Wendy - You know, it's not, can we increase the target of instead of 15%, could we make it 30? I'm saying, no, let's talk about 50%. And let's think of that in everything we do, because we are 50% of the world. So we should have that sort of influence in the computing industry as well.

Kat - This is the Suffrage Science podcast: How women are changing science, brought to you by the MRC London Institute of Medical Sciences. I’m Kat Arney and over the coming series we’ll be exploring the journeys of women in science - reflecting on progress we’ve made and the challenges still to be addressed - through conversations with an incredible group of women scientific leaders, who have all received one of the Suffrage Science awards over the past ten years.

We’ll be hearing from inspirational figures from the world of science like former Chief Medical Officer Sally Davies, space scientist Maggie Aderin-Pocock and engineering champion Hayaatun Sillem, so make sure you’ve subscribed to the Suffrage Science Podcast through Apple podcasts, Spotify or wherever you get your podcasts so you don’t miss a single episode.

This time I sat down for a chat with Dame Wendy Hall, Professor of Computer Science at the University of Southampton and one of the most influential women in computing.

Wendy was one of the first cohort of Suffrage Science awardees in maths and computing, receiving her award in 2016 - a silver bracelet inscribed with a mathematical equation. Two years later she handed it on to Ursula Martin, Professor of Computing Science at Oxford University.

In 1984, Wendy joined the brand new Computer Science Group at Southampton, where she and her team invented an online media system known as Microcosm, which predates the World Wide Web. Ten years later she became the University’s first female Professor of Engineering, and went on to work with Sir Tim Berners-Lee, the inventor of the world wide web, to found the discipline of Web Science - studying the technological and societal implications of the internet.

Today she’s Regius Professor of Computer Science and Executive Director of the Web Science Institute at the University of Southampton. She co-chaired the UK Government’s AI Review in 2017, was the first UK AI Skills Champion and is the chair of the Ada Lovelace Institute. She’s held many seats on prestigious national and international bodies and various leadership roles including stints as president of the Association of Computing Machinery and the Chartered Institute for IT, and Senior Vice President of the Royal Academy of Engineering. She became a Dame Commander of the British Empire in the 2009 UK New Year's Honours list, and is a fellow of the Royal Society. Not bad for someone who was the first in her family to go to university!

Back in 1987, Wendy and her colleague Gill Lovegrove wrote a paper entitled “Where have all the girls gone?” about the dearth of women in computer science during the 1980s, which is widely credited with kickstarting the modern movement for promoting women in computing. So, where had they gone, and have they come back?

Wendy - I went back to Southampton as a computer science lecturer and my colleague Gill Lovegrove and I, she was another lecturer, more senior to me. I think we were the only two women in the department - very small department then - but we had launched a computer science degree. And up until that point, the students on the courses, there was a healthy representation of women: about maybe 25%, 30% - similar to maths. This is in 1984 I went back to Southampton. It was around that time, mid eighties, and Gill and I, we, were looking at the registration lists for the new term at the end of September. And we realised that there wasn't one woman's name on any of the lists. So we had three years of computer science students - first, second, third year - there were no women at all on the list. So we started asking around other computing departments in the UK to see if it was just us or if others were experiencing the same phenomenon and others were experiencing the same phenomenon. The women had gone. They had disappeared. That actually led to the formation of something called 'Women in Computing'. And it was the first sort of women's network in computing that I belonged to. We then wrote the paper in 1987, Gill and I, and we did an analysis of admissions and we basically showed that the number of women applying to, and then coming into universities to read computer science fell in both, both in absolute terms and relative terms. We just showed the figures then, but retrospectively you could see what was happening. It was the time of, the personal computers were coming out. Very few people had them in their homes. They were sold as, and bought as, toys for the boys, because there was very little you could do with them other than play the simple war games that were around then or program in basic or assembly language for those who wanted to dive under the bonnet and be self-taught. And it wasn't the only thing that was going on, but basically that was the beginning of the culture that said computing is very geeky for those that like to do this type of thing and it's not something that girls are interested in. And that - in the West - we have never shaken that off, that change in culture that says computing isn't for girls. And so your question was, "have they come back?", well, not much is the answer, unfortunately, despite all the efforts in the meantime. So this was over 30 years ago now. Despite all the efforts, there are more women studying engineering than there were back then now, relatively and in percentage terms. The number of women in the sciences has caught up somewhat, but in computing it stayed horribly flat at around 12 to 15% of computer science classes - just doing it on that metric - are female. You get more women doing computing and business or computing and something, but yeah, we have not changed the dial back again. But the thing is that as I travel around the world, I see in other cultures, lots of women doing computer science... You go to India, generally you go into a class of computer science students; it will be more than 50% women in India. And there are other countries in the world, in Southeast Asia as well, where this is also true. And more in Southern Europe, too - you get more women in Italy, say, than you do in the UK and Germany. It's about the same in America, there are some amazing universities where women in particular have shown leadership and really increased the number of women on the computer science courses, but they are the exception rather than the rule.

