Widening of Employment Opportunities in ITEC

Professional Advancement through ITEC Skills

equalitec dti ipa

“As much as you need competence, luck and hard work, I think WILL has a lot to do with it”

Anne Mulcahy, Chairman and CEO, Xerox

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Report for Equalitec and the
Department of Trade and Industry ITEC Skills Team

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"And when women do choose to work we need to do more to break down the barriers they can face in realising their potential. When women's talents are frustrated by discrimination or lack of choice, it is a personal injustice. But there is also a strong economic case for action: the Women and Work Commission estimated that increasing women's participation in the labour market, and in higher paid occupations and roles, could be worth between £15bn and £23bn a year to the UK economy".

Ruth Kelly, Communities Secretary and Minister for Women, Government Action Plan, September 2006

Foreword from the Deputy Minister for Women and Equality

I am delighted to welcome this new report by Equalitec and the Involvement and Participation Association showcasing women professionals who have applied their Information Technology, Electronics and Communications (ITEC) knowledge and skills in an exciting range of technology related jobs. The case studies demonstrate the diverse opportunities available for women with ITEC skills, from weather forecasting at the BBC to e-health and IT security.

The Government wants to see more women working in ITEC related jobs. ITEC is a key contributor to the UK's productivity and competitiveness and it is vital that technology sectors harness the full potential of the workforce available. To meet the continuing growth in ITEC, we need to encourage more women to consider ITEC related careers, and promote the challenging and exciting opportunities offered in these fast moving technology sectors. Breaking down occupational segregation is key to the Government's drive to close the pay gap between men and women. A range of measures, from improved education and careers advice through to supporting flexible working, are in the Government's Action Plan which will implement the Women and Work Commission recommendations.

The Women and Equality Unit in my Department works closely with DTI and its key partners, including Equalitec, to make both employers and individuals aware of the positive benefits for business in having a diverse workforce. I am sure this report will contribute towards greater understanding of the important contribution that women in ITEC can make and the business culture needed to ensure more women choose ITEC

Meg Munn
Deputy Minister for Women and Equality

"Women have been making their mark in ITEC leadership roles, most notably, until recently, Carly Fiorina as CEO at HP; others still in their job roles include: Ann Mulcahy, as chairman and CEO at Xerox; Meg Withman, as chairman and CEO at e-Bay Technologies; Patricia Russo, as chairman and CEO of Lucent Technologies; Ann Budge, as founder and CEO at Sopra Newell and Budge, Ursula Burns, as president of Business Group Operations at Xerox; Hina Patel as Group Head of Business Systems at GCap Media; Helen Routh, as Head of Healthcare Systems and Information Technology Group at Philips Research; Bridget Cosgrave, as CEO at Belgacom; Christina Scott, as Head of Software Development at News Interactive, BBC; Trudy Norris-Grey, as UK Managing Director at Sun Microsystems; Annie Brooking, as CEO at Astron Clinica-UK, Maggie Beaton as Head of IT Integration, Royal Bank of Scotland…."

Careers for the 21st Century: Get into ITEC, Equalitec report, September 2006

Information Technology, Electronics and Communications: A World of Opportunities for Women

Since the mid 1980's, when I became a lecturer in computer science at Southampton, I have been concerned about the lack of women in computing. In those days – prior to the advent of the internet and the Web – few people had any idea of the revolution in the workplace that was about to occur driven by the rapid development and deployment of ITEC. But it was already clear that women were not attracted to a career in the computing industry for reasons that we still don't fully understand. Twenty years later the situation is depressingly similar, even though the career opportunities in ITEC are now much more diverse and some level of ITEC skills are an essential requirement in almost any profession. The latest statistics indicate that the number of women working in the IT profession, however you count such jobs, is decreasing rather than increasing. So I welcome this report, which highlights the growing diversity of ITEC occupations and the enormous contribution that women can make to ITEC.

It is particularly important to emphasise that there are many different pathways into a career in ITEC. This point is illustrated particularly well in the report with a raft of stories from women who have successfully developed a career in ITEC from a huge variety of different backgrounds. ITEC is transforming the workplace, and the way we live our lives. It is so important that we encourage women to positively consider developing skills in this area as a mainstream part of their career or to enable them to progress further in the career they have chosen. Women returners in particular should be encouraged to develop ITEC skills and appropriate courses need to be provided, and well-promoted, to help them get back into the workplace with an ITEC career in mind. It is also important that we have a healthy number of women working in the industries that require higher levels of technical qualifications, such as a degree in electronics or computer science, otherwise these industries will remain forever as male-dominated as they are today.

Despite stories to the contrary, there is a huge IT skill shortage and this is only going to get worse as an increasing number of professions rely on ITEC skills for future development. We need more women in ITEC, and so we need more women to be aware of the amazing opportunities that will open up to them if they choose to advance their career through ITEC skills. This report is therefore extremely timely, and should be promoted as widely as possible.

Professor Wendy Hall
School of Electronics and Computer Science
University of Southampton

"IT, telecommunications and audiovisual industries are converging, with century-old barriers disappearing between content and service, and between telephone and TV.

New opportunities in areas as diverse as culture and healthcare can flourish in this rapidly changing environment. The rules of the game have certainly changed when you can make a film and distribute it worldwide with your mobile phone, or when super-powerful 'grid' computing allows medical researchers to improve drug design"

Viviane Reding, European Commissioner for Information Society and Media

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Chapter 1

Introduction

This is the report of a project entitled "Widening of Employment Opportunities in ITEC: Professional Advancement through ITEC Skills".

The purpose of the project has been to identify employment areas outside the traditional IT sector where demand for IT skills is increasing, and to highlight the possibilities for new types of careers for women, including those returning to the labour market following a career break. The project examined case studies of newly-emerging occupations with the aim of investigating whether there is in these occupations a positive employment culture with career development opportunities for women. It is hoped that the results of this work will be used to encourage women to consider careers in different scientific and technical professions from those which they might normally be aware of.

This report presents the results of fifteen case studies of new occupations and of women working within them. It showcases path-breaking women professionals working in some of the newest areas of information technology, science and engineering. The examples show that:

- new ITEC occupations are considerably more diverse than the conventional image of ITEC work tends to suggest
- there are many different entry points for new ITEC professions, and it is important that women considering entering them are aware that not all of these are conventional, formal educational channels
- more clarity is needed about progression pathways and career development routes for ITEC professionals once in employment
- the most 'women-friendly' ITEC employing organisations are those which have clear, coherent and thoroughgoing equality or diversity frameworks

The women's work is described, the skills requirements of their jobs are analysed, and the report also considers the organisation of training, learning and career progression opportunities in these new professional areas. At the end of the report, some conclusions and recommendations are made for changes in both organisational and public policy, designed to help to draw women into the new ITEC professions. In the annex, we provide summary information on the participating women and their employing organisations. We also provide a list of organisations which are active in promoting gender equality in ITEC or science, engineering and technology (SET) occupations.
The following women and men generously contributed to the material which appears in this report: Ellin Barklund, Diane Benjamin, Maggie Berry, Kate Caldwell, Raffaella Carzaniga, Angela Clements, Jean Devonshire, Duncan Fisken, Clare Foster, Ruth Jones, Juliet McMullen, Rosemary McNaughton, Kathryn Moore, Elizabeth Pollitzer, Jemima Rellie, Christina Scott, Suzanne Stewart-Smith, Penny Tranter, Helen Willetts, and Ruth Woodward.

The research was funded by the DTI ITEC Skills Team and is part of the work of the Development Partnership "Equalitec: Advancing Women in ITEC" which receives support from the European Social Fund under the Equal Community Initiative Programme. The project was conducted by the Involvement and Participation Association (IPA) in collaboration with Equalitec.

The IPA is a not-for-profit organisation which works on practical and policy initiatives to improve organisational performance through better involvement of employees. Further information about the IPA is available at www.ipa-involve.com.

Equalitec is an initiative which aims to develop new employment opportunities for women in information technology, electronics and communications (ITEC) professions. Information about the Equalitec Development Partnership and its objectives can be found on www.equalitec.org.uk.

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Chapter 2

Emerging Occupations in Information Technology, Electronics and Communications - Some Examples

2.1 e-Logistics – Radio frequency identification development

Radio-Frequency Identification (RFID) technology develops and extends the technology of the bar code. Signals or product information are transmitted using the radio frequency portion of the electromagnetic spectrum (rather than being captured in the lines of the bar code), the signals are read, and the information is transferred to a processing device. The RFID tag is the most visible and recognisable part of the RFID system – this is the integrated circuit containing the information to be transmitted, and the technology analogous to the bar code. Unlike the bar code, however, RFID tags can transmit information at a distance from the reading device, so scanning can take place without the need to physically pass the item over the reader.

RFID is becoming widely used in retail, logistics and transport, wherever a unique identification system is needed. RFID tags can carry simple product and pricing information on food, clothing and household products, or more complex information such as cleaning instructions on garments and even instructions on how to assemble a car. Some automotive manufacturers, for example, use RFID systems to move cars through an automated assembly line. At each successive stage of production, the RFID tag tells the computers what the next step of assembly is.

One of the emerging occupations concerned with RFID is that of developing the information standards to be used in conjunction with the technical systems. RFID implementation involves close collaboration with working groups consisting of the users of the technology, who may be large retailers or manufacturing organisations, or small companies.

"I like working with people. I like making sure the standards are accurate. I like helping people understand them and making sure they are implemented properly. You get so much satisfaction when you go on a training course, and people tell you that they understand it now, thanks to you."
(Suzanne Stewart-Smith)

Related technologies, solutions and opportunities

As the use of RFID systems spreads more widely, it will drive demand for technical skills in associated technology areas. Further developments of RFID systems will depend on innovations and advancements in a number of related technology areas. Among the key elements where progress is being made or is needed are: antenna and transceiver design; accuracy in the recognition of radio frequencies; ensuring signal quality and uninterrupted transfer of information for processing; RF circuitry; analysing collected data to support business functions and organisational processes; storage and updating of information on the tag itself, with the associated memory and power requirements issues.

The standards-setting process incorporates the requirements of these organisations into the information standards through negotiation. Standards are currently being developed from scratch at both national and international levels.

"There is a set of standards which are being created to define exactly how the data is going to be held inside the tag, exactly how the tag will send the information to the reader, and how they are going to communicate. They also specify exactly how the system side is going to work and how the systems will communicate information between them, hold that information, and how the track-and-trace functionality will work. So all those different components need to have standards and specifications, and those don't exist at the moment."(Suzanne Stewart-Smith)

At present, there is a serious shortage of RFID professionals with substantial implementation knowledge, and this is expected to get more pronounced as the technology develops and is taken up on a more widespread basis.

Case Study 1: Suzanne Stewart-Smith, RFID Consultant

Suzanne Stewart-Smith is a Consultant for RFID working at GS1UK, the UK association for users of RFID and other electronic commerce technologies.

Much of her work takes her into the national and international standard-setting arena, facilitating the work of user groups who are specifying their requirements of these newly-emerging technologies. She works closely with GS1UK's sister organisations throughout the world, and with standard-setting organisations like the International Standards Organisation (ISO). As a Consultant for RFID working in a user association, an important aspect of her work involves helping organisations to understand the relevance and application of RFID to their own processes, and helping them to migrate from their existing (perhaps bar code-based) systems to RFID technology and its associated standards.

Before going into the RFID world, Suzanne worked in insurance, where she had worked in claims and risk management. She had an interest in project management and supply chain management, and wanted to pursue this in a way that allowed her to work directly with people. So she didn't have a technical background when she moved into working with RFID but gained her systems knowledge through training provided by her employer into barcode technology. She also gained a considerable level of experience on the job, working with user companies, and through conferences and events. She values this mix of technical and interpersonal elements in her job.

2.2 e-Science – Photonics

Photonics is defined as the science and technology of generating and controlling photons, particularly in the visible light spectrum. This technology includes terahertz technology, a technology which involves low frequency light waves.

There is growing interest in terahertz radiation because of its ability to penetrate into many organic materials without the damage associated with other forms of radiation such as X-rays. Terahertz radiation is readily absorbed by water, so it can also be used to distinguish between materials with varying water content.

Terahertz technology for biomedical imaging is a very new field of application, and its use in mammography is being explored. One research lab has developed a technique for using it to detect the presence of cancerous cells. Other potential medical applications include the diagnosis and management of skin conditions, and the identification of tooth decay.

