after earning my university diploma; otherwise, I would not be able to obtain food stamps for me and my child. I still remember that, each day at this company while I was doing design work for long weeks and months—we were designing a steel factory in Katowice—I knew that I was working for the regime. It was a long nine months until I could begin my new job at Cracow University of Technology, but despite the difficult political time, I was happy in academia, even though I earned just half of what I had earned in industry. But as my mother used to say, “Freedom is priceless.” And since then, scientific research become my passion and my mission.

Finally, at the end of 1980s, came Poland’s new post-Communist era. We started to build our democracy again after 50 years. My engineering research had always been connected to human perception and all human-

related aspects of safety and equality. Right after receiving my Master's degree, I got a scholarship in Finland and had a chance to work in Tampere for few months with the Finnish state railroad engineering company, where I was the only woman engineer. I was told that they had one woman engineer in Helsinki, who worked in the head office, not on the building site—which is why I caused a lot of curiosity when I visited construction sites. Together with my roommate, Stacy, another scholarship holder from the United States working for the Finnish state road company, we gained good professional experience in international design and construction. This helped me to trust that women can indeed be creative engineers and researchers internationally. Discovering “engineering without borders” was fascinating and definitely helped me to understand that this profession is not only technical, but human, solving people's needs in a sustainable way. Thus environment, beauty, human perception of space, and equity in engineering became the key words for my future research.

With Poland's independence came the opportunity for me to work in engineering education and research in cooperation with the international world of academia. During my first trip to the United States, I found in the Berkeley library some interesting literature on the new approach to road-safety analysis, and this became the research topic for my doctoral dissertation. I also met women engineers working in top positions, which was very empowering. In Poland at that time, women engineers were not

promoted to prominent positions, even in academia, despite my country's impressive history of having the greatest 19th-century female science icon, the Warsaw-born, two-time Nobel Prize winner Maria Skłodowska Curie.

In my study of highway infrastructure safety, I was on my undiscovered path of perceiving engineering objects from the position of users—men and women, young and senior, experienced and novice—in traffic in several international projects. During those years I also published and disseminated new models for safety perception of the road environment worldwide, observing changes in approaches to engineering toward human and interdisciplinary knowledge. This process was slower in my country than in Western Europe. It was not easy to find an understanding of my approach to transportation research even at technical universities in Poland, where a hard engineering approach and old models were deeply rooted. My many mentors were from abroad, including professors such as Rudi Hammerslag from Delft University in the Netherlands and David Shinar from Ben-Gurion University in Israel; both were great, open-minded professors. In Poland I had outstanding support from my university's past rector, Kazimierz Flaga, but also from wise women—who weren't necessarily engineers.

My first and most important supporter was my mother, who used to tell me, "If I was your age, I would do the same as you are doing. So don't worry about difficulties, they will only make you stronger." The difficulties

in earning my PhD and then moving on to scientific independence were twofold. At the workplace, the problem was the stereotype of civil engineering professors being men; this was very ingrained. And it was at home where I faced the second type of difficulty, one that was also connected to the stereotype that it is only men who can be wise and powerful within a family: My husband, also a civil engineer, was not ready to appreciate a wife who was rising to the top of her academic career. He started to neglect me after I did my PhD, and he resented my work. This evolved into continuous harassment and mental abuse.

In 2004 came an era of great change in my country, when Poland became a full member of the European Union. Thanks to the process of adapting Polish law to European standards, we took a great step toward democracy in science. I had the honor and pleasure of being a partner in an EU-funded “5th Framework” research project, the first one at my university. The SIZE project (2003-2007) was a challenge to study and design mobility conditions and infrastructure for better quality of life for senior citizens in the EU countries. Poland was eligible, as a full EU partner, to take part in all EU-funded programs in science, research, and infrastructure. I was cooperating in four large European projects as a management committee member at another EU-funded program called COST (European Cooperation in Science and Technology). I was active in several research groups, setting up several interdisciplinary research networks

internationally. For COST, we organized meetings, conferences, training schools for young researchers, and short exchanges, all on scientific topics to do with transport and urban planning. The most innovative European project I did internationally was called TEA, which was researching models of fair distribution of transportation and mobility infrastructure. TEA was led by a woman and included researchers from more than 20 countries. It aimed to incorporate equity considerations in transport-project evaluations and decision making—opening a new era in the European approach to gender equality. I remember one of my older Polish colleagues, a professor in transportation, who simply did not understand this new project’s goal, claiming that equity in transportation “is impossible!” This was an excellent opportunity to expose the stereotypes held in male-dominated engineering communities.

