

unlocking potential –

perspectives on women in
science, engineering and
technology

Edited by Meg Munn MP



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John Smith believed that social justice and economic efficiency were two sides of the same coin. This phrase, which guides the work of the Smith Institute, is particularly apposite to the issue of women in science, engineering and technology (SET). Despite rapid progress in other areas of the labour market, women are still under-represented in SET jobs. The authors of this collection of essays highlight not just the inequalities of this situation but also the cost to the UK economy. We hope that this publication, which offers some practical suggestions on how government and the professions can help create a more balanced and skilled SET workforce, will raise awareness of the issue.

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Paul Hackett, Director of the Smith Institute

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Introduction

Meg Munn MP

Living in the UK in the 21st century, it is difficult to comprehend the scale of sexist remarks and outright bullying that some women experience at work, or how they can feel so isolated that they leave the profession for which they have studied and trained. It is in the fields of science, engineering and technology (SET) that some businesses and university departments perpetuate a culture which leads to around 70% of women with relevant qualifications leaving, not to return. The result, for companies and academic institutions, is a huge waste of skilled workers, and the UK economy has a serious problem because badly needed skills and talent lie unused.

The more we dig into the statistics, the more worrying it gets. In 2008, there were 620,000 female science, technology, engineering and mathematics (STEM) graduates of working age in the UK but only 185,000 were employed in SET occupations. In 2010 nearly 100,000 female STEM graduates were either unemployed or economically inactive.¹

This outflow of skilled women, coupled with the derisory number of girls and young women choosing to study these subjects, means we waste a huge amount of talent. Who can know the innovations that remain undiscovered, the improvements in manufacturing that could produce better for less? This situation threatens the country's chance of keeping pace with the rapidly growing leading-edge economies of the world.

The UK economy loses billions of pounds when qualified women scientists, technologists and engineers leave for work in other fields, or are unemployed or economically inactive. It is precisely in the areas of science, engineering and technology that we need to develop and grow if the UK wants to remain one of the top economies in the world.

EEF, the manufacturers' organisation, points out the importance of manufacturing to the economy, stating that since the end of the recession, growth in manufacturing has been three times that of the rest of the economy. Its global value chains survey has identified that production is part of innovation, and that if the UK loses the ability to make things then we will lose the push to innovate.

In 2004 the then Department for Trade & Industry, in partnership with Intellect – the trade association for the UK IT industry – published a research report on how to retain women in

¹ UK Resource Centre for Women in SET *Women & Men in Science, Engineering & Technology: The UK Statistics Guide 2010*

the IT industry.² It found that women in their mid 40s were leaving the sector, at arguably one of the most productive points in their career. The main reasons given were poor work-life balance and an industry culture that did not value the skills of coaching and team working which are strengths of many women. It is unlikely that much has changed since then.

Looking to our near neighbours and economic competitors, a recent report by McKinsey & Company on the impact of the internet on the French economy³ notes that the internet was responsible for a quarter of the growth in the French economy between 2004 and 2009. McKinsey estimated that in 2015 the significance of the internet in French GDP could rise from 3.2% to 5.5%. As part of this growth, around 450,000 jobs would be created, all requiring technological skill and aptitude.

Every science and engineering institution knows about the problem, and many words in many reports have analysed it. A number of initiatives have been developed, and good practice exists, in pockets. Yet despite these efforts the figures change little, and in the area of technology the situation has gone from bad to worse. Female participation in the UK's technology workforce plummeted from 27% in 1997 to 21% in 2004.⁴ In terms of improving diversity, at best science and engineering are treading water, and technology is going backwards.

There are many issues at the root of this problem, many of them deep-seated and part of ingrained cultures. Some affect boys too, with science, engineering and technology failing to attract sufficient interest across both genders. This monograph brings together analysis of the issues from the classroom to the workplace, and gives voice to young women who are working in SET, so that we can learn from their experiences.

Problems identified

A number of themes emerge from across the contributions:

Firstly, it is clear that those working in science, engineering and technology have to get much better at portraying what they do, and show the passion and excitement felt by the contributors to this work. It is not just about better careers guidance and more contact between schools and the world of work; it's the need to show society just what engineers, scientists and technologists achieve.

² Department for Trade & Industry and Intellect *How to Retain Women in the IT Industry* (2004)

³ McKinsey & Company *The Impact of the Internet on the French Economy: How the Internet is Transforming our Country* (2011)

⁴ Office for National Statistics *Labour Force Survey*

Harnessing men and women who work in SET as role models is one way to do it, as is building on the approach that promotes successful young people as ambassadors. Ensuring that schools, from the earliest years, show children both women and men undertaking a wide variety of jobs is crucial if young girls are not to grow up thinking the world of science and technology is not meant for them.

Secondly, careers for girls in science, engineering and technology must be shown as interesting, challenging and rewarding. The women writing here describe how the idea of obtaining a challenging job inspired them to explore the possibility of a career in these sectors – job satisfaction is more often gained in careers that are demanding and challenging.

Increasing the number of women working in SET professions has to be seen as a central issue in policy terms, not just an add-on. The Labour government set up the UK Resource Centre for Women in Science, Engineering & Technology (UKRC) to provide advice, services and policy consultation. It works with employers, professional bodies, education institutions and a wide range of other organisations to promote gender equality. But unfortunately it remained funded from the Science and Society Budget, suggesting that its work was not central to the UK's science needs. The decision by the incoming government to cut the funding, while at the same time stating its determination to protect the science budget, showed a clear failure to understand the importance of investing in women and science.

More than one contributor was clear that some of the problems faced by women in SET careers are no different from those faced by women and men working elsewhere who have caring responsibilities. By working part-time, people do not lose touch with the changes and developments in their profession – often a key issue in areas where the pace of change is significant. Adopting flexible working has proved to be successful for many companies in both recruiting and retaining skilled employees.

For those that do take a career break, it should be possible to do so and not be forced to leave the profession. A poll by the Institute of Physics showed that seven out of 10 female physicists who took a career break did so to have children. But while 34% of all physicists left jobs in industry to start families, only 14% returned to the same posts – and 55% of those who did go back to the same employer went part-time.

For apprenticeships, it is theoretically possible for employers to offer part-time opportunities, but in practice few are available. Doing more to increase the numbers using this route to obtain both knowledge and skills is not just a matter of advancing

opportunity for women, but is vital to improving the skills base and productivity of UK plc.

There are proposals for schools to have responsibility for providing the careers service. To avoid compounding the paucity of applicants for careers in science, engineering and technology, those providing careers guidance will need to understand the very real opportunities these fields offer students of all abilities. With the wide range of jobs available needing different skills levels, it is a crucial area we have to get right.

We need to spread more widely present good practice, to understand better the causes of the skills shortages, and to tackle the difficult area of cultural change. Without recognising the importance of workplace culture, we will have to be content with the current glacial speed of change here. Getting more of those already qualified back into the workforce is important, but ultimately we need a new generation of scientists, engineers and technologists of both genders to ensure we remain a top-flight developed economy.

The contributions

In the first contribution, Sandi Rhys Jones puts forcibly the economic argument for businesses, showing that diverse organisations achieve more, and that with the present skills shortages we cannot afford to ignore half the population. She also challenges a pervasive belief in the SET sectors that somehow they are different, and that that is the reason progress is stubbornly low. Common to all businesses that want to attract and retain female employees, there is a need for part-time and flexible working, but crucially it is the entrenched cultural norms that require greater and urgent attention.

Sue Ferns complements these views. Prospect, which represents a significant number of women working in SET occupations, surveyed its members on a wide range of workplace matters. Some issues affect both men and women, while others are significantly more likely to impact on women. Men as well as women report problems with work pressure affecting home life – an indication that more flexible working could help all employees. Women continue to experience a significant pay gap, and find having children a negative influence on their career. As in many sectors, there exists a presumption against part-time working, which is particularly true for senior roles.

The importance of leadership and top management setting the tone for their organisations has long been known. And while many at the top have got the message

that diversity is important, strategies and policies flounder because of poor implementation by managers further down the organisation. Both Sandi Rhys Jones and Sue Ferns identify the importance of middle management in really transforming the habits of an organisation – a message for all those intent on changing policies and culture.

Athene Donald highlights the need for multiple interventions in universities, taking a comprehensive approach with different actions at different career stages. She highlights the Athena Swan Charter, a scheme that recognises excellence in science, engineering and technology employment in higher education. Any university or research institution committed to the advancement and promotion of women in higher education and research can apply for membership. It is a proactive way of codifying and spreading good practice. Athene Donald sees things changing slowly and memorably writes, "The leaky pipeline still wastes too much talent at every stage from undergraduate on."

So while action is being taken to plug the leaks, attention must be given to increasing the number of girls and women entering the pipeline. This must start early. Clare Thomson, writing on the importance of schooling, tells us that from year three onwards children understand the concept of "girls' jobs" and "boys' jobs", while Deidre Hughes, writing on careers education, quotes research that says "what children say at the age of 11 is highly predictive of their actual behaviour at aged 16" .

While promoting enthusiasm for science is a well-established aim in schools, more attention needs to be given to the values and context of science, with girls and boys being inspired by different uses of science and technology. Science can be advanced as the means by which many of the major problems facing humanity can be solved.

Clare Thomson further emphasises the importance of ensuring the appropriate subjects are studied post-16, as this can affect the subsequent courses and careers students can follow. She tells of the importance of students being able to meet inspiring individuals from scientific backgrounds as they can act as a catalyst to changing minds. In this vein, Deidre Hughes expresses disquiet about current changes in careers guidance and the potential detriment to the goal of increasing those studying science, technology, engineering and maths (STEM) subjects. School teachers tend to have a poor understanding of the engineering profession and are likely to perpetuate misplaced assumptions: that engineering is a dirty occupation; that engineers are car mechanics; and that engineering is for men. From work

placements to options such as apprenticeships, a great deal has to be done to improve the quality of advice and to ensure that it does not perpetuate gender stereotypes.

Katie Perry's contribution is about putting women back into the pipeline. Describing the work of the Daphne Jackson Trust, she shows that it is possible to overcome the challenges facing those returning to work after a career break. A charity, it helps those wishing to return gain valuable up-to-date experience through a research fellowship. The success rate is impressive, with practically all those supported by the trust successfully re-entering their profession. Given that most career breaks are only between three and eight years within a working life of probably 40 years, it has to make sense to invest a relatively small amount of money so as not to squander skills and experience.

In a description of the apprenticeship programme of the successful engineering company MBDA, Gareth Humphreys and Jenny Harvey show how these young people acquire the skills their business needs for the future. The impressive comments from their young female apprentices, just out of school, demonstrate that with a clear programme of outreach and persistence it is possible to attract young women in significant numbers into a company.

The penultimate chapter of the monograph contains contributions from women working in science, engineering and technology, drawing on their own experiences. The women seem to share a determination to take on a challenge despite others trying to put them off. For some it was precisely because it was not seen as a job for a girl that they were motivated to prove people wrong.

Liz Ainsbury, Institute of Physics Very Early Career Woman Physicist of the Year, emphasises the rewarding nature of a career in science. The importance of job satisfaction is stressed as opposed to financial reward. As a motivation for entering a career, it's a good one.

The widespread perceptions of engineering are a significant barrier to more women seeking it as a career. Claire Jones, Institution of Mechanical Engineers Young Member of the Year, explains how personal experience meant she was not influenced by the gender stereotyping around engineering that she believes is more engrained in Britain than in the rest of Europe. She calls for parents and teachers to be educated to understand that engineering is a career suitable for all.

Arlene McConnell, Institution of Engineering & Technology Young Woman Engineer of

the Year, talks of ingenuity, creativity and pure genius when describing some of the things technology and engineering have achieved. She also says, "it took me a while to work out what engineering was and how it fits into and improves the society we live in". She makes a passionate plea for greater attention to these industries: "If no one shines a light on the men and women solving the challenges that face us all or passionately champions these fields in order to inspire a new generation of engineers and technologists, then as a nation we are risking our future."

All these women identify the importance of mentors and role models, and they have taken on this job with enthusiasm. Presenting awards to young women, and showcasing their achievements, has to be one of the easier ways of creating role models. It is noteworthy that technology, with its paucity of institutions, does not have the same young female champions as science and engineering. Research in Motion, which makes Blackberrys, for a few years promoted awards for women and technology, but this has not taken on the same importance as those promoted by the science and engineering institutes.

Monika Sud throws a light on the experience in Australia, which shares a number of the same challenges as the UK. She describes how the shortage of skills in engineering is driving cultural change and creating opportunities for qualified women.

Conclusion

The voices of these engineers and scientists show that there is no shortage of enthusiastic women who want to take on the challenges in science, engineering and technology. A concerted effort is needed if we are not to see repeated time and time again the sentiments of a female scientist member of Prospect who wrote, "I am becoming more frustrated with what feels like fighting every day. An under 30 female science graduate is not an easy thing to be in my place of work ... I'd like to get out of SET as soon as possible." The cost to her and society is just not acceptable.

Much is going on, but it needs joining up if we are to make a difference. Schools, academia and business all have to work together more closely. Telling the world what engineering, science and technology do is the job of those already engaged in that work, and they could start with schools. Teachers cannot on their own present the appropriate models of work. We know that the present knowledge and experience of work in schools is poor – businesses need to make links to school to change that.

Universities and businesses have to undertake the crucial changes in the culture of their organisations if they are serious about attracting and keeping skilled women. They

have to be committed and undertake a real examination of their current workplace culture and what needs to change. This means not just a commitment from the top, but having the policy embedded into the middle management layers.

I am reliably told that there are 37 science and engineering institutes. The urgency of this issue demands that they work more closely together. They could act as a focus for good practice and pool their resources in this area in order to change the face of science, engineering and technology in the UK forever.

Government should look again at careers advice. Leaving it to schools without any support and guidance will fail the next generation of children.

The government also needs to re-examine the support it gives to encouraging women into these vital areas of the economy. The allocation made to the Royal Academy of Engineering for the new Diversity in Engineering Programme is £200,000 a year, less than 10% of the £2.5 million previously allocated to the UK Resource Centre for Women in Science, Engineering & Technology. It represents a miniscule proportion of the total science and research allocation of £4.6 billion per year. It is time for a thorough review of spending to identify in all its many areas of work where greater emphasis could be given to ensuring women both enter and remain in SET.

The figures for women in science, engineering and technology careers remain stubbornly low, the skills shortage is well known, and the importance of these disciplines to our future economic growth is uncontested. Nothing less than a concerted, determined and persistent approach by all will be sufficient to achieve the transformation that is required.

Chapter 1

Business culture and HR

Sandi Rhys Jones OBE, FCIOB, Partner at RhysJones Consultants and
Non-executive Director of EngineeringUK

Business culture and HR

Frustratingly, despite considerable effort and a raft of initiatives, progress remains slow in raising the percentage of women working in science, engineering and technology (SET). The arguments have been debated for many years, and there is a wealth of information and academic data on the subject. The arguments have generally been based on four key drivers – skills shortages, demographics, economics and social justice – combined with the virtues of what are regarded as particularly female attributes and competences, such as collaborative working, good communication skills and empathy.

Meanwhile, women continue to progress in virtually every other sphere of industry and commerce, and are also recognised as significant purchasers of business and domestic goods and services. This reinforces another of the arguments for increasing the number of women in the SET workplace: helping companies to be more representative of their customers.

This paper proposes some reasons for the slow pace of change, provides some examples of what has worked, and highlights specific challenges requiring action.

1. Cost or value?

A major challenge is to demonstrate the tangible, bottom-line benefit value of employing women in the SET workplace. Initially arguments were based on the financial cost of losing women, rather than the economic benefit of keeping them, particularly when seen against the high attrition rate for women working in SET. It is known that some 70% of women with SET qualifications do not work in SET occupations. Another economic argument for increasing the number of women in SET is that employers benefit from a cheaper workforce because women are generally paid less than men for jobs of the same value.

However, in the last five years several research projects have been carried out to demonstrate and quantify the positive business benefits of greater gender balance. The international consultancy McKinsey began researching the relationship between gender diversity and financial performance in 2007. In *Women Matter: Gender Diversity, a Corporate Performance Driver*,¹ the company reported that from 2005 to 2007 the 89 listed European companies (all with market capitalisation of more than €150 million) with the highest levels of gender diversity also had higher returns on equity, operating results, and stock price growth than the averages in their respective sectors.