Aside from the challenges of developing these technologies at the basic research stage, a considerable amount of effort is needed to convert these inventions into usable applications. This means brokering connections between researchers in university laboratories and companies which can support and develop the technologies. The job of the technology transfer consultant is concerned with this process.

"I wanted to bridge the gap between university research and industry, which I think there is a huge need for. The company was started to help the transfer of technology into the commercial environment. That is our main mission. Our job is to get the good technologies which are developed using government funds, out of the lab and into the commercial world." (Ruth Woodward)

Related technologies, solutions and opportunities

Photonics covers a wide range of technologies. Key areas of expertise include: optoelectronics, optical lithography, semiconductor manufacturing, electronics materials, Ethernet, process development, circuit design, imaging, RF and digital signal processing and many others. It is a field of wide and expanding opportunities for individuals with a background in electronics, physics, materials science, chemistry, mechanical engineering, manufacturing process engineering, and programme managers.

Case Study 2: Ruth Woodward – Company Director

Ruth began her career with a degree in Physics and German, and a master's degree in Semiconductor Science and Technology. Her grandmother's death from breast cancer prompted her to look into ways of using her physics background to investigate advanced medical technologies. Her doctoral research examined the role of terahertz technology in the detection of skin cancer, and she discovered that it was possible to differentiate between diseased and normal tissue using her terahertz analytical techniques. Ruth went on to establish her own company, HT Consultants, which works on the development of imaging technologies for a variety of applications.

Like other women working in cutting-edge areas of science (including others who appear in this report), she states that she is more interested in applications than in pure science. She is particularly concerned to improve the transfer of technology from the academic research arena into real-world application. To this end, Ruth's work is concerned with encouraging private-sector companies to license or buy terahertz technologies and develop them. She reviews the technologies being developed in labs worldwide, particularly those concerned with chemical sensing or imaging, brokering deals for them to be taken up by larger corporations. She provides the link between the technology developer and the commercial client. A major concern is with finding the right company to nurture the right technology, and with keeping technological capabilities in the UK wherever possible. This means visiting technology developers to assess what is available and could be exploited, and getting a wide-spread sense of the different innovations. It also means developing good working relationships with researchers and commercial clients and being able to bring them together on common ground. The skills involved are obviously technical, but there are large elements of communications, interpersonal and management skill involved. *"I have to lead people, I have to hold interviews, I have to manage their career development, all sorts of things."*

Despite her obvious current success and the high esteem in which she is clearly held by her clients and peers, Ruth's career has not always been plain sailing. During her postgraduate studies, Ruth's work attracted the attention of her peers and the media, and she began to receive conference invitations and requests for television interviews. Her work was path-breaking and widely recognised as such, but she had to strenuously protect her intellectual property and promote her own career development. She established HT Consultants with these aims. Since establishing the company, Ruth has secured world-wide recognition for her work, and plays a key role in the global institutions which are involved in developing, transferring and promoting terahertz technologies. Terahertz technology is a field in which women are still found in only very small numbers, at least in the UK (elsewhere in Europe and in the US women are more numerous in this field). Ruth Woodward does not believe that this is due to any intrinsic aspect of the work, but simply that it is a newly-emerging area in which women have yet to feel confident about making a mark.

2.3 e-Science – Bio-imaging

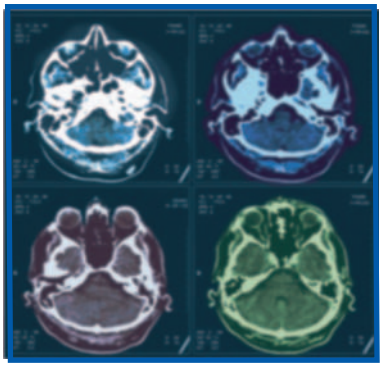
Biological imaging is a term which is generally used to denote the process of scanning the human body, and has a popular association with brain scans or full body scanning. However, bio-imaging has another meaning, referring to the use of imaging tools, mainly microscopes, for the examination of biological cells. In this sense, it is the science and technology of setting up the tools, preparing the specimens, and capturing the images in the most appropriate way to address a particular scientific problem, so involves expertise in both cell and molecular biology and the technology of imaging, such as microscopy.

At the BBSRC[1] Centre for BioImaging at Rothamsted Research, the staff provide consultancy and support to the scientific community in the use of these tools to help scientific researchers to get the best results out of the technology for their particular scientific problem. The staff are themselves hybrid scientists and technologists, and a major element of their work involves advising scientists, helping them choose the right techniques and use them in the right way, and troubleshooting the scientific and technological problems which the scientists may encounter.

A wide variety of technologies are involved in this work. The microscopes are chosen to suit the scientific problem and the specimen: light microscopes, electron microscopes, confocal microscopes are all used in the Centre. Similarly, the range of samples to be studied includes frogs' eggs, nematodes, viruses, plant cells, insects, and fungi, and this demands wide-ranging expertise in imaging.

A great deal of their expertise is in the correct preparation of the specimen before it is offered to the microscope, and the actual examination of the image through the microscope is the very last part of the process.

"the intercation between us and the research scientists is always very close" (Raffaella Carzaniga)



Related technologies, solutions and opportunities

The field of optical imaging is developing rapidly and has the potential to impact across the whole of the biological sciences, where new and emerging bio-imaging techniques drive innovation in the imaging equipment, with associated advancements in electronics and information processing technologies. Recent developments in this area have included the use of atomic force microscopy as a tool for the mapping of protein functions and for the study of enzyme dynamics; 3D visualisation of cellular organisation; image capture and 3D modelling of cerebellum and motor learning; imaging the architecture of photosynthetic membranes; use of confocal microscopy to study membranes dynamics.

1 Biotechnology and Biological Sciences Research Council. The BBSRC oversees a family of research institutes around the UK, of which Rothamsted Research is one. This is a similar working environment to a university, but without the requirement to teach students.

Case Study 3: Raffaella Carzaniga, Project Leader, and Jean Devonshire, Research Assistant, Rothamsted Research - Centre for BioImaging

Raffaella was first and foremost an art student at secondary school, but studied biological sciences at university. She gained a degree and later a PhD, specialising in electron microscopy. She later undertook post-doctoral research in molecular biology, and in imaging - *"my heart kept driving me back to imaging. I get very excited looking into microscopes."*

Jean Devonshire is a research assistant who has spent her working life since leaving education at Rothamsted Research. She works with Raffaella and a team of researchers in the Centre for BioImaging there, supporting the work of scientists who wish to use microscopy technologies to study biological specimens.

Together with her colleague, Elspeth Bartlet, Raffaella developed Drive Online, a system for giving students real-time remote access to a scanning electron microscope over the internet. Using the system from a computer in their own school or university, the students are able to guide the instrument remotely, to magnify or rotate images, and to view biological specimens in fantastic detail. It is hoped that this system will not only stimulate the students by giving them hands-on access to scientific instruments, but also refresh the school curriculum in a difficult-to-teach area, and stimulate the scientists in the research labs to open up their work to a broader public.

Raffaella, Jean and their colleagues are strongly committed to advancing the public understanding of science through their work. Raffaella sees particularly powerful applications for her work in the arts, and believes that Drive Online has enormous potential for presenting specimens (such as leaves or ice crystals) at very high magnifications to display their aesthetic or architectural qualities – their structural beauty. She has exhibited 'touchy feely fungi' at the Royal Microscopical Society Summer Exhibition, and is particularly interested in advancing the interactive applications of microscopic technologies to engage the public, through the Microscience Exhibition, for example. She is now working on the development of a webcam to show the preparation of biological samples in the Rothamsted labs.

"Some of the problems in microscopy arise because people think that using a microscope is easy, that it is just an instrument, that you just put the specimen there and you get out a pretty picture. But the problem is that you need to get out a pretty picture that contains a scientific answer to your particular question. We need to help the user to understand how to frame the scientific question. With our expertise in cell biology, we can help them understand which preparation technique they should use to get the result they want. So the interaction between us and the research scientist is always very close. We need to understand their project" (Raffaella Carzaniga).

2.4 e-Science - Weather forecasting

Weather forecasters in the UK are employed by the Meteorological Office (known as the 'Met Office'). The main functions of the Met Office - forecasting, commercial, business, marketing and computing activities - are centred at its offices in Exeter, and it serves a range of organisational and corporate clients, employing around 1500 staff. One of the largest of its clients is the BBC, for which the Met Office supplies forecasting and broadcasting services through a dedicated outstation at BBC Television Centre in London.

The Weather Centre office at the BBC operates 24 hours a day, 7 days a week, and the weather forecaster works on shifts which are altered every six weeks. Depending on the shift she is working on, the forecaster comes into the Weather Centre and must very quickly familiarise herself with the briefing of the previous shift, getting a synopsis of what is happening and what is expected, not only in the UK but around the world. She then plans her work around the broadcasts that she will have to deliver during her shift, and begins work on preparing for these.

Weather forecasting for the BBC is effectively a dual role – one of forecasting combined with one of broadcasting. The first part of the working shift usually involves the forecasting element of the job. She assesses the weather charts, other information and guidance brought together by a large team of staff including the Chief Forecaster in Exeter and sent to the Met Office at the BBC. The Exeter team run different versions of a computer model to cater for slight variations in existing weather conditions (such as changing wind speeds), and this is what can give rise to some slight uncertainty in the forecast. Additionally, the UK Met Office models are compared with models generated by its counterparts in France, Germany and the US. The Exeter forecasting team has to decide which scenario is the most likely one, and offers guidance along these lines to the forecaster in London, who is now moving into the role of broadcaster. She will 'add value' to the forecast, by presenting it in terms of how probable it is, how confident she is in the predictions, and what this means in practical terms from the viewpoint of the audience.

"We are really data interpreters nowdays, communicators" (Helen Willetts)

Related technologies, solutions and opportunities

Meteorology is a rapidly developing science and new forecasting methods, many of which use computing concepts and technologies, are continually evolving. The field covers a whole range of specialist technologies and areas of expertise, which are also advancing. They include: remote sensing, forecasting techniques, graphics systems, satellite imagery, advanced radar systems, as well as data processing and analysis, and even chaos theory. Underpinning these are many more traditional ITEC technologies important for data collection, storage, and processing, as well as for creating the basic information processing, analysis and integration framework.

Probable scenarios are generally expressed along these lines: *"There is some uncertainty as to how quickly this band of rain will push into Scotland, but probably in the evening rather than the afternoon"*. The forecaster/broadcaster has a telephone conference with the Chief Forecaster to discuss and agree the content and emphasis of the forecast, thinking about how the information can best be presented during the broadcast later in the shift.

The combination of forecasting and broadcasting skills is probably unique to this line of work, but it is very important to be able to both handle and interpret scientific information, and present it in an accessible way. A forecaster examines what is wrong with the weather. *"What is this front doing? What is this area of high pressure doing? Where are the severe weather events around the world? You have to do the comparison with what has been going on and how things will feel to the public. People expect far more nowadays from a weather forecast than just 'there will be a band of rain moving south today'. You have to elaborate much more, so it is much more about interpretation and feel and emphasis and communication nowadays. We are really data interpreters nowadays, communicators."* (Helen Willetts)

"We are a specialist type of forecaster. Like an aviation forecaster will write their terminal aerodrome forecast in language that aviators understand, we have to do it in language that the public will understand. Although we can do a very good job, and six days out of seven and 87% of the time it is right, there is always this element of uncertainty in the atmosphere because of chaos. We use this technique called 'ensemble forecasting' which is like probability, in that we run our computer model quite a few times with slightly different start conditions, and it can come out with a completely different forecast. Our techniques nowadays are far more probabilistic than deterministic. We can come out with fifty different forecasts, and more often than not they will gravitate towards three different potential solutions".

Case Study 4: Helen Willetts and Penny Tranter - BBC Weather Forecasters

Helen and Penny are well-known household names who appear regularly on TV and radio presenting national weather forecasts. Both became interested in weather forecasting at an early age, and joined the Met Office straight after leaving university. Penny Tranter took her degree in Environmental Science and then trained as a weather forecaster with the Met Office. Her job initially took her around various RAF stations and weather centres, and after a successful audition for the BBC Weather Centre, she moved to the Met Office at the BBC. After the birth of her first child in 1994, Penny returned to work part-time on a 21-hour per week contract, and has worked part-time(with varying weekly hours) ever since. Like all weather presenters, she also works night shifts, weekends, and on other shift arrangements. These are organised on a six-weekly roster system. Helen Willetts has been interested in weather forecasting almost since childhood, a result, she believes, of growing up in North Wales where she experienced some dramatic and continually changing weather patterns. After taking science A levels and a degree in Physics at the University of Nottingham, she joined the Met Office, originally hoping to do research. However, she was offered a job in forecasting which she was happy to take and found she loved it. She has worked in the Met Office on a full-time basis ever since, and now works as a forecaster and broadcaster, presenting the weather on BBC radio and television.

