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HANDBOOK 2020

AI and the Future of Engineering with Hugo Magalon

DOES STEM HAVE A PROBLEM WITH WOMEN?

An Interview with Elizabeth Donnelly, CEO of the Women's Engineering Society

FIXING THE FUTURE: ENVIRONMENTAL ENGINEERS AND CLIMATE CHANGE

THE BEST ENGINEERING MASTER'S MONEY CAN BUY

N° 1

CEO's Note

BY ANDREAS HOFFMANN

Engineering is one of the most diverse and important disciplines of the modern age. Engineers build our roads and bridges, keep our electricity flowing, fix our vehicles, and develop the technology we need to mitigate environmental catastrophe. With that in mind, it's with great pleasure that I introduce you to the first ever NewEngineer.com Handbook, a collection of literature dedicated to engineers and the engineering discipline. NewEngineer.com has been helping engineers find courses, programs and jobs since its inception in 2016, and this Handbook is a culmination of all those years of hard work. Inside, expect to find quality career and study advice, advice that has already helped thousands of engineers take the next step in finding a job or continuing in higher education.

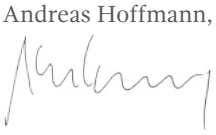
But that's not all you can expect. As a company serious about engineering, we're also serious about tackling the problems and inconsistencies that engineers face every day. To that end, we've done our best to explore some of the most critical issues of the current age: gender inequality, still rampant in society and especially in the STEM subjects, and the impending climate systems breakdown. A discussion of the gender discrimination within STEM, and an interview with Elizabeth Donnelly, CEO of the Women's Engineering Society, sheds some light on the problems and potential solutions for granting women equal opportunity in schools and in their careers. And what of the impending climate catastrophe, something we here at NewEngineer.com care very much about? We think environmental engineers might have the answer - or at least part of it.

Aside from these large problems we're still tackling, 2019 should be a year of celebration. In the U.S. alone, engineering jobs are predicted to increase by around 140,000 over the ten year period from 2016-2026. Investment in environmental engineering, for example, has boomed over the last decade. The United States has a target of 20% wind power by 2030, something that will create around 500,000 jobs, and a large proportion of these will be in engineering fields. And, of course, the elephant in the room is automation; already automation is set to create up to 70,000 jobs in the U.S. by 2024. It remains to be seen how totally this relatively fledgling field of science will change the face of the engineering discipline, but suffice it to say, engineering won"t look the same tomorrow as it did yesterday.

But fear not! There will always be jobs for engineers, the backbone of our society; as James Kip Finch, the great American engineer said, "the engineer has been, and is, a maker of history." We here at NewEngineer.com couldn't agree more.

Thank you to everyone who has supported us thus far, enjoy the Handbook, and we looking forward to serving you in 2020 and beyond.

Andreas Hoffmann,



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Fixing the Future: Environmental Engineers and Climate Change

BY JAMES MATTHEW ALSTON

A climate crisis looms over our heads. The struggle to save our planet – that is, to save ourselves – has never been more pressing. The realities of the coming catastrophe are becoming more obvious, projected daily on our television screens. An IPCC report from 2018 showed definitively that droughts and rainfall deficits, massive damage to ecosystems and biodiversity, and higher rates of disease and crop failures (all of which lead to increases in poverty and death, especially across the developing world, and all of which we've seen already), will become even worse in the near-future if we don't do something about the climate change problem now. And people are starting to get worried too, even if they aren't prepared to give up their hard-earned cash to alleviate the problem. The Atlantic reported in 2019 that, while the majority of Americans are unwilling to pay even $10 a month to counteract these problems, seventy percent of Americans say these issues are of personal concern to them. The climate problem is real and it's urgent. So where does engineering fit into all this?

Engineering change

Environmental engineering has existed, though not under its current name, since before the Common Era. Humans have always tried to figure out ways to control the environment in order to make it safer for humans to use, even if they often destroyed it in the process. Way back in 3000 B.C.E. the Indus Valley Civilisation was cleaning its water and depositing it into wells, baths and storage tanks, and it had relatively sophisticated sewage and drinking water systems. Fast forward five millennia and the story is much the same. Environmental engineers have come up with the most innovative solutions to waste management, recycling and the protection of public health we've ever seen; and the related practice of sustainable energy owes a debt to those environmen-

tal engineers who spent their time working out how we could lead a better, healthier existence, while at the same time protecting the environment.