Kat - I do find it really fascinating to think that perhaps it's the decisions that were made in the Spectrum marketing department, that these are like boys' games, have had such an unintended consequence because you know, you look back very famously. We have things like the film, 'Hidden Figures' and knowing that women were actually The Computers, literally they were called The Computers and you have this long tradition of women in computer science. And then suddenly, because I remember I had my first computer in the eighties - I had a BBC because I was a nerd. All my male friends were like, "no, it's for boys. These are these video games for boys. These aren't for girls. "

Wendy - Well, first of all, Kat, you don't look old enough. But secondly, there are several things in that. So yes, it's amazing. And I think it clearly wasn't just the person computers, but there were unintended consequences of government policy too. The story here was at the time what we call the Business Department - you know, BEIS today, was called the Department of Trade and Industry. And there were some people there that really felt we should be getting computers into the schools, right? Because we wanted to be a modern technology-led country. And with the very best of intentions, they set up a program to put computers in schools, started in secondary and then even put computers in primary schools. But they, in the secondary schools in particular, they put one computer in the school. Now I was taught, I learned a bit at the feet of Seymour Papert and he used to talk about; "what difference would it make if you put one pencil in a classroom one day a week to students' abilities to write?" One computer to a school, you could maybe get every class getting access to once a week maybe. And what would you do on it? And the other thing they did at the same time was they created National programs for developing the use of computers in schools. They centralised those and so they took out of schools, the teachers that had the most creative ideas about what to do with computers, leaving the teachers in the schools, not knowing what to do with them because there were not enough -there were the teacher training programs then but these things take a while to develop. So the people who led the use of the computers in schools were the boys that had learned on the home computers. And they, they really ran the out of hours games

Kat - A computer club and stuff. Yeah, it seems just so boyish.

Wendy - It all set that culture. The completely unintended consequences of that action, which was, as I say, with the best of intentions. So I think everybody, I'd really recommend everybody reads the book Programmed Inequality by Mar Hicks. This is an amazing story she tells - all true. Well, let's say it's a true story and she tells it in a way that has an explanation for why the UK lost its computing industry. And the basic story is that, as you said earlier, like in Hidden Figures during the war and post-war there were lots of women that got involved in this sort of area. They were The Computers initially. And then as the computer machines came along, there were lots of women involved in, I mean, I hate to say it, but doing a lot of the input, but also being involved in the programming and in the management of these departments. I mean, there were lots of women in management of IT departments back in those days. I remember them, they're still around today. But what happened was that we had a strong computing industry that became ICL. There was a program of lacking confidence in the women that were doing this and removing them from their jobs, literally, and replacing them by men who were not as skilled as they were at doing those jobs. And the book takes you through this journey. And at the end of the journey, the UK loses its computing industry. And the book says you put two and two together and think about why that happened. So we've got a double consequence here of the fact that the culture has changed so that women are perceived as you don't do this type of work. It's not the sort of work you'd be interested in. And there's all the anecdotal stories that we know about, you give the same CV with a male or female name on, and they recommend the male goes into the computing industry and the female doesn't, right? And then you see also that the unintended consequences of this policy and the way that the marketing was done, again: unintentional, has left us with this no computing industry and, this complete inequality in terms of the sorts of people that work and do study computer science and work in the computing industry in terms of developing code and being software engineers and so on.

Kat - It feels like it's given us such this kind of hangover of sexism because every so often there'll be another row about like, well, women just aren't as good at this stuff as men. And every time I see that story, I think back to this fact that like, no, there's no intrinsic biological reason at all.