Helen Willetts

Penny Tranter

"This is a little niche I have found that I love. It is a great job. I do like coming to work. The fact that we have got so many females working here, and so many working part-time, must show that it is a pretty good place to work."

2.5 e-Content – Digital art

With the expansion of the web and its applications, there is a burgeoning set of activities concerned with capturing and presenting material online. Web-based material is becoming ever more varied and wide-ranging, and organisations increasingly seek to reach their target audiences or users through their web-based services and products.

Organisations which work in the creative arts are no exception to this development, and online content is seen as a key means of reaching new audiences who cannot gain access to physical content directly. At the Tate group of art galleries, for example, there are Digital Programmes in place, the purpose of which is to support the digitising and placing of all the galleries' material online, and so to create a new online gallery in addition to the four physical Tate galleries. Through the Insight project, 65,000 works of art (representing the entire Tate collection) are now available via the website, and search tools are being developed to allow people to access them easily.

It has taken the organisation about five years to complete this process, and it is of course a continuous one as more work is acquired and new exhibitions are mounted. Running a Digital Programme such as this, particularly in a large networked organisation such as the Tate, means undertaking a very wide range of activities on a daily basis. As Jemima Rellie says, *"I get to work with literally every single department in the organisation. In one day, I will be speaking to people in Tate Enterprises about e-commerce initiatives, and then to the communications department about marketing, or the press team about publicity around programmes, and to curators, who are increasingly developing bespoke digital content to complement the offline exhibitions and displays.*

"We want to make sure that we spend the tax-payer's money as sensibly and as safely as we can, so we try to future-proof our work. You do need to have an understanding, and experience of online technology and how it is changing, and be able to guess how it will change in the future in order to ensure that content remains usable in the future." (Jemima Rellie)

Related technologies, solutions and opportunities

Computers are increasingly accepted as means of artistic expression and communication, and the growing use of internet has helped to create and raise awareness of virtual and communication-driven societies, with interest in and access to shared art-related content. Numerous ITEC technologies contribute to advancements in this area, including multi-media, visualisation, computer graphics, rendering techniques, digital aesthetics, dramaturgy, interactions, virtual environments, networking and many others. These, newer technologies pose serious challenges to and drive innovation in the more traditional areas of ITEC, which are needed to accommodate ways of handling very large file sizes, proliferation of formats, the need to process and accurately reproduce colour information, retrieve images on the basis of visual information, and many other requirements.

"I will deal with the magazine team, the finance department in terms of our requirements for transparency, HR, the collections department. We are ahead of the game in terms of access to our collection online." This is a challenging job technically, in that the public service remit of an organisation like this creates particular technical imperatives. There is a constant search for new potential applications to add to galleries' and museums' online content – online exhibition listings, a calendar interface, bespoke information for users with personalised reminders tailored to alert individuals to events of personal interest. This is a growth area with considerable potential for women to enter.

Case Study 5: Jemima Rellie, Head of Digital Programmes, Tate

Jemima is the Head of Digital Programmes at the Tate, a post which was newly-created in 2001 for the new Department of Digital Programmes in the Tate. This is a central team which works across all the departments and all the four galleries of the Tate.

Jemima's work involves setting high-level strategies for, and co-ordinating the delivery of, public-facing digital content. This is an extremely varied job involving working with all departments in the organisation, so she has daily contact with a wide range of people and covers a wide-range of functions.
Jemima did not have a technical background when she began her career. She studied Art History, and gained both a Bachelors and a Masters degree. She left university and went to work as an intern at the Institute of Contemporary Arts, spent some time teaching English abroad, and then spent several years working in art book publishing. During this period, she enrolled in a one-year evening class learning basic client-side programming languages. Her prior experience of publishing software packages proved an invaluable combination with web publishing tools which she now learned, and this combination allowed her to move into web editorial work. She set up the first website of the art publisher, Phaidon.

This took her into new media agency work where she worked as a web editor working on a wide range of projects, from designing web pages to developing company shareholder voting sites. She looks back on this as a time when she went through an extremely steep and useful learning curve, because web technology was developing so fast. She also spent some time in an interactive TV company at a time when it was in its very early infancy. This variety of experience proved to be an ideal training ground for running Digital Programmes Department at the Tate, where she runs a thriving and growing department.

2.6 e-Content – Digital libraries

The digitisation of content is an activity which covers many types of material, from visual arts to the written word. Many library collections across the UK are undergoing this process, which is seen as a way of widening access beyond immediate catchment areas and enhancing their ability to meet their public service remit in an electronic age where people no longer consume content only by physical means. The British Library is aiming to become the national digital library for the UK, presenting all of its physical content electronically so that the Library is 'ready for the future'.

The work of digitising a vast collection of written materials involves developing products and systems which capture and make available these materials. At the British Library, the work is carried out in collaboration with supplier companies in the information industry. It involves bringing in and using ready-built systems to digitise some parts of the Library's products and services, but also commissioning the development of new technologies to digitise other areas of content. The purpose is to widen access to the content, and at the same time find ways of generating revenue for the institution.

To do this, the information professional, in this case the Head of Product Development, has to contribute to the formulation of the institution's digital strategy. Once this strategy is in place, she has to oversee its implementation. This involves managing a series of 'digital partnerships' with suppliers at a high level. In 2005, for example, the Library announced a strategic partnership with Microsoft to digitise 25 million pages of content from the Library's collections, with further digitisation planned for the future. This will also involve the development of search facilities to enable users to find the material they want through the web.

"It is about information. This happens to be carried in books at the moment, but how do we embed ourselves in the future? As material becomes less and less homogenous, we will have researchers who will want to use the material here but also increasingly remotely. Or are we just a place where you store some old stuffy books? How do you enable people to get to information?"
(Ruth Jones)

Related technologies, solutions and opportunities

Libraries and museums are evolving today into electronic portals and global collections of digital content, seeking to support access to millions of pages of text and visual information, creating digital archives and on-line cultural heritage sites. Scalability, accessibility, connectivity, integrated access, and digital preservation are just some of the key technology trends and reasons for the development of tools to support digitisation tasks such as multimedia enhancement; full-text searches; cross referencing; creating annotations; adding bookmarks and highlights; and creating embedded glossaries and dictionaries. Some specific ITEC technologies which are widely used in this area include: XML, databases, content and document management systems, scanning and image enhancement systems, information retrieval, portals, virtual worlds, information and data security, networks, as well as the more traditional storage, processing and communications technologies.

The Head of Product Development, Ruth Jones, manages this and similar strategic partnerships, and ensures that the information strategy of the Library is addressed in the short and long terms. As she says, *"a big part of what I do is getting information to people, by balancing all our stakeholders' requirements and putting it on a technology platform that makes some sense."* The Library currently has information in several formats and 'silos', including books, newspapers, sound, even office records from the East India Company. To make these different forms of information accessible and useable means finding ways of joining up these different sources, and this is one of the key challenges of a job in information systems product development. Another part of the challenge of the work involves anticipating and catering for future technological developments - specifying solutions for digital content that will preserve its readability many years into the future, despite changes and enhancements in application areas. Ruth concludes, *"you know how hard it is to open a Word document that is three years old. Imagine in two hundred years …"*

Case Study 6: Ruth Jones, Head of Product Development, British Library

Ruth studied for a degree in Astronautics and Aeronautics at the University of Southampton, one of 10% of women on her course. However, she elected not to pursue a career in engineering, and decided to use the skills she had acquired in other work. She says, *"if you look at what an engineer is actually trained to do, you are trained to be quite good with numbers, to have a feeling for approximate rightness rather than accurate wrongness, to work with people to find solutions, and to put the solution to the need that is out there. Everything else is common sense."*

Ruth entered science publishing and became a commissioning editor, putting products to market and ultimately working with electronic publishing. This clearly demanded her engineering skills and knowledge, because it involved working with IT and publishing technologies. She worked on the use of multimedia with professional scientists, advising them about how it could help them produce different and better published products.

Her next job moved her back still further to her engineering roots. It involved managing the building of a hosting platform for scientific journals that would interface with the emerging library information systems of the time, working with the programming team and ensuring that the project kept to its brief and provided the most appropriate solution with the time and resources available. She was then recruited into the position she currently holds as Head of Product Development at the British Library, based on London's Euston Road

"It is a really fascinating job. It integrates the management of technology, an appreciation of where technology might take us, relationships with people who are really at the forefront of e-technology, but balancing the enormous history of the public institution with doing the right thing for the future."

2.7 e-Content – Interactive news software development

Interactive news is news which is delivered to the public through interactive media. It is not delivered through the traditional channels of radio and television, but rather through newer media such as the internet, ceefax, digital text, email and mobile phones.

As with most senior technical positions, there is a substantial element of management involved in the process of software development. The job involves working with specialised teams of developers with expertise in the different media platforms. These teams have to be supervised, technical problems have to be addressed and solved within those teams, projects have to be steered and progress ensured, and the strategy for systems has to be defined in relation to business strategy.

Related technologies, solutions and opportunities

Broadcasting technologies make use of a wide range of ITEC specific technologies and tools, which are continuously advancing and converging. They include: digital content production systems, satellite networks and communication, multimedia, content retrieval and archiving systems; desktop and post production systems; internet and web technologies; intranet and broadcast client-server systems, as well as programming environments and languages such as Linux, Java, Visual Basic, Pearl and database systems such as Oracle, SQL and ASP.

Case Study 7: Christina Scott, Head of Software Development, BBC News Interactive

Christina found she had an aptitude and enjoyment for maths and physics while at school, and she was sent on a week-long course on Women in Engineering run by one of the professional institutions. This was designed to encourage women to consider engineering as a degree subject, and it worked for Christina. The course triggered her enthusiasm for engineering and she went on to do a degree in Mechanical Engineering. She was one of four women in a cohort of 100 students.

After graduating, Christina worked for a while in the oil industry before joining a large consulting company. Here, she learnt some programming skills, testing and project management skills for very large technical systems, and also learnt about a wide range of different industry sectors through the varied clients of the organisation.

During this time, she developed her expertise in, and preference for, working in the media and her next job took her into software development and project management for digital television, which at the time was a new and very exciting field to be working in.

Christina has since had two children, and has held another position as Head of Software Development for a direct marketing company, before joining the BBC in 2005. As Head of Software Development for BBC News Interactive, Christina is responsible for the development teams and the project management teams, in all about 60 people. The BBC handles most of these activities in-house.

Christina finds the BBC a very family-friendly working environment which works well for her as a parent of two small children. The organisation offers flexible working arrangements, including holiday purchase schemes, career break schemes and there is also a workplace crèche. Very long working hours do not figure in Christina's day, and she is able to attend to childcare issues if they arise. At the same time she has achieved promotion since joining the organisation, which she believes highlights its commitment to equal opportunities - the personal circumstances of staff do not influence promotion decisions.

2.8 Health Informatics – Telemedicine development

Telemedicine is broadly concerned with the use of telecommunications technology for medical diagnosis and patient care when the provider and patient are separated by distance. Applications include the transmission of patient data to clinicians over networks, enabling clinicians to diagnose and discuss individual cases without the patient being physically present. This is useful where clinical expertise is not available in a particular area, or where the patient cannot physically travel to the clinician. It is also useful where different types of clinicians cannot physically meet, but need to discuss the patient's treatment plan.

