Accepted Article

Without Role Models: A Few Pioneering Women Engineers in Asia

American Behavioral Scientist
2022, Vol. 0(0) 1–10

DOI: 10.1177/00027642221078508
journals.sagepub.com/home/abs
SAGE

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Abstract

The importance of role models in inspiring and influencing the career paths of young people cannot be overstated, particularly in the fields where certain population segments are under-represented. However, when there are no role models, a few exceptional people become pioneers; these are people who carve out their own paths. Most research in early history of women in engineering focuses on the Western world, with relatively little information from the other parts of the globe. This paper presents the stories of a few Asian women who went against the odds, against social norms and expectations, without role models, and ventured into the field of engineering.

Keywords

early Asian women engineers, role model, pioneers

Introduction

There have been many studies on the effect of role models in career choices of young people, and it is generally accepted that girls, more than boys, benefit from having role models of the same gender, particularly in the fields of science, technology, engineering and mathematics (STEM). These results have made their way into the popular media, although they originated in serious scholarly journals. A recent article in the Guardian (Fuller, 2020) includes this remark: "… as the saying goes, if you can't see it, you can't

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be it. The study of 11,500 girls and women across 12 countries discovered that girls were much more likely to consider a career in STEM if they had a visible role model." Based on two studies (one on the effect of gendered role models on self-perceptions and the other, on career preferences), Lockwood (2006) concluded, "that female participants were more inspired by outstanding female than male role models; in contrast, gender did not determine the impact of role models on male participants."

It is now commonly accepted that increasing the number of female faculty members in engineering would encourage, support, and retain women engineering students (Bauer, 2008). The need for female engineering role models both in academia and industry is an ongoing topic of discussion. One trailblazing woman engineer, Dawn Childs, who had a career as an engineer in the UK's Royal Air Force (RAF) for 23 years, states: "We need to create more realistic role models to whom women can turn when they are finding it tough—perhaps at specific career or life milestones" (cited in Burnford, 2021). It should be noted that Ms Childs herself succeeded without any role models, was the first female Officer Commanding Engineering Wing at RAF Waddington, the first female Head of Engineering at an international airport, and currently has the title of "Change Director" in UK's National Grid. All over the world, for a long period of time, many women were pioneers and went where "no woman has gone before."

While fully acknowledging the need for (and benefits of) role models, I propose that we may use a different, additional tool if we wish to inspire young girls and women to venture into activities and career paths even if there are no female role models in that field. I suggest that the excitement of being the first one in any given field may hold its own attractions for some people, and this should be acknowledged and encouraged. The absence of gendered role models can sometimes be overcome by appropriate mentoring and family support systems, and there is historical evidence for that.

Imagine this scene. Decades ago, in an unnamed country, a young girl who likes math and science having a conversation with parents:

Girl: I wonder if I could become an engineer when I grow up.

Father: Oh, I don't think engineering would be a good profession for girls. Why would you want to be an engineer? You could be a doctor instead. Or a teacher, professor. Those are good for women, I think.

Mother: Well, I think there is great demand for women doctors, and always will be. Women engineers, I'm not so sure …

Girl: I like math and science, and I like machines and gadgets.

Father: Well, you can become a math teacher.

Girl: True. But engineering seems like fun, too

Mother: Maybe. But I don't know any woman who is an engineer. Do you? Have you met any, heard of any?

Decades ago, in the country of this girl, the answer was a definite No. No one in the family, or in the extended family, or within their circles of friends and relatives, has ever met or heard of a woman who is an engineer. They all know some men who are engineers and assume that is the way it is meant to be. There are men's professions and there are women's professions.

In that situation, perhaps the last part of the conversation goes like this:

> Girl: No, you are right. Engineering probably is not good for a girl.

What if the conversation had gone like this instead?

> *Girl*: No, but that's not a problem, I can be the first one! That would make it even more exciting.