"If we are going to do something about the forthcoming disaster, engineers are going to have to remain on the front lines, brandishing their innovative solutions like bayonets against the invading global warming army"

Take the National Environmental Policy Act (NEPA), passed by the United States on 1 January 1970. The act specified that Federal agencies were obliged to provide environmental assessments and impact statements before moving forward with any actions. This means that, for example, if a Federal agency was looking to build a new highway route, it would have to provide detailed analysis of how this would affect the environment and act to minimise those effects. Moreover, it stated that every single person has the responsibility to preserve the environment, "as trustees for succeeding generations." As a result of this act, over a hundred other developed countries adopted similar laws that stated the environment must be an immediate concern when any major engineering works were planned. Environmental engineers would be the ones who would carry out these risk and impact assessments, hoping to mitigate environmental damage.

The act was a direct result of a developing environmental consciousness due not only to Rachel Carson's famous 1962 book Silent Spring, but also because of the 1969 Santa Barbara oil spill, which caused mass outrage. Since then, concern for nature has become a bigger part of the engineer's job as the general public has become more environmentally conscious and governments have begun to respond in kind.

Unfortunately, for all the efforts of environmental engineers, the current climate systems breakdown isn't getting better, but worse. If we are going to do something about the forthcoming disaster, engineers are going to have to remain on the front lines, brandishing their innovative solutions like bayonets against the invading global warming army. And this enemy is an insidious one.

Solar cities and globalised work

Globally, environmental engineering is "one of the fastest-growing engineering disciplines... [with] future growth rate in terms of investment at somewhere between 12 and 15% annually", according to a 2011 Canadian report. One of the main areas this investment will fund is the provision of safe, clean drinking water for people in heavily populated countries such as India and China. This will be led by new processes in contam-

ination reduction, and will also help to improve water and wastewater systems, both of which are essential for improving the general quality of water provided to populations. And naturally, environmental engineers will continue developing sustainable energy sources, making them more efficient and, in the long run, cheaper. Already we see this happening, Elon Musk's SolarCity being a prime example of more affordable solar energy that creates jobs for engineers. The U.S. has a target of 20% wind power by 2030, a goal which requires 100,000 wind turbines and will create up to 500,000 new jobs, many of which will be in the field of environmental engineering. This, along with the United Kingdom's current target of zero emissions by the same date, means engineers will have their work cut out for them over the next decade.

But the discipline faces challenges in the job market. In North America especially, faculty positions have been decreasing in frequency even as market demand for engineers increases. Moreover, many working professionals are set to retire in the coming years, meaning an employment deficit is expected. Western countries may also begin to lose their environmental engineers as exciting and lucrative opportunities arise in other places across the world, a result of an increasingly globalised workforce. With globalisation comes another problem, too: as more workers from developing countries move to the West willing to work for less, the average wage for engineers is set to decrease. Environmental engineers may, however, be protected from this, as they are seen as essential for our future, and therefore worth the money. Nonetheless, engineering faces problems in the job market at a critical juncture in our world history.

"Engineers will have to change tact from simply solving problems to predicting them and fixing them before they have developed. This means, at its most basic level, working with experts from other fields to prevent disaster before it starts"

Fixing the future

If environmental engineering is going to face the challenges of the impending climate catastrophe, it will be forced to evolve. Education will have to be overhauled in

order to deal with the concerns of the future and make the discipline more appealing to prospective students. One of the things brought up in the 2019 study *Environmental Engineering for the 21st Century* was the fact that engineers will have to change tact from simply solving problems to predicting them and fixing them before they have developed. This means, at its most basic level, working with experts from other fields to prevent disaster before it starts. Important players in this will be those in the social sciences, who will enable engineers to learn about the social, economic, legal, and political contexts within which they work. Some of this has already started: universities have begun to implement, for example, leadership initiatives which layer, on top of the environmental engineering degree, courses in social consciousness and creativity. Moreover, continuing education will become ever more important as the number of those with undergraduate degrees increases – a good thing by anyone's estimation, but something that arguably lowers the value of a BSc or BA. Specialisation will also become more important, again forcing students to continue into highly-specialised graduate programs. And it isn't only experts who need to be brought into the equation, but the public, too: as interest in the environment and the protecting of it increases, environmental engineers will be forced to deal with the demands of an ever-more-vocal public.