For example, video-conference networks of clinicians from different disciplines can substantially improve their ability to collectively reach a rapid diagnosis and treatment plan, and to initiate that treatment. This is particularly important in the treatment of potentially invasive diseases such as cancer. Kate Caldwell says "*it cuts down the review time for patients, so instead of waiting six months to see a specialist, a patient could be reviewed, their surgery and therapy decided on in that meeting. Clinicians tend to run the clinic straight afterwards, so they see the patient and get this instant feedback. You cut down the amount of time it takes for them to go through the system. That is obviously hugely important.*"

The Telemedicine Developer is concerned with developing the technological infrastructure necessary to enable the transmission of patient data. This can include scoping the sites into which the technology will be installed, developing the technical solution, trialling products and network technologies. It can also mean project-managing installations, putting out tenders and making contracts, overseeing contractors, ensuring quality, and configuring technological solutions. This requires a high-level understanding of the technical solution being specified, in order to be able to oversee the work of the different

"I have never thought of myself as the best technical person, but I do have organisational, project management skills and things that don't seem to come naturally to people who usually go into this field." (Kate Caldwell)

Related technologies, solutions and opportunities

Telemedicine enables a physician or specialist at one site to deliver healthcare, diagnose patients, give intra-operative assistance, provide therapy, or consult with another physician or paramedical personnel at a remote site. The role of ITEC in supporting the delivery of healthcare is growing. ITEC impacts at a number of levels, from intelligent sensors to communication infrastructure, and health informatics systems can include a myriad of more specific technologies, such as: telecommunications, networks, databases, videoconferencing, interaction, geographic information systems, broadband applications with the ability to transmit complex data such as computer-aided tomography scans, as well as low-bandwidth applications such as wireless transmission for use in disaster and emergency settings. Other contributing technologies include internet, virtual private networks (VPN), and data and information security.

Case Study 8: Kate Caldwell, Telemedicine Developer

Kate Caldwell is employed as a Telemedicine Developer in the Cambridge e-Science Centre at the University of Cambridge. She works on a number of research programmes supporting the National Health Service Cancer Plan. The plan set up regional cancer networks, the aim of which was that everyone diagnosed with cancer would receive the best possible care in their area.

Kate's work aims to overcome the uneven national distribution of clinical expertise by bringing the patient's data to the clinician through video-conference networks. These networks enable multi-disciplinary teams of specialists to meet regularly even though they are not physically together.

Her expertise is in building the video networks which support conferencing and other forms of collaboration between health professionals. The networks have clear advantages for the speedy diagnosis and treatment of the disease. In order to do this, she needs a clear understanding of how clinical processes conventionally work and what can be done to improve them through the application of video networks. She is also an accomplished project manager, a skill necessary in almost all fields of technological development.

"You have to be an expert in the networking technologies involved and in the video technologies. You want to get the best value for money for the NHS and other funding organisations involved", she says.

Kate didn't start her working life in IT. She began as a personal assistant, and only later returned to higher education as a mature student to do a degree in Computer Science. She graduated in 2000, and found a job as a graduate trainee in a telecommunications company developing optical networks. She was the only woman in sixteen graduate entrants to the company. She joined the Cambridge e-Science Centre in 2002.

2.9 Health Informatics – Health information management

Like every other industry sector, the healthcare sector is strongly dependent on both information and information technology. The progressive application of information technology to the management and delivery of healthcare over the past twenty years has led to major changes in the nature of healthcare jobs and has created enormous challenges for the development and progression of healthcare professionals.

Health Informatics refers to a cluster of professions incorporating ICT work, knowledge management, information management, health records management, and clinical informatics. The central purpose of all of these is to enable, promote and support the effective use of data, information, knowledge and technology to support healthcare delivery. With the formulation of the HR strategy 'Making Information Count', for the first time, the occupational profiles and requirements of health informatics professionals in the NHS have been recognised and mapped. [2]

Knowledge management is a function which supports health professionals and management staff in their education, training, development and professional practice. Knowledge managers include librarians who provide both information and some information training to other healthcare professionals. Information management refers to the retrieval, analysis, interpretation and presentation of health data and information, all of which enable the planning and understanding of the delivery of patient services and patient care. An information manager needs to have a solid understanding of health care processes in settings such as primary care, acute services, social services, and mental health.

"If you are going to work in an organisation like health, with clinical practitioners, they are all qualified. They expect others to be similarly qualified and committed to delivering their own professional work in the best possible manner." (Diane Benjamin)

Related technologies, solutions and opportunities

The multi-disciplinary field of healthcare is a massive generator and user of information. Effective management and exploitation of this critical resource is fundamental to the effectiveness of all groups and individuals in this field, at strategic, management and operational levels. ITEC technologies contributing to information management include records management, database systems, data analysis and management systems, data mining, natural language processing, ontologies, geographic information systems, knowledge representation and management, information security and confidentiality, formal methods for modelling and validating medical records, image processing and image searching, data compression, user friendly interfaces and secure networks.

[2] NHS Information Authority (2003) Making Information Count: A Human Resources Strategy for Health Informatics Professionals, London, Department of Health.

Case Study 9: Diane Benjamin, Head of Health Informatics Standards

Diane's early adulthood was spent as a wife and mother of two young children. Only once her children had started school did she embark on higher education and then a career. She gained an Open University degree and a professional librarianship qualification, and then entered the NHS to work as a medical librarian responsible ultimately for several hospitals and for the co-ordination of a multi-disciplinary library service.

This was highly qualified work, and necessarily so. Information management was at this time an emerging specialism in health, concerned both with managing public resources effectively and with ensuring good health outcomes for patients and carers. Diane's experience fitted her well for this work, and she moved into an information management role, while undertaking postgraduate study in Information Management. This move coincided with the growing application of information technology to health in the early 1980s. She says, *"it was fascinating work, I can't tell you how interesting it was, but it was hugely demanding."* With her knowledge of local healthcare information and management issues, Diane moved into IT systems implementation, managing change processes at a regional level. She worked on the implementation of, among others, maternity systems and national child health systems, in the process developing an interest and expertise in the emerging skills needs of health technology professionals and in their professional development.

Her next post, in the NHS Training Directorate, was concerned with establishing and operating training and development for health professionals working in information roles - in information management, knowledge management and IT. This was a very new specialism in which the knowledge base was still being defined.

As Head of Health Informatics Standards in the NHS Health and Social Care Information Centre, Diane has been leading the formulation and implementation of an HR strategy for healthcare informatics professionals, a project which directly draws on her own personal career development and experience, but also on her breadth of experience. In conjunction with Agenda for Change, this strategy covers the identification of the different health informatics job functions, the entry points to these professions, qualification requirements, and training and development pathways. Few new ITEC professions are so comprehensively articulated and supported through training and development opportunities.

"The world was changing so swiftly, and we didn't appreciate what they needed to know to deal with it. But you couldn't rely, as the technology became more sophisticated in the mid 90s, on amateurs, however gifted or interested. I enjoyed supporting people to learn and deal with changes in their own organisations", says Diane.

2.10 Electrical and Electronic Engineering – Power electronics

Energy electronics cover a wide field of engineering activities concerned with providing and maintaining the electricity supply, from the provision of domestic power to the running of the national grid.

The study of electrical and electronic engineering includes a considerable element of mathematics and physics, and power electronics applies these bodies of knowledge to the supply of power. Application areas include the supply to large electrical systems, through to the powering of relatively small consumer devices such as computers, mobile phones or televisions.

It is not a field in which women have traditionally been represented, though one which might be attractive because of its potential application to a range of problems, including social and development issues, as Ellin Barklund's case shows. Women in this field appear to show a preference for the social applications of power electronics.

Related technologies, solutions and opportunities

Power electronics incorporates concepts from several separate ITEC areas of expertise, including: analogue circuits, electronic devices, control systems, power systems, magnetics, electric machines, numerical simulation. Applications range from electric vehicles to generating systems for utilities, manufacturing power systems, consumer appliances, medical equipment, naval electronics, intelligent machinery controls, and a wide range of products for control applications such as rectifiers, inverters and converters, battery chargers, switch gears and motor controllers

Case Study 10: Ellin Barklund, Student in Electrical and Electronic Engineering

Ellin is a final year undergraduate student of electrical and electronic engineering at Imperial College in London, one of 25% of women in her year. Her specialist area of study is power electronics – the provision and maintenance of power and energy supplies. She is fascinated by physics and the concepts behind it, and feels this sets her apart from her male counterparts who make up the overwhelming majority of staff and students in her specialism. Ellin is on course to study for a PhD, but she would like to do it in an environment where there are more women around her.

Ellin has already had substantial and relevant work experience. This has included working on the development of new solar panel products in a company which designs these installations. She has also worked as an electrical engineer designing instrumentation equipment for fuel cells, in the Imperial College Undergraduate Research Opportunities Programme. This is a programme which offers undergraduates the opportunity to work in another department from their department of study, applying their own skills on an inter-disciplinary research project.

Ellin was recently awarded the Siemens medal for Engineering Excellence, which is given annually to university students in the UK. She won this for earning "an unprecedented grade average" in her subject, and for her performance in her industrial placements. *"I am the geekiest of them all!"*

But she is keen to counter the stereotype of high-performing engineers: *"I wish they would advertise the fact that I won this prize a little more prominently so that people could see that women can do this. There are so many competent female engineers out there, but unfortunately they are not visible."*

Many people are keen to see her succeed in what is still a thoroughly male domain. In November 2005, she was invited to speak at a meeting of the All Party Parliamentary Group for Women in Science, Engineering and Design about the barriers she has faced in her engineering studies and how she has overcome them.

In her PhD, Ellin would like to pursue her interest in the social dimensions of energy electronics, such as the development of renewable energy and how it can be put to work in society. Like many women, she is not particularly interested in studying technology for its own sake, but would find it more interesting and worthwhile to look at social needs and design technologies around these needs.

2.11 Strategic IT – IT security

IT security is a relatively new area of work but one which is now central to the activities of most organisations and an increasingly disciplined field. It is concerned with ensuring the protection of IT systems and products from fraud, hacking and other abuses.

The work of an IT Security professional involves an understanding of IT networks and architecture, as well as systems and programming knowledge. Typically, it involves the management of the design, establishment and maintenance of security systems such as firewalls, the definition of entry ports, access control mechanisms, systems processes and procedures, and data protection arrangements. IT security also means scrutinising the range of potential opportunities for abuse of systems and networks, including through fraud and attacks. There is a strong element of risk management involved in this.

In essence, IT security succeeds through good organisational design. Much of the work is concerned with establishing secure procedures in an organisation, rather than with refining IT systems themselves. A simple example is getting staff to use good passwords on their computers. IT security works best where organisations engender a culture which promotes a consciousness about security issues among all staff and the development of robust processes for the everyday management of the organisation. So an IT security professional is a person with both knowledge of IT systems and networks, and also an understanding of the role of organisational structures, cultures and processes in contributing to security. It also works well where the professional has a good understanding of the business and its needs.

"I understand our business and what our business needs. My role is probably more about understanding what the business objectives are and trying to engender an appropriate security culture, such that we can meet our objectives and deliver them. And that is really what it is all about."
(Kathryn Moore)

Related technologies, solutions and opportunities

Information is one of the most important assets of an organisation so anything that puts information or the processing of that information at risk may directly endanger the organisation. IT security operates at a number of different levels, from putting in place software and hardware protections on the network to defend systems from external intruders and viruses to issuing policy recommendations safeguarding the systems from internal misuse or human error. The full exploitation of internet for e-business could not be achieved without effective system security at the platform, operating system, network, application and infrastructure levels. This may involve use of cryptographic techniques and algorithms, secure networking protocols and operating environments and mechanisms to monitor and maintain overall system integrity. This is an area of growing need and rapid advancement.

Case Study 11: Kathryn Moore, IT Security consultant

Kathryn Moore is a consultant specialising in IT security and working at a major international investment bank. She is responsible for defining the organisational model and strategic plan for the operational management and technical delivery of the security monitoring infrastructure. Kathryn graduated from Imperial College in London, with a degree in physics.

Her first job in BT was in a software engineering group at their Martlesham research laboratories, though she had had no prior contact with software engineering. She worked in a number of different roles in BT, including network management, testing, systems administration and some systems architecture, design and coding.

BT supported her sabbatical while she studied for a Masters degree at University College, London. She then took a series of computing jobs in the company, and spent a year working on an international collaborative project in the USA.

She subsequently moved into an IT security team, which involved travelling worldwide in the company, project managing global security infrastructure improvements. She learnt many of her skills and acquired considerable knowledge on the job. This took her career into the domain of IT Security and she landed the position of Head of Security in Genie, the mobile data ISP which later became part of O2, the mobile telephony company.

In this position, she was responsible for both physical security and IT security – the security of buildings, property and staff on the one hand, and the security of the firm's mobile products from hacking, fraud and abuse on the other. This involved a process of organisational and cultural change as much as one of technological change.

Working on IT security provides a broad grounding which facilitates movement into other infrastructural and management roles, covering a range of business processes. With her expertise, Kathryn has since moved into consultancy, which allows her considerable freedom in her working life, and gives her the opportunity to build her experience in different organisations.