¹ McKinsey & Company *Women Matter: Gender Diversity, a Corporate Performance Driver* (2007) (www.mckinsey.com)

In the same year, research carried out by the not-for-profit organisation Catalyst² found that Fortune 500 companies with more women corporate officers, on average, financially outperformed those with fewer. Further research found that the same holds true for Fortune 500 companies with more women on their boards of directors. On average, companies with more women board directors significantly outperform those with fewer women, by 53% on return on equity, 42% on return on sales, and a 66% on return on invested capital.

These reports provide positive evidence of the business benefits of employing women. McKinsey, together with other organisations including Ernst & Young and PricewaterhouseCoopers, have produced further material in support of the positive business and cultural benefits of recruiting and retaining more women. The growing contribution of women in business is also promoted on a weekly basis by the *Financial Times*, in addition to its annual report on influential women in business across the world.³

Challenge: SET is different

The challenge is in convincing employers that the arguments produced by international management consultants and an independent, US-based think-tank, covering a broad cross-section of business and industry, are equally valid for the SET sectors. There is a long-established belief among such employers, particularly those in construction and engineering, that they have unique challenges, compared with other sectors, that make gender equality particularly difficult to achieve.

Those few SET companies who take positive action to recruit and retain more women are often regarded by others in the industry as simply being exceptional, with efforts to encourage others to replicate the good practice often being met with the dismissive, "Well, they're different; it wouldn't work for us."

There is also resistance to these bottom-line arguments by some gender equality campaigners who are concerned that arguments for increasing women's entry to SET are based solely on creating truly inclusive cultures rather than on business needs.

2. The SET culture

What is it about the SET workplace that makes gender equality so challenging? The progression of women in other traditionally male-dominated sectors such as medicine,

² Catalyst *The Bottom Line: Corporate Performance & Women's Representation on Boards* (2007) (www.catalyst.org)

³ "Women in Business" in *Financial Times* (www.ft.com/indepth/women); "Women at the Top" in *Financial Times* (<http://womenatthetop.ft.com/articles/women-top>)

law and accountancy is now seen as the norm. Even if there are concerns about insufficient women at the top of these professions, the pipeline is flowing faster and fuller than that in SET.

The level of female participation in different SET disciplines varies greatly. Science and research roles enjoy the highest proportion of women workers (40%-47%), but only a minority of around 5% work as engineering professionals. The lowest participation is within the skilled construction and building trades and skilled metal and electrical trades, where women account for only 1%. There has not been much improvement in female representation since 2001.

Challenge: The 24/7 dilemma

EngineeringUK, in a 2008 briefing paper on women in SET,⁴ called for a different approach in recruitment and retention, citing evidence to suggest that "engineering employers with a predominantly male workforce exhibit corporate cultural norms and values, which are often alien to female employees. This factor alone dissuades many women from entering or remaining in engineering occupations."

In the same year, the UK Resource Centre for Women in Science, Engineering & Technology (UKRC) commissioned a team from Loughborough University to research workplace cultures. Led by Professor Barbara Bagilhole and Professor Andrew Dainty, the report⁵ concluded that competitive workplace cultures mean SET employers value economic efficiency more than employee well-being, sustaining the tradition of long working hours, task or project oriented work and the expectation of total availability. Anything less is interpreted as a lack of commitment to career, profession and company. This is particularly significant for women, given that they usually have more domestic responsibilities than men.

3. The soft skills debate

The widely held view that women tend to have a more collaborative approach, work well in teams and be concerned about governance is supported by academic research, although these soft skills are difficult to quantify. Irritating though this may be to those who feel that the soft skills argument detracts from more important issues, there is a growing belief that these are important attributes in the business world where risk management, compliance and regulation are of growing importance and concern.

4 EngineeringUK *Women in SET*, briefing paper (2008)

5 Bagilhole, B, Dainty, A, Powell, A, and Barnard, S *Researching Cultures in Science, Engineering & Technology: An Analysis of Current & Past Literature*, research report series for UKRC no 7 (UK Resource Centre for Women in SET, 2008)

Alun Griffiths, group HR director of the leading international consultancy Atkins, says:

Our own experience suggests women are particularly strong at collaboration and partnership – essential skills in any project. A diverse workforce helps us bring different perspectives and a variety of approaches to the table, helping us to meet the challenges of the major design and development projects we're working on around the world. It means we can deliver much more effective results.

Challenge: Collaboration or capitulation?

The commitment to gender equality from a very successful engineering and design business such as Atkins is encouraging. However, compare and contrast the remarks above with the following comment from a successful woman with many years' experience in the high-tech communications industry. Trudy Norris-Grey, chair of the UKRC, asks:

Is collaboration really valued? Business is highly competitive, so the pervading workplace culture is generally highly competitive. I am a big believer in team working, but I have noticed that people can be unwilling to share their intellectual property because they feel they risk losing their personal value, particularly in times of cutbacks. In today's SET workplace, is being collaborative an advantage for a woman, or a liability?

4. Does size matter?

As pointed out in the McKinsey report:

It's notable, if not surprising, that larger companies are likelier to take more actions to achieve diversity: more than 50 per cent of respondents at companies pursuing seven or more measures have more than 20,000 employees, compared with 19 per cent at the smallest companies.

This trend is reflected in the profile of SET organisations committed to gender equality. The majority of organisations cited in case studies or signing up to the UKRC CEO Charter are large organisations, with the internal HR structures and resources to help implement and monitor programmes. More importantly, large companies are better able to cope with the complexity and burden of employment legislation. Some SET employers, particularly in construction and engineering, also argue that in comparison with other sectors, the profit margins are so low and the economic cycle so turbulent that spending time and money on gender programmes is a luxury.

Challenge: Innovative and independent action

What has become clear over the past 10 years is that change is sometimes driven by small and medium-sized enterprises (SMEs), and in particular by private or family-owned businesses where bold decisions can be made quickly without concerns over impact on the share value or negative analyst statements. Even more significantly, when such enterprises decide to take action, the practical help and advice they find most useful has often come from the voluntary, not-for-profit sector.

For example, construction company Durkan's building maintenance workforce grew to 50% female following participation in the Building Work for Women project conceived and delivered by the charity Women's Education in Building (WEB). This charitable organisation is sadly defunct, after more than 20 years of consistently and successfully training more women in construction trades from one west London training centre than the Construction Industry Training Board achieved across the UK.

Recently, Astins, a specialist subcontractor in the construction industry providing internal fit-out and external cladding services, has invested £1 million to set up its own fully accredited NVQ training academy to develop the skills of young people, particularly women, who would otherwise be unemployed. In developing its own training programme, Astins has conceived an assessment tool that empirically demonstrates that good training pays for itself many times over in improved quality, productivity and well-being. The advisory board includes representatives drawn from Astins' major contractor clients, who are also committed to recruiting and retaining more women.

5. How can businesses change to alter the gender bias?

The mechanisms for change within business to recruit and retain more women in SET are well known. Flexible working, mentoring, role models, transparency of pay, and structured career paths (with breaks) are consistently proposed. There are persuasive examples too. BT estimates that its flexible work culture has saved it more than £510 million a year in office costs, while its home workers are on average 20% more productive than their office-based colleagues.⁶

One of the few research projects to find out why women leave a SET profession was carried out in 2007 by the Raising the Ratio task force of the Royal Institution of Chartered Surveyors, which produced data showing that, contrary to many assumptions, women who stopped practising as surveyors had not given up work altogether.⁷ In fact,

⁶ BT Conferencing *Flexible Working in BT*, case study (BT, 2009)

⁷ Kingston University *What Motivates Women to Leave the Profession: A Study of Qualified Surveyors Currently Holding Non-practising Status with the RICS*, research carried out for RICS Raising the Ratio task force (RICS, 2006)

40% of those surveyed had retrained in careers that were more appealing. Salary was less of a driver than flexible working, proximity to home and job satisfaction. The high cost of losing these skilled women, together with the cost of recruiting replacements, was a powerful argument in encouraging employers to review working structures. The RICS agreed to fund the research project after the task force pointed out that the institution was losing some £250 million a year in lapsed subscription revenue.

The role of HR professionals is also under scrutiny. Margareta Pagano, business editor of the Independent on Sunday, wrote recently in an article for the journal of the Chartered Institute of Management Accountants:⁸

Egon Zehnder International (EZI), an international recruitment firm, showed that one of the reasons why companies claim they can't find the right women is that they are using the wrong criteria in their search process. It's sponsoring its own PhD project at Cambridge to look at the "systemic bias" it believes is endemic to the recruitment process, which is largely carried out by the "male, pale and stale" and seeks others in its own image. If this prejudice is proven, EZI will then look at how recruitment companies can change the way they assess people so that bright women can be brought forward. Women have so many other competencies – not always measured by recruiters – which have to be drawn out in different ways.

Creating the positive environment required to bring these practices about is generally seen to require top-down commitment together with gender awareness training among managers, particularly at middle level. Unfortunately, middle managers often see themselves as vulnerable, holding back those below them and obstructing the flow of initiatives from the top.

Challenge: Positive action – a poisoned chalice?

One of the biggest inhibitors, however, is that even when such structures are put in place, the prevailing workplace culture means that women are reluctant to take them up. As the UKRC workplace cultures report⁹ says, work-life balance and flexible working opportunities are viewed as rhetorical and as a "women's issue", despite their availability to men, and as a result their take-up is perceived to have negative consequences on careers.

A 2006 study of high-tech organisations in Ireland¹⁰ revealed that women believed that although their organisations provided family-friendly policies, the organisational

8 Margareta Pagano, comment piece for *Financial Management*, journal of the CIMA (<http://www.fm-magazine.com>)

9 Bagilhole and Dainty, op cit

10 Cross, C and Linehan, M "Barriers to Advancing Female Careers in the High-tech Sector: Empirical Evidence from Ireland Women" in *Management Review* vol 21, no 1 (2006), pp28-39

cultures meant they were realistically unable to avail themselves of these policies. Rather, women perceived that to take up the policies would put them at a distinct disadvantage in relation to their men colleagues, who rarely used such policies.

Challenge: Mentor and role model or queen bee?

Women are viewed in a biologically determinist way, which means they are visible by their sex (they are in a minority) and invisible as engineers and scientists. For this reason, it is seen as helpful for women to work in groups of at least two or three, rather than solitary individuals in traditionally male-dominated workplaces. This is also recommended at senior manager and board level.

However, successful solitary women can be as protective of their hard-won position as an ambitious man, and indeed value their individuality. Rather than helping to change the culture for women, there is a tendency for senior women to pull up the drawbridge behind them.

As Trudy Norris-Grey comments:

There is no doubt that mentoring is very effective and role models valuable. But it is essential to have the right role models. If you have the wrong role model – the female sociopath – you get the wrong behaviour.

The recent recommendation to follow the Norwegian model and call for quotas for women on the boards of British companies generated a heated response. It was notable that the majority of women who objected publicly to quotas were already on the boards of at least one company – but were quick to express the concern that women appointed under such an arrangement would be mediocre tokens rather than capable candidates.

Lucy Kellaway, *Financial Times* columnist, was one of those dismissive of quotas, and also commented that while she enjoyed being one of two female non-executive directors it was not her role to support the progression of women in the company. Several letters critical of her views were published, including one pointing out that ensuring a positive business culture is a responsibility for board members, whether executive or non-executive, male or female.

In the SET sector there is growing support for board quotas, in the face of such slow change at the top. As Trudy Norris-Grey puts it, "I have resisted the idea of quotas for many years, but I now believe that it is the only way to bring about change."

6. Entrepreneurship – or sisters doing it for themselves

In 1996, the report *Tomorrow's Team: Women & Men in Construction*¹¹ put forward a series of practical recommendations to bring about change and increase the number of women entering, staying and progressing in the industry. Most of these recommendations remain valid today and have been reflected in this paper. In addition to proposals for employers, the report also included a set of practical recommendations for women themselves. As a result, a number of women's groups were set up, some within professional institutions, others as informal networks.

This call for women to be proactive rather than passive in male-dominated occupations has been echoed in other reports. But as the UKRC report on workplace culture commented:

The coping mechanisms women have been shown to adopt tend to be individualistic strategies, whereby the management of gender is seen to lie in women's own hands, but such coping strategies have failed to challenge the persisting cultures and structures in SET.

Challenge: Optimism and celebration

It is an occupational hazard that authors writing about barriers to change tend to focus on the negative, and on the overall percentages that gloomily depict a glacial pace of change. Dispiritingly, the authors of the UKRC workplace culture report conclude, "Concerns over whether SET professions should be marketed to women given the barriers that they face have re-emerged throughout this period as increasing numbers of women have failed to prevent the reproduction of masculine cultures." Frustratingly, the authors call for further research into the issues, rather than proposed specific actions to assist in bringing about the change.

In such a climate it is very important to balance the negative with identifying the positive, recognising that the topic of women in SET remains on the agenda, and that there are a number of employers who have committed to making a difference, who are seeing numbers of women rising in their workforce and progressing up the career ladder. Major projects such as London 2012 have also encouraged the development of gender-diverse training and opportunities by SET employers.

Following on from the observation that women have responded to managing their careers through individual strategies, it is fascinating to note that almost every one

¹¹ Construction Industry Board *Tomorrow's Team: Women & Men in Construction* (Thomas Telford, 1996)

of the women who have risen to the top of their SET professions – becoming presidents of their professional institutions – are either independent women running their own businesses or work in academia.

What stops women working in SET companies from progressing to these highly visible professional positions? And why do organisations lose such entrepreneurial and professional talent?

Women presidents of SET bodies

The **Royal Town Planning Institute** has had three female presidents, starting with Sylvia Law in 1974, Hazel McKay 20 years later, and in 2008 Janet O'Neill, who runs her own practice.

The **British Computer Society** (now known as BCS: The Chartered Institute for IT) has had four female presidents. The first, in 1989, was Dame Stephanie Shirley (an entrepreneur and philanthropist), followed in 2003 by Professor Dame Wendy Hall (an academic), in 2007 by Rachel Burnett (who runs her own business) and in 2010, by Elisabeth Sparrow (a consultant).

The **Royal Institute of British Architects** (RIBA) currently has its first female president, Ruth Reed (who runs her own practice and is an academic), who will be succeeded by its second, Angela Brady (who also runs her own practice).

Other notable first female presidents in the SET sphere are:

- Pam Liversidge OBE, **Institution of Mechanical Engineers**, 1997 (runs her own company)
- Professor Dame Julia Higgins, **Institution of Chemical Engineering**, 2002 (academic)
- Professor Dame Jocelyn Bell Burnell CBE, **Institute of Physics**, 2008 (academic)
- Jean Venables CBE, **Institution of Civil Engineers**, 2009 (runs her own practice)
- Dr Sarah Buck, **Institution of Structural Engineers**, 2010 (runs her own practice)
- Professor Lesley Yellowlees, **Royal Society of Chemistry**, 2010 (academic).

Conclusion

Recruiting and retaining more women in the SET workplace is difficult. The culture, attitudes and behaviours are deeply entrenched, the business environment challenging and the pipeline of women smaller and leakier than for other sectors.

However, there is a wealth of research and an explosion of employment legislation, despite there being little need for more of either – apart from board quotas. There are also the tools, mechanisms and professionals who can provide practical help to businesses.

For example, the *Building Work for Women* project addressed the Catch 22 situation facing women training in the construction trades: finding employers willing to provide the site experience necessary to complete the transition from training into work. The project was successful, because the delivery team helped employers deal with the issues inhibiting change and supported the women trainees.

At the property and construction company Simons Group, a female non-executive director was asked to find ways of increasing and developing the women in the company. Through workshops and an innovative mentoring programme, with senior women from its blue-chip retail and financial clients, women in the businesses were encouraged and empowered to realise their potential – not only becoming visible as professionals, rather than simply as women, to their male colleagues, but also being recognised as professionals with ability, influence and value.