"Engineers in particular will be at the forefront of the solution to the most pressing concern of our time"

All of these developments will transform the discipline of environmental engineering into something truly modern. The field has something essential to contribute to the health and prosperity of the world, particularly as climate change is now at the top of the agenda. Climate problems have to be prevented before they have materialised, because this crisis can't be solved after the fact: it needs to be mitigated with preventions. Whether improving water supplies, helping to grow the sustainable energy sector, or working with the public, experts and at-risk communities to adapt to a fast-changing world, environmental engineers in particular will be at the forefront of the solution to the most pressing concern of our time – perhaps of all time. They have continued proving they are up to the job; now, with the developments that are required of them, they will have to work harder than ever.

AI and the Future of Engineering: An Interview with Hugo Malagon

BY JAMES MATTHEW ALSTON AND WILLIAM PEARSE

What does the future hold for engineering? Perhaps we won't know the answer until it arrives; when it comes to a field with such breadth as this, anything is possible. One thing's for certain, though: artificial intelligence will play an enormous role in what happens to the discipline over the next few years. It's already shaping the manufacturing industry and it won't be long before all engineering specialisations are transformed in one way or another by this revolutionary technology. To better understand how things may develop, NewEngineer.com sat down with neuroscientist and AI expert, Hugo Malagon, to talk about exactly how AI could affect engineering and how engineers can get involved in the field.

Could you describe your role in the field of AI?

I am a neuroscientist. I use different machine learning techniques to analyse big data sets of neuronal activity recorded directly from the brain.

What has been your career trajectory?

After doing my diploma in Electronics Engineering at the Universidad de Ibagué in Colombia, I completed a Master's degree in Artificial Intelligence at the Catholic University of Leuven in Belgium. Following that, I gained a PhD in Neuroscience at the Medical University of Vienna. Currently, I am a postdoc at the Laboratory of Cognitive Neurobiology at the Center for Brain Research of the Medical University of Vienna where I am investigating different cognitive aspects of behaviour, such as learning, decision making, memory, anxiety and general executive functions.

Which engineering field is most suitable for someone who wants to enter the AI industry?

I would say electrical, electronic, or mechanical engineering. That being said, any field with a good background in mathematics and programming is a helpful starting point. Other areas like psychology and philosophy can also suit the AI industry, as it does not only focus on technology development; several humanities-related issues, such as ethics, are necessary to take into consideration too.

Why would you recommend young engineers enter the field of AI? What skills do they need to possess to succeed?

The most important thing is to focus on a programming language, one which contains AI libraries like Python (or MatLab if they want to pursue a career in the academy: doing a PhD, focusing on research). I would strongly recommend having an understanding of the mathematical processes that underpin AI.

What are the biggest challenges that engineers face in AI right now? How can engineers help to solve these problems?

I think AI has been developing incredibly fast. Right now, AI is bringing optimal solutions to many different areas. There are several challenges regarding technical parts of AI, such as computation power and transfer learning. However, they are being efficiently addressed. Unfortunately, I have the feeling that more has to be done regarding the ethical implications of AI-related technology. The challenge to understand and create awareness not only in the industry and academy but also in society about the extent of AI usage is important and needs to be widely discussed. We need to talk about both the implications of robots (not so sci-fi anymore!) and decision making, and about simple AI tools and their usage for surveillance, data sharing/protection and weaponisation.

How is AI going to impact our lives in the coming years?

I believe it will improve living standards at least for those in developed and developing countries. Artificial intelligence tools will be used to diminish traffic accidents and improve the quality of transportation. It will certainly play a critical role in medical treatments, diagnosis and preventive diagnosis. Predictions of natural disasters might be possible, and it could even help develop strategies to lower the human impact on climate change.

The ethical development of AI discourse will affect our lives both socially and politically, and will influence things like data protection, individual and social rights, inequality, and democracy in general.

What will be the role of engineers in this AI future?

Engineers will have to play a key role. Artificial intelligence tools will be used in almost every aspect of life. Engineers will not only have a technical responsibility but also a moral one. Our role is to be able to interlace and create synergy with other areas of human knowledge to positively contribute to society.

The OpenWorm project attempted to simulate a biological organism in a different body through Whole Brain Emulation (WBE). WBE has been touted as a way of keeping humans alive after their bodies give up on them, but is also related to AI. How do you think WBE will develop in the future? What will be the consequences of this technology?

Much of the potential of WBE remains hypothetical. Technologically we are still quite far away from achieving such a thing, and right now it is still in the realm of science fiction and philosophical discussions. We still do not fully understand the brain, and we still have much to learn about the information processed in neuronal networks. Therefore, we can talk about WEB as something belonging to the far future. But to reach that point, we will have to first pass by a near-future of a better understanding of the brain. Basic research in neuroscience attempts to achieve such understanding, but funding depends mainly on politics, and it is not a pressing issue right now.