2.12 Strategic IT – Police systems administration

The job of a systems administrator in the police force is a very new occupation, created to cater for the rapidly burgeoning application of IT to the detection, reporting, recording and prevention of crime. One major area of IT application is in crime systems which handle the recording of crimes after they have been registered through a 999 call. This kind of system has been developed in Hampshire Constabulary, with a link to an intelligence database.

The job of the system or database administrator in an environment such as this is to assemble, test, maintain and support the crime system, ensuring that it is technically robust and upgraded periodically to adapt to new hardware and operating system platforms. This is primarily a back-office function, and includes collaborating with suppliers and contractors to adapt and upgrade the system infrastructure, building test environments and building training environments. Business analysis comes into the job too, as systems originally built for application in one police environment (police force or even a different country) are adapted for use in another. Working on the interfaces with related or linked systems is also part of the job.

At the Hampshire Constabulary, the project team designed an intelligence element to the system, creating an logging system, that interfaces with the 999 system. Everything is logged through Command and Control: *"We now have an interface that directly sends information to this instant logging system", explains Rosemary McNaughton. "Where a police officer is deployed somewhere, they can radio back and confirm the crime to Command and Control, who can automatically transmit the data straight into the crime system. Officers in the office can just pick that information up and do any related links and investigations on the system". "The second phase is to interface with the Police National Computer and the Prisoner Management System, linking the whole lot together".*

There is, of course, a vital issue of risk and reliability to be dealt with in such a strategically critical system. Parallel servers are established, sharing one set of disks, so that if one server fails, the other takes over seamlessly. Disaster recovery systems also have to be designed, developed and built. The application of IT to police processes is still relatively novel, particularly in comparison with other areas of work where its use is far more established. However, application areas and rates of use are growing, and consequently a substantial element of systems work in the police force can mean managing a sharp rise in these.

Related technologies, solutions and opportunities

Systems administration ensures that the systems on which organisations depend work well and so the organisation itself can work. The area covers a range of different technical responsibilities, including administration of computer systems, network systems, e-mail, databases, internet and web related systems, as well as any industry specific applications. Increasingly, organisations are utilizing internet technologies to support and improve their processes and services. Web enablement of business processes has generated demand for business intelligence (BI), a need to extract knowledge out of the vast quantities of collected data, which may be residing in disparate systems such as accounts, customer databases and sales records.

"When I joined, there were about 200 police officers using the system. Overnight it went up to 400 and the system just couldn't cope with it because the application wasn't designed for that many users. So I arranged for a new server to come in, rebuilt a new server with the latest release of software, the database engine, and worked to transfer the old database into this new one. So I managed all of that. By the end of 2 years we had 800 people working on it. The infrastructure that the database is on is quite complex. It is not just a database, there is a middle tier that has a logical sequel on it. It runs the middle tier, so effectively you only have one connection to the database, not thousands of users making a connection to the database. This middle layer is load-balanced. It is an interesting environment to work in".

One of the main challenges of the job is to help police officers who are new to IT applications to work with a new system, and one that is very different from the Window-based systems they tend to encounter in their everyday lives. The database administrator has to set up and design training environments for them, including the physical classrooms, computers and dummy systems. In Hampshire, there were 4000 police officers to be gradually trained in the crime system. In addition to the training implications of developing a system such as this, there are major implications for the information processes which police officers utilise in doing their jobs. Where once they would have operated separate systems to record crimes – discrete spreadsheets or even a simple book – now they use the one integrated system and their information processes have to be streamlined accordingly.

Case Study 12: Rosemary McNaughton, Database Administrator, Hampshire Constabulary

Rosemary first came into contact with information technology when it was a very new technology – in the early 1980s. She studied IT and finance in the course of taking a diploma in Business Studies, before going to work in one of the big banks as a system programmer. Here she gained a considerable amount of experience in programming and upgrading the bank's VMS system, and subsequently worked on transferring financial systems into an Ingress database.

She continued working on back-end infrastructural systems in subsequent employment, and gained experience in setting up testing environments and in general project management.

Rosemary joined Hampshire Constabulary as an Ingress database administrator in 2001. Her work was concerned with upgrading the elderly computerised crime system which needed support and systematic maintenance. At that point, there was no technical support role in the police force, so Rosemary's was a new job which was created to provide this support.

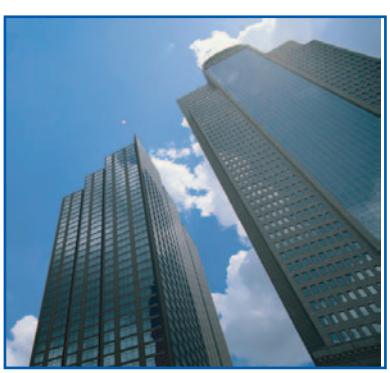
She plays a key role in the development, support and interfacing of the infrastructure for an integrated crime information system which is linked to the Police National Computer and Prisoner Management system.

2.13 e-Government – Public information service provision

Information and Communications Technologies offer the possibiliy for information services to be provided to the public through new channels and in new formats which supplement traditional face-to-face and paper-based forms of communication. Throughout the UK, national and local government organisations alike have been actively developing electronic services to widen and simplify access to government information, and a great deal of effort has been devoted to the project of delivering electronic government – 'e-government'.

At local government level, e-government initiatives include innovative ways of supplying information on local government services and allowing service users to communicate with local authorities in more user-friendly ways. Examples of such initiatives include automated payment facilities which operate on a 24/7 basis, and which accept credit and debit card payments. These facilities can cover council tax and rent, but can equally allow payments for other council services such as birth certificates, weddings, libraries, district court fines and council fees. This is the type of initiative being developed by West Dunbartonshire Council, among others, where it is known as the 'Customer First' electronic service delivery initiative.

It is the job of the Head of ICT in a local authority to oversee the development and provision of new electronic services. In West Dunbartonshire Council, there are projects to develop a one-stop shop supported by an integrated information system. The aim is for users to be able to make enquiries about the most common aspects of council services – library provision, planning applications, education services, social services, council tax, for example – and to receive information on the spot from a staff member who has access to the integrated system which pulls together information from across council departments and presents it in a single place. West Dunbartonshire Council aims to have 80% of all its enquiries handled through this channel – one of several initiatives



Related technologies, solutions and opportunities

e-Government is about changing the way government works. It has the power to renew and redefine the relationship between public services and citizens by enabling, for example, personalised services that reach out to vulnerable groups in the way that traditional services cannot do. ITEC technologies play an essential role in providing the infrastructure needed to support the democratic process and new modes of delivery of public services. Primary amongst them are: internet, text messaging and digital TV, used as delivery channels, as well as technologies to enable integration with legacy systems, customer relationship management (CRM), networking and broadband, wireless communications, workflow systems and smart card solutions.

Case Study 13: Angela Clements – Head of ICT and Business Development, West Dunbartonshire Council

When she started her career, Angela did not set out to work in an IT profession. After taking a degree in Technology and Business, however, Angela was employed first in a local authority in Scotland and later in a large IT company.

After her second period of maternity leave, Angela moved back into local government, a working environment she found supportive for combining paid employment with the needs of her family. She has worked in local government IT positions since then. She now has four children, one of whom is disabled.

Angela has now reached the position of Head of ICT and Business Development at West Dunbartonshire Council. In this role, she is responsible for developing local authority information services. West Dunbartonshire Council serves an area where there is high unemployment and poverty – so there are substantial demands on its resources.

Angela leads the Modernising Government Agenda which incorporates several developments aimed at providing local people with innovative information services. It also includes career development initiatives for local authority staff, and it is in recognition of these efforts that Angela and the authority were between them nominated for three British Computer Society awards in 2005: the Women and IT Award, the IT Director of the Year, and the Career Development Framework Award which they won.

2.14 Financial Services – Infrastructure support

Financial services companies are among the highest organisational investors in information technology. They are extremely reliant on computer systems for all aspects of their business, including information infrastructures, customer relationship management and back office systems. The job of the infrastructure support professional in a financial institution such as a bank is concerned with maintaining and supporting banking IT systems, networks and applications. In a large institution like an international bank, several hundred staff can be employed in IT support functions, often working in specialised teams according to the system or application they are supporting.

The role of the systems administrator in infrastructure support is to configure the computers through the operating system, to upgrade the operating system, to repair faults and to develop new routines to provide better support to users. The team leader of an infrastructure support team is concerned with the management of these teams, and this role includes allocating work and resources. It also involves reporting to higher management, and involving technical managers in the resolution of technical issues.

A team leader needs to do capacity planning: ensuring that the correct technological provision for the organisation is available, and that systems are upgraded correctly and regularly. The job also involves frequent meetings with internal users ('customers') in business areas about their requirements, how well the support service meets these requirements, problem areas, and future projects. New projects are developed with colleagues and departmental management.

"I was actively seeking a company that stated that it had flexible working, family-friendly employment policies. It was a conscious decision to try and build in a bit more flexibility. I knew that there was a competitiveness among the big banks to offer family-friendly policies as part of their package, and I knew that these companies did have a stated policy."
(Juliet McMullen)

Related technologies, solutions and opportunities

The banking industry depends on information systems to make payments, transfer funds, and manage liquidity. These systems must function with precision and reliability on a massive scale. In the modern world of real-time financial services - where e-commerce, microbilling, and self-service banking are fast becoming the norm - the batch-oriented, end-of-day processing systems developed 30 years ago are fast becoming outdated. The financial industry is forever hungry for new systems and technologies that can accommodate new business models and workflows. Most recently, the focus has been on Linux and open source technologies, market data distribution platforms, IP-based multimedia terminals, grid computing; technologies for portals, hosting, integration and networking; business continuity and recovery solutions; as well as databases, communications, storage and archiving; and perhaps most importantly information and data security.

Case Study 14: Juliet McMullen, Technical Team Leader, Citigroup UNIX Department

Juliet started her working life with a degree in molecular biology. She worked as a research scientist in this field, but decided not to pursue an academic career and chose an IT career because it allowed her to continue to use her technical skills but was 'more marketable' than an academic career. She took a masters degree in IT and then went to work as a systems administrator in the UNIX department of a large airline, where she developed her skills in UNIX.

Working for a big bank is an attractive and empowering career move for someone with Juliet's skills. ITEC work is well-paid and technological systems are sufficiently advanced that these firms offer considerable learning opportunities. Financial institutions also have a reputation for hiring technical staff at the top of their field and commanding high salaries. Juliet sought a job with these opportunities, and given her desire to have children, specifically looked for an employer who could offer flexible working arrangements. With the help of a specialist IT recruitment consultant, Juliet's next career move took her into Citigroup. She was the only woman in a team of 35 people, and despite her minority status in her own department, found the organisation very supportive of women's progression.

She currently works as a technical team leader in a department of 100 people in Citigroup's offices at Canary Wharf in London. Her department runs the UNIX infrastructure for Citigroup. This involves running the systems of support, many of the banking applications, and the networking facilities used by the traders and other front office staff. Juliet's team takes care of the back-up requirements for those systems – the backing up, storing and saving of the customer data on the bank's computers. Around 20% of her department is female.

Juliet was nervous about combining maternity with work and fitting everything into her life, but has found Citigroup a good employer. On the positive side, she received a lot of support during her pregnancy, including occupational health advice. After her maternity leave, and in line with her legal rights, Juliet asked to work four days a week, including one day from home, and this was agreed. There were other options open to her and offered by the company, including compressed hours and job sharing.

The company offers other important support for women and parents. It provides an emergency crèche which Juliet has used. It runs a 'Citiwomen' group to provide support for women in the organisation, and a 'Citiparents' group to provide practical advice to staff on childcare, children's nutrition, and first aid for babies and children.

Juliet says, "*it makes you feel part of a wider community. It is useful practically and it is also supportive. It is nice to know that your company cares about that.*"

2.15 Financial Services – IT support

With information systems underpinning investment banking and trading processes, there is a crucial role for IT support professionals to maintain and, where necessary, address systems problems. This is the work of the IT support professional. The job involves taking initiatives to improve systems functioning, and responding to problems reported by users. In an investment bank, users range from front-line traders to support professionals and back office staff.

Providing IT support to front-line staff in such a business is time-critical and highly pressured work. A poorly-functioning IT system has enormous ramifications for the financial performance of the business and can result in the loss of very large sums in a very short space of time. Consequently, the IT support professional has to be highly skilled in analysing systems problems and in programming fixes rapidly and accurately, but often working on several issues simultaneously. In addition, there is a need to be promptly responsive to the demands of 'customers' - the users of the system or systems, to be able to step into their shoes, rapidly understand and interpret their needs and requirements, and communicate technical information to them in an accessible way.