In this imaginary scene, we see a young girl who is excited by the prospect of being the first woman engineer in her country. She may be an exception, but with a little encouragement, we may discover many more such people.

This paper presents a few such women, each with her own unique essence but sharing the common feature that they did not wait for role models: they curved out their own paths, thus becoming role models for others. While it is true that women started to get into the engineering profession in late 1800s in the United States and in early 1900s in Europe, it is also true that by the mid-1900s, China and India were already graduating many women engineers. Indeed, the first three women engineers in India graduated in 1943, and there is record of a Chinese woman with a Bachelor of Science degree from the National Technical School of China coming to Massachusetts Institute of Technology's (MIT) electrical engineering department in 1925 and graduating in 1929; the first Japanese woman engineer graduated in 1947. These Asian women were dreamers and possessed the skills to succeed in the real world, and their stories are fascinating but not widely known.

There Was a Dream in a Remote Corner of Bengal

For things that seem impossible in reality, some people present their ideas in the form of dreams. It is amazing to learn that a young woman named Rokeya, born in the Bengal Presidency of British India, in 1880, who at the age of 25 imagined a country where women scientists invented all kinds of machines: an elaborate system to control the weather, electrical devices that enable farming without a lot of labor, solar power harnessed for flying cars as well as for cooking (Hossain, 1905). Rokeya did not use the word "engineer"; instead, she called them "scientist," but clearly these were engineers in her imaginary country named "Ladyland" which she presented in her novella "Sultana's Dream," written in English. This young author, who never went to school but was taught to read and write both Bengali and English by her elder brother, later became a pioneer of women's liberation in South Asia; she was a feminist thinker

before the word came into vogue, and she imagined women engineers, without knowing of any in real life. The story "Sultana's Dream," where women were designing and building all sorts of useful electrical devices, was published in 1905 in *The Indian Ladies Magazine*, written by a woman with no formal education, from a remote village in what is now Bangladesh. The story was later published as a book and has been called a feminist utopia; indeed, besides the super-talented women scientists/engineers that Rokeya envisioned, she also envisioned other interesting things such as a two-hour workday so people could spend a lot of time in leisurely and creative activities in this country run by women. These women engineers in Rokeya's dreamland were a competitive and productive bunch, as she describes:

> In the capital, where our Queen lives, there are two universities. One of these invented a wonderful balloon, to which they attached a number of pipes. By means of this captive balloon which they managed to keep afloat above the cloud-land, they could draw as much water from the atmosphere as they pleased. As the water was incessantly being drawn by the university people no cloud gathered and the ingenious Lady Principal stopped rain and storms thereby… When the other university came to know of this, they became exceedingly jealous and tried to do something more extraordinary still. They invented an instrument by which they could collect as much sun-heat as they wanted. And they kept the heat stored up to be distributed among others as required…While the women were engaged in scientific research, the men of this country were busy increasing their military power. When they came to know that the female universities were able to draw water from the atmosphere and collect heat from the sun, they only laughed at the members of the universities and called the whole thing "a sentimental nightmare"!'

It is not clear whether the book *Sultana's Dream* created any sort of awareness in Bengal/India in the year 1905 or later; instead, it was ignored as a sentimental woman's dream. However, in the following few decades, a few women did start to venture into the then male-only fields of engineering.

The Support System—A Chinese Example

It seems that the earliest women who ventured into the fields of engineering had considerable family support: even now, this is an important factor in the success of women in the field, but in some cases, in the modern society, there are avenues of women to follow their dream even without family support. However, in the beginning, in the absence of gendered role models, family support seems to have been crucial. Even for the dreamer, Rokeya, it was her husband who encouraged her to publish her story after she had read it to him.