Nevertheless, if this technology can be achieved (some experts say that around the mid-21st century it will be possible), the consequences will be varied and difficult to predict. It might be possible, for instance, that we come close to achieving immortality, a development which could result in mass overpopulation and a severe lack of resources. This, of course, will highly depend on our lifestyles and levels of consumption at that time. Moreover, will a person uploaded to a computer or the cloud, able to live on forever, still be able to comment on real-world issues? Or will they live on in a sort of “simulated paradise”? These and other ethical questions have yet to be answered.

How does AI relate to the other issues of our age, such as climate change? Can AI help remedy environmental damage, or will it add to the problem?

The contributions of AI to other issues, such as helping mitigate climate change, will be extremely important. I strongly believe that AI tools will mainly benefit human development, and that they can play a positive role in solving several of today's issues. However, developing such tools should be done with extreme care for the environment and the social issues I have already mentioned. For example, the extraction of raw materials used in phones and computers has in several cases been linked to the exploitation and mistreatment of workers worldwide. It is not the direct fault of AI development, but still, it is partially linked to it.

How much of a concern is people programming their own prejudices into AI? What can be done to guard against this?

A strong focus on politics, social values, and ethics, combined with constant interrogation of social biases should form the basis of education in both schools and universities. Only with critical and social thinking, as well as ethical boards and committees that review the results of AI-related technologies, can we help to guard against programming biases.

In your opinion what has been the biggest AI breakthrough in last 5 years?

Even though the concepts of deep learning have been there since the '80s, I believe that the usage of deep learning to develop automats - which have bested humans in many different games (e.g. Go, Chess, DOTA and Starcraft) - opens up a realm of possibilities.

What advice would you give to future generations of engineers working in AI?

My main advice is that they should not only develop as amazing engineers or programmers but also as good citizens with a critical, political and social mind. Professionals of every discipline, including engineers, have to be interested in the problems of the everyday world. Do not leave aside the humanities and the social sciences. It is crucial that future professionals dealing with AI are not only technically remarkable but also people with discerning minds and ethical behaviour.

Does STEM Have a Problem with Women?

BY WILLIAM PEARSE

While in recent decades women's participation in the labour market has significantly increased, wide gender gaps still persist. Broadly speaking, women's working conditions tend to be worse, particularly remuneration; glass ceilings often block career progress, stifling motivation; and achievement goes less recognised, denting morale. Job opportunity, too, is restricted, some areas of work demarcated, implicitly, if not explicitly, as "men's only". Make no mistake: equality of the sexes is still some way off.

Despite many well-intentioned attempts to rectify this inequity and, it should be said, an overarching, albeit slow, move in the right direction, there remain some intransigent areas refusing to budge. Of the guilty parties, the STEM disciplines, especially, stand out as having much to answer for. As way of evidence: in 2018, in the U.S, just 24% of those employed in STEM were women, while in Germany, Europe's engineering hub, the proportion of women aged 30 to 34 with a STEM qualification fell from 6% in 2005 to only 2.6% in 2016.

"The 'girls can't do maths' nonsense is one of the oldest sexist tropes going and its consequence, when impressed upon the young, can be a malignant internalisation of imagined inadequacy."

Such disparity in any area would be troubling, but given the general trend towards digitalisation, and as a consequence, the greater need for technological skills, the issue is even more acute. STEM skills are no longer just requisites for STEM jobs, and because, statistically, far fewer women possess them than men, their career options are unfairly limited. Without change they will reduce further; significantly, at a time when the job market is becoming less and less forgiving.

Evidently, this must be dealt with, sooner, rather than later. But like any problem, to solve it requires an understanding of where it's originating from. With respect to STEM, this will help explain why, despite considerable effort, equality in the workforce has proved so elusive, and then, in turn, help inform a better strategy to finally overcome it.

Back to the start

Taking the US as a case study and the problems pertaining to STEM are seen arising early, manifesting in a stigma young girls attach to the study of maths. Research has shown that from around fifth grade, that is 10/11 years old, girls begin to underestimate their capabilities in the subject, while boys of the same age begin to overestimate theirs. According to researchers from New York University, the University of Illinois at Urbana-Champaign, and West Chester University, this can, in part, be attributed to teachers who as early as kindergarten start to perceive boys' maths ability as superior to girls", regardless of actual levels of achievement. The "girls can't do maths" nonsense is one of the oldest sexist tropes going and its consequence, when impressed upon the young, can be a malignant internalisation of imagined inadequacy. It is consolidated by the teacher bias, which although in many cases unconscious, can be read as a reflection of

a broader culture reluctant to fully let go of restrictive "traditional" gender roles.