An IT support professional in an investment bank can expect to acquire considerable experience of a wide range of issues very quickly, particularly when working closely alongside users, on the trading floor for example. Given the pressure of the work, multi-tasking skills are vital.

Related technologies, solutions and opportunities

Many of the activities covered by financial services are mission critical and the systems that support these services must deliver uninterrupted performance. Financial companies are obliged to have in place tested disaster recovery and business continuity strategies and solutions. Financial organisations are highly dependent on email and collaboration systems, databases, data storage and archiving, video conferencing, and customer relations management systems. Many companies are moving towards digital document management systems. The security of data and information is paramount and risk assessment and management form an essential part of IT systems support and management.

Case Study 15: Clare Foster, IT and Analytics Support Manager, Lehman Brothers

Clare Foster is an IT analyst who works for the global investment bank, Lehman Brothers, in the City of London. With a degree in Computing and Communications Systems Engineering, and a Masters degree in Advanced Computer Science under her belt, she entered the bank as a graduate software developer.

Her career took her next into IT support in the same organisation, and her job as an IT and Analytics Support Manager now involves supporting and maintaining the information systems used by the bank's traders.

She finds her work stimulating and engaging, though highly pressurised with long working hours, including some night shift working. For Clare personally, this is not a problem since she is young, single and highly committed to her work.

She states that she has a strongly 'results-driven' personality, which is a vital skill for someone whose work centres on solving the problems thrown up by the bank's IT systems very rapidly so that the minimum time is lost on the trading floor.

Clare declares her employer to be a 'very supportive organisation', which promotes women's development and advancement through networking groups, coaching schemes, information seminars, and flexible working arrangements including the possibility of working part-time and from home. Some of these options are likely to become increasingly important to Clare as she progresses through her career.

"Companies that want to succeed cannot afford the luxury of bias, prejudice or discrimination.

They must recognise and deploy talent regardless of what package it comes in"
(Carly Fiorina, 2006)

The potential for women to embark on new ITEC careers

There are many different new areas of ITEC employment for women to consider, and as the profiles in the previous chapter show, many women are already successfully filling these roles. Such women can, to some extent, serve as role models for others. However, for women to be able to migrate into these new areas, it is important to indicate what skills and expertise are necessary, particularly for those coming from non-technical backgrounds.

In this chapter, therefore, we consider what previous skills and experience these jobs require. We also look at other issues which might shape women's ability to embark on ITEC careers. Women base their employment choices on a number of factors, such as the quality of working life and the potential for working flexibly in a job. Such considerations are particularly important for women returning to the labour market after a career break, perhaps after childbirth, but they are important to all women. Are these newly-emerging occupations likely to be attractive types of employment for women to enter? How do they compare with more traditional forms of ITEC employment in their terms and conditions, and quality of working life offering? In other words, are they 'women-friendly'?

3.1 Skills requirements

Do I need to be a science or technology graduate?

In certain fields of science and engineering a degree, and preferably additionally a doctoral degree, is an essential pre-requisite for a career in these fields. A traditional research career, whether in an academic institution or in an applied setting such as a governmental agency or research institute, demands a degree and usually also a higher degree, as do certain highly specialised types of ITEC work, such as meteorology, and also systems development.

A computer science degree is necessary for entry into those ITEC jobs where technical discipline needs to be formal and rigorous. Some programming or systems administration occupations, for example, require this discipline, and certain employers demand computer science degrees for entry into these jobs.

Technical qualifications give the holder domain knowledge, discipline and credibility with peers. Some of the large international banks, for example, require computer science or related degrees; they are extremely selective and have a reputation for employing and developing people with high levels of IT skill. Working in such specialised IT application areas also requires specialist domain knowledge (of financial regulations, audit requirements, and so on, in the case of financial services). In almost all of the occupations we are considering, the technical qualification needs to be supported by an ability to apply this knowledge in practical situations.

"A lot of my knowledge that I developed during my PhD is applied, and I don't necessarily find myself 100% focused on terahertz. It is actually the appliance of the knowledge, the skill-set that you learn as a student, to a different technology space that is important."

In other new ITEC occupations, the technical expertise and knowledge necessary for the work can be gained through other routes. Indeed, according to UK Labour Force Survey data for 2005, only 10% of women working in full-time ICT jobs hold an ICT-related degree [3]. Degrees in non-technical disciplines are valid, and can be helpful qualifications for entry, allowing employers to assess the holder's skills in organising knowledge and information, and in thinking independently.

Furthermore, experience, much of which is acquired through previous employment and life events, is extremely valuable, and also extremely valid. It is possible to enter some of the professions identified in this report from a background, say, in information management or publishing, provided the possession of key skills are demonstrated and the relevant ITEC skills are acquired. The following remarks highlight the range of activities involved, and some non-technical routes of entry:

"It is a common misconception that you need to have a PhD in some kind of in-depth computer technology to be successful, because you don't. There are an awful lot of areas where women can be successful."

"The whole information environment is very technically based, but that doesn't mean you have to be the person that makes the widget or makes the site. It can be management-level, creative, or not creative, or business-focussed, or just purely service-focussed. People could come into this field with any background."

"Within health informatics, a woman could come in with very few formal qualifications. They should be able to pick up their qualifications as they go along, and grow into a role. Or qualified women who have been at home with families can enter with IT qualifications and update them on the job. A qualification gained at a university twenty years ago is not necessarily going to fit you for a job in the 21st century."

"You certainly don't need a degree in computer science to work in digital content, you can come into this work with an arts background, but you do need experience of the field. The more familiar you are with an online environment, the more useable the content is. There are issues around copyright and ensuring that the material has a long shelf life, ensuring that it works on Netscape browsers, on Explorer browsers, on PCs, on Macs, on mobile telephones, on a 56K modem, but yet is as wonderful as possible for someone on a 10 MB broadband connection with an extremely large plasma screen. Just thinking through all the different issues and trying to make sure that it is the best possible experience for the full range of potential visitors to your site – that you cannot do without experience and also a knowledge of where the technology has come from."

What kind of technical skill is required?

The requirement for technical knowledge is common to all the new occupations discussed in this report. However, the level of knowledge required varies considerably from one type of specialism to another. In e-science fields such as bio-imaging and weather forecasting, both scientific and technical expertise are important, and many working in this field have acquired both types of expertise in their working lives.

Degree-level knowledge of the scientific discipline (physics, environmental science or biological science) is important here. In weather forecasting, the forecaster needs to be able to read and interpret meteorological data, often rapidly and often critically with reference to the strengths and limitations of computer modelling systems and other data sources.

In the light of her scientific judgement of the data, she will discuss with colleagues the most likely outcome in terms of imminent weather in order to be able to present the forecast in an accessible way to the TV or radio audience.

3. e-Skills UK (2005) Quarterly Review of the ICT Labour Market, e-Skills Bulletin, Quarter 3, 2005

"You go through a process in your mind. I visualise the atmosphere in three dimensions – I am lucky enough to be able to do that. That is part of forecasting. You look at the atmosphere and you can visualise what is going on, and you can understand the science behind it but you can also understand what it is going to be like and feel like for people".

Increasingly, however, IT expertise is also vital. This is because the development and application of IT to both imaging and forecasting has added an extra dimension of complexity – but also interest – to the process. For example, microscopes used to be relatively straightforward tools which people could use easily with just a few basic instructions.

Today, the bio-imager has to understand the software, the hardware, and the peripheral tools (such as digital cameras), so the IT skills needed are extensive. A knowledge of programming languages is important where the user wants to use the wider capabilities of the instrument, and to do so needs to write her own routines to guide it.

Jobs concerned with the development or testing of systems require a 'hands-on' technical understanding and a knowledge of operating system or programming languages (UNIX, C, Peral, for example), development processes and methods, and applications languages. In digital content development, hands-on expertise in web publishing tools, programming and even online design is necessary.

This means having HTML and Java skills, and perhaps content management system design skills. The ability to design for online rather than offline content, which are quite different from one another, is perhaps a less well-understood but equally critical part of the online content developer's job. Similarly, the RFID consultant is likely to be involved in testing RFID standards before the technology goes live in a user organisation.

"You are creating the standard, making sure it is technically accurate, and you may in future get involved in testing it as well, prototyping it and so on. And dealing with any intellectual property rights that come up as a result. By doing that, you are getting involved in the shaping of these standards, which will be used for years and years to come."

Hands-on technical expertise is also necessary when working on very long-term projects or those where there are issues of public accountability. This is the case in NHS development projects such as telemedicine, or where public accessibility is a pre-requisite of public funding.

For publicly-funded projects where value for money is also paramount, the technical expertise necessary for developing appropriate systems involves not only an understanding of current technologies, but also an understanding of the direction in which these are evolving, so that money is not wasted on short-lived technical outcomes.

"You need to understand that in this day and age you are creating content that will appear on a number of different platforms in the future, and at this point we don't even know what some of those platforms might be. And so we are just trying to ensure that the content is structured in such a way that it is repurposeable as cost-effectively as possible."

"One of the obvious things you do is that when you work with a contractor who is creating some Flash for you, you ensure that you get a copy of the script that creates the movie as well, so that it is easy to extract the information within the Flash movie further down the line. Similarly, with a project like Insight, where you are digitising works, you need to make sure that you are digitising them to an extremely high resolution."

"Even if you are not anticipating using those very large image files initially, you can be sure that you will in the future, as screen sizes increase, as digital picture libraries become the norm, as bandwidth becomes cheaper. You don't want to have to go back and re-digitise the entire collection again."

Some new ITEC occupations do not require in-depth technical knowledge, but call for something more akin to technical familiarity, particularly jobs at project management or strategic level. This familiarity has been dubbed 'media literacy' by one of the women profiled in this report. Media literacy – as distinct from theoretical and hands-on technical expertise - is vitally important for all new ITEC professions. It is particularly critical for the informed management of projects and of other project participants. These might be colleagues or contractors, but the requirement to be able to work closely with them, speak their language and make informed judgements remains the same. This requirement is highlighted by women who are involved in strategic development projects such as digital content production or network installations. Even if the professional is not working daily with the detail of a technical system or software solution, it is important for her to have an understanding of the workings, advantages and disadvantages of the relevant technological options.

"I don't know XML in and out, but I know what it does, what it looks like, what is going on, what the trends are, and what the business benefits for us would be. Where I am successful is because, despite my lack of technical training, I am comfortable with looking at code, talking about code. I have a fairly broad extensive experience of delivering different types of projects. I know the standard issues that tend to arise and can then think laterally and think of ways that delivery can still be achieved despite potential technical obstacles.

If you don't have any knowledge of technology, you can just come to a dead end. If you are not able to question the developer on why something isn't possible, why they think it wouldn't work, you can't deliver the solution."

There is also a life-course dimension to the need for technical skill in new ITEC professions. Although in early to mid-career, ITEC skills are paramount to the performance of many jobs, the requirement for them declines with seniority, just as it does in traditional ITEC professional careers. At this point in a professional's career, the need for management and business skills, coupled with general media literacy, tends to displace the requirement for hands-on technical skills. The senior ITEC professional becomes more concerned with the overall delivery of the product or service than with its detailed workings.

"I understand the type of technical issues you get, I understand how we should do system development – the methodologies. I think the thing that I couldn't do at this stage, and haven't done for a long time, is to sit down and do the programming myself.

Unless you remain very hands-on in development, it is actually a very difficult thing to keep your skills up to speed at, and I would question whether it was ever something I was particularly good at. I really enjoy being in a technical environment, but I am not a hands-on person now. "

"It is an extremely varied job which requires you to be comfortable speaking to people with very different agendas and knowledge and experience. Some of them are far more technically savvy than others. But the job gets less technical the more senior you get. So it is far more hands-on at the beginning."

For the ITEC professional, then, being expert in the detail of her technical area diminishes in importance as her career progresses. Instead, her skills in delegating and managing other people's expertise, including in recruitment and development of staff, become paramount.

"If things are going well, you can afford to get less involved."

"I am good at recruiting and retaining a team, and inspiring and motivating them. So, the people management, the team building, the giving of motivation, are all important. My IT skills, though, have atrophied. There are loads of people better than me. At this stage in my career, I don't consider IT skills to be the things that I need."

Other Skills Requirements - Business Skills

Many of the types of skill which are in increasing demand are skills where women tend to have a strong track record – management skills, organisational skills, communications skills, service skills. 'Business skills' are important in almost every new ITEC profession. Unless the job is solely concerned solely with "blue skies" research and development, ITEC professionals usually have some role in the application and implementation of newly-emerging technologies. This usually requires an understanding of business or organisational processes and how to develop or adapt, and implement the new technology appropriately, in the context of these processes.