Twenty years later, in 1925, in a different way, in a different country, family support was evident when a young Chinese woman accompanied her husband to MIT in the United States and enrolled in the electrical engineering program—the first Chinese woman to do so. She created quite a sensation in Boston. The Boston Papers reported:

"Pretty little Lee Li Fu has registered for electrical engineering at MIT and has begun a long journey on the road, that will place the little Chinese lady on equal footing with her husband" (cited in Chinese Students Monthly, 1925). Lee's husband Kuan Tung was 2 years ahead of her, and both were students of electrical engineering. Lee was accepted well in the MIT community, and was elected by the MIT Chinese Students' Club as the chairman of the social committee. It appears that she became a widely admired figure at MIT, generating much curiosity in a positive way. Quoting from China Comes to MIT: "In their story, 'Chinese Wife at Technology Strives for Hardest Degree,' the Boston Globe declared Lee 'Technology's most interesting student this year" (cited in Chinese Students Monthly, 1925). The Globe reported that Lee was considered a model student by her professors, always completing her homework on time. It further noted that this unusual student from China had "made a decided hit with the rest of the coeds at the Institute," who welcomed her warmly and made it their duty to "help the lonely girl, away from home" to get acclimated to American culture and the English language. The couple were reported living at 21 Lee St, in Cambridge, where Lee could be found in the evenings doing "her studying and the housework for her husband." Kuan, for his part, was reported to be a devoted husband, who walked her to and from class every day, carrying her satchel. The Globe concluded: "without a doubt Mrs. Tung is the most interesting coed that has ever registered as a student at Technology and she is registered in a course that is harder, so the Technology men say, than 99% of coeds ever think of taking."

Unfortunately, not much is known about Lee's professional career after she graduated from MIT, but the point of this story is elsewhere: the fact that even though she was a lonely figure, there was no hostility or discrimination; in fact, quite the opposite. Lee might not have had any role models, but surely, she had a supportive family which was the source of her strength, in addition to her academic talents. Within a couple of decades after Lee's graduation, by the mid-1900s, the number of women engineers in China had reached many hundreds. According to Cheng (2014):

> in Anshan, which was China's leading steel center, more than 600 women engineers, designers and technicians --- all post-1949 graduates --- were working in metallurgical, steel-rolling, power-generating, machine-building, and mining departments. Substantial numbers of women engineers and technicians also worked in the railroad system. Women civil and mechanical engineers served in railroad construction departments as well as rolling stock plants.

In today's China, it has become commonplace for women to study science and engineering, and the issue of gendered role models may have become unimportant; but the story of Li Fu Lee remains relevant as an example of how it all began.

From Dream to Reality—Back in India

In a different part of India far from Bengal, in 1919, 14 years after the book *Sultana's Dream* was published, a girl was born who would later become the first woman engineer in the Indian subcontinent; she designed smokeless ovens, power transmission equipment including protective gear and substations power, and a type of electrical musical instrument, much like Rokeya's imaginary women engineers who designed and built electrical gadgets. This girl, Ayyalasomayajula Lalitha, has a unique life story that can still inspire many women around the world. She was married very young, according to local customs of the time: at the age of 15. She gave birth to a daughter at the age of 18, and her husband passed away when the baby was 4 months old. A young, widowed mother in India in those days would generally be expected to spend her life raising her child and essentially hiding herself from the world, but this one was different, and was fortunate to have a supportive family, including a father who was a professor of electrical engineering, and brothers who were also engineers. She entered the electrical engineering department at the College of Engineering, Guindy in Chennai (then Madras) and graduated in 1943. Two other women entered the college a year later, in civil engineering: Leelamma George and P K Thressia, and the three women graduated in the same year because the curriculum was shortened due to the war.

It is interesting to explore how the male-only institution reacted to the first women being admitted there. Was it a shock to the community? How did the other students take it? Was there any hostility? Were the girls labeled as freaks? Were they insulted, or were they admired? It turns out, from recollections of Lalitha's daughter, Syamala Chenulu, that the environment was actually quite supportive (Patel, 2019):

> Contrary to what people might think, the students at amma's (mother) college were extremely supportive. She was the only girl in a college with hundreds of boys but no one ever made her feel uncomfortable and we need to give credit to this. The authorities arranged for a separate hostel for her too. I used to live with my uncle while amma was completing college and she would visit me every weekend.