The relative scarcity of female role models in STEM, so important for young people to pin ambitions onto, then compounds this issue. Whether at the top of industry or portrayed in film and television they are rare, and when they do appear in the media are normally depicted as subordinate to male characters, often creating more problems than they solve – think Julianne Moore in Jurassic Park: A Lost World. This is of great significance. As social cognitive theory contends: "repeated observation of symbolic models, such as those found in media environments, teaches cultural patterns of behaviours" and "through the process of "identificatory learning" viewers learn to imitate behaviours from media characters they observe". The conspicuous underrepresentation of women in STEM in popular culture, therefore, serves to strengthen the notion that it really is man's domain.
Within such a culture, it's hardly surprising that many opt out of STEM subjects at the first possible opportunity. In actual fact, at each developmental period, from adolescence, emerging adulthood, to professional life, the underrepresentation becomes disproportionately more severe – a pattern sufficiently alarming it's been given a name, researchers, Nilanjana Dasgupta and Jane G. Stout, calling it "the leaky pipeline".

Heading to Work

Within the world of work the pipeline maintains its potency, ensuring that gender disparity worsens with increasing seniority. Engineers, especially, have it bad; indeed, the retention of women in the field has always been a problem. Numerous studies have been undertaken to ascertain the reasons behind this. Perhaps the most comprehensive was published in *Frontiers of Psychology* in 2017, and involved a sample of 1464 women, all of whom had left the engineering field. The study used qualitative analyses to understand, categorise and code the 1,863 statements' participants gave. The reasons cited were then reduced to 3 main concerns:

First, poor and/or inequitable compensation, bad working conditions, inflexible and demanding work environment that made work-family balance difficult; second, unmet achievement needs that reflected a dissatisfaction with effective utilization of their math and science skills, and third, unmet needs with regard to recognition at work and adequate opportunities for advancement.

Of all reasons named, those relating to a work-life imbalance stood out in their frequency. Particularly those with young children mentioned the difficulty of reconciling a rigorous 40-plus-hour week with childcare. Because employers' maternity packages are often limited and part-time work in engineering is notoriously hard to come by, many women having children simply left the field. Unequal compensation was next on the list of reasons for leaving, numerous participants complaining that not only was there clear evidence of a glass ceiling preventing career development but also that male colleagues of the same skill level were on a higher salaries. This led to demotivation, despondency and then departure. Workplace culture was also reported as influencing exit. Perhaps typifying this reasoning was one woman who described her former employer as an "old boys club" that had "been run for so many years by white men... that these guys had no idea how to integrate women into their organisation."

"Whether at the top of industry or portrayed in film and television female role models in STEM are rare, and, when they do appear, are normally depicted as subordinate to male characters"

Lack of recognition played a key role too. It was reported that early on in training engineers are taught to recognise two disparate skill sets: hard skills, comprised of technical ability and problem solving; and soft skills, sometimes known as professional, that include teamwork, communication and relationship building. Crucially, it is also taught that the two sets are gendered: the hard viewed as masculine, sought-after and revered; and the soft viewed as feminine and commanding a lower status. Although not always, the study provides evidence that women, mentored by men, are often guided in the direction of positions that require softer skills, and thus carry less prestige. Many believed this reinforced the stereotype that female engineers are less technically capable, which, however retrograde, is still pervasive. Of the interviewees previously employed in these "softer" areas, some went as far as saying they never felt like "a real engineer", such was the lack of respect for what they did.

What can be done?

Given their reputation as problem solving disciplines it's curious that with this particular conundrum STEM has proven so inept. Construct a building almost a kilometre tall, it can do; welcome women into its classrooms and workforce and it's stumped. Clearly, some of its problems simply mirror society's. The gender stereotyping that damages children's ability to assess their own capabilities, for instance, can hardly be put at the door of an engineering institution – that is a problem in which we are all implicated.

“There needs to be greater exposure of women who have succeeded in STEM, their achievements must be told and their stories celebrated”

At the same time, there does seem to be something particular about STEM that exacerbates gender prejudice, prevents corrective steps being taken, and is, therefore, requiring of our immediate attention. An obvious first point is its lack of female role models. There needs to be greater exposure of women who have succeeded in STEM, their achievements must be told and their stories celebrated. (Here the Women’s Engineering Society is doing much admirable work, laying out a useful blueprint.) To the same end, female-mentoring programmes, in universities and workplaces, should also be implemented, providing – when necessary – support and advice to help navigate any particularly male-dominated environments.