The key is to match the help with the needs and profile of employers and individual women, taking a pragmatic view, understanding the business realities and providing appropriate support and advice to bring about mutual benefit. Eloquent and determined champions are essential, to present the arguments, encourage collaboration and promote the importance of SET and the contribution of women within it.

Chapter 2

The view from the workplace

Sue Ferns, Head of Research and Specialist Services at Prospect

The view from the workplace

Women's under-representation in science, engineering and technology (SET) is not a new problem but, despite some slow progress in recent years, it remains pervasive. In 2008 women accounted for 12.3% of all employees in SET occupations,¹ up from 10.3% in 2003, but this compares with 45.1% of women in the workforce overall. Women are even less well-represented in some SET occupations: for example, only 6.9% of engineering professionals and 1.1% of skilled tradespeople are women. Furthermore, the "leaky pipeline" ensures that a higher proportion of women than men either never use their STEM (science, technology, engineering and mathematics) qualifications in an SET role or leave for other occupational pastures: 29.8% of female STEM graduates of working age are employed in SET, occupations compared with 50.3% of men.

The Smith Institute is right to be concerned about the future: we are facing widespread job insecurity in the public sector, where many women in SET occupations are employed, as well as systematic undermining of government support for gender equality – including an 80% cut in the funding for the UK Resource Centre for Women in Science, Engineering & Technology. But there are opportunities too. There is already evidence of SET skills shortages and gaps across a number of sectors, and the government has recognised the important role of a STEM-qualified workforce in securing and sustaining economic recovery.

In thinking about what works well and what needs to be done to secure real progress, I want to focus on the views of women who work in SET and are members of my own union, Prospect. Prospect represents 121,000 professionals and specialists across the public and private sectors. Around 50,000 of our members work in SET roles. Women account for approaching a quarter of our total membership, though they make up a higher proportion of recent recruits. We cover some of the most gender-segregated sectors of the economy, including energy and defence. However, we are immensely proud that Sarah Curtis, the winner of the 2010 Women's Engineering Society Prize, is a Prospect member. Prospect does not recruit in the health sector, where women do best in SET, constituting over half of all professional and associate professionals.

Membership survey results

In 2010 Prospect undertook a comprehensive membership survey,² to which 10,000 members responded. The survey included a series of questions to help us understand

1 "Women and Men in Science, Engineering and Technology: The UK Statistics Guide 2010" (http://www.theukrc.org/files/useruploads/files/final_sept_15th_15.42_ukrc_statistics_guide_2010.pdf)

2 "Membership Survey 2010 – Full Report" (<http://library.prospect.org.uk/id/2010/00750>)

respondents' views about their working lives. As might be expected, women and men working in SET had similar perceptions on some issues. For example, around three-quarters of both said that they enjoy their job. Just over half (55% of women and 57% of men) consider that they have sufficient training opportunities at work, but 24% of both groups do not think that this is the case.

But there are also some interesting differences between the attitudes of women and men. A higher proportion of women (66%) than men (56%) express concern about their job security. Women (35%) are less likely than men (42%) to feel that they have opportunities either to develop in their current job or for promotion (15% of women and 19% of men).

While 99% of both women and men report that they work for longer than their contracted hours, women (60%) are more likely than men (54%) to work between one and five hours extra, and men (19%) are more likely than women (12%) to work for six hours or more beyond their contracted hours.

Similar proportions of women (48%) and men (47%) are concerned about being too stressed at work. However, 41% of women (compared with 35% of men) report that they have experienced a period of stress they considered to be work-related and which affected their health and well-being. Similarly, a higher proportion of women (14% – compared with 9% of men) said that they have experienced bullying or harassment at work.

Some 40% of women and 38% of men report that work pressures are affecting their home life, but women (28%) are more likely than men (22%) to say that they do not have a good work-life balance.

Although women (42%) are more likely than men (38%) to express satisfaction with their pay, in fact the median salary of the women we surveyed was in the £20,000-£30,000 band, compared with a median salary band for men of £30,000-£40,000. Men were twice as likely as their female counterparts to have a salary in the band £40,000-£50,000 and four times as likely to be paid £60,000-£70,000. This pay distribution is probably influenced to some extent by the younger age profile of women respondents (median age range 31-40) compared with men (41-50). However, it is not easily explained by level of qualification – although 52% of male respondents are qualified to doctoral level, compared with 48% of women, men are also over-represented at lower qualification levels – 18% are qualified only to A-level or equivalent, compared with 12% of women. A more telling fact may be that just 32% of women are members of a professional body, compared with 53% of men.

These survey findings are helping to inform the work the union does on stress, well-being, work-life balance and working time,³ and we are constantly developing the support we provide in response to the demands of the current economic and political climate. For example, a recent conference of Prospect's health and safety representatives focused on the impact of organisational change on health and well-being, building on our published guidance on "Fair Change".⁴ We have also devised a series of career workshops and resources to provide practical support to members facing redundancy.

Prospect's litigation in the case of Health & Safety Executive inspector Bernadette Cadman provided a long-awaited breakthrough for women in specialist roles whose pay had been disproportionately affected by very slow progression through excessively long pay bands. However, this is only the tip of the iceberg, and the government's public-sector pay freeze is already adding to equal-pay pressures, including as a result of its decision not to honour negotiated pay progression arrangements.

Women's voices

However, we still wanted to gain a richer understanding of women's experiences in SET workplaces. So very recently Prospect's survey work has been supplemented by qualitative research specifically to gather the views of female science and engineering members working across a range of sectors.

These women speak very positively about the enjoyment to be had from "doing the science", "providing solutions", "working with stakeholders", an "interesting mix" of work, working "pro-actively and anticipating issues", "juggling many balls", "the intellectual challenge and learning new things" and "making a difference". They also highlight the importance of been "given credit for my work" and "appreciated by colleagues". Causes of frustration include "lack of inspirational leadership", "poor management", "unwillingness to consider people when decisions are made", "lack of consistency" across an organisation, "being sidelined", "the amount of paperwork" or other system requirements, and "lack of commitment" to the science being undertaken. Women are still frustrated that "all the managers are men"; "there is still an element of the culture of presenteeism rather than output focus"; and that organisations don't provide cover for gaps in staffing, including maternity leave.

One woman working in the private sector said: "There is a lack of women in the company in middle and senior management – I'm often the only woman or one of a couple

³ For example, see: <http://www.prospect.org.uk/equalities/women> and <http://www.prospect.org.uk/healthandsafety/workrelatedstress>

⁴ "Fair Change – Prospect Guide to Organisational Change" (<http://library.prospect.org.uk/id/2009/00546>)

of women in meetings. I have also in the past been accused of being emotional – a label that would never be placed on a man. I've heard other women say they've felt the environment is hostile towards women – I wouldn't go that far, it can however be intimidating and draining to be constantly championing a different perspective to the rest of your colleagues."

The role of managers again featured strongly when we asked what single change would or has made the biggest difference to our members' working lives. Responses highlight the importance of positive approaches from management, particularly line and middle managers. One respondent commented that while "there are very good guidelines on discrimination, programmes aimed at advancing female members of staff ... this does not always get filtered to the 'rank and file' who have to implement these procedures".

Line managers who are supportive evidently make a huge difference to the quality of women's working lives. Opportunities to network with other "strong" women are one way to combat isolation at work, though one respondent commented that "there are so few women engineers and, with the geographical spread, I am not likely to meet them ... Having more women at engineering and line manager level would make the greatest difference. The company does not really acknowledge that women engineers may have different requirements from their male colleagues and I fear that every woman has to make her own way in solving these problems."

The impact of caring responsibilities

Sadly, women's negative experience of work after having children continues to have a major influence. Many of the women we spoke to felt that they had only survived, let alone thrived, because they didn't have caring responsibilities. However, a number did recognise that in this regard workplaces have "changed a lot over the years", though there is still something of a presumption against part-time working, especially at more senior levels. One woman engineer commented that while she had never experienced discrimination as a woman engineer, "When it comes to being a mum and working part-time then I have experienced issues over the years and I'm not sure they've changed all that much. Being a valued engineer has made it easier to work part-time but the organisation does not deal proactively with the issues [involved] and it can depend to a huge extent on the attitude of your line manager."

Those without caring responsibilities also acknowledged the benefits of flexible working arrangements for all staff, provided they are applied constructively. However, another respondent noted that although it was easier for her to combine work with caring responsibilities than it had been for her mother and grandmother, "just recently

there seems to be the beginning of a backlash against flexible working and work-life balance". The high costs of childcare are also undoubtedly a deterrent for some, including relatively well-paid women.

Most of the women we spoke to expected to stay in SET, and most expected to stay in their current organisation, though their reasons ranged from the very positive ("there is still a challenge for me and a lot I can offer") to pessimism about lack of alternative opportunities. Respondents working in the public sector were notably more uncertain about whether they would be able to stay where they were. One noted that she had personally benefited from a deliberate move out of SET at an earlier stage of her career, stating: "I found this a useful addition to my skill base, making me much more effective on my return to the technical world."

This contrasts with the views of two women at early stages of their career who commented, respectively, that, "I am becoming more frustrated with what feels like fighting every day. An under-30 female science graduate is not an easy thing to be in my place of work" and "I suppose it's possible that if I were to go abroad the pay may be better .. but in the UK, no, I'd like to get out of SET as soon as possible. It feels like being trapped in a dead end." Another respondent in mid-career articulated a preference that accords with actual experience across a range of Prospect membership areas: "While I stay with this employer I expect to stay in SET – but if I left I think I would look for a career change. Been there, done that – is my view at the moment."

Women's assessment of their own prospects

These women vary in their assessment of their own career prospects. Comments fall under four main themes:

- *Optimism*: "As the engineering population demographic in [my industry] is highly skewed, with many due to retire in the next few years, there are real opportunities for those with time left to progress."
- *Uncertainty*: "The only reason I would leave ... would be for redundancy."
- *Glass ceiling*: "I think I have reached the highest level I can in the organisation, there are even less women higher up and I think I'd feel even more isolated."
- *Resignation*: "My male counterparts who I was recruited with have all progressed to [a higher] level and have been there for a good few years. I have taken a year off on maternity leave so should be a bit behind, but maybe not this far."

No doubt these perspectives reflect a combination of factors including career stage, employment sector, and quality of management. Several respondents also expressed

frustration that opportunities for progression are management focused and that specialist, "hands on" career paths are few and far between.

These women are inspired by great scientists, such as Jocelyn Bell Burnell and Professor Nancy Rothwell, but equally by: their mothers, partners and families; "women in higher management and visible political roles"; peers who have worked their way up from the shop floor; and networks, such as those provided by the Women's Engineering Society. Self-confidence and self-motivation are also very important, not least because "reorganisations have stripped away the organisation's spirit and commitment to the common good".

Encouragingly, young women in particular are inspired by their own choices, whether to "do a physics degree" or engage with their professional body. One Prospect member described how proud she is to have recently been elected as the youngest fellow of the Society of Biology. Another reported how working on the Young Members Board of the Institution of Mechanical Engineers has "not only given me the opportunity to meet prospective employers but [has] improved my impact and influence in work".

There is nothing unique about this group of women. Their experiences confirm that more still needs to be done to deal with endemic problems, for example relating to work-life balance, the glass ceiling and the culture of SET workplaces. Some of the problems they face require political action and others will be affected by economic pressures. It is core to Prospect's mission to try to influence political and economic decision making: that is why, for example, our new manifestos for Scottish science⁵ and for science in Wales call on all the candidates in the May elections to make a commitment to safeguarding the SET skills base, providing decent pay and careers for staff and tackling the under-representation of women in SET.

As our members have identified, changing organisational and management behaviours is crucial, and unions too need to do more to visibly promote the rights and needs of women in SET. Prospect is keen to work collaboratively with good employers where there are opportunities to do so, and also to build on our existing links with other TUC unions, the UKRC, WISE, the Women's Engineering Society and the Campaign for Science & Engineering.

But the final word goes to one of our young members, who said: "I am inspired by blue sky thinking. I believe anything can be reality if you try hard enough." Perhaps if we all try hard enough we can move from unlocking women's potential to realising it.

⁵ *Ten Steps, One Giant Leap. Prospect's Manifesto for Scottish Science* (March 2011) (http://www.prospect.org.uk/dl/23224_1469992670.pdf/as/2011-00318-Leaflet-booklet-Ten-steps,-one-giant-leap---Prospect's-manifesto-for-Scottish-science-Version-08-03-2011.pdf?_ts=19913&t_s=19913)

Chapter 3

The leaky pipeline wastes too much talent

Professor Athene Donald, DBE FRS, Director of the Women in Science, Engineering and Technology Initiative at Cambridge University and Chair of the Athena Forum

The leaky pipeline wastes too much talent

Any set of statistics about any academic science department or faculty in the country will show the same basic fact: women are not represented at the highest levels of the scientific academic ladder in the same numbers as they are at the undergraduate level. My own discipline, physics, starts off with a relatively low number of women entering university to read the subject, around 25%, but the fall-off is not too precipitous, with around 15% of lecturers being women (although only around 6% at professorial level). In the biological sciences, undergraduate courses may have a heavy preponderance of females in the undergraduate classes – up to 80% – but at professorial level the percentage of women nationally is around 15%.

The reasons are complex: multiple factors play a role, and which of these dominate depends on both the particular scientific sub-discipline and the individual. If there is no simple, single contributing factor, there will equally be no simple solution or set of actions that will transform the situation. Nevertheless, some strategies can be employed to help redress the balance.

At both the individual departmental level and at the institutional level, thoughtful actions can make an appreciable difference to the experience of individual women, and increase the likelihood that they will not leave the field. Key to any successful outcome is that an organisation gathers appropriate data, to identify where the problems are most significant, and uses these to prompt self-reflection on how to move things forward. Particularly when money is tight, it is important that actions taken are those most likely to be productive. However, very often the sums of money required to make a difference are small, and it is the cultural changes that are crucial.

An interesting and explicit example of a higher-education institution that has publicly examined its internal practices and considered how to move forward, admittedly outside the UK, is MIT. In 1999 it published its first report on the status of women,¹ which has very recently been followed up, allowing an examination of progress.² This pair of reports is particularly illuminating because they show how progress can be made relatively easily, but also reveal the sometimes unanticipated consequences of actions taken which can create new problems. However, the US offers a very different climate (particularly as regards the legal position around issues such as maternity leave) and so it can only provide indicators.

1 <http://web.mit.edu/fnl/women/women.html>

2 <http://web.mit.edu/newsoffice/images/documents/women-report-2011.pdf>

The challenges that women face can be divided up under a variety of headings. Firstly there are those factors that are personal, under which I would include:

- family;
- work–life balance;
- lack of confidence.

Although these factors may be personal, there is much that an organisation can do to ameliorate their effects, as I will show.

Then there are those factors that I would attribute to the local working environment:

- isolation;
- lack of role models;
- lack of mentoring;
- lack of support networks.

Finally, and most perniciously, there are factors that arise due to more concrete actions by others around the individual, both at the same level and higher up the hierarchy, which may create a difficult, and sometimes impossible, work environment:

- unconscious bias present in co-workers;
- stereotyping allowed to persist;
- bullying and harassment.

Any of these factors may be enough to cause women to say, "Enough! I am not going on battling in this uncondusive atmosphere – I will take my services and skills elsewhere." Elsewhere may often be back home to lick wounds, when combining academic life and children just seems too hard. These are frequently women the workforce can ill afford to lose. However, there are other options that may tempt women out of academia into situations that seem less stressful or where the workforce is more balanced in its gender mix, thereby removing the isolation that can hit women hard.

Institutional buy-in

Individuals can do only so much to keep fighting in an unattractive atmosphere. Having the senior leadership give visible and explicit backing to policies and their implementation provides an important signal to all, including the next tier of management (such as heads of department) to indicate how important maintaining a fair environment and encouraging diversity is to the institution.