Having a professorship in my career plans, I assumed that since Poland was now an EU member, my university would have to open top engineering positions to women. However, there were still very strong barriers. Several times I had to take few steps back, making the whole habilitation process last 13 years. My first habilitation looked like glass-ceiling syndrome; my case was sent from faculty to faculty, from university to university, only to finally be rejected. I was busy with my interdisciplinary research internationally during those years, so I applied for a ministerial research scholarship and in 2008 went to UniRomaTre in Italy to test my

hypothesis in the laboratory conditions of a driving simulator. My second habilitation book, with new results, was published and sent directly to the civil engineering commission for processing—but was again stopped by the same group of “old boys,” including one reviewer. The procedure back then had no time limit, so sometimes reviewers didn’t respond for years, and the process seemed to have no end.

I was forced by one of these traditional reviewers to make another mathematical analysis, and also to pay money to his university colleague for statistics he decided to do at his university, which was stressful. I had also colleagues who wished me luck but did not really believe I could overcome such strong resistance (one female colleague used to say, “Seeing the difficulties you’re facing, I prefer to stay in my adjunct position.”). But things finally became easier: during the past decade, new rules in Poland meant research career policies had to adapt to EU standards and become more transparent. Thanks to those policies, I was able to overcome the endless procedure and send my work directly to the central commission for scientific degrees. I was successful before my opponents had a chance react. In the end, all of these struggles actually made me stronger.

During the past 20 years I have been actively involved in professional engineering associations and research organizations in the transport and infrastructure fields, promoting international cooperation and empowering young women engineers. In 2008 I co-founded the new

Women in Engineering (WIE) standing committee at the World Federation of Engineering Organizations (WFEO). In cooperation with the WFEO Committee on Engineering and the Environment (CEE) we engaged women engineers in activities and special events at the United Nations Framework Convention on Climate Change (UNFCCC) forums in Bonn, Paris, Katowice, and Madrid. For me personally, but also for all female engineers in Poland, it was a great opportunity to put the topic of gender equality on the list of issues that are important in engineering. Indeed, no longer is this profession perceived as only a male one since two women finally became presidents of WFEO, representing more than 30 million engineers globally: Maria Jesus Prieto-Laffargue, from 2009 to 2011, and then Marlene Kanga, from 2017 to 2019.

I am also proud to be an active member of several women's associations, building the capacity of women in science with the International Network for Women in Engineering and Science (INWES), designing gender-equality strategies with the European Platform of Women in Science (EPWS), and creating a mentoring arena for young female engineers in the Polish network of Women in Engineering at Technical University in Krakow (WIEmy). In 2014 I was elected as the first female president of the Polish Association of Engineers and Technicians of Transportation Engineers (SITK RP), Cracow board. The added value of my engineering work was opening international cooperation agreements with several European engineering

bodies, aiming to realize sustainable engineering projects.

But while all of that work and professional success was appreciated by my peers, it was not appreciated by everyone: It must have placed a lot of stress on my husband, because he was increasingly aggressive towards me, and even became physically violent. In 2014, I left our 30-year marriage. I had paid a big price and learned a hard lesson. But even though I lost so much when he cut off all contact with my son and me, including some treasured family portraits and old art pieces, I am thankful for everything I do have: my family (including my beloved son and grandson), my new home, and my work. I am at peace with all of this.

My mission of creating more sustainable engineering continues in my current projects, which are connected to the UN's Sustainable Development Goals. Works are running nationally and internationally in two European HORIZON2020 projects, namely Gender Equality in Engineering through Communication (GEECCO) 2017-2021, and Commitment and ACTonGender (2018-2021), which aims to advance gender equality at RPOs and RFOs across Europe. I'm also helping to create innovative projects within the new international organization, WOMENVAI (which stands for WOmen and Men in ENVironment and Artificial Intelligence): its aim is "Transforming our ideas into a smarter today."

I am going to conclude my story here. Thank you for reading about my life journey, and my engineering journey involving innovative,

sustainable transportation. I'm especially pleased to have had the chance to share in this chapter my insights on, and my involvement in, women's issues and equality in engineering. I feel so strongly that we need to keep tapping the talents of half of our world's population—because engineering needs both women and men working *together*.