In dealing with its broader culture, it’s imperative STEM institutions facilitate frank discussion of the implicit biases they currently perpetuate, address the pay gap they’ve allowed to persist, and re-evaluate their gendered division of key tasks. Although on their own not enough, these steps would set a good precedent – the beginnings of a roadmap. To fully achieve the transformative change needed, so belatedly, STEM will be forced to draw upon all its diagnostic, creative and pragmatic skills, for which it is so heralded. And it should start now; there is much to do.

“Does STEM Have a Problem With Women?”: An Interview with Elizabeth Donnelly

BY JAMES MATTHEW ALSTON AND WILLIAM PEARSE

CEO at the Women’s Engineering Society (WES), Elizabeth Donnelly, kindly took a moment out of her busy schedule to sit down with NewEngineer.com and discuss her life in STEM. The conversation ranged from her experience as a woman in the male-dominated environment of STEM, the change in culture she has witnessed in the field over her career, through to the admirable work WES is currently doing, and its plans for its centenary year.

At what age were you initially drawn to STEM? What in particular was it that interested you?

I was keen on computing when I was about 12 or 13. My dad bought a ZX81 and I started to learn programming on it. Being one of four who are all only a year apart, with three brothers, I had to fight to get any time with it, and often lost, so it was difficult. I liked that I could write logical steps to make something happen, and that it didn't rely on anything other than my brain. It was the early days of computing, so it took me another 15 years before I actually worked in IT, but I was hooked from then on. Later I was introduced to aerospace and went to work at Rolls-Royce, and I was fascinated that the simple principles behind aero engines resulted in very sophisticated engineering.

Do you think girls are sufficiently encouraged to study STEM?

I think there is a lot of encouragement out there in the form of initiatives, but girls have to fight a series of stereotypes and a lack of role models. These are tough barriers to overcome.

Why do you think fewer women study STEM?

For the same reasons – there are stereotypes that women are not supposed to go into these fields, yet over 70% of medical and veterinary students are female, so we need to change perceptions of engineering.

Men are statistically more likely to get jobs and enjoy promotion in engineering than women. Did you experience difficulty while trying to find work, and do you think that there are structural biases in place that restrict women's ability to climb the job ladder?

I fell into IT sort of by accident because I was interested in it as a hobby and then was encouraged at a small company to help install email and the internet. I remember when trying to find work being told "a little bit of knowledge is dangerous" and that I shouldn't bother because I didn't know what I was talking about. Over the years it became clear that men felt very threatened by a woman with "a little bit of knowledge" and these prejudices can prevent women getting on. Fortunately there are a lot more women in engineering these days, but they are still facing difficulties. This is why WES celebrates the Top 50 Women in Engineering every year – to show the quality and capabilities of female engineers.

Some bosses attempt to ensure gender equality by "treating everyone in an identical manner". Do you think this approach is beneficial?

The difficulty in treating everyone identically is that it assumes that women and men are identical. We are not and generally the treatment assumes a default male template. Bosses expect women to react and think the same as men and seem to be baffled when women behave differently. The world expects women to change, when it is the structures that need to change.

As a corollary, what initiatives do you believe could be implemented to help overturn some of engineering's gender biases, for example the gender pay gap? Is enough currently being done?

So much more can be done. Men routinely negotiate salaries and women accept what is on offer, because negotiating can be seen as aggressive. So be transparent about pay when advertising a role. If a company is happy to pay a rate for a job then pay it, don't try and save a couple of thousand pounds because a woman accepted what was on offer. Check your websites for images of women in technical roles. A woman is less likely to apply if she can't see herself. Use our gender ad decoder to check your job adverts for male language because women are less likely to apply for jobs that seem male. Stop asking for "essential criteria" – men will apply if they fulfill 60% of the criteria and women are unlikely to apply unless they fulfill 100%. Instead encourage applications by saying "if you fill at least three of the following, please apply".

The lack of visibility of successful women in engineering is a serious issue. How does WES attempt tackle this?

We have a lot of initiatives – we have pages of female role models on our website. We celebrate 50 women in engineering every year with awards based on a different theme. We created International Women in Engineering Day (INWED), which we celebrate annually on our birthday on 23 June, and aims to inspiremillions of women across the world. We award the Karen Burt Memorial Award to the best newly-chartered woman engineer in the UK. We hold conferences for students and apprentices, and we advise companies on how to increase the number of women in their organisations.

What would you consider to be WES' crowning achievement to date?