One very successful tool for encouraging both senior-level buy-in and self-reflection is the Athena Swan Charter³ and its awards, made to both entire universities and subsequently to individual departments. The charter has six strands, which need to be incorporated into action plans:

1. *To address gender inequalities requires commitment and action from everyone, at all levels of the organisation*
2. *To tackle the unequal representation of women in science requires changing cultures and attitudes across the organisation*
3. *The absence of diversity at management and policy-making levels has broad implications which the organisation will examine*
4. *The high loss rate of women in science is an urgent concern which the organisation will address*
5. *The system of short-term contracts has particularly negative consequences for the retention and progression of women in science, which the organisation recognises*
6. *There are both personal and structural obstacles to women making the transition from PhD into a sustainable academic career in science, which require the active consideration of the organisation.*

In seeking to become a member of the Swan Charter, first a university must submit an application as a whole, to demonstrate the organisation's commitment to these principles, and – assuming this is successful at the bronze level – thereafter individual departments can make their own application for bronze, silver and gold awards. Some universities have multiple departments achieving silver awards, others have none.

A key part of the application has to be the internal reflection that a department (or university) has to go through when assembling its proposal. Monitoring is integral to this: gathering data on the numbers of women at each stage of the pipeline, whether they are on comparable terms (for instance, are there more women than men on fixed-term contracts?), and where women are being lost or stuck at some bottleneck along the pipeline. Based on this, an appropriate action plan can be put together to try to overcome identified problems.

There are many relevant issues beyond simple statistics which this self-assessment may tease out, and many types of good practice a department or institution might already be pursuing or could readily adopt.

3 <http://www.athenasurvey.org.uk/universities.htm>

At the institutional level, areas that should be scrutinised include:

- consideration of flexible working patterns;
- transparency of processes around recruitment and promotion;
- involvement of women in decision-making processes and high-level committees;
- the creation of support networks; and
- the provision of mentoring.

At the departmental level, relevant steps might cover:

- exit questionnaires, to establish why people are leaving;
- the timing of research seminars to be sure they are family-friendly;
- inclusive staff meetings;
- discussion forums, maybe different ones for people at different stages, to identify concerns and propose actions, and/or staff satisfaction questionnaires; and
- again, the involvement of women in the decision-making processes.

Many of these initiatives do not cost much in explicit cash, although some may be quite time-consuming for key people in an organisation, but the impact on the working culture can be extremely beneficial.

There are different ways of establishing how the workforce feels about working conditions, but questionnaires (anonymous) are often useful if numbers are large enough for anonymity to be preserved and statistics to be meaningful. Within the UK, a useful tool has been the national ASSET (Athena Survey of Science, Engineering and Technology) survey⁴ carried out every few years. There is a good-practice guide associated with this at the website, which identifies helpful approaches and ways to use the institution's disaggregated responses. Because the survey is for men and women and carried out at regular intervals, it is particularly illuminating about differences for the sexes, and how these may be changing over time.

Different career stages, different actions needed

The undergraduate population clearly represents the start of the university feeder pipeline. As mentioned above, the proportion of women starting degrees in the sciences may be well over half in the biological and veterinary fields, but the subsequent fall-off is substantial. On the other hand, in physics, engineering and mathematics the numbers hover around a quarter of the undergraduate population, and do not seem

⁴ <http://www.athenasurvey.org.uk/universities.htm>

to be increasing substantially with time. These numbers are clearly related to problems much earlier in the schooling system, and probably also cultural messages young girls receive about what is "appropriate" for them to do through the media, their friends and peers, family and even teachers. This stage of the pipeline represents a different challenge, beyond the scope of this article. However, the very fact that fewer girls than boys enter physics or engineering degrees may mean that those who do have already self-selected as being willing to be strong-minded and actively to be "different".

Universities need to ensure they are monitoring how male and female students are performing. Anecdote has it that girls are less likely to take risks, are more likely to end up with second-class degrees, with fewer receiving marks at the extreme ends of the ranges than men do, and that they are likely to be favoured by continuous assessment more than exams. Course directors should see to what extent these possible outcomes apply to their own specific course and, if an attainment gap is found between the sexes in examination results, they need to try to work out why. Does this actually reflect a genuine difference in ability as, for instance, measured by school examination grades, or is there something more insidious at work here, including the way exams are either taught/tutored or marked?

In particular, are there subtle messages being given during the course teaching which may cause young women to underperform? The work of Claude Steele on stereotype threat, usefully pulled together in his book *Whistling Vivaldi*,⁵ explores issues that may lead college students (again from the US) to underperform because of expectations that they will do so. He also highlights so-called self-affirmation strategies that may be used to help overcome such negative outcomes, something which has also recently been highlighted in work specifically with physics students.⁶ Small actions, again, can be seen to make big differences in outcomes.

Early career researchers

The time that women start research careers, during their PhD and initial postdoctoral years, is the time when the local working environment becomes so important for them in aiding retention. If young researchers feel unsupported and isolated, if they feel there is no one to turn to if things start going wrong – particularly if this explicitly relates to their gender – then they may well choose to leave for a situation they find more conducive, or drop out of science completely. Here is an arena where universities and departments can do a great deal to offer backing by ensuring that supervisors and

⁵ Steele, C *Whistling Vivaldi* (WW Norton, 2010)

⁶ Miyake, A, Kost-Smith, LE, Finkelstein, ND, Pollock, SJ, Cohen, GL and Ito, TA "Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation" in *Science* vol 330, no 26 (2010), pp1,234–1,237

peers are well aware of what is unacceptable and that any inappropriate behaviour (even relatively minor comments in the tea-room) are stamped out. The role of a head of department is crucial in setting the right tone, and those who allow minor transgressions to be laughed at rather than dealt with will infect other members of the department.

Proactive steps will also be extremely helpful. Departments should think about setting up mentoring schemes, not necessarily using female mentors (almost certainly there won't be enough of them) or senior members of the department; those only a rung or two higher up the ladder than the mentee are often most useful because they remember better what it was like to be at that stage. Support groups, perhaps explicitly backed by the department in the form of provision of refreshments and space, enable individuals who otherwise might not often encounter other women to come together and share experiences and advice.

Appropriately targeted workshops around skills such as confidence building, CV writing and interview techniques may benefit all researchers at this stage, but often women will particularly profit. In developing appropriate strategies, for instance to cope with being the only woman in a room, assertiveness training and role plays can be very effective. Universities should explore the availability of such workshops; online courses simply don't work in the same way as face-to-face sessions.

Thus there are a variety of low-cost but targeted actions which may provide the support women need to give them the encouragement to stick in university science. However, the women themselves have to take responsibility for career planning and control of their lives. In order to facilitate postdocs knowing what questions they should be asking, and what actions they may need to take, the Athena Forum has produced a bookmark⁷ and accompanying guide⁸ which it is hoped individual universities will adopt and personalise with their own websites and logos.

In mid-career

A particular challenge is that childbearing years tend to coincide with that crucial stage of getting a first independent fellowship or a permanent position. There is no way around this biological factor, made worse by the fact that most universities are recruiting faculty at an increasingly late stage, in other words not just after a single postdoctoral position. For many women this is crunch-time, or else they decide there

⁷ <http://www.athenaforum.org.uk/Athenabookmark.pdf>

⁸ <http://www.athenaforum.org.uk/forum%20bookmark%20web%20text091222-1.pdf>

is no solution so they give up without trying to combine motherhood and academic career.

Visible role models are valuable here: women in institutions who can stand up and say, "Yes, I did it; it's not easy but ...", or case histories available on university websites. Additionally, Ottoline Leyser has created an excellent booklet⁹ of such case histories, which serves to debunk some of the myths of what scientific mothers can and cannot do (for instance around the timing of having children) and illustrate the enormous variety of ways mothers can "have it all".

Availability of good, on-campus and ideally subsidised childcare is vital: not only early-years nurseries, but also after-school and holiday provision. The importance of the availability of this extends beyond the simply practical to delivering a positive message to parents, of both sexes, as well as prospective parents. (I am discussing childcare in the context of mid-career, but these issues can, of course, be relevant to women at earlier stages in their career.) Timing of meetings should also be carefully considered: end-of-day meetings that clash with children returning from school should be avoided and, where at all possible, key departmental meetings fixed during the middle part of the day when anyone working flexibly (see below) can attend.

Another key issue will be the availability of flexible working practices and the generosity of maternity leave, particularly with pay. What happens to a young mother who wants not to return to work full-time – at least to begin with – after the birth of her child? University policy might permit several options, including graduated return (returning to full-time working over a matter of months or even years) as well as part-time working. The latter can be creatively managed so that a woman might choose, for instance, to work full-time during school term but reduced hours in the holidays. The important thing is to enable dialogue to take place to work out an outcome positive for both the individual and the institution. Facilitating "keeping in touch" days during maternity leave, so that women don't feel completely cut off during their absence, helps a continued sense of involvement, as does ensuring that emails about departmental events and news continue to be sent out.

Another useful measure an institution can put in place is some mechanism to facilitate the returner re-establishing her research. Certainly in research-intensive universities, this is likely to be of greater importance than simply returning to join the cohort of teachers or committee members. Routes to achieve this might be a commitment to

⁹ Leyser, O "Mothers in Science: 64 Ways to Have it All", downloadable from the Royal Society's website at <http://royalsociety.org/Content.aspx?id=3224>

the woman having no new lecture courses to give within the first year of her return, a release from laboratory teaching, or even (and requiring explicit cash) funds being offered to allow the recruitment of a researcher for a fixed period to kick-start the returner's research programme, or allow new directions to be explored. A good example of this last was set up at Sheffield University in the form of the Women Academic Returners' Programme (WARP),¹⁰ whereby funds were made available to the department to cover any additional staffing needs so that the returner could get research up and running again.

The worst thing a department can do at this stage is to expect an immediate return to full strength on all the fronts of teaching, pastoral care, committee work and research. A department that does that should not be surprised if women find the expectation too great and hence choose to leave rather than struggle on. Recent changes in paternity law may mean a greater number of men take extended leave around the birth of a child, so such policies may increasingly be of importance for male employees too.

Mid-to-late career stage

A key finding from the original MIT report was that women felt marginalised, not involved in important committees and the decision-making process as a whole. As women moved up the career ladder this was a sensation they became increasingly aware of as they watched less-senior male colleagues' views being sought while theirs were not. The recent MIT report² shows that the lessons have been learned, and there is now a much stronger sense of inclusion and being valued felt by female faculty. This is a lesson that all universities should take on board.

Committee membership should be diverse, to ensure not only that women's voices are formally heard, but also that an appropriate breadth of views are taken into account. It is, after all and in another sphere, becoming established that companies that have diverse board membership tend to thrive better than those in which the board is uniformly white, male and all of a similar age.

However, for women in the sciences where the numbers of senior women are still low, there is a potential downside: the few women there are may end up with a high volume of committee work expected of them to the detriment of other parts of their job, including research. This fact needs to be taken into account when committee membership is discussed and creative approaches should be taken to solve the problem (for instance using a woman at a slightly earlier career stage, upon occasion, than

¹⁰ <http://www.sheffield.ac.uk/hr/opportunitynow.html>

would normally be the case). Women themselves should also consider carefully invitations to serve, to ensure that the roles being asked of them are meaningful and relevant, not just being offered to fulfil nominal quotas.

A corollary of this is that at times strong chairing of committees will be required to ensure that the women really are heard, and that inappropriate behaviour by male colleagues does not occur, which otherwise can lead to the involvement of women being no more than a fig leaf covering up continued marginalisation in practice.

As at earlier stages in their careers, senior women may feel quite isolated as their numbers are so low. Furthermore, if they have not had appropriate mentoring and confidence building previously, their ability to assume a full leadership role within the university may be compromised (promotion is likely to be due to factors other than leadership skills). Skills-based workshops, including formally around leadership and management, may be helpful. If the courses are also allowed to bring women at equivalent levels together, they may be able to share tips and experiences, creating an informal network that can help to disseminate best practice across the university.

Out of such networks it may also be possible for the university to identify a series of champions in different parts of the university, to be visible beacons of success and experience to encourage junior women to stick with academic careers, and to act as two-way conduits for information exchange. Such champions can also usefully be involved in and with groups setting policies and strategies regarding the working environment, once again helping to disseminate best practice.

Conclusions

There is no doubt that the climate for women in the sciences in universities is improving, and the numbers of such women are slowly climbing. However, the leaky pipeline still wastes too much talent at every stage from undergraduate onwards, and active steps must be taken by organisations to reduce these losses. This article documents a few interventions that may help individual institutions to stem the outflow of women. Absolutely central to any programme of change must be clear and visible buy-in regarding the importance of this issue right from the very top, and encompassing heads of departments and equivalent.

Only by taking active steps to support women at each stage, and by demonstrably working to overcome negative stereotypes and what is often quite crude bad behaviour in some quarters, will all the talented women who wish to pursue academic careers be facilitated in doing so. That the supply of young women entering the pipeline at under-

graduate level in the physical sciences and engineering is so low is a different sort of problem, but one that also urgently needs to be addressed.

Chapter 4

The importance of schooling

Clare Thomson, Curriculum and Diversity Manager (pre-19) at the Institute of Physics

The importance of schooling

A-level physics, or its equivalent, is a gateway subject to a whole range of careers in the physical sciences, engineering and technology, as well as in many other areas of finance and business. For that reason, it is a major cause for concern that the proportion of girls studying physics post-16 has remained around 22% for the past 20 years. Although girls enter medicine and the biological sciences in at least equal numbers with boys, they are not engaging with physics in the same way. The early success of young women in education does not translate into similar advantages in terms of careers and pay in later life, and they are significantly less likely than men to work in science, engineering and technology.

The analysis of gender differences is complex and indicates a number of interacting influences. There is no simple solution to the lack of girls choosing physics post-16, and many long-standing beliefs about the reasons for girls' alienation from physics have been contested in the literature. Efforts to improve the situation have had some limited success, but frequently the results have not been clear-cut and there has been a lack of sustainable change. The problem is deep-rooted, multifaceted and thus difficult to solve, but it is vital that girls find the physics classroom experience engaging and meaningful, if they are to progress with physics beyond the compulsory stage.

Promoting enthusiasm for science is a well-established aim of school science, not only to encourage take-up of subjects post-16, leading to careers in science and engineering, but also to enhance all students' interest in scientific issues as they continue into adult life. In recent years there has been a range of studies concerning students' attitudes to science, focusing on factors that influence attitudes and subject choice post-16. The best-known of these are the Norwegian Relevance of Science Education (ROSE) project¹ and the Trends in International Mathematics and Science Studies (TIMSS).²

Negative attitudes

These studies show that the more developed the society, then the more negative the view of school science held by young people. Those countries whose students are the most successful in the TIMSS studies, and which offer a very traditional science education with an emphasis on scientific knowledge, have students with the most negative attitudes towards science. Such data are of concern to all developed societies

1 ROSE: Relevance of Science Education (<http://www.ils.uio.no/english/rose/>); introductory overview of the ROSE study (<http://www.scienceinschool.org/2006/issue1/rose>)

2 TIMSS: Trends in International Mathematics and Science Studies (<http://nces.ed.gov/timss/>); TIMSS 2007 International Mathematics and Science Reports (http://timssandpirls.bc.edu/TIMSS2007/intl_reports.html)

who perceive a lack of student interest in the study of science as a threat to their knowledge-based economies.

Osborne and colleagues conducted a major review of the research in the area of student attitudes.³ They observe that, in the UK, more pupils than ever are taking A-levels or their equivalents, and have an increasing range of subjects to choose from. The consequence is that fewer and fewer are taking only science and mathematics A-level combinations. It may be that it is not so much that science is not interesting, but rather that science is less interesting than other subjects. Simon and Osborne⁴ point out that there is a gap between students' attitudes to science itself, which are generally positive, and their attitudes to school science, which are increasingly negative for a significant proportion of students. Studies suggest that this gap is due to the message presented by school science, which situates school science as a value-free, detached activity, unrelated to any societal context that would give it meaning or relevance.

Haste, in her work⁵ analysing questionnaire data from samples of the youth cohort, suggests it is not so much that girls are less interested than boys in science, but rather that girls focus on different things. This is clearly exemplified in the English ROSE data whereby respondents were asked to rank 108 items that they would like to learn about in science. The top five items for girls and boys are shown in the table below.