Although my engineering path is more than 30 years long, I do not feel that I am at the end of my professional journey, nor do I consider my career to be at its peak. My journey will go on for as long as my brain will work!

AFTERWORD

HANS JÜRGEN HOYER

In my global responsibility to lead the Secretariat of GEDC and IFEEES, a critical issue—and opportunity—over the decade since these organizations have been in place has been to identify and more deeply understand the role of women leaders and deans globally. Many of our colleagues, regardless of what position they occupy in the engineering profession and regardless of their cultural background, have faced challenges. This book, our second edition, is another big step towards achieving a broader understanding of those challenges. We have also begun the process of writing a third and fourth edition focusing exclusively on India and Africa, respectively.

Here's how the idea of creating such books started. Years ago, I had the opportunity to visit Sudan while I was living/working in East Africa. I traveled extensively throughout the region despite some of the political—even war-related—challenges faced in numerous countries, and was so pleased that Tagwa Musa, the only female engineering dean in that complex society, decided to join our GEDC. I reached out to her to ask if she would share with our global community some of her reflections about the challenges she has faced as a leader in this little-understood African country. I was delighted when she responded positively to my request to write a thoughtful

article, which we published in our IFEEES/GEDC GlobalEngineer bulletin. When I read her article, I felt inspired by her vision, commitment, courage and capacity to deal with a variety of obstacles, and felt that more people should have a window on the experience of women around the world in engineering education.

So, I decided to reach out to many of my close colleagues and friends around the world and ask them if they would also be willing to share their personal journey as a female engineering leader in their respective countries. The responses were overwhelmingly positive, and more than 30 leaders from every continent agreed to share their personal and professional experiences by writing a chapter for our first edition of *Rising to the Top*. I feel inspired, humbled, and grateful for the thoughtfulness demonstrated by each and every contributor, and hope that readers will appreciate the fact that these engineering leaders are so openly sharing with the world their individual journeys—no matter how difficult that journey has been.

For this, our second edition, I was fortunate to be able to get it started by working closely with Marlene Kanga, an important global engineering leader based in Australia. She played a key role as we identified other women leaders and new voices to contribute their stories.

The goal of the first and second editions of *Rising to the Top* is for a new generation of female engineering leaders to be inspired by their peers. Equally important is that many of our male colleagues are sure to be positively impacted as they read about the unique journeys honestly shared within these pages. My hope is that this second edition will trigger

even more men in the profession and in engineering education to seriously reflect on how they can be more effective, engaged, and sensitive in terms of supporting women in their leadership roles—regardless of what culture they live in.

Hopefully, there will be more opportunities for all of our colleagues—women and men—to talk openly and frankly about their own journeys, despite having very different backgrounds. After all, the many commonalities shared by deeply committed leaders are a powerful way to make a real difference in this complex global environment. I feel honored and fortunate to be able to accompany so many colleagues and friends on this important journey.



Dr. Hans Jürgen Hoyer is Secretary General of the International Federation of Engineering Education Societies (IFEES) and Executive Secretary of the Global Engineering Deans Council (GEDC). He is a Resident Scholar in Global Engineering at George Mason University and was also Dean

of the School for International Training in the United States. He is an Honorary Professor at education institutes in Hungary, India, Kazakhstan, and Peru; an Advisor to SUSTech in Shenzhen, China; and an Ambassador to Monterrey Tech, Mexico. He is a governing board member for the International Center for Engineering Education (a UNESCO organization) at Tsinghua University in