The ITEC professional may need to assess the site of application, the need for the new technology or system, the processes to which it is to be applied, and to develop a strategy for its application. To enter occupations concerned with a business application (such as RFID or even strategic police intelligence systems), some business development, project management or consultancy experience is usually required in addition to systems skills:

"There is a whole raft of companies which are involved in barcoding, RFID and business messaging, and they are taking on people who have got knowledge of systems, knowledge about how things interrelate and what the implications are. You have got the systems and the business side to the skill requirements."

"[My engineering training] was quite useful in cutting through the dead wood. I don't believe we would have been able to launch if I hadn't been able to do that, and that training really did develop a logical mind that had been trained to get it right enough to move. It is about discipline and prioritising.

I hadn't realised I had been taught that, that I had been taught to guestimate numbers, to say 'It feels like this'. And that is what my first year in numerical analysis actually taught me. It gave me really strong numeracy skills that means that in any business environment I can estimate the best answer. It allows you to work faster and more effectively."

Several senior professionals involved in long-term and high-profile systems development projects highlight the need for a broader organisational and strategic vision of the role of these systems in the overall delivery of a service, a vision that is gained at least in part through experience and understanding of their domain, but goes beyond a technical understanding.

"What are the things that are sustainable but are also the right things to build on, as you move into the future? I think you know that from your experience, your knowledge of what is required in your field, and your political know-how, because you know what is politically sustainable in terms of resourcing. You also know from where your values lie."

People thinking of entering ITEC work can make choices depending on what their strengths and preferences are. In some organisations, there is stronger emphasis on using systems skills, whereas in others, business skills are more central to the process of implementing this technology:

"There are some people who don't like the customer element. They are happier with the standards, managing the technical nature of the standards.

It really depends what you want from it, but whatever you want from it, there is something for you, because it is such a mix of business development, sales, marketing, standards management – the technical side – and people. It is a whole mixture. It is a case of finding the company which is offering the mix that you want."

Project management skills

Most of the new professions covered in this report tend to be focussed around the delivery of an IT or new media product, involving a team of people working to this common objective.

Consequently, a significant part of the job often involves complex project management at some level - placing the project within the overall organisational objectives, communicating the project and getting support from other areas of management. It also involves holding the project to its objectives and those of the organisation as the project progresses. Part of the process of project management consequently includes developing and communicating clarity in relation to the project's objectives, channelling or managing the skills of other people, and setting deadlines for them.

All these activities are important, but become even more critical for the professional who is dealing with contractors, as a significant proportion are. Several of the women whose accounts appear in this report strongly emphasise how lacking these skills generally are, and how this presents important opportunities for women to fill this gap.

"I don't have to understand the technologies to know what I want the eventual outcome to be. I am a delivery person, I am good at getting the job done, and that skill is so lacking in IT. Women are very, very good at that."

They needed somebody that could do more than sit in a room and plug things together. They needed somebody with other skills as well – people skills, organisational skills. In IT you tend to find there is a huge lack of that."

Communications skills

For some jobs, communications skills are obviously a key requirement. Weather forecasters and broadcasters clearly have to be able to communicate complex scientific information in a clear and accessible manner and in a way to which the public can relate.

This means translating scientific data into information which means something to people who simply want to plan their day or their business processes.

"It takes a certain kind of personality. You have got to be a great communicator. Effectively, what you are doing when you are reading the forecasters' guidance, looking at the models, talking to the chief forecaster, having a briefing, you are piecing together a story, storyboarding the day as a newsperson would do.

We are looking at a sequence of events that will go on with the weather, and we put our words and our weather story to the pictureboard of the day. It is like doing a Powerpoint presentation."

The need for communications skills runs across a much wider set of new ITEC professions than is perhaps realised. In fact, the majority of these professions demand advanced communications and interpersonal skills, a requirement which is still underestimated by ITEC professionals and the public alike.

The ability to brief colleagues and senior managers on technical matters is an important skill identified by ITEC professionals – being able to convey technical information in a way which is relevant to business considerations.

"You need to be able to talk up a level to management people that don't have the technical details, but also be able to speak at a more technical level to the people that are involved in the nuts and bolts of the work. You need to know the audience you are talking to and adjust your tone and content accordingly."

Communications skills are necessary for ITEC professionals to interact not only with their peers with also with professionals in other disciplines for whom they are developing systems. In telemedicine, for instance, this means that the developer needs to be able to listen to health professionals and interpret their requirements into a technical solution.

To be able to do this requires an ability to work across disciplinary boundaries and with professionals who may think in different ways from the ITEC professional. Similarly, in the standards-setting process (as for RFID), there is a considerable degree of negotiating users' needs and requirements into a technical solution, for which good communications skills are paramount. The client organisations are very varied, and so too are the individuals who represent them.

This adds both challenge and interest to the job, requiring an ability to connect with people in various fields and at various levels. In the international standard-setting arena, user groups include organisations from throughout the world, so it is important to be able to work with people of all nationalities and cultures. This is arguably one of the main reasons why technical projects often fail due to lack of communication at every level – between clients and project team members, among project members, between team personnel and contractors, and so on.

This is another area of skill shortage which could signal promising opportunities for women, who seem much more likely to possess the kind of people skills which are increasingly recognised as crucial to the success of ITEC projects.

There is a strong belief held by many already working in ITEC professions that the entry of more women, with the communications skills that they might bring to the work, would decisively improve the quality of the IT product being developed.

"People don't want techie sales talk nowadays. They want to be able to understand it, they want their hands held a lot, and that is somewhere where women do come into their own. Women do tend to be more people-related and we do also tend to pay a lot more attention to detail than men. Men are not so good on the follow-up."

"I think it would be of real benefit to have some female server-side developers because I think women are better at communicating and there can still be quite a lot of difficulty in developers communicating with other colleagues in the organisation who do not necessarily feel comfortable with technology.

Without a doubt, the technology would benefit from the entry of people who are able to communicate – verbally. It is about interpretation of need, and making sure that you really do understand those needs and requirements."

In the field of engineering, too, there is a belief that women are more alert to the real needs of users – rather than their imagined requirements - and therefore design more usable artefacts.

"For example, we had to design an ECG heart monitor. What interested me was to go and find out what this product needed to do to satisfy the needs of patients and doctors.

Most of the guys were interested in what kinds of methods they could use to transfer this wirelessly. Fair enough, that is interesting, but for me it is not interesting by itself. We had to keep pulling the guys back by saying 'No, this is what we need the device to do. We don't need a built-in MP3 player! What 83-year-old woman with a heart problem is going to want that? Clearly, somebody with the skills in applying the technology to the right purpose is going to keep the project on track."

"You do need a lot of the technical skills, but you need to apply them with people for whom the technology is not the main issue. And I think women are better at that than men."

Some women whose accounts appear in this report have also suggested that the masculine culture which has traditionally dominated in ITEC work is in part a culture of pretence. By this they mean that it often involves the maintenance of a façade by professionals which does not permit them to raise questions or make admissions of ignorance.

Yet increasingly it is clear that project accuracy and success depend precisely on the raising of questions and clarification of terms, something which women are much more inclined to do. Communication and understanding of needs are not simply desirable but essential.

"In an industry where there are dozen names for the same thing, where people talk in acronyms and so on, you would think it was absolutely vital to clarify exactly what it is you are talking about. I just think women can bring so much to the industry."

Design skills and creativity

It is often assumed (often by women who are deterred from entering it) that ITEC work, particularly that connected to development, is uncreative and somewhat monotonous. New ITEC professionals dispute this perception, and argue that the work is – or should be - extremely creative.

The professional, they point out, is essentially determining the shape of the content, how useable it will be in the longer term, and what is possible.

Design skills are obviously central to jobs concerned with digital and online content development. But there is also considerable scope for developers more generally to be proactive in engaging with users and their needs, translating those needs through their design skills.

At the same time, the technical constraints to creativity that used to be commonplace are beginning to be overcome, so there may now be improved opportunities for creative people who can anticipate and cater for users' needs.

Craft skills

Central to contemporary and emerging technological work is a strong human component – in essence, the ability to connect and communicate with other people. This is an aspect of technological work which might contribute to the appeal of new ITEC professions for women. Equally, in newly-emerging scientific professions, a picture emerges in which non-technical skills are as important as technical expertise.

Craft skills enter the work of the bio-imaging specialist. Working with biological specimens combines the application of advanced science and technology with the finest of manual skills and dexterity, a combination which makes the job difficult to do well, but which is often appealing.

"Some of our techniques are crafts. You learn with your hands. Cutting 60 nanometer sections with a diamond knife or a glass knife, this is a skill that you learn from somebody else.

"It is a fantastic job because it retains the human component of skill – using your hands, your eyes, to do something, and then using the technology – the most advanced electron microscope and software that you can imagine. It all starts in your hands and ends up with the most advanced technological instrument. And I love that."

In the newly-emerging ITEC occupations covered in this report, there are widespread opportunities for the use of skills which are not purely technical, but which combine technical expertise at various levels with numerous other skills and personal qualities.

Not only might women find the prospect of using their human skills an appealing one, but clearly these skills are increasingly indispensable to the success of ITEC activities and projects. But will women find other aspects of newly-emerging ITEC work to their liking?

We now examine the culture and conditions of ITEC work, and how they might encourage or deter women from entering newly-emerging professions.

3.2 Learning, support and professional development

Training and learning

How are development and career progression organised in the newly-emerging ITEC professions we have been discussing in this report? Do they rely, as in the established IT professions, on continuous employment and continuous exposure to new techniques? Or do they work along different principles of employee development, and so offer new opportunities for women, including those who are returning to the labour market following a career break?
In the established IT professions, learning is largely individualised, and professionals keep their skills current by means of informal, technology-based mechanisms - web forums, chat rooms, professional literature and informal interactions with colleagues.

Because of the pace of technological change in the IT field, it is often argued that these professions are not ones from which it is possible to take a career break. Skills, it is argued, quickly become obsolete during a career break.

This state of affairs presents challenges for women who wish to start families or have to take on other, perhaps long-term, caring responsibilities.

Professional development in new ITEC professions is as varied as the professions themselves. In the new media industries, most of the training that is provided is consumed online.

Professionals effectively train themselves by visiting forums or tutorials. Skills updating takes place in a highly individualised ways, the responsibility lying squarely with individual professionals. This can be problematic: formal courses are often very expensive to participate in, while informal learning can be difficult for women with very young children or very demanding caring responsibilities to engage in.

And the idea that a career break may be harmful to women's prospects receives some support among the professionals covered in this report, who point to the fast pace of change which is happening simultaneously across several different technology platforms, particularly in the field of new media and digital content production.

"I was on maternity leave for 10 months, and when I came back I found I had lost some of my technical edge, if you like. In the technical area there is a lot of work to be done and you have to keep your skills up, so you do a lot of reading in your own time, and I just haven't got the time to do that any more, to be honest."

On the other hand, the advantage of working in new media or ITEC professions is that the technology itself facilitates the maintenance of skills through online forums and other such learning environments.

In general, however, women, particularly returners, need a great deal of support in keeping their skills current for re-entry into the labour market. Some of the larger employers of women profiled in this report offer important facilities through formal and systematic training programmes and skills assessments.

In the Met Office there is a clear progression pathway supported by resources for training and development of staff, open to all. There is a training college at the Exeter headquarters which supplies refresher and short courses, because it is important for forecasters to keep themselves up-to-date with recent research and the new techniques that are available to them. There are specialist courses available to forecasters working in specialist conditions, such as in war zones. There is also management training. Supported by these learning and development facilities, forecasters can and do progress into senior scientific or management roles in the Met office, including while working part-time or in other flexible working schemes.

Professional development schemes offered by other employers include workshops designed to 'fast-track' capable women into executive positions, as well as networking, mentoring and education programmes designed to bring women employees into contact with one another, give each other support and provide information about diversity, working parenthood and other issues of relevance to women returners. Paradoxically, some women with children report finding it hard to find time to attend these activities.

By no means all employers offer such support, however, and so there is clearly an important role for a national initiative such as the Return campaign, run under the auspices of the UK Resource Centre for Women in Science Engineering and Technology, to provide integrated support services to women returners.