Figure 1: The top five items boys would like to learn about in science and the top five for girls (English ROSE data)

Boys	Girls
Explosive chemicals	Why we dream when we are sleeping and what the dreams might mean
How it feels to be weightless in space	Cancer – what we know and how we can treat it
How the atom bomb functions	How to perform first aid and use basic medical equipment
Biological and chemical weapons and what they do to the human body	How to exercise the body to keep it fit and strong
Black holes, supernovae and other spectacular objects in outer space	Sexually transmitted diseases and how to be protected against them

3 Osborne, JF, Simon, S and Collins, S "Attitudes towards Science: A Review of the Literature and its Implications" in *International Journal of Science Education* vol 25, no 9 (2003), pp1,049-1,079

4 Simon, S and Osborne, JF "Students' Attitudes to Science" in Osborne, JF and Dillon, J (eds) *Good Practice in Science Teaching* (2010)

5 Haste, H *Science in My Future: A Study of the Values & Beliefs in Relation to Science & Technology amongst 11-21 year olds*, Nestle Social Research Programme (2004)

The things boys are most interested in we would categorise as physics or chemistry and the things that girls are most interested in we would call biology. Girls want to know about areas of science and engineering that affect them personally. They are also more concerned about the ethics associated with the application of science and appear to have a more realistic view of the future, believing that science cannot solve basic problems like poverty and unhappiness. Clearly, if girls hold these values, a decontextualised, value-free science without opportunities to explore the social or ethical implications of science is unlikely to appeal.

Simon and Osborne⁶ suggest that contemporary society gives pre-eminence to the individual and therefore school science needs to present itself to young people as the means by which the major problems facing humanity can be solved:

The values emphasised by contemporary advanced societies include care for the environment, democracy, care for others, creativity and self-realization. That this is so is reflected in the fact that recruitment in Western societies into medicine, the life sciences and environmental studies is not falling and, in these areas, girls often outnumber boys The desire, therefore, to work in an area that students find meaningful is a driving force in their choice of subjects to study.

Examining girls' lack of engagement

As a result of the concern over the continuing decline in the numbers of students, particularly girls, choosing A-level sciences in the early part of the 21st century, the Institute of Physics commissioned two pieces of work about girls' engagement with physics. The findings draw together the research over a wide number of sources.

"Yes She Can" was an investigation by Bob Ponchaud (former government inspector of schools for science) into schools that are successful at attracting girls to study A-level physics and how this might inform other schools. This report was not published separately, but forms the basis of the first section of the 2006 publication *Girls in the Physics Classroom: A Teachers' Guide for Action*.⁷

Patricia Murphy and Elizabeth Whitelegg of the Open University carried out a review of the research into the participation of girls in physics.⁸ This aimed to consolidate current

6 Op cit

7 Hollins, M, Murphy, P, Ponchaud, B and Whitelegg, E *Girls in the Physics Classroom: A Teacher's Guide for Action* (Institute of Physics, 2006)

8 Murphy, P and Whitelegg, E *Girls in the Physics Classroom: A Review of the Research on the Participation of Girls in Physics* (Institute of Physics, 2006)

understanding of the problem and to identify from existing research the reasons why girls choose not to continue studying physics. The two reports reveal some of the important issues that underlie the statistics for examination entries:

It cannot be assumed that in the current National Curriculum provision all students, in particular girls, are gaining meaningful access to physics. It is of particular concern that the most recent statistics for GCSE triple-science results (2010) show that all three sciences are still being taken by more boys than girls (roughly 54% of total entries).

Students' interest in science declines as they progress through school, and the decline appears to become steeper after age 14, particularly for girls and particularly in physics.

Girls, more than boys, experience a difference between their personal goals for learning and the learning objectives of the physics curriculum. As a consequence they are less inclined to opt for physics, even if they achieve high grades and enjoy the subject.

As they go through secondary schooling, students experience physics as increasingly difficult. This perception is partly due to the mathematical demands of the subject but also to girls' developing feeling of "not being able to do physics". The feeling is not borne out by the reality of girls' performance; see figure 2.

Figure 2: Percentage of the cohort (girls or boys) who achieve an A* or A grade at GCSE

	Mathematics		Physics		Chemistry		Biology	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
2010	16.0	16.4	47.9	48.8	51.3	46.9	49.1	45.0
2009	15.2	15.5	49.2	49.5	53.1	49.1	48.8	47.0
2008	14.8	14.1	52.1	51.2	54.4	51.2	49.0	48.1
2007	13.8	13.7	45.8	48.5	48.3	45.9	46.4	43.4

Source: JCQ

The key influences on students' attitudes to physics were identified as:

- self-concept – that is, students' sense of themselves in relation to the subject, the value they place on the subject and their willingness to engage with it;
- views of physics – that is, how students experience physics at school; and

- teacher-student relationships – that is, how personally supportive students find their physics teacher.

Ofsted has just published a report⁹ on girls' career aspirations, based on a small-scale survey. This looked at the choice of courses and careers made by girls and young women at various stages in their education and training. Inspectors found that from year three onwards, the girls spoken to were thinking about what they would like to do after they left school. For girls of all ages, this thinking was strongly influenced by family and friends, and they were aware of the conventions surrounding "girls' jobs" and "boys' jobs".

Almost all who took part in the survey were open to the possibility of pursuing a career that challenged gender stereotypes, if it interested them sufficiently, but their awareness of this potential did not always translate into practice. In the few examples where girls had changed their minds and set out on a new and unfamiliar route, that change had often been catalysed by a personal experience of meeting a professional in school, or directly encountering the new kind of work for themselves.

The key findings of the report echo other work in this area, and include the following:

- The programmes of careers education and work-related learning, and the provision of information, advice and guidance in the schools visited, were not focused sufficiently on the knowledge, understanding and skills that girls and young women need in order to deal with factors such as career breaks and the role they might wish to play as future parents.
- A narrow range of gender-stereotypical work placements dominated choices in almost all the settings seen.
- The girls and young women had limited knowledge and understanding of how choices about courses and careers influenced pay and progression routes.

What can be done

It is clear that, although societal pressures have a significant impact on the choices that girls and young women make, schools can and should do more to help overcome the perceived barriers and stereotypical views held by many of the girls and young women going through the education system. School science needs to offer girls, in particular, a vision that shows it is the physicist or engineer who is going to make major contributions to providing new

⁹ Ofsted *Girls' Career Aspirations*, ref no 090239 (2011)

alternative energy sources, animal- and environmentally-friendly food production, new methods of eliminating disease and solving the challenges of global warming.

After the publication of the two Institute of Physics reports, the Science Learning Centres obtained funding to explore supporting teachers using action research to help girls engage more successfully with physics. This work took place in two phases in 2006–07 and 2008, with the second phase involving around 66 schools. The Girls into Physics action research programme arose from a desire to work in a way that shared information with teachers and supported them to try out strategies that had been identified as successful in the *Teachers' Guide for Action*. In their evaluation of this work, Daly, Grant and Bultitude¹⁰ concluded that teachers require time, space and support to implement significant change in their pedagogy and the culture of the school. There were three themes identified as crucial first steps in the process of changing girls' participation in physics in schools:

- A consideration of gender equality in relation to theory, policy and practice is needed to inform teachers in their current practice and have an impact on girls' participation in physics in the long term.
- Action research is an effective way for teachers to use the Institute of Physics materials. This type of learning is experiential, with teachers trying out methods for themselves. For many, the starting point is very general, but there is the opportunity to engage with the issues personally and as a school, leading to the development of more meaningful research questions.
- Listening to students and valuing their contributions is an important legacy of the project. Many teachers reported that they found pupil voice to be one of the most informative aspects of the project. The informal and qualitative discussions that teachers had with pupils had a significant impact on their appreciation of the extent of girls' disengagement from physics.

A follow-up report commissioned by the Institute of Physics shows that for such work to have a lasting impact on embedding and extending good practice in gender-aware teaching of physics, and a significant increase in girls' take-up of A level physics, a number of key factors need to be present. Of prime importance is the support of senior management in the school, as well as the leadership and inspiration provided by the

¹⁰ Daly, A, Grant, L and Bultitude, K *Girls into Physics: Action Research*, research brief DSCF-RB103 (Institute of Physics, 2010) (<http://www.education.gov.uk/publications/standard/publicationDetail/Page1/DSCF-RB103>)

head of science, and alongside this a commitment to improving science and physics achievement across the school. Successful teachers have a reflective approach, with a desire to improve their practice, and use teaching and learning strategies in class that engage students with the ideas of physics and that support active learning. A good physical environment, both in terms of laboratory space and equipment, also helps.

In conclusion, girls are more likely to continue with physics after the age of 16 if physics is taught in a way that engages with the interests of young people and where there is an expectation that anyone can do physics. In successful schools classrooms are managed to ensure active participation by students, and the focus of learning is ideas rather than unconnected facts. Students feel supported in their learning and understand the contribution that physics makes to society and can make to their lives.

The teacher is crucial to the success of the delivery of such a context-based or humanistic curriculum, which assumes a particular view of physics knowledge and an approach to teaching and learning where the teacher acts as a guide to students but the students have responsibility for their own learning. Some teachers struggle with the approach, either because it conflicts with their view of teaching and learning or because they need more support to teach and assess using this approach. However, interest in the work with teachers and the institute's resources has been growing, and there is hope that, if the impact can be sustained, then there may be measurable improvement in the number of girls continuing with physics post-16.

Implicit within this is the necessity for schools and subject teachers to develop a better understanding of the wide range of progression routes available in science, engineering and technology so that girls and young women can make informed choices. Ofsted recommends that schools should develop more carefully planned opportunities for young women to meet professionals working in non-stereotypical roles and to learn about what such work entails, so that they have a better understanding of the long-term impact of career choice on their lives and potential earnings. Subject teachers need to consider how to link, more frequently, the content of lessons and the skills to be developed to career opportunities.

A good supply of well-qualified and enthusiastic physics teachers is vital, because girls, who often lack familiarity with the situations and activities that are commonly used as contexts in physics, require more support to negotiate shared meanings and are therefore more sensitive to poor teaching than are boys. Teachers need to be able to set their subject in well-chosen and engaging contexts for their particular students and should be able to run well-ordered and stimulating lessons.

Any changes to the physics curriculum should be informed by an understanding of the gender issues, and assessment processes must not introduce barriers to the participation of girls in physics. The physics curriculum itself must develop students' understanding of how the physics they are learning relates to themselves, has an effect on the modern world, and opens up a range of professional and technical careers.

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Chapter 5

A new era for careers – choices and consequences

Dr Deirdre Hughes, Immediate Past President of ICG and Associate Fellow at Warwick Institute for Employment Research

A new era for careers – choices and consequences

Shifting global and economic conditions are affecting the opportunities that individuals perceive they can readily access, including opportunities to learn and earn abroad. With the economic growth of the BRIC nations (Brazil, Russia, India and China) and the challenge they represent for Europe and the US – and with China and India being the two most heavily populated countries in the world¹ – there is pressure on the UK to sustain its competitive edge by inspiring more individuals to acquire and apply science, technology, engineering and mathematics (STEM) knowledge, skills and expertise.

Research evidence shows that fewer girls and women engage in STEM subjects, studies and occupations, thereby creating significant loss of human capital for UK plc. Across Europe, changing patterns of working, learning and career development² highlight the importance of job mobility and enhanced careers services for individuals in a wide range of settings. In the UK, it is notable that despite women's labour market participation in numerical terms now being roughly comparable with men's, their work commitment and related employment patterns are often different, in many ways more complex, and seem to be increasing in diversity. Given this reality, how adequate are careers support services in responding effectively to girls and women in relation to STEM?

A major international comparative study, ROSE (Relevance of Science Education)³ led by the University of Oslo in Norway, researched the relevance of science and education and suggested that it may be seen as paradoxical that "in spite of the increasing importance of science and technology, schools in many countries are facing a lack of interest in these subjects". The problem seems to be that many individuals are broadly content to enjoy the benefits of STEM, but STEM subjects are commonly perceived as difficult or boring to study and learn. To unlock potential, particularly in girls and women, it is necessary to stimulate their interest and curiosity in these subjects and to promote their confidence and abilities in STEM and other related areas.

This article briefly examines some trends relating to emerging perspectives on the formation of career aspirations from an early age and how this can affect young

1 A combined total in 2008 of 2.4 billion people out of 6.6 billion (adding up to 36% of the total world population)

2 Browne, J et al *Securing a Sustainable Future for Higher Education: An Independent Review of Higher Education Funding & Student Finance* (2010)

3 Schreiner, C and Sjöberg, S "Sowing the Seeds of ROSE: Background, Rationale, Questionnaire Development and Data Collection for ROSE (Relevance of Science Education) – A Comparative Study of Students' Views of Science and Science Education" in *Acta Didactica* (University of Oslo, 2004) (<http://www.ils.uio.no/english/rose/key-documents/key-docs/ad0404-sowing-rose.pdf>)

females' and adults' perceptions of women in science, engineering and technology. The current policy context in England for a new all-age careers service⁴ is also considered within the context of "improving social mobility, increasing retention within education and reducing drop-out". There are growing concerns about a lack of investment in careers education and workforce development to ensure teachers and careers professionals are sufficiently trained in providing access to accurate labour market information and appropriate careers guidance support in the interpretation of data relevant to individual circumstances. It sets out the main challenges for those responsible for the design and delivery of careers support services to help tackle gender and ethnicity imbalance issues.

Trends and emerging perspectives

With 80% of the 2020 workforce already in work, it is clear that "we must fix the 'stock' of adult skills as well as the 'flow' of young people into the labour market".⁵ The *Science for Careers* report from the Science & Society Expert Group⁶ and subsequent findings published by Holman and Finegold⁷ outline a growing need to commence careers-related work from an early age. A further review of the evidence base by Bysshe and Hughes⁸ reaffirms that the formation of aspirations begins early: for example, "what children say at the age of 11 about their educational intentions is highly predictive of their actual behaviour at aged 16."⁹

Gottfredson¹⁰ argues that children aged nine to 13 begin the progressive elimination of least-favoured alternatives. By this stage, children and young people are beginning to dismiss a large range of occupations according to gender stereotypes, at unacceptably low or high levels, or beyond their capabilities. Although this eases the burden of choice, it also forecloses individuals' potential by limiting their experience and educational choices. It is also notable that only around a third of undergraduates in STEM disciplines are female, and although this position has improved over time, the

4 <http://www.bis.gov.uk/news/speeches/john-hayes-national-careers-service-for-england>

5 UK Commission for Employment & Skills *Ambition 2020: World Class Skills & Jobs for the UK* (2010) (http://www.ukces.org.uk/upload/pdf/UKCES_FullReport_USB_A2020.pdf)

6 Garnham, D *Science for Careers: Report of the Science & Society Expert Group* (Department for Business, Innovation & Skills, 2010) (<http://interactive.bis.gov.uk/scienceandsociety/site/careers/files/2010/03/BIS-R9199-URN10-767-WEB.pdf>)

7 Holman, J and Finegold, P *STEM Careers Review: Report to the Gatsby Charitable Foundation* (2010)

8 Bysshe, S and Hughes, D *Future Choices: Raising Aspiration & Attainment in Years 5-8* (Aimhigher Initiative, 2010)

9 Croll, P and Moses, D *The Formation & Transmission of Educational Values*, final report to the ESRC, project no R000239963 (ESRC, 2005)

10 Gottfredson, LS "Gottfredson's Theory of Circumscription, Compromise, and Self Creation" in Brown, D (ed) *Career Choice & Development* (4th edition) (Jossey-Bass, 2002), pp 85-148

gender gap is still considerable. As a consequence, it is crucial to explore, support and inform individuals' aspirations and to help them to see a relationship between what they are doing in the present and what they may wish to do in the future – thus linking aspiration and attainment, throughout the life course.

Ofsted¹¹ has recently reported that girls are receiving weak information about careers, making it difficult for them to make informed choices about courses. It highlights that most examples of work placements for young women collected from school records were stereotypical experiences. It also found that most of the schools were not doing enough to promote confidence and ambition in girls or encouraging them to challenge vocational stereotypes. In general, girls aged 11 to 14 had limited knowledge and understanding of how choices about courses and careers influenced pay and progression.