Lalitha went on to have a full engineering career and left behind a legacy of courage, motivation, and dedication to her chosen profession. Being the first woman in an all-male college did not deter her; it may have inspired her to excel even more. Women studying engineering and other technical fields is not a rarity in today's India, and there are plenty of highly successful women in these fields, including university faculty, who can and do serve as role models for the young generation. However, with or without role models, the important of family support systems cannot be overstated.

The Barriers to Overcome—A Story from Japan

What were the biggest problems for women as they started entering engineering colleges which had previously been all-male institutions? Clearly, the decision to enter

the institution and obtaining admission must have been the biggest hurdle; the woman's family had to go against social norms, and the college administration had to break tradition in order to allow the first women to enter engineering education. Once this hurdle was overcome, what was the environment for the women in these institutions? Being the only woman in an entire university must have been a very lonely, stressful experience. This lone woman most probably could not participate in the extra-curricular activities, sports and games, all of which were designed for men. There were no women professors. There was no dormitory for girls. No women's restrooms in the buildings. These pioneering women entering the profession had to operate in very restrictive, limited environments, but still managed to thrive and shine. They overcame numerous barriers by sheer willpower, mental and physical endurance, and by finding creative solutions to basic problems. The story of Japan's first female engineering student's campus experience may seem amusing now, but was a serious issue at the time.

Michiko Togo (Lezott, 2021; Tokyo Tech, 2014), who entered Tokyo Tech after passing their extremely difficult entrance examination in 1947 (the success rate that year was only 21%) stated that her biggest problem on campus was the lack of a women's restroom. After consulting with academic advisors, she obtained a piece of paper with "Women Only" written on it, which she pasted on one bathroom door in the common area of men's restrooms. What other barriers she faced on campus or during her studies is not known, but it seems that she was generally admired as the "only girl" and respected by her fellow students in electrical engineering. Tokyo Tech has had a few other women students before Michiko, but not in engineering; Michiko was determined to become an engineer because she desperately wanted to contribute to Japan's recovery after the war. In her case also, as in the cases of the pioneering women engineers from China and India, family background and support played a big role: Michiko's maternal grandfather, Kunihiko Iwadare, was the founder of the Nippon Electric Company Corporation, and her father was also a graduate of Tokyo Tech. Michiko Togo graduated with her electrical engineering degree, went to the U.S. for higher education and enrolled in Bryn Mawr College. However, her life journey took an unexpected path as she met Shigeru Yoshioka who was studying at seminary and married him later in Japan. It seems Michiko did not work professionally as an engineer, but devoted significant amounts of time to gather historical documents about Tokyo Tech and electrical engineering education. It should be noted that the absence of women's restrooms on campus was not really a barrier, but only a result of the fundamental assumption that engineering was a male profession. There were many other assumptions and expectations of gender-specific roles, strongest among them perhaps the cultural and social norms that persist to this day. That might explain why Michiko Togo surrendered her hard-earned engineering career to support her husband's missionary work.

Contrary to India, China, and a few other Asian countries where women have entered the engineering profession in larger numbers ever since the first paths were paved, Japan still lags behind, not only in engineering but in all STEM fields (Lezott, 2021). According to the Japanese Cabinet Office's White Paper on Gender Equality,

only 10.2% of engineering researchers are women. This number is somewhat better for other STEM fields; however, in total only 15.3% of Japanese researchers are women. Suffice it to state that not only in Japan but all over the world for hundreds of years, countless women have surrendered their personal and professional aspirations in favor of preserving social harmony and adapting to social norms.