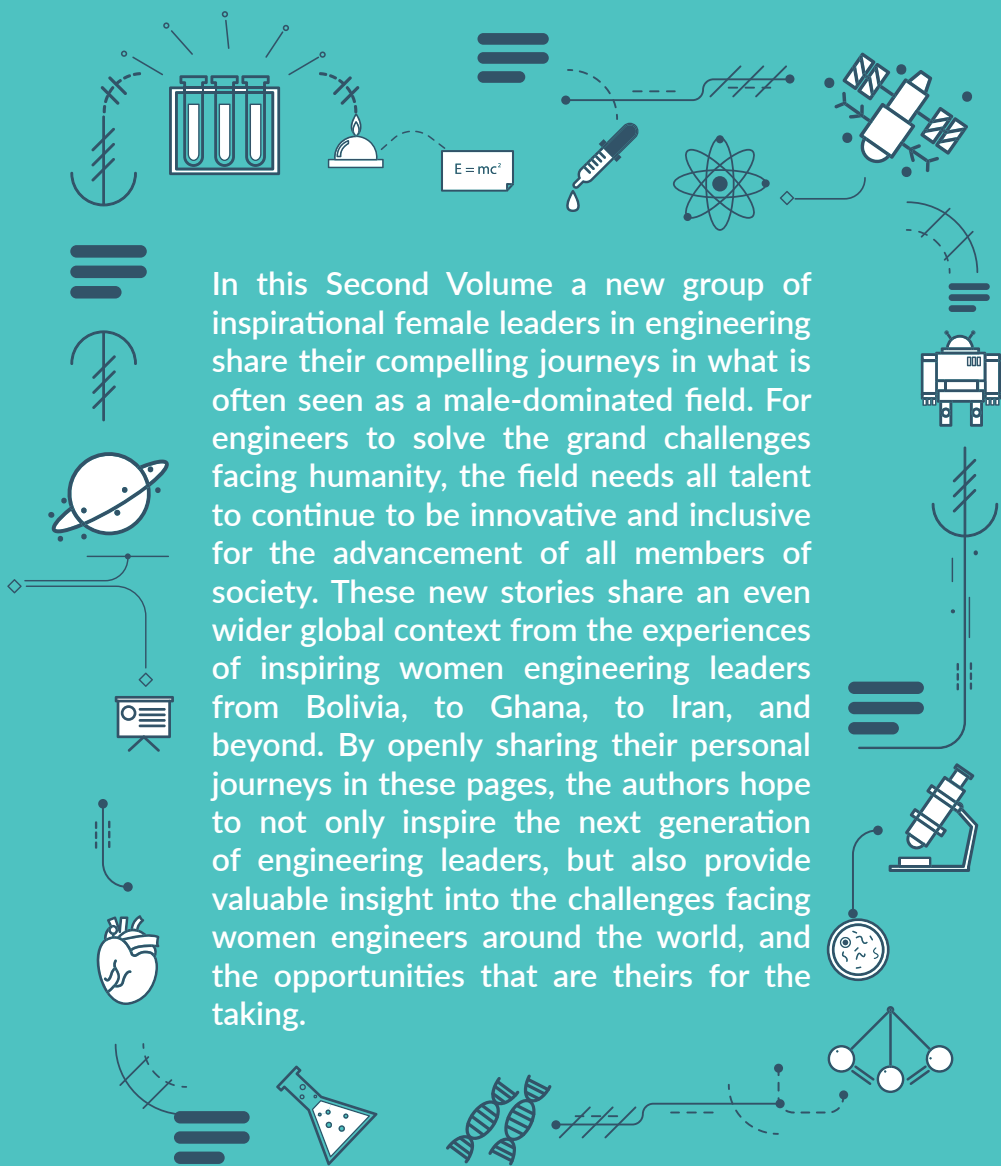
Beijing, China, is on the Board of Trustees of Tishk International University in Erbil, Kurdistan (Iraq), and is an advisory board member and co-founder of the Indo-Universal Collaboration for Engineering Education.

ABOUT IFEEES

The International Federation of Engineering Education Societies connects engineering education societies around the world to leverage the collective strengths of its members and community to improve engineering education worldwide. IFEEES' network works to enhance global engineering education through collaboration between educational, corporate and other organizations interested in engineering education. Learn more at IFEES.net.

ABOUT THE GEDC

The Global Engineering Deans Council serves as a global network of engineering deans, industry affiliates, former deans, and other leaders in the field, leveraging the collective strengths of its members for the advancement of engineering education and research. GEDC Regular Members include deans, rectors, or principals of engineering colleges and faculties. The GEDC's goal is to provide a space for leaders of engineering institutions to connect and share the successes and challenges of providing world class engineering education programs in an increasingly interconnected and fast-paced world community. Learn more at GEDCouncil.org.



In this Second Volume a new group of inspirational female leaders in engineering share their compelling journeys in what is often seen as a male-dominated field. For engineers to solve the grand challenges facing humanity, the field needs all talent to continue to be innovative and inclusive for the advancement of all members of society. These new stories share an even wider global context from the experiences of inspiring women engineering leaders from Bolivia, to Ghana, to Iran, and beyond. By openly sharing their personal journeys in these pages, the authors hope to not only inspire the next generation of engineering leaders, but also provide valuable insight into the challenges facing women engineers around the world, and the opportunities that are theirs for the taking.