Examples of work being carried out to understand issues related to the gender imbalance in STEM subjects and careers resources can be seen through a plethora of initiatives, including the National STEM Centre¹² and Teachers Development Agency for Schools (TDA), which together are planning to update professional development materials for teachers to include a focus on ICT and STEM. There is also the intention to explore the scope for involving the TDA in increasing teachers' knowledge and understanding of STEM careers through initial teacher training. Without these new approaches, unlocking potential among girls and women (and other under-represented groups) remains a missed opportunity in harnessing available human capital to good effect.

The OECD¹³ indicates that across the UK and further afield:

Academically trained teachers have often spent most of their lives in education. Their experience of the wider work environment can be limited and their formal or informal advice to students may be biased towards general education and university pathways. They may be reluctant to recommend vocational courses, particularly to bright students.

While this can be interpreted as a broad generalisation of those in the teaching profession, it does illustrate powerfully the requirement for a new partnership approach between teachers, careers professionals, employers and training providers.

11 Ofsted *Girls' Career Aspirations* (2011) (<http://www.ofsted.gov.uk/Ofsted-home/Publications-and-research/Browse-all-by/Documents-by-type/Thematic-reports/Girls-career-aspirations>)

12 <http://www.nationalstemcentre.org.uk/>

13 OECD *Challenges & Policy Options for More Effective Career Guidance* (2010), p5

Last October, the Education and Employers Taskforce¹⁴ published a report undertaken by Deloitte on the role of employers in careers education. The findings made clear that young people today enter a labour market that is highly dynamic and confusing without adequate knowledge of the range of jobs and careers, nor of the skills required for each role. The task force stated that "even at this time of record youth unemployment, some 15,000 apprentice places remain unfulfilled, and with increases in university fees due in 2012, the penalty for a wrong careers decision grows greater".¹⁵ In summary, it is widely agreed that careers support services need to improve significantly in order to increase levels of connectivity between young people (and adults), educationalists and employers.

The policy context

John Hayes, the minister for further education, skills and lifelong learning, has articulated clearly the importance of career guidance in promoting social mobility increasing retention within education and reducing drop-out.¹⁶ The government's approach builds upon the 2010 Browne report,¹⁷ which highlighted the importance of career guidance in relation to entry to higher education, whereby "students should be better informed about the range of options open to them.... Their choices will shape the landscape of higher education." Also, the 2009 Milburn report¹⁸ outlined the role of career guidance in broadening access to the professions, followed more recently by the deputy prime minister's launch of the government's Strategy for Social Mobility.¹⁹ In the latter report, it is stated that "it is notable that between 2000 and 2009, 15-year-olds in the UK have fallen from 4th to 16th in international rankings in science",²⁰ with similar statistical trends reported in relation to literacy and maths.

This is reinforced by concerns raised in the 2011 Wolf report,²¹ which outlines the challenges faced by young people aged 14-19 in their selection of vocational studies, and the need for greater involvement of business and employers in promoting successful and sustained progression into the labour market. What appears to be

14 <http://www.educationandemployers.org/what-we-are-doing.aspx>

15 Nick Chambers, director of the Education & Employers Taskforce in England, speaking at the Institute of Career Guidance annual conference, November 2010

16 John Hayes in the Education Bill Committee, 29 March 2011

17 Browne, J et al (op cit), p25

18 Panel on Fair Access to the Professions *Unleashing Aspiration: The Final Report of the Panel on Fair Access to the Professions* (2009)

19 HM Government *Opening Doors, Breaking Barriers: A Strategy for Social Mobility* (2011), pp40-41

20 Op cit

21 Wolf, *A Review of Vocational Education – The Wolf Report* (Department for Education, 2011) (<http://www.education.gov.uk/publications/standard/publicationDetail/Page1/DFE-00031-2011>)

missing is the need to find more creative ways to stimulate interest and learner engagement in STEM subjects, in particular for girls and women. We know that schooling performs a moral purpose by enabling individuals to construct themselves as adults. Yet within a wide range of educational institutions (ranging from primary schooling through to higher education) insufficient attention is given to careers education and the design and delivery of effective careers support services.

There is great concern that the Coalition's current education legislation proposes to remove the secretary of state's direction-making powers regarding local authority services in England and to place a duty directly on schools requiring them to secure access to independent careers advice. Thus pupils would be reliant on the quality of advice secured by individual schools. With fewer young women choosing STEM subjects, and by not encouraging young women through careers education and guidance interventions, there could be further gender stereotyping in education, with resultant occupational segregation in the workplace. Bimrose²² argues that occupational segregation is one of the three main factors contributing to the gender pay gap, alongside pay discrimination and unequal impact of caring responsibilities.

Occupational segregation is apparent in the majority of apprentices in the two highest-paying sectors dominated by males (manufacturing engineering, and electro-technical), whereas the majority of apprentices in the three lowest-paying sectors are dominated by females (hairdressing, early-years work, and health and social care).²³ From a STEM perspective, it may well remain the case that, however well girls and women achieve, they are likely to face disparity in earnings in spite of increased attainment²⁴ unless further work is done on this. In order to address this obvious gender imbalance, it is vital to step back and consider how this can be tackled when the provision of careers advice becomes fragmented.

The current government reportedly views careers education as an on-going process, part of what schools do as a matter of course to prepare their students for the next stage in their learning or career, and they believe that schools should be trusted to do that. But therein lies a dual problem.

Firstly, embedding STEM careers into the curriculum is one of the routes open to raise awareness of students (and teachers), strengthened by a partnership approach with

22 Bimrose, J "Guidance for Girls and Women" in Athanasou, JA and Van Esbroeck, R (eds) *International Handbook of Career Guidance* (Springer, 2008), pp375- 404

23 *STEM Choices: A Resource Pack for Careers education, Information, Advice & Guidance Practitioners* (2009), p15 (<http://www.education.gov.uk/publications/standard/SchoolsSO/Page14/STEM-CHOICES>)

24 Op cit, p15

career professionals.²⁵ Although the government has confirmed that local authorities continue to have responsibility for provision of advice until the law is changed, given the recent demise of Connexions services throughout England there is justifiable concern about what will happen to this year's cohort of year 10 and 11 students.

Secondly, OECD findings cited earlier highlight that many teachers are ill-equipped to design and deliver effective career learning for their students. These problems could be further compounded by applying free market principles to the delivery of careers guidance services²⁶ and the removal of ring-fenced funding in schools for careers education and allied careers support services.

Workforce development issues

Until the new National Careers Service is fully launched in April 2012 and its structure and design specified more fully, it will be essential to ensure resources and expertise are not completely lost. The Careers Profession Task Force in England (commissioned by the government in February 2010) has highlighted the need to further strengthen the competence of those working in the careers sector.²⁷ A conclusion from the research was that this should be done by embedding STEM, labour market information and ICT skills and competencies as central in both initial work-based and off-the-job training.²⁸ Similar conclusions emerged from a recent review of careers services in Wales.²⁹ The UK Careers Profession Alliance,³⁰ led by Ruth Spellman OBE, is now establishing a new set of common professional standards and a code of ethics for careers professionals and careers educators.

In autumn 2010, the STEM subject choice and careers project team (led by Sheffield Hallam University)³¹ linked up with the Warwick Institute for Employment Research to produce an online learning module to support the active learning through continuous

25 Op cit, p3. Note: "It is important to ensure that career routes and qualifications form an intrinsic part of all STEM courses ... this will require a partnership approach at the level of curriculum design from both careers professionals and teachers"

26 Bimrose, J, Hughes, D and Barnes, SA *Integrating New Technologies into Careers Practice: Extending the Knowledge Base* (UK Commission for Employment & Skills, 2011) (<http://www.ukces.org.uk/upload/pdf/Integrating%20New%20Technologies%20into%20careers%20practice.pdf>)

27 Department for Education *Towards a Strong Careers Profession: An Independent Report to the Department for Education* (2010), p2 (<http://www.education.gov.uk/publications/eOrderingDownload/CPTF%20-%20External%20Report.pdf>)

28 Op cit, p13

29 Edwards, H, Sanders, D and Hughes, D *Future Ambitions: Careers Services in Wales* (Welsh Assembly Government, 2010)

30 The Careers Profession Alliance is committed to creating a professional, single-body organisation, which will set standards, maintain a professional register (possibly leading to a licence to practice), and will provide a range of professional services.

31 <http://www.shu.ac.uk/research/cse/stem-careers.html>

professional development (CPD) of teachers and careers professionals in the area of STEM. This resource will provide labour market information on STEM issues and support the process of learning required to think through and undertake research into current and reliable labour market information on STEM on an on-going basis. It will be available in late spring of 2011. This work extends and complements that of the National STEM Centre, drawing on resources that have been already been developed under this initiative.

The main challenges for policy makers and practitioners include how best to inspire girls and women to realise their full potential and to explore all alternatives open to them, including STEM opportunities. The urgent imperative is to open up new possibilities for careers aspirations to move beyond traditional stereotypes, while simultaneously providing UK plc with an increase in human capital in this sector. To maximise impact, access to reliable labour market information and STEM resources for young people and adults is necessary through the provision of both online and local face-to-face services.

Policy makers and practitioners will need to meet this challenge at a time of shrinking resources in this current climate of austerity. The UK Commission for Employment & Skills has recently published a series of reports on different aspects of integrating ICT into careers practices.³² These are all available through a common portal and provide a clear indication of the potential for extending and developing practice in this area. These works make clear that the adequacy of careers support services cannot be left simply to over-reliance on online services.

In conclusion, there is a strong need to eliminate gender stereotyping from an early age. Teachers are well placed in local communities but their skills and experience in providing careers support is generally very limited. The demise of the Connexions services has exacerbated the issue of young people's access to high-quality and impartial careers guidance. A lack of ring-fenced funding in educational institutions for careers provision is a major concern. While this period of uncertainty remains, professionals will have to find a way of managing this. Embedding STEM, labour market information and ICT within both initial work-based and off-the-job training must be achieved at low cost. However, there is a high cost for individuals, particularly for families and communities and for the national economy, of ill-informed career decisions. Inspiring girls and women to visualise and experience future possibilities in STEM has to be up there as a major priority.

32 <http://www.ukces.org.uk/our-work/strategy-and-performance/information-advice-and-guidance/>

Chapter 6

Returners

Dr Katie Perry, Chief Executive of the Daphne Jackson Trust

Returners

Personal perspective

Some years ago I thought I had reached a point in my professional career where nothing much surprised me. Having worked as a physicist, for a learned society and in science communication, I knew certain things: that there will always be a battle to try to increase the numbers of women in science, engineering and technology (SET); that, despite any amount of legislation, the landscape faced by female scientists, engineers and technologists will not change overnight; that, whatever amazing projects are initiated, someone somewhere will always be ready to criticise them; and that there will always be small groups of determined campaigners working very hard but whose voices will struggle to be heard above the noise.

Knowing all the current trends in promotion of science, engineering and technology, and with the experience myself of being a woman in a male-dominated environment, I embarked on what I thought would be a predictable new role as press and PR officer with the Daphne Jackson Trust and started communicating on a regular basis with a sector of the scientific community who were new to me – returners.

As I had more dealings with the returners who had completed Daphne Jackson fellowships, I began to realise what an incredible and under-utilised resource returners actually are. Remarkable, inspiring, determined, resourceful: these are just a few of the ways to describe these women – and, more recently, men – who have been helped by the Daphne Jackson Trust. My “predictable” role turned out to be anything but, and I am now delighted to see on a daily basis just how talented and inspiring returners can be, and also delighted that eight years on I am now the chief executive of the charity.

Barriers faced by returners

I am very often disturbed by the anecdotal evidence I hear about employers, in both public and private sectors, not valuing staff who are parents, worrying about whether staff will have time off if they have children who are ill, and generally questioning the commitment of those who are parents. In my experience, both of being a parent and in dealing with returners who have children, there is no better training for a stressful work environment and working to deadlines than having a career break to bring up small children. As anyone who has done it knows very well, it sharpens your multitasking abilities, negotiation skills (especially when dealing with teenagers), ability to deliver on time and on budget, and conflict resolution skills. Having made the decision to overcome the many barriers and return to a career, returners will show a high degree of dedication, loyalty and commitment that is less often seen in other employees.

Career breaks are taken not only by those who have children, though, and not exclusively by women either. There can be many reasons for a break in a scientific career, such as relocation with a partner, caring for elderly relatives, or illness. As society gradually changes and men and women are in more equal partnerships in terms of careers, it can often make more sense for a father rather than a mother to take a break to care for children, or for a man to take on a supporting role and have a break from his own career as his partner goes up the career ladder. Even so, it is still predominantly women who take career breaks, and the most common duration is between three and eight years.

Scientists, engineers and technologists often feel unable to return to their previous careers, for a wide variety of reasons: lack of part-time or flexible posts, difficulties with childcare, unpleasant and outdated working environments, lack of career progression, secretive and unfair recruitment and promotion procedures, to name but a few. In fact, it can be almost impossible for many to return without the help of a Daphne Jackson fellowship, as this offers the opportunity to re-establish scientific credentials and obtain a recent research record while retraining and renewing skills that are essential for a future career.

The Daphne Jackson Trust is the only charitable organisation in the UK dedicated solely to returning scientists, engineers and technologists to their careers following a break of two years or more. The trust offers flexible, part-time, paid fellowships in universities and research establishments throughout the UK, normally for two years, during which fellows undertake a challenging research project and an individually tailored retraining programme. Fellows must be resident in the UK and intend to stay in the UK after completing their fellowship.

With the current global economic crisis, employers in both academia and industry can no longer afford to ignore the fact that scientists, engineers and technologists who take a career break often do not return to their old jobs. This has serious implications for the cost of recruiting and training staff and, overall, is affecting the competitiveness and productivity of the UK. The business case for employing returners is now stronger than ever. High staff leakage rates lead to very low return on initial investment and high recruitment and training costs.

Not only are returners fully qualified for the role in the first place, but also their career breaks have often heightened the skills required by top-class employers: time management, flexibility and adaptability, conflict resolution and working under pressure. So by taking on returners, employers gain a person with enhanced skills

and better company and industry knowledge than a totally new employee. More importantly, but perhaps less easy to measure, are the intangibles: boosted morale and performance among staff overall, increased competitiveness, and diverse thinking reflecting a diverse customer base.

The Daphne Jackson Trust has become a trusted source of experience and knowledge about returners, the barriers they face, the business case for employing them, and the benefits of engaging with this untapped pool of talent. Fellowships are individually sponsored by organisations with an interest in both the research being undertaken and helping return a valuable scientist to the workplace. The list of sponsors spans the public and private sector and includes research councils, universities, charities and companies.¹ The trust benefits hugely from donations of all amounts from those with an interest in helping scientists return to careers so that they can make a valuable contribution once again.

Undoubtedly a change in culture is required, but that is true for all women, regardless of whether they have had a career break. Sadly, little has changed over the last few years to make any of those who work in the sector feel that much headway is being made. The trust produced a report in September 2006 which was concerned with the issues faced by returners and was drawn from three seminars at which returners hotly debated the issues and their own experiences. The report made recommendations for all those who deal with returners, as well as the returners themselves, and these are summarised below.

Report recommendations

These recommendations, from the Real Returners report published in September 2006, are the activities and actions that women who are either trying to return to a career in SET, or have recently returned, feel would make the greatest difference to their situation.

Learned societies and professional bodies

Attendees at the seminars indicated that they were most likely to turn to these bodies for information on jobs, opportunities and support when looking to return to their careers. However, those who had sought help from these bodies had in some cases been disappointed by the lack of advice and help on offer. Learned societies, professional institutions and the research councils must make clearer on their websites and in their literature the various sources from which returners can get information, advice and funding for returning to a career in SET.

¹ A full list of sponsors and donors is on the website at www.daphnejackson.org.

There is also a role for these bodies in helping those on a career break to keep their skills and knowledge up-to-date, whether via the internet or regular publications specifically targeted at their needs.

Learned societies and professional bodies can also take direct action to tackle the old-fashioned and outdated attitudes prevalent within many academic departments and industry by establishing schemes similar to the Institute of Physics' diversity surveys of physics departments across the country.

Research councils

The research councils must make their policies for funding applications absolutely transparent and must also actively welcome funding applications that include part-time workers. This process is already under way, but it is vital that the research councils do more to publicise these policies to academic departments.