Conclusion: Complicated Dynamics

In many societies and countries, sociocultural norms and traditions clearly hold that science and technology are men's domain. These are extremely powerful elements that dictate and shape most people's lives unless major systemic disruptions occur. For example, the socialist revolution more than a hundred years ago, along with rapid industrial development and government strategies driven by a specific ideology, followed by the Second World War created such a step change in some countries (former Soviet Union and her allies) that gender stereotypes were destroyed or abandoned, and large numbers of women entered engineering and other STEM professions. The quest for economic development and targeted government policies can also overcome sociocultural norms and traditions, as has happened in China, Malaysia, and several other countries where plenty of women now study and work in engineering and other STEM fields. In India, Bangladesh, and some Middle Eastern countries, the numbers of women in engineering are rising faster than some more developed countries in the Western world. The fact that in many less developed countries with generally low levels of gender equality, more women have entered STEM fields compared with highly developed countries with supposedly higher levels of gender equity gave rise to the term "STEM Gender Equality Paradox" and has been debated widely in the recent years. An interesting and detailed report on this can be found in Buzzfeed (Lee, 2020) which provides links to a great number of references on the topic and the ongoing debate surrounding the issue.

There is general agreement that the issue of significant and continuing gender imbalance in the engineering profession is extremely complicated. Exploring and analyzing the historical evidence of how some women succeeded without any obvious role models could open new possibilities for policymakers. Stories of the first few women engineers demonstrate that the combination of family support, mentoring from academic advisers, and sheer determination can go a long way toward producing new role models for the benefit of those who will come later. For the pioneers, the excitement of being the first ones must have been an amazing and fulfilling experience. For us, the lesson is that nurturing, supporting, and encouraging the pioneering spirit may help overcome the negative impacts of the dearth of role models.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Disclaimer

Fahmida N. Chowdhury is employed at the U.S. National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

References

Bauer, I. (2008). The need for female role models in engineering education. Proceedings of the 2008 WEPAN National Conference, St. Louis, MO, 8–10 June, 2008.

Burnford, J. (2021, February 11). The engineering journey: A woman's view. *Forbes*. Retrieved August 01, 2021 https://www.forbes.com/sites/joyburnford/2021/02/11/the-engineering-journey-a-womans-view/?sh=6aa8e4267377

Cheng, C.-Y. (2014). *China's economic development, 1950-2014: Fundamental changes and long-term prospects*. Lexington Books.

Chinese Students' Monthly (1925). The first Chinese woman student at MIT. *21*(2), 69. Retrieved August 04, 2021 http://chinacomestomit.org/lee-li-fu

Fuller, G. (2020, June 23). 'We need to show girls that engineering is exciting': How role models can light a spark. *The Guardian*. Retrieved July 31, 2021, from https://www.theguardian.com/careers/2020/jun/23/we-need-to-show-girls-that-engineering-is-exciting-how-role-models-can-light-a-spark

Hossain, R. S. (1905). *Sultana's dream*. Archived from the original on 23 September 2015. Feminist Press. Retrieved 1 June 2015.

Lee, S. (2020, February 13). A controversial study claimed to explain why women don't go into science and tech. It just got A 1113-word correction. *Buzzfeed News*. Retrieved August 6, 2021, from https://www.buzzfeednews.com/article/stephaniemlee/women-stem-gender-equality-paradox-correction

Lockwood, P. (2006). "Someone like me can be successful": Do college students need same-gender role models? *Psychology of Women Quarterly*, *30*(1), 36–46. https://doi.org/10.1111/j.1471-6402.2006.00260.x

Lezott, C. (2021, February, 11). 5 pioneering Japanese women in STEM fields. Zenbird. Retrieved August 5, 2021 https://zenbird.media/5-pioneering-japanese-women-in-stem-fields/

Patel, T. (2019, June 8). Married at 15, widowed at 18: How a single mom became India's 1st woman engineer!The better India. https://www.thebetterindia.com/185532/india-first-woman-engineer-a-lalitha-inspiring-history/

Tokyo Tech (2014, June) *Rikejo: Japan's pioneering women in science*. Retrieved August 04, 2021, from https://www.titech.ac.jp/english/public-relations/about/stories/research-pioneer-rikejo

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