Wendy - It's not in our DNA, right? The women in India will tell you. Mind you, I will tell you another story, which is absolutely true. I went into, when we were traveling, I went into one Indian classroom and one of the female students was the head of the ACM chapter in the University, she was so proud. And she was organising everything, they were in the second year, I think of their degree. And I said to her, "what made you want to study computing? What excited you about it?" She started off talking about the excitement and then she added, "my parents thought I'd find a better class of husband if I studied computing." So there's always something. I'll tell you another one, I laugh because it's all so true. I went to Qatar and visited the University of Qatar, Engineering and they teach men and women separately, but they also have joint classes, some women are not allowed to attend them and some are. But anyway, I went into a joint class on the bit of the campus that men and women can mix. And it was 90% women, computer science class, 90% women! And the men were hanging back just like the women do here. And so I asked again, you know, "what is it? Why do so many women do computing?" And they said, two things, one: because women see it as a career, they can continue after they've had their families and could maybe even work from home to do. But secondly, the men are all off being educated in America.

Kat - Oh great.

Wendy - So they were going to the top universities in America to study their computing and then come back. The women had to stay at home. So there's always an issue, but it isn't part of our DNA. It is not. It is not biological.

Kat - We’ll come back to Wendy in a minute, but now it’s time to hear a few words of advice from another Suffrage Science maths and computing awardee, Hannah Dee.

Hannah - I guess if you want to do something, go ahead and do it. It doesn't matter if it's a thing that's seen as a thing for boys, or seen as a thing for girls. If it's something that interests you, just go ahead and do it.

Kat - Let’s return to our conversation with Wendy Hall, to find out more about her career in computer science, and the future of the field.

Wendy - I'm obviously a well-known computer scientist and put up there as a role model. I never really enjoyed coding ever. I've done it, obviously. I learnt it and I taught it, but it wasn't something I wanted to spend my weekends doing. I've always enjoyed - although my first degree and my PhD were pure mathematics, which are all about the brain, right? Pure mathematics is about puzzles. All you need to do pure mathematics is a brain and a pencil.

Kat - And some coffee!

Wendy - Maybe some coffee, yes. And I loved that. I loved the abstractness of it. And I think this is important for me going forwards because as I moved into computing, I got interested in computing through the, what we call now multimedia, through the idea of being able to put pictures and videos and sound onto computers, because I saw that this would really help people learn things, right? It's all about information for me. I did a lot of artificial intelligence work as well in the early days using prologue to do a computer-based education system. I then moved into a world where what I was thinking about was how machines and people interacted. So I got quite quickly into that world. I think again, because I think abstractly, I don't tend to worry about how are we going to do something. I just think about what is going to be possible in the future so let's aim for that future. And I've always been lucky, or I've made my own luck and built a team around me who could do the coding. Right. So I'd think about what I wanted to build and they do it. Okay. You don't have to be someone who spends all your days coding to be a famous computer scientist. You can be, there's many of my colleagues, women as well, who are there because that's what they enjoy doing. But for me, it was about how machines could help people. That's what's always interested me and been my passion.

Kat - I feel like a similar analogy in the life sciences where I come from would be like, if you're a biologist, you're just pipetting. That's what you do. You just pipette. You just move liquids and that's what biologists do. And forget the whole swathe of the life sciences in all kinds of ways.

Wendy - As we became the multi-media research group of Southampton, people assumed that what I was doing was making CDs. Right. And then when I moved into the world of the Web, people assumed that what we did was websites. And then I foolishly moved with Tim and Knight and others, we developed the idea of web science. The study as the web from a socio-technical point of view. And when I talk about that in interviews, they often pick it up as the study of websites because "web science" and "websites" often sound like the same thing. So clearly what I do is make CDs and design websites.

Kat - I mean, that's a pretty good job nowadays, apart from the CDs. But yeah, I did want to talk to you a bit about that because you know, these very early days of the web and what was the sort of the vibe around that time? What were you thinking about the challenges that you were facing and where this might be heading? Because obviously now we have like the hypermedia internet with videos everywhere and you and I talking across a web link, but what was going on right at the beginning?