Creating INWED and getting support from UNESCO. We decided to create a National Women in Engineering Day for our 95th birthday and it has now become a global phenomenon, to the extent that I get asked if I've heard about it!

Having worked in the industry for a number of years how much positive change in the area of gender equality have you seen? What has been the pace of this change?

Every year the age of the women I meet who have yet to experience sexism in the workplace gets older. When I started out everyone assumed women would meet sexism. Five years ago women in their late 20s would say they hadn't experienced any problems. Now it's women in their early 30s, so it is getting better. It's at the point where women take time away from work for caring responsibilities that it starts to creep in and expectations of women are lowered. And sometimes it's at the point where a group of engineers who all joined a company together and progressed together suddenly discover there are only a few jobs at the next stage. At that point the men often do better than women because they are more competitive and will fight for the promotions. I'm also at the age where my generation are now getting the top jobs. We were the first women to enter engineering or technology consistently every year rather than just the occasional one or two every so often. So we are now becoming the leaders, and just becoming visible. And there aren't as many of us as started out. However, I expect that to change significantly in the next 20 years and we will see many more women in senior positions.

What has WES got planned for its centenary year?

During the first half of the year we held our Centenary Conference in London, our Wales Centenary Conference, and a Change Makers event to celebrate all the women who have led WES over the years. We celebrated INWED and the WE50 in June, as well as with our second ever Apprentices Conference. We will also host Dr Anne Stevens from Anglo-American in October when she gives the Caroline Haslett Lecture at our Awards event at the ImechE in London. Our Student Conference will be held at Warwick University in November. And throughout the year we are holding our Centenary Trail which celebrates the women in engineering who made history over the last hundred years. This includes a number of Wikithons to increase the number of women engineers on Wikipedia.

Recommended Engineering Study Opportunities

PETER THE GREAT ST. PETERSBURG POLYTECHNIC UNIVERSITY - INTERNATIONAL POLYTECHNIC SUMMER SCHOOL AT SPBPU

More info: https://newengineer.com/post/1385256
St. Petersburg Polytechnic University runs high-quality academic credit-bearing summer school courses in English for international students. The International Polytechnic Summer School offers invaluable insights into up-to-date and real-life issues in different fields of studies: space technology, natural sciences and engineering, digital technology, IT, civil engineering, energy technology, food science, business and management, humanities and Russian language and culture. The summer school is enriched by a cultural program and networking events, and gives you the chance to explore the great city of St. Petersburg while attaining academic credits.

ROCHESTER INSTITUTE OF TECHNOLOGY - MASTER'S OF ENGINEERING IN MICROELECTRONICS MANUFACTURING ENGINEERING

More info: https://newengineer.com/post/1358322
The microelectronics manufacturing engineering masters covers the intensive aspects of integrated circuit technology, modeling and simulation techniques, and hands-on laboratory verification of these processes. In the laboratory, students from various engineering and science backgrounds design and fabricate semiconductor circuits, learn how to utilize imaging equipment, develop and create systems, and manufacture and test their own integrated circuits in our cleanroom. Microelectronics manufacturing at RIT utilizes many different disciplines such as chemistry, physics, and engineering to provide a degree that makes our students very sought after in the job market.

FLINDERS UNIVERSITY - MASTER OF ENGINEERING SCIENCE (CIVIL)

More info: https://newengineer.com/post/1374977

The Master of Engineering Science (Civil) provides a broad range of skills to investigate, plan, design and maintain complex civil engineering solutions. Throughout the course, there is a strong emphasis on practical skills and teamwork. Civil engineers develop and maintain a wide variety of physical infrastructure such as bridges, buildings, airports, roads, railways, ports, mine sites, water and wastewater supply, treatment and reuse systems. They also help to maintain sustainable natural environments. Civil engineering graduates are in great demand with career destinations including building and construction, transport and mining industries. Further, the excellent links that Flinders engineering staff have with industry partners on research and development projects mean that there are many work placement opportunities available.

UNIVERSITY OF ILLINOIS AT CHICAGO - MASTER'S OF ENERGY ENGINEERING

More info: https://newengineer.com/post/1377470

Become an energy professional with the ability to work in many aspects of the energy industry with a Master of Energy Engineering degree. The demand for energy engineers continues to grow. The energy industry, from creating energy efficient buildings to storage to power production, is covered in the master's program. Whether students are concerned with HVAC design, energy efficiency, management of engineering projects as well as power from production to storage to delivery, upon graduation they will have knowledge that can be immediately applied on the job. Students will expand their career opportunities when they increase their energy engineering knowledge with a Master of Energy Engineering degree.