The research councils should also work with the Research Assessment Exercise to ensure an applicant's career breaks are taken into account – whether the person is applying for funding, a new job or a promotion.

Industry

In order to tackle the misconceptions that exist about part-time workers in industry, visits should be arranged by large companies participating in schemes such as the Daphne Jackson Trust fellowship scheme, to showcase how it is possible to work part-time successfully, particularly to smaller organisations. Many returners who work part-time feel that they are ambassadors and would be happy to participate in such visits.

An opportunity also exists for employers to put a business case to the Employment Agencies Federation regarding the recruitment of returners to fill positions within science, engineering and technology. Many recruitment agencies do not operate in the science sector because they have difficulty finding candidates to propose. If they could use the pool of returners, this would open new areas of business for many of their agency members and would encourage companies to seriously consider women returners.

Academia

According to the women attending the seminars, academia is one of the last strongholds of negative and outdated attitudes towards women returners. In many cases, heads of departments and senior managers persist in fostering an atmosphere that is not conducive to the needs of female staff or returners. Academic institutions must look

closely not just at their attitudes towards returners but also at their policies for funding applications, recruitment, promotion and diversity in general.

Government

One of the biggest factors for many women in deciding whether to return to a career in SET is the provision of good-quality, affordable childcare. Where such facilities exist, places are often oversubscribed or prohibitively expensive. Yet in many locations, suitable childcare is not available near the place of work and does not match the hours a woman works. The government must make more effort to provide suitable childcare for all.

There is also a role for the government to encourage companies and academia to tackle the prejudices that many of these organisations have against part-time working, showing the benefits that employing women returners can bring.

Women returners

Returners must be motivated and consistent in their approach to finding suitable opportunities to enable them to return to their careers. Individuals need to see their break as a positive experience that has enhanced their skills and put this on their CVs, rather than regarding it as a negative. They must sell their skills at interview and use the existing part-time structures within universities (which allow employees to spin out companies, for example) and companies to their own advantage.

Has there been any change?

Since the report was published in late 2006, I am aware that some of these areas are being addressed. However, we certainly still have a long way to go before all the recommendations have been taken up and we have the kind of culture change needed to really make a difference. That is why, when asked to contribute to this report and offer my thoughts on what more can and should be done for women returners, I have restated these recommendations. They are what the returners themselves know would make a difference to them, and there is still a long way to go. All those who were at the seminars were clear on one point, however, and that is that without a Daphne Jackson fellowship they would not have returned to their careers.

Benefits of a Daphne Jackson fellowship, and success rates of fellows

The fellowships offered by the trust really do make a difference to the careers of many talented, well-qualified and very experienced scientists, engineers and technologists. The tremendous success rate may be attributed to the service that is offered to these individuals from the moment they initially contact the trust. The fellowships offer an

unrivalled amount of flexibility and support to each candidate to allow them to reach their full potential to return successfully. Each individual has their own challenges, both personal and professional, to overcome in order to return at the right level to their career.

The fellowships offer flexibility, and each one is unique and tailored to meet the needs of the individual. The retraining programme of at least 100 hours may be used to learn new skills and expertise in a slightly different scientific field or discipline, in order to increase employability and long-term career prospects. The trust offers support and encouragement through each stage of the application process and then through the fellowship itself. After completion, each fellow is encouraged to remain in contact with the trust and help in whatever way they can to promote the fellowships.

In 2007 a project was undertaken to contact as many past Daphne Jackson fellows as possible in order to obtain some accurate statistics about what has happened to them after their fellowships have finished. It uncovered some quite inspirational stories from many of the past fellows. The trust is often asked about its success rate. This invariably leads to a need to define what is meant by "success". The fellowships offered to returners are intended to take away the disadvantages inherent in taking a career break for research scientists and equip them to re-enter the workplace of their choice. At the end of a fellowship, the fellow should be back on a level playing field with their peers and able to compete for employment once more. Therefore, the trust counts success as a fellow obtaining SET-based employment for a period of at least two years at any time after completion of the fellowship.

The overall success rate in returning fellows to SET-based employment is 96%. It was very interesting to find out that 72% of past fellows returned to employment in research careers, while 10% returned to careers in teaching and 15% returned to careers in SET-based academic administration or management. Such is the nature of research that 21% have moved from an initial research career to another career in the broader SET sector, such as university administration or other work in the public or private sector. Some of the careers that past fellows have moved into include science writing, science presenting on television, or starting a new business. Some have now retired but enjoyed fulfilling careers for a number of years after their fellowships. There are many past fellows who have returned to very enjoyable and worthwhile careers in research and who have been very successful. The trust now has four past fellows who have been awarded personal chairs, and many others are well on their way to such an accolade.

There are many inspiring case studies to be found in the trust's annual reports and in other reports on the website at www.daphnejackson.org.

The future for returners

The Daphne Jackson Trust remains focused on its goal of returning more and more talented scientists, engineers and technologists to their careers. As the incoming chief executive, I have some key goals in mind and am determined to see returners moving up the agenda, discussed independently and not tacked on as an afterthought in discussions on women in SET.

I am often asked in a work setting what I would like for the trust, and – after the flippant response of a few million pounds, an extra day in the working week and the ability to clone myself – my serious response is that I would like the engagement of each and every university in the UK. Personally I don't think this is an unreasonable request: it would take very little input and effort from each one, and it is my mission to make that happen.

Chapter 7

Apprenticeships

Gareth Humphreys MBE, HR Adviser at MBDA, and Jenny Harvey,
Fourth-year Engineering Apprentice at MBDA

Apprenticeships

Investing in employees

MBDA is a world-leading, global missile systems company, delivering cutting-edge technologies with around 10,000 employees based across the UK, France, Italy, Germany and the US. MBDA has always employed engineering and commercial apprentices since its sites were opened over 60 years ago.

Current apprentices are on four-year programmes built around three pillars of development: professional, personal and technical. Structured rotational work placements combined with learning objectives are supported by day release at college or university, providing apprentices with a broad range of technical skills and knowledge.

MBDA provides not only further-education opportunities but also a significant number of bespoke courses in technical and personal development, run both internally and externally. These include presentation skills, languages, negotiation skills, team working, project management and further technical courses. Apprentices have access to 3,000 online courses and an additional £200 a year to spend on books and further training of their choice. They receive full-time programme managerial support and trained mentors to support their on-going development and transition to a permanent role.

The average length of service for employees is 25 years, and the development of apprentices guarantees continuity of service to our customers. We have to ensure continuity of high-quality skills and technical knowledge to support updates, servicing and disposal requirements for our industry. Our programmes are tailored to ensure that anticipated skills gaps of the future are addressed and filled. The apprentice programme demonstrates commitment to long-term support of our customers, which allows us to maintain our technical competitive edge.

Improving diversity

A higher percentage of apprentices are female compared with the rest of the employees of the company, demonstrating our commitment to improving diversity and equal opportunities within MBDA.

To attract women into science, engineering and technology, MBDA takes groups of school pupils (made up of half girls and half boys) to engineering events including Farnborough Air Show, the Institution of Mechanical Engineers' Formula Student and

Big Bang Events. The school pupils are mentored at the events by MBDA apprentices, both male and female. This gives the students an opportunity to meet women working in engineering and ask any questions they might have about the industry.

We also send female role models into schools to give presentations and attend careers events within engineering and technology schools and colleges. This raises the profile of engineering, apprentices and females in the industry. We give workshops and site tours to technology teachers to improve the awareness of engineering and the opportunities it brings.

We have an extensive work experience programme at MBDA that is divided equally where possible between female and male students. Each student is mentored during the week by apprentices, which gives the students a real insight into how the company works and what it is like to be working as an engineer.

Working in partnership

We are actively working with the National Apprentices Service (NAS) to open access to 3,000 of our suppliers so that NAS can promote apprenticeship programmes. This is key to our success, as these businesses need to have the people with the right skills and knowledge to support the future growth of our business. We have also run numerous visits and workshops for other companies and shared our expertise to help promote apprenticeships. Our own scheme has grown considerably in four years; development is continuing as the business changes.

Local schools and colleges benefit from the time, effort and energy of apprentices who support science, engineering and business projects. MBDA allows its apprentices to go into schools and act as role models for students. As a result of our dedication to support local schools, we have forged excellent working relationships and have constant requests for help at events.

MBDA strives to ensure that all apprentices are actively involved in local community projects and they all receive quarterly performance and progress reviews, which determine their yearly salary increases. Projects managed by apprentices helped raised over £132,000 for charity in 2010, and such work experience also helps build apprentices' confidence for the future. They have opportunities to work in Europe as well as placements on all three MBDA sites in the UK.

Through long-established partnerships with educational institutions such as Hertfordshire University and by supporting local charities and community projects,

our apprentices develop confidence, leadership and organisational skills. They represent MBDA at all company events and are involved in many visits from outside guests, including hosting and presenting to MPs.

Taking on accountability for our own programmes is key to their success; we are also prepared to share our expertise in developing apprentices with other companies, running workshops, hosting visits and attending meetings about apprentice development. We have taken apprentices from other companies on our training schemes and are giving the NAS the opportunity to work with our supply chain and offer support for increasing apprenticeships in other sectors. We organise and run training programmes for local schools, colleges and training providers so that they are fully aware of the latest technical developments, which helps increase their knowledge and skills.

Developing skills

Apprentices work and learn simultaneously, allowing them to transfer skills and knowledge from university and college to the workplace, thus enhancing performance at work and academic results. Support and guidance from managers and peers has equipped them with a solid understanding of business demands in a complex industry, and the tasks and projects that they are asked to complete help develop their capabilities while ensuring business objectives are met.

They benefit from gaining academic, vocational and professional qualifications, together with the skills to present in public and manage small teams, and they also develop the confidence to communicate with all kinds of people, from schools pupils to senior executives. Apprentices enter national and international skills competitions; since 1992 there have been many national winners, and some have gone on to represent the UK at WorldSkills events.

Apprentices receive personalised training to enable them to be more flexible when adapting to new working environments and are trusted with a high level of responsibility, taking on key roles in organising company events, which helps shape their own development.

In their final year, all apprentices are placed in a department where they receive specialist training in their chosen discipline. By the end of the programme they will have completed NVQs at level 2, 3 and 4, as well as either an HND or degree, and a City & Guilds level 4 in personal development.

Investment in performance-to-excellence training for staff has increased, so they know how to pass on knowledge, skills and competencies. Apprentices have won 20 national

skills competitions, and over a nine-year period retention rates are 100%.

As apprentices settle into their final roles towards the end of their programmes, this ensures they are highly skilled, motivated professionals, ready to commence their professional career already having gained invaluable experience in their chosen discipline.

The business case

Our apprentices have infectious enthusiasm and commitment alongside their willingness to learn and their striving for continuous development. These attributes help to motivate and reinvigorate those employees supporting them, and help to develop people management and leadership skills as well as the personal satisfaction of those responsible for their development. Due to the time and effort put into training, these apprentices are facilitating their confidence building and play a key role in enabling the business to keep moving forward.

The participation of apprentices in national and international skills competitions has helped to recruit further high-calibre school leavers, who can be further developed to improve the business in the long term, and has.

Quotes from apprentices

I really appreciate that our opinions are valued within the business and more than that, they are encouraged and respected. The most inspiring factor is when someone who has been in the business for 40 years would ask myself for advice

Samantha Ball, aged 18

I was attracted to engineering as I enjoy taking things apart and putting things back together. I'm interested in finding out how things work and function to do certain jobs. Also I am fascinated by engineering drawings and how technical and precise they have to be. In addition my elder brother inspired me to do engineering as he is also an engineering apprentice working for Marshall's Aerospace.

Kelly Yarwood, aged 17

I really enjoyed electronics at school and wanted a career that would continue along the same lines and engineering was an option that fulfilled those criteria.

I wanted to do a job that would make a difference because you always hear about famous women who were nurses or designers or charity workers and there is nothing wrong with

that. But you never hear about women who build bridges or invent things or design rockets. I thought why not have a go at being the first woman to be recognised for that and engineering was the way to do that.

Heather Peach, aged 16

I've always been interested in subjects such as maths and science, I also enjoyed having a project and something to make in technology, but it had never crossed my mind to look into engineering. After researching it I realised that engineering incorporates all of the subjects that I enjoyed at school in new and challenging ways; there are a lot of different branches of engineering to go into and you can be at the front of some of the latest technology.

Melissa Garratt, aged 19

What attracted me to engineering was that it isn't a narrow career path, there are so many different areas to it and it's interesting, especially knowing that you could look at something and think, "Yeah, I have an idea how that works," and gain a better respect and understanding for things. Also I just love the idea that it can take you anywhere, from MBDA in the defence industry to architecture and lots of other vast things, I liked that it's a career that is always needed and can help you outside of work and in other aspects as well.

Beki Davies, aged 17

Engineering brings challenges which can lead to great new or updated technology. This can lead to improving people's lives or even saving them. I've always admired engineering as it is what shapes the world of tomorrow.

Tammy Imber, aged 20

What attracted me to engineering is the satisfaction I get from making something. I was also attracted to engineering because I was told that I wouldn't go anywhere as a female engineer, as it's mainly male dominated, but so long as I apply myself and concentrate I can prove them wrong and be the best.

Lauren Wood, aged 18

Chapter 8

View from three award-winning young women in SET careers

Dr Liz Ainsbury, Institute of Physics Very Early Career Woman
Physicist of the Year

Claire Jones, Institution of Mechanical Engineers Young Member of
the Year

Arlene McConnell, Institution of Engineering & Technology Young
Woman Engineer of the Year

Dr Liz Ainsbury, Institute of Physics Very Early Career Woman Physicist of the Year

Luck is not a very scientific concept, but I want to start by saying that I feel I have been very lucky. I actually came into physics in what might be described as rather a fortuitous manner. At school I was interested in everything. I did fairly well at most subjects, while not really excelling at anything. I actually chose to study physics at university (Bristol) mostly because I wanted to do something really hard that would impress my peers! But also of course because I was still interested in everything, and, although it is rather a cliché these days, physics really is the science of everything.

Well, after three years of study and one year in industry, I gained my degree in physics with astrophysics, and managed to secure a postgraduate place, still in Bristol, in the Human Radiation Effects Group. Four years later I submitted my PhD thesis, and started a job in the Radiation Effects Department at the Health Protection Agency. In short, studying physics was the best decision I ever made: I loved my studies, and now that I am fortunate enough to have a career in scientific research (still at the Health Protection Agency), I love my job. Few people are lucky enough to be able to say that.

In February 2007, just five days after submitting my thesis, I was awarded the Institute of Physics Women in Physics Group Very Early Career Woman Physicist of the Year Award. The award was for my PhD research looking at the physics of extremely low-frequency magnetic fields and my contribution to physics outreach. I was extremely honoured to receive this award, and extremely surprised too. I had become involved in outreach work as I also love telling people how much I enjoy my job – I truly believe that a career in science is one of the most rewarding things you can do. Sadly, it seems that that message is still often lost in the reams of careers advice that young people receive, which often seems to be purely geared towards potential future earnings. Of course science careers are not the most lucrative, but shouldn't job satisfaction be the most important thing? I still continue to do as much outreach work as possible, with the full support of both the Institute of Physics and the Health Protection Agency (I'm still in the same job).

At the time of receiving the award, I was largely unaware of the work of the Institute of Physics' Women in Physics Group, and only applied on the advice of a senior female lecturer at Bristol. Since winning the award, I have become much more involved in the work of the institute, joining both its Women in Physics Group and diversity committees. I now really appreciate the huge importance of the Institute of

Physics and the work it does for its members, providing information, resources and career support.

In fact, 2007 was the inaugural year for the Very Early Career Woman Physicist of the Year Award, and the award event was the culmination of a large amount of work carried out by the Women in Physics Group, who work extremely hard to encourage and support women in physics careers. The main aim of the award itself is to recognise the outstanding work of women embarking on a career in physics, to promote the career opportunities open to people with physics qualifications, and to provide role models at the start of their careers.

Each year since 2007, the Women in Physics Group has invited applications from women who are at the start of their careers in physics, who have made a substantial contribution to the subject and have undertaken activities to support and encourage others in the field. The prize is awarded to a woman who is within five years of the award of her first degree in physics (bachelor's or master's) and is either working as a physicist or is engaged in postgraduate study in physics.