Wendy - The vision was there. I learned at the feet of Ted Nelson who coined the terms hypertext, hypermedia in the sixties and seventies and Doug Engelbart who invented the mouse and Windows. They had this idea of, you know, putting multimedia onto computers and having links between the information - that was Ted's idea, the hyperlinking. And Doug said, right, we're going to point at this with a mouse and you'll go to another window. And that window might draw information from another computer on this thing called the Internet. So we designed a system called Microcosm at Southampton, which was the most fabulous hypermedia system. It linked to videos and sound and text, and it did inference on the links because the links were kept separate. So it was a wonderful design, it was very pioneering, that's why, I guess I got called a pioneer in that area. Because what we were building was science fiction. It was taking all these ideas, the internet, and the idea that, you know, we have digital things, videos and so on and putting it all together. And it was a beautiful system, but what we weren't doing, the standards weren't open, it, didn't run on the internet per se. And of course that's where Tim and the World Wide Web, that's what he absolutely got, right. That vision that you could use the internet to, you know, have the standards that would download files and you could embed links in them to download more files. During the 1990s, we had the .com boom and bust, and several things started to coalesce around the web. And we were using the web. But, you know, I wrote a research proposal. I was looking back at this the other day in 1996 with my five-year research plan that didn't actually mention the World Wide Web. And I can't imagine that now.

Kat - It's really amazing to think though, that, you know, 25 years ago, you're trying to put video files on a server in Southampton, and here we are Netflix and Zooming to each other

Wendy - In terms of Covid, I think of all the awful harrowing traumatic things that have happened, one of the amazing things is how resilient the internet has been. We all, this time last year, jumped on the Internet to do everything right? The demands on it were amazing, and it has stayed up and stayed totally resilient. We argue about who's controlling it, of course, who owns it and all that. But, you know, we just, here we are, Zoom, TikTok, all these things. They save lives and save people's sanity and enabled businesses to keep functioning and us to still do our work. And it's been quite, quite amazing. I've just been, you know, writing a book about the internet - well, I've written - it's due out soon, it's called Four Internets, my colleague: Kieron O’Hara, about how the internet is under more pressure now than it's ever been from geopolitical forces. The technology is proven and the technical standards have so far held, but if they break, well all bets are off. And nobody owns this space, so nobody controls it. But who would you want to control it? If anybody did control it. It is of us, right? It's ours as much as anything. And so I think it's beholden on all of us to try and help keep it being a force for good in our world.

Kat - It's like, the landing on the moon, it's for all humankind. It's here, we've got here.

Wendy - I've been talking about this lately. That's where the next, I don't want to say wars, but the next battles for domination are going to occur, right? The race to Mars is - possibly in my lifetime we'll see people on Mars. We'll certainly see more people on the moon, and we're certainly going to see the internet going up to the satellites and a whole new power struggle there. And Vint Cerf gives - The Invention of the internet with Bob Kahn - gives a wonderful talk about the interplanetary Internet, because, you know, if you go to Mars, you're going to want to take an internet with you!

Kat - You're going to want Netflix, Netflix on Mars. It's going to be a long journey.

Wendy - So yeah, it's all quite technically feasible and fun to talk about. There's a lot of little latency issues to worry about, but the geopolitics of it is really quite fascinating.

Kat - It's going to be a fascinating future. I mean, when you look back over your career, which is obviously still going, but when you look back on your career, could you ever imagine that we would have got to where we are and - here we are talking about how do you bring the internet to Mars!

Wendy - Um, no, I don't think - it moves so fast. You know, I often think, I love looking back at history, it's what's happened. I'm particularly at the moment concerned about the developments in AI, without thinking through the unintended consequences of what we're doing, really carefully. I don't mean stopping doing what we're doing, but just making sure there is a framework in which that discussion happens. And I think all scientists are morally obliged to think about the consequences of what they're doing, but you don't... The passion is the challenge, the immediate challenge, like I always think about the Wright brothers and when the plane took off right, the first time, imagine how that felt. They weren't worrying about the pollution that a jumbo jet was going to cause in the 21st century, they were worried about getting that plane off the ground. If Tim had worried about the unintended consequences of the World Wide Web we wouldn't have had one, right? But on the other hand, you can't walk away from that responsibility. And I think with AI, we've really got to - we talked about the unintended consequences of putting computers in schools in a way that didn't help with diversity, and you know, with AI the consequences could be far worse.

Kat - One of the other people we've spoken to for this podcast is the activist Helen Pankhurst. And she's just so passionate about the fact that we have to have more diverse people in science and computing and maths and engineering, because otherwise in her work, she says, you know, the world is only half built. If you only have half the world deciding what the world is going to be like.