UNIVERSITY OF MICHIGAN - MASTER'S OF SCIENCE IN ROBOTICS

More info: https://newengineer.com/post/1374621

The University of Michigan is producing tomorrow's robotics leaders with their new MSc in Robotics program, already ranked #2 in the United States. Students design, create, analyze, and use embodied computational systems that interact with the physical and human environment. They study robotics and its place in the world, drawing on many fields of engineering, including computer science, mechanical engineering, artificial intelligence, computer vision, electrical engineering, control systems, human-robot/computer interaction, and biomedical engineering. In this program students learn from these fields and apply that knowledge to build robots and related systems.

RWTH AACHEN - ENGINEERING SUMMER SCHOOLS

More info: https://newengineer.com/post/1327428

RWTH International Academy Summer Schools offer a truly dynamic and engaging academic and cultural environment for their international visitors. Through its academic summer course offers in the charming historic city of Aachen, the top-ranked RWTH Aachen invites students to take part in state-of-the-art and hands-on approaches to technical learning at one of Europe's leading science and research institutions. With topics ranging from Structural Engineering to Robotics, the RWTH Aachen summer courses provide a fantastic opportunity to experience what studying at RWTH Aachen is really like.

UNIVERSITY OF BOLOGNA - MASTER'S COURSE IN ARTIFICIAL INTELLIGENCE

More info:

https://corsi.unibo.it/2cycle/artificial-intelligence

The two-year master in artificial intelligence provides solid competence and expertise in the founding areas and innovative applications of artificial intelligence. The programme adopts a broad-spectrum, interdisciplinary approach, addressing a variety of topics in artificial intelligence, such as machine learning, automated reasoning, artificial vision, natural language processing, data science, optimization, and decision support systems, while also offering perspectives in cognitive neurosciences and in ethical and social issues. Students will acquire soft skills which allow them to interact professionally with industrial stakeholders and researchers.

THE UNIVERSITY OF BRITISH COLUMBIA - MASTER OF ENGINEERING LEADERSHIP (MEL)

More info: https://newengineer.com/post/1356649

The UBC Master of Engineering Leadership professional Master's degree combines business courses with specialized engineering courses. This program is a hybrid graduate degree that expands your technical knowledge and business skills in just 12 months. With seven program specializations available, including Advanced Materials Manufacturing, Clean Energy Engineering, Dependable Software Systems, High Performance Buildings, Integrated Water Management, Naval Architecture and Marine Engineering and Urban Systems there's an innovative program for you. Whether you are an emerging leader, a seasoned executive or considering a shift to a new industry, these professional programs give you the skills you need to advance your career and confidently move into positions of leadership and increased responsibility.

UNIVERSITY OF SOUTHERN QUEENSLAND - MASTER OF ENGINEERING SCIENCE

More info: https://newengineer.com/post/1380463

If you want to become a professional engineer, and have a three-year engineering degree but no work experience, the Master of Engineering Science from the University of Southern Queensland will get you there. In this degree, you will gain hands-on practical lab and industry experience to prepare you for working in the engineering profession and can expect to apply your newfound knowledge to a real-world problem in your research project - a great stepping-stone to further research degrees, including your PhD. The specialisation study option provides students with knowledge and skills in a specific discipline, including Agricultural Engineering, Civil Engineering, Electrical and Electronic Engineering, Environmental Engineering, Mechanical Engineering, Power Engineering, Structural Engineering, and Engineering Management and Enterprise.

BIOGRAPHIES FROM EDITORS

James Matthew Alston is Content Marketing Manager at NewEngineer.com. After working in the SEO business for several companies in London, he moved to Berlin to continue his studies and build on his knowledge of the industry. Now leading NewEngineer.com's highly successful SEO strategy, he simultaneously works with the development and editorial sides of the company to ensure the website continues to excel as one of the leading engineering websites of the moment. Alston also regularly puts pen to paper himself, writing for NewEngineer.com's successful blog with a focus on how engineering can help to solve the current climate systems breakdown.

William Pearse is New Engineer's Senior Editor. With degrees from both England and Germany, he has brought his vast academic experience and keen analytical eye to the discipline of engineering, overseeing the curation of New Engineer's thriving blog. In between directing his team of freelancers and coordinating the website, he's also been known to set down his own thoughts, typically writing on his favoured topics of climate systems breakdown and the future of AI. Forever the optimist, Pearse is looking forward to engineers coming to the fore and leading the world, one innovation at a time, out of its current mess.

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