The winner is presented with £1,000 and an award certificate at a major Institute of Physics Women in Physics Group event in spring of each year. Initially the prize was sponsored by HSBC, but since 2008 has been sponsored by Shell. The magnitude of the prize is designed to demonstrate how important the development of young people is to the institute, and sponsorship by such illustrious external partners demonstrates that events such as this are recognised as being hugely important by industrial employers. As well as providing recognition of the winner's work, the event also provides valuable networking opportunities, and I have met a large number of extremely interesting people at the events – invited speakers as well as winners, all of whom have been brilliant.

So, I want to conclude by saying again that I have been very lucky – I have received a huge amount of support from teachers, lecturers, and the Institute of Physics, and I really hope that I have been able to go some way towards fulfilling one of the aims of the Women in Physics Group in setting up the award: to encourage other young people to consider a career in physics too.

Claire Jones, Institution of Mechanical Engineers Young Member of the Year

I believe the route to achieving more women in the SET workplace lies not in special treatment but in having women in their role because they have earned it on merit, on a fair playing field with men. Both positive and negative discrimination, whether actual or perceived, has detrimental effects on not just the woman involved but their peers and those that succeed them. In my experience, the lack of women, particularly in high positions, means women are noticed, judged and remembered – for good or bad – more than their male counterparts.

I have worked within five different companies as an engineer, and I believe that the first two months are the most critical. Starting a new job will always be a challenging experience; while university and work experience can prepare an individual for the work, it cannot help you fit into a team. As a new starter, I have often had my patience and sense of humour tested by the existing engineers. I have been the recipient of sexist (and ageist) comments. Understanding the difference between comments meant in jest, and those with malicious intent, can sometimes be difficult.

This is where I believe a mentor can be invaluable. The best mentors I have had are those working within my office who have not been officially appointed, but have grown out of an office friendship. A mentor in this sense does not need to be in the same technical field, but to be able to provide advice outside the mentee's management structure, understand the team dynamic and be a vessel for honest communication.

Gender stereotypes are engraved in British society, and with regard to engineering more so in Britain than in the rest of Europe. Education, of parents and teachers, is the key to both men and women believing that engineering is a suitable career for all. I believe the foundations to my career were laid by my parents, who believed in gender neutrality for both household chores and their children's toys. Subsequently, I was brought up in an environment whereby in the early years I was unaware of gender stereotypes and questioned my peers' assumptions. As I grew, I became aware of society's stereotypes but I had already formed my own opinions.

An individual's mindset and ability are the key to success. I believe it is best to think of oneself as an engineer, not a female engineer. While it is obvious that you are a female, the novelty for your colleagues soon wears off and you are judged on your abilities. At the age of 13, I knew that I wanted a career in the engineering or science sector. I wanted a career that would challenge and interest me as well as providing me with

financial stability. I was aware of gender stereotypes at this age, but they did not hold me back: in truth, I think the challenge made it more appealing.

I believe the lack of personnel management training within many companies results in managers finding themselves in positions where they are forced to manage others with no training or guidance. Managers who have conducted their career in a male-only environment may find having to manage a female a testing time, and their difficulties can often be transferred to the female. I do not believe this is the individuals' fault, but increased training for management may help to resolve this issue.

The nuclear sector is growing rapidly, providing engineers with exciting projects and promotional opportunities. Legacy issues result in the sector still being male-dominated and old buildings not always having adequate female welfare facilities. The industry currently relies heavily on contractors. While this can be good in the short term for companies, it does not facilitate long-term training for the individual or secure long-term success for the company. The lack of benefits from associated terms and conditions (maternity pay, flexible working and so forth) make this an unattractive environment for women. Consequently, there are very few women in contracting. To attract more females into the nuclear sector, more permanent staff jobs need to be available.

The nuclear sector divides into jobs on-site and off-site, and while a number of jobs need to be based on-site in old buildings with unsociable working hours, there is opportunity for change. In moving non-essential workers off-site there is a greater possibility to improve the working environment for all, resulting in attracting and retaining more male and female engineers.

Arlene McConnell, Institution of Engineering & Technology Young Woman Engineer of the Year

When you pull yourself out of bed in the morning and reach for the shower controls or jump into your car to travel in climate-controlled, smooth comfort to your workplace, very rarely, if ever, do you pause for a second to admire the ingenuity, creativity and sometimes pure genius of the things we've come to take for granted. Technology and engineering surround us from the instant we wake up, making our lives healthier, greener, more productive and more enjoyable; it is so much part of how we live that we never pay it any attention. This indifference has become normalised, to the point that young people today are failing to take up careers in the STEM industries that make these everyday impossibilities possible. If no one shines a light on the men and women solving the challenges that face us all or passionately champions these fields in order to inspire a new generation of engineers and technologists, then as a nation we are risking our future.

My name is Arlene McConnell. I am a recent graduate of Glasgow University, a RADAR and advanced targeting systems engineer for SELEXGalileo and this year's recipient of the Institution of Engineering & Technology Young Woman Engineer of the Year Award. I arrived at a career in engineering by a slightly unconventional route. Upon leaving school, I opted to work for a couple of years in different jobs; I was employed as a support worker for deaf-blind people and also served in the Gulf as part of the Royal Auxiliary Air Force. It wasn't until after I returned from overseas service that I realised that I had spent a fair proportion of my spare time building things to make life in the Gulf more comfortable. As a result, I decided to complete an HND in automotive engineering.

This led me to university, where I studied for a degree in electronics and electrical engineering before taking up my current position with SELEXGalileo. I have been successful in the early part of my engineering career and I hope here to give a brief insight into my experience and observations on early career development in the science, engineering and technology sector and elucidate why I think accolades such as the Young Woman Engineer of the Year Awards help, through increased visibility and interaction, to inspire and encourage young women to take up valuable roles in the STEM industries.

The Engender report submitted in the 55th session of the Commission on the Status of Women stated that over 70% of women who have studied SET subjects do not go on to work in SET occupations, resulting in a high proportion of women working

below their level of education.¹ At the time I was looking for an engineering job, I found statistics like this both confusing and unnerving; confusing because, having worked so hard for years to secure a good class of distinction, I thought not going into industry seemed futile, and unnerving because I thought maybe there was an unspoken reason why young women were not applying for positions.

There certainly was no lack of positions; in fact, I had to decline several offered to me. However, when I took up a position with SELEXGalileo I found I was the only female graduate out of an induction of 18. This is surprising, as there are a healthy proportion of female engineers working within the company. When I questioned the reason for this, I was told squarely that they just did not have young women applying for the positions. So, if there are women qualified in STEM subjects and the opportunities for them to put these skills into practice, then why are they not making this natural progression?

Among the plethora of reasons to which this drop-off is attributed, there may be a correlation in the fact that there were a good proportion of girls studying engineering with another more obviously creative subject, such as music. I found that these young women chose a combined degree because while engineering provided an outlet for their problem-solving and analytical passions they felt that music quenched their creative thirsts.

However, I believe that STEM industries do require a high degree of creativity, imagination and ingenuity. These expressive aspects of engineering are simply not extolled enough. For example, the video game industry is one that requires solid grounding in both mathematics and artistic skills. Furthermore, the independent skills review, commissioned to investigate how growing industries such as video games can be supported and sustained, identified two stumbling blocks to future growth. First, the lack of general awareness of just how big and successful this industry is in the UK (in the next three years it is set to be worth over a billion pounds). Second, the lack of people furnished with the correct skills, namely mathematics and art, showing that it is rarely recognised that these two subjects are interrelated. Therefore, raising awareness of this interconnection may generate some of the much-needed interest in STEM careers.²

In addition to bringing attention to the already existing exciting opportunities, it is equally important that the people behind the achievements of UK engineering are made

1 *Engender Jobs for the Boys & the Girls? Women & Girls' Experience of Segregation in Learning & Work in Scotland*, report submitted the Commission on the Status of Women (2010)

2 *The Livingstone/Hope Independent Review of Skills in the Video Games & Visual Effects Sector* (National Endowment for Science, Technology & the Arts, 2010)

highly visible and accessible. The Institute of Chemical Engineers identified this need, and its success in doubling the number of chemical engineering students can in large part be attributed to creating a network of young ambassadors and young professionals,³ making their contributions visible and tangible.

Mark Twain once said that "the really great make you feel that you too can become great". It would seem there is no substitute for role models and real-life examples when it comes to inspiring and motivating young people to study and take up positions in the STEM industries. This is the premise behind awards such as the Institution of Engineering & Technology Young Woman Engineer of the Year Award. By allowing me to speak at universities, run workshops at graduate fairs and get involved in engineering and science events across the UK, this title has given me a platform from which to influence opinion and policy and on a human level.

My route into engineering was haphazard. I did not succinctly move from school to university and then employment in a few easy steps; it took me a while to work out what engineering is and how it fits into and improves the society we live in. Making an example of my story, I hope, makes a career in industry seem more achievable to other young women. Perhaps if I had been shown an example at a younger age and come into contact with someone who was passionate about engineering and not afraid to show it, I might have entered the profession sooner. I believe we all need role models to set expectations, as we know what we are capable of only when we see it in front of our eyes.

From my experience of studying a STEM subject, working in the engineering sector, and participating in the opportunities afforded me by the Institution of Engineering & Technology award, three major concepts have become embedded in my mind. First, we need to change perceptions towards working in STEM industries by highlighting all the exciting and unknown aspects of these industries. Second, we need to ignite passion about the possibilities and achievements that are out there. Finally, we need to lead by example, set the bar high for the new generation of scientists, engineers and technologists, and show them what they are truly capable of once that passion is ignited.

³ "Material World", BBC Radio 4, interview with Dr David Brown, chief executive of the Institute of Chemical Engineering, broadcast on 24 January 2011

Chapter 9

Engineering down under

Monika Sud CEng, Senior Engineer at KBR

Engineering down under

Despite the advances that engineering has brought to the world, engineering is still not seen as an attractive career for women and is not heavily promoted to females. It is still stereotyped as a male industry, and there are few women visible in the industry to encourage and inspire others to join. That has to change, not only because we simply need more young engineers – both men and women – to help find sustainable solutions to the energy, transport and environmental challenges that we face, but also because there is no real reason why women as well as men cannot find and develop successful careers within the engineering field.

Part of the problem is perception, and the rather narrow way people think about engineering as something that happens on muddy construction sites with lots of guys in hard hats. There are of course a wide variety of engineering roles that are just as suited to women as to men, but they do not get talked about enough. The awareness gap can be narrowed, and there is a strong business case to do so (especially in countries such as Australia, where there is an acute shortage of qualified engineers and recruitment costs are rising), but the industry is going to have to work harder at it to achieve results.

Money is also an issue. Overall, the engineering sector is not as highly paid as some other sectors, like finance, although this is changing because of globalisation and the demand for skilled labour. In Australia, for example, engineers are in short supply and employers are having to offer financial incentives to attract people from the UK and elsewhere. As the recruitment process is opened up, there are more opportunities for women like myself who are upwardly mobile and willing to relocate for the sake of their career.

Being an engineer is of course not something you do at the drop of a hat. You have to make a long-term commitment, which can be costly in terms of university fees. However, unlike many other professions, engineering has a long history of apprenticeships and sponsorships. Some of the big engineering firms are now offering young people a career path with paid apprenticeships and the prospect of covering the costs of tuition fees. This should attract more young people.

Unfortunately, though, for women the apprenticeship route seems to be the exception rather than the norm. I was the only person, for example, out of 240 on my mechanical engineering degree course, who left the traditional schooling pathway of A-levels and took an apprenticeship linked to technical qualifications (the Engineering Construction Industry Training Board and Higher National certificates).

Working alongside a number of multidisciplinary engineers, designers and managers actually inspired me to continue my studies. My employer at the time, Foster Wheeler (which took me on as an enthusiastic 16-year-old), sponsored me through university, where I became a Whitworth Scholar (the Whitworth Scholarship programme, run by the Institution of Mechanical Engineers, is a first-class example of the sort of schemes for young people that can make a difference).

Going back even further in perception development, I think children in schools are not encouraged enough by parents and teachers to take alternative career paths, and the majority follow the standard route to gaining a degree. There is nothing wrong with this approach, but people may not realise that there are alternative options to reach the same end-point. Perhaps we need to provide more information and educate parents, teachers and career officers, and promote role models and mentoring?

The engineering industry has to take the lead in raising awareness and do more to promote the benefits of the profession to women in all walks of life. In particular, this needs to be done at different stages of education and development so that possibilities are considered from an early age.

The industry also has a lead role to play in helping promote women into managerial and board roles. Companies should aim to have a certain percentage of women in these roles. This issue, of course, is not particular to engineering alone, but the record so far is hardly impressive – especially in the petrochemical environment, which is renowned for being a predominantly male workforce.

When I moved to Australia, I decided I wanted to move out of petrochemicals into a new area to gain new industry experience, so I started working at KBR (formerly Kellogg Brown & Root) within the water area. I was very surprised to find myself among a large number of female engineers, which was a big change for me, having worked in a male-dominated environment during my entire engineering education and career.

I have found working in Australia has brought me great working experience and opportunities that I might not have received as readily back in the very male-dominated petrochemical environment. Gaining these opportunities is partly due to having brought my UK work culture and experience to Australia and being able to share this among Australian engineers.

Ensuring the workforce is continually receiving training, mentoring and professional development is critical to attracting and retaining women. I have been lucky to receive

all of the above throughout my career, which has been one of the main reasons I have stayed within engineering. At my current employer, KBR, I have been mentored by a number of senior staff and undertaken several training courses, as well as being chosen to take part in the KBR Future Leaders programme.

Encouraging working mums back into the engineering industry by offering flexi-time, job sharing, opportunities for working from home and good paid maternity leave is also important. Many women leave the industry to start a family and never return. Anecdotal evidence suggests that women often start work in engineering, have children, and then find work in other industries (notably finance and business services). Survey work by Engineers Australia shows that many organisations are putting policies in place to assist all engineers in balancing work and family commitments. The largest change, as reported by women in the 2007 survey, was the availability of carer's leave, paid maternity leave, part-time work, flexible work hours and job sharing.

It is also well known that women engineering graduates, with a background in maths and science, switch professions after graduating more than men. We need to do more to understand why that is and take action to keep more women in the sector.

Retaining women engineers is a challenge, but there need to be more willing candidates in the first instance – especially among the smaller, more boutique firms that cannot afford to offer training or apprenticeships. Financial incentives from government for women willing to take on apprenticeships should help, but public funds are limited and politicians look to the industry to make the changes needed.

Government can work more with engineering institutions such as the Institution of Mechanical Engineers and the Institution of Civil Engineers to come up with ideas on how to promote and increase awareness of engineering in society. The government could also enforce equal opportunities legislation, which would motivate engineering companies to keep hold of their current female workforce and recruit more women into roles. Firms should be monitored on this and possibly rewarded.

I am currently performing the role of chairman at the New South Wales branch of the Institution of Mechanical Engineers and am the first female to take that position in Australia. One of my goals is to increase awareness of the institution and engineering among Australian engineers and students, and also to increase the number of younger members.

Engineers Australia has established a subgroup called Women in Engineering, which seeks to make engineering an inclusive profession that values, supports and celebrates the contributions of women in engineering teams. It links with the International Institute of Women in Engineering, and runs nationwide campaigns and offers professional development courses and scholarships. I believe such organisations should be replicated within other engineering institutions and across engineering-related professions.

In Australia women make up less than 10% of the professional engineering workforce. That number is rising (as are retention rates) because of engineering skill shortages and changing public and corporate attitudes towards women in work. More women are in fact moving to Australia to work in the sector, which shows that where the need dictates, cultures can change.

However, females in the profession remain overwhelmingly at low levels of responsibility, and a lot more needs to be done to attract young women into engineering in the first instance. We need to create a bigger pool of skilled women engineering graduates and increase the percentage of women in senior management roles. Women are good for engineering, and organisations such as Women in Engineering are working hard to make the profession more inclusive and more attractive to tomorrow's young people. But the sector also has to do more to assist all engineers in balancing work and family commitments.

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