Wendy - That's what I say about computing in computer science, we have so few women and such a lack of diversity. And I always say, you know, we really, really - the whole world uses this stuff, right? So we need representation or we need the whole world involved in building it. And as we think about going into AI, it's bad enough in computer systems. You know, the mobile phones were designed for men's hands, right? This is part of the problem why we can't use them as easily. A woman cannot use a mobile phone with one hand generally because their hands are smaller. So it's bad enough in terms of those physical artefacts and the way computer systems have been built. And we just sort of work around it. But with AI, when it's making decisions about you, if those decisions are biased in ways that are against you, then we really need diversity of approach in terms of making sure that that isn't the case.

Kat - So what can we do to encourage a more diverse pipeline? Because we've had this problem where, you know, 30 years ago, the number of women going into computing collapsed, we're starting to bring it back, getting more people from ethnic minorities, more different people. What more can we do to encourage more diversity in computing; what's going to help?

Wendy - I wish I knew the answer to that because if I did, I'd be very rich or something,

Kat- You'd get even more awards!

Wendy - People, you know, we've struggled. We wrote that paper 'Where have all the Girls Gone' in 1987 and they've still gone. Culture change is really hard, there are no quick fixes because you have to affect children at all ages. People say you have to start in primary school, well, okay- you can wait for another 20, 30 years before you make any changes. But even then, if you do go into primary schools - of course some people do, to encourage an equality of approach to computing - when the hormones kick in at 12, 13, 14, things change again and peer pressure. And the fact that you want to become attractive to whatever sex you want to become attractive to, becomes the, you know, the driving force.

Wendy - And the influences of your parents and let along teachers on your career choices are so enormous. I had a friend of mine who's a parent of a 12 or 13 year old daughter. Her daughter likes computing; wanted to study computing. She was the only girl in the computer class at her school - It's a mixed school, good school, mixed school. And for the options for the GCSE years, computing had been put in the same option class as drama and the creative arts. So a lot of the girls were just choosing not to do computing. Her daughter and the computer science teacher wanted to do computing, but nobody else did. And the argument is, well, the universities don't rank computer science. So you have this sort of vicious circle. And of course we haven't in the past asked for computer science because there was so little of it taught in schools.

Wendy - But now we're trying to change that. We've had the, you know, the unintended consequences of Michael Gove's policy when he said, right, we're going to change the I.T. Curriculum. It's not going to be I.T. - it's going to be computer science. You can learn programming. But what we didn't do was build the teacher training programs around that. Now retrospectively they're doing that, but we had two or three years where they removed it and replaced it with very badly taught, or hardly taught at all, computer science classes because there weren’t the teachers trained to do it. I mean, that's sweeping generalisations, but you can see the numbers, the numbers of people taking computing in schools has dropped since that change of policy and particularly the number of girls doing it has dropped. So we've got to reverse that again. So that was an unintended consequence of that decision.

Wendy - And that's in recent times, so we've gone backwards. They've put the money in to do the teacher training. We've got the Institute for coding that needs support. They've done remarkable work, but it's like you're constantly having to claw back. So with the AI program of really trying to talk about diversity as you know, it's not, can we increase the target of, instead of 15 % girls say, take the metric of girls in studying computer science at universities instead of 15%, could we make it 30? How about saying: no, let's talk about 50%. Let's just talk 50%. And let's think that in everything we do, because we are 50% of the world. So we should have that sort of influence.

Kat - Thanks very much to Wendy Hall.

Next time I’ll be speaking with neuroscientist Mona Xu, about her work on the neuroscience of love, about a recent flawed study on female mentoring, and how to break down barriers for women and minorities in science.

Mona - A lot of it is figuring out where the barrier's actually are and what policies can change at the system level. Because I think we have a lot already emphasising maybe a little too much at the individual level. So we think, okay, if you do these things, you can overcome these challenges, but that's not a good long-term strategy.

And before we go, here’s a final word from Suffrage Science maths and computing awardee Carron Shankland, about her hopes for the future.

Carron - In the future, I would like to see computing be more diverse than it is today, because I think this is going to make computing a better subject for the whole of society. You know, so our professional body, the BCS says "making it good for society". We can't do that. If we've only got a limited range of people making those computing systems. So I think that would be really good.

The Suffrage Science Podcast: How Women Are Changing Science is presented by me, Kat Arney, with audio production by Georgia Mills. It is produced by First Create The Media for the MRC London Institute of Medical Sciences Suffrage Science scheme. Find out more and read profiles of previous awardees at [suffragescience.org](https://www.suffragescience.org/) and follow @MRC\_LMS on Twitter and the hashtag #SuffrageScience for all the latest news. Until next time, goodbye.