Equally vital is the support of organisations like the Daphne Jackson Trust, which focus on women seeking to re-enter scientific and technical professions after a career break. Additionally, there is a key role for intermediary institutions such as the professional associations to play in providing training, careers advice, and linkages between employers and potential entrants to the labour market. We look at the role these institutions can and do play in the next part of this report.

Career progression

A career in a new area of ITEC work might involve several different types of pathways. It can be achieved through migration from another type of job within an organisation, such as an information-handling or administrative job. It can mean progressing within an organisation over time into a new and senior position in ITEC.

In systems development or administration, such as in UNIX, a common career pathway is to start as a UNIX systems administrator, configuring UNIX systems, and to develop UNIX skills on the job. At a certain level of proficiency, employees move away from hands-on technical work and become senior systems administrators and then technical team leaders, before moving into management roles.

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"If you go down the management route, more and more of your day is taken up with audit and compliance issues, resource management, management reporting, that kind of thing. There is a feeling that if you stay technical, there is not really anywhere to go, except by moving from company to company. Or some people go into consultancy, which is another route you can take".

New ITEC occupations can open up new progression pathways. What is striking about many of the new professions discussed here is the fact, that much more than in traditional ITEC occupations, there are diverse and unconventional routes into them. This is particularly true of occupations which focus on content digitisation or on management of technology, more than hands-on scientific and technical processes, and it widens the pool of women who can enter these professions.

"I can remember going to meetings when I was first an information manager. In a room of 60 to 100 people, I would probably be one of two women. That has changed significantly and there are far more of us in there. I think this is because a number of us have come up through different routes. We have seen this as an avenue of our own development."

Progression opportunities in some new ITEC occupations are not yet well-developed. Where new ITEC specialisms are mapped onto old occupational hierarchies, organisations may not yet have developed appropriate development routes. This is apparent in the case of ITEC professionals working in the police force, where the progression pathways are designed for police and not for IT staff. Consequently, IT staff in this sector do not yet have an obvious career route to follow.

One solution to this has been the application of British Computer Society standard role profiles to IT staff in the police force, but it is important that these are uniformly and consistently applied to be effective and to be perceived as fair. However, precisely because the progression pathways in new ITEC occupations are ill-defined, there is a need for clarity about how to progress within them, and what qualifications are needed at what points in the career pathway. If career progression and continuous professional development through education, training, and learning are to be ensured, then the features of these new professions need to be identified and agreed. In the case of the cluster of professions falling under the 'health informatics' umbrella, there are a series of frameworks setting out entry routes to the different professions, qualification requirements, job functions, on-the-job training and progression pathways. Such clarity has long been seen to be particularly important for improving equal opportunities and access to professions; lack of it can lead to a falling back on 'common sense' understandings of job requirements which can in turn promote discriminatory recruitment and progression practices.

Many of the women highlighted in this report have achieved considerable seniority in their employing organisations, but this is mainly in spheres where women are strongly represented throughout organisational hierarchies, and where organisations are large enough to have an internal labour market, as in museums, galleries and libraries, in the Met Office, the NHS and the BBC. The culture of the employing institution is critical to the opportunities which are open to women to move into ITEC professions, and once in them, to progress into senior positions. Often, a wider organisational commitment to equality and diversity signals good practice in the opening of career development opportunities.

West Dunbartonshire Council provides a strong example of good practice in providing opportunities for women's progression. It places high value on continuous improvement in service delivery and professional development. It has put in place a 'Career Developer' programme as an integral part of its staff development and salary structure. This is felt to be essential to develop the competencies required to meet the demands of ICT in today's working environment.

In the ICT department, this programme covers IT, administrative and telephony staff, and it provides opportunities for administrators and telephonists to move into IT roles. As a result, more than half of the council's IT staff are female, and more than two-thirds of its senior IT staff are female, proportions which far outstrip the national average for female participation in ITEC professions. The scheme was awarded the British Computer Society Professional Development Award for 2005. By contrast, there are organisations which have much work to do to improve their development and progression practices. Universities emerge as particularly weak in comparison to other organisations in terms of career development for science and technology researchers, and many still employ a 'two-tier' workforce of permanent and temporary (contract) staff, with women over-represented in the latter group across disciplines. Despite their organisational size, an established culture of patronage together with these dual internal labour markets combine to create significant obstacles to the development and progression of women.

For the ITEC professional, an alternative career option is to leave organisational employment and to move into self-employment in a related area of work, such as solutions provision or consultancy. Some women see this as an attractive solution to their wish to work in ITEC without the pitfalls of organisational life.

3.3 The role of intermediary organisations in promoting career migration

Scientific and technological professional life is constantly evolving - new work opportunities are developing as fast as the technologies themselves. However, awareness of these opportunities is understandably not widespread, nor is it clear how women can gain access to them, particularly if, when returning to the labour market, they have no close connections or awareness of what is possible through their existing work. Intermediary organisations operating between employers and employees, educational institutions and professional life, have a vital role to play in raising this awareness and supporting women seeking to move into these new careers.

These organisations include professional associations, employers' associations, trade unions and employee representative groups, and the various organisations concerned with improving women's participation in science and ITEC careers. There are many examples of information and support services provided by these bodies, a few of which are highlighted here. A list of organisations and resources is supplied at the end of this report.

Promoting diversity in science and technology education

A key cause of women's under-representation in scientific and technical work is their under-representation in these areas in education, including higher education. In other words, the pipeline feeding women into ITEC professions is itself narrow, and consequently employers often report that they have a small pool of applicants from which to choose when they are making recruitment decisions.

In the UK, considerable effort is being made to address this narrow pipeline, and this effort is all the more necessary as the range of new ITEC professions which women can potentially enter grows. Yet to date, most interventions aimed at increasing women's participation in science, engineering and technology (SET) educations have signally failed to do so.

In physics, for example, the participation rate has remained at the same level – around 20% for the past two decades or more. The same is true of other scientific and technical disciplines. The reasons for this initiative failure and resultant continuing under-representation are complex, but intermediary institutions can still play a key role in addressing it. Because of their oversight of complete disciplines in the UK, they are well-placed to monitor participation across educational institutions and to promote diversity in them, in relation to both gender and age. For example, such monitoring is carried by the Institute of Physics through site visits to university departments in which their diversity practices are assessed and recommendations for improvement are made.

The Institute also operates an undergraduate bursary scheme which provides an annual £1000 bursary to undergraduate students from groups who are normally under-represented in physics.

Providing training and mentoring

Aside from the issues surrounding women's access to science and technology disciplines at university level, it is extremely difficult for women seeking affordable training and development opportunities, particularly to update their skills, to access these opportunities.

Formal training is expensive and informal training often involves a considerable amount of self-driven effort which carers in particular tend to find hard to manage alongside their other responsibilities.

Professional associations and specialist support organisations can and do help to improve access by providing training at different levels, including skills updates for women returners. These include those offered by the Daphne Jackson Trust, which arranges and administers industrial placements and research Fellowships to enable talented individuals, both women and men, to return to their careers in SET. Fellowships are normally for two years part-time, or one year full-time, during which Fellows carry out a supervised research project and retraining programme.

Because women (and men) who have been away from paid employment often experience a considerable drop in their self-confidence, a widespread need has been identified for mentoring services.

Mentoring can help people to articulate their abilities and knowledge and identify likely skills requirements by employers. Several of the professional associations and the support organisations concerned with attracting women into ITEC and SET occupations offer mentoring services, including WiTEC UK, The Women's Engineering Society MentorSET project, the Institute of Physics and the UKRC for Women in SET.

Supplying careers and skills advice

Because some of the jobs we have examined in this report are so new, it is difficult for careers advisers to maintain up-to-date information about the roles and their requirements. As a result, it is very unclear to women considering entering new occupations what skills are required and how they should prepare themselves, or update their existing skills. Professional associations can and do help to bridge this gap by publishing skills and careers advice on new occupations.

Just as importantly, however, professional associations can provide guidance to the existing employees and returners among their members on mid-career issues which can be difficult for an individual to acquire. For example, there is a pressing need for guidance on managing career breaks and maintaining skills so that a career break, taken for whatever reason, does not come to mean a drop in career prospects or an extended period of involuntary unemployment.

The challenge for the professional associations is to ensure that this advice reaches those people who really need it, who may not be members, or who may be unemployed or isolated in some other way. Some creative partnerships may be needed here between professional associations and other organisations to which women returners may have more access.

It is also unclear to employers what skills are necessary for emerging roles and how they can assess their own ITEC skills requirements and skills gaps. The Skills Framework for the Information Age (SFIA) has been developed by a partnership of British Computer Society (BCS), Institute of Management Information Systems (IMIS), Institution of Engineering and Technology (IET) and e-Skills in order to provide an online skills assessment tool for employers. The framework and tool are designed to increase clarity about specific ITEC job roles and to assist organisations with appropriate skills development.

Publicising job opportunities

It is often helpful for women considering entering ITEC work to know which companies and employing organisations are actively encouraging women applicants. Equally, given the recognised shortage of women applicants for science and technology positions, an information service which brings women into contact with potential employers is valuable.

Such a service is supplied by a specialist provider of online information about job opportunities for women, called 'womenintechnology'. Supported by some of the big banks and financial services institutions, it publishes a web-based job board which shows which organisations are actively seeking to recruit women, and the posts they are seeking to fill. In addition, it publishes a weekly online newsletter covering women and technology issues. It also runs networking events and meetings for women and girls, including events aimed specifically at schoolgirls.

Brokering introductions and placing employees

An important way of drawing women into ITEC occupations, and introducing potential employees to employers, is through employment 'taster' schemes or industrial placements. A placement may be for a fixed or trial period in the first instance, and if successful, is subsequently confirmed and extended by the employer. The Daphne Jackson Trust, among others, offers a scheme which matches and places returners into science jobs, drawing on a pool of employers and potential positions. Employers' organisations such as the Engineering Employers' Federation could develop similar schemes among their members.

Providing networking support for employees

Networks are vital means for women to provide each other with information, advice, and support and to compare experiences of working in science and technology professions. Aside from the internal women's networks offered by employers, valuable networking support is provided by specialist intermediaries.

The UK Resource Centre for Women in SET and womenintechnology both offers networking support to women. The trade union, Prospect, which represents scientific and technical employees, facilitates two networks of women members, in addition to the specialist training it offers women members. 'Womanet' keeps Prospect's women members in touch with each other, and provides advice and support. Wisenet, Prospect's Women in Science and Engineering network, campaigns to keep women's needs on the SET agenda and serves as a contact for women scientists and engineers in Prospect.

Supporting and disseminating good employer practice

Intermediary organisations, particularly employers' organisations, have a vital role to play in encouraging and assisting their company members to introduce and develop good employment practices and workplace cultures which promote gender and other forms of equality. Although the public sector is bound by a legislative duty to promote gender equality, the private sector can equally demonstrate a commitment to the recruitment, retention and progression of female employees through the implementation and dissemination of leading edge equality practices. There is considerable potential for activity in this area.
In the field of science, engineering and technology, there is an obvious role for organisations such as the Engineering Employers' Federation, which could advise and assist member companies in moving beyond basic compliance with equality legislation to high quality workplace practice.

This might include brokering learning networks between good practitioners and others, providing advice and guidance to members, fostering connections between employers and equality practitioners, and organising incentives for improvement, such as awards.

Sponsoring prizes and awards

Several professional bodies already organise and sponsor awards for female scientists and engineers, and this has proved an effective way of showcasing and encouraging female talent. Examples are the Young Woman Engineer of the Year Award, which is sponsored by the Institution of Incorporated Engineers and seeks to recognise and reward female engineers. The British Female Inventor of the Year award is sponsored by the British Female Inventors and Innovators Network to recognise the inventions of women. The Blackberry Aurora Women Technology awards recognise successful business women in technology. In higher education, too, institutions offer awards for outstanding achievement in engineering and science subjects. Ellin Barklund, featured in this report, won such a prize for her achievements in her engineering examinations at Imperial College. Such schemes are highly empowering to women, and although there is a potential danger that they might serve to ghettoise women and their achievements, equally they invariably provide a platform for women to come forward for recognition where they might not otherwise do so.

Chapter 4

Conclusions and recommendations to encourage women into new ITEC occupations

Skills and occupational profiles

There is a need for more clarity about entry routes, job functions and progression pathways in new ITEC occupations

There is a paucity of informed careers advice on newly-emerging ITEC occupations. Careers advisers, especially within educational institutions, do not always seem aware of the various occupational possibilities, particularly in very new areas of ITEC work, and are therefore often ill-equipped to advise students and potential entrants of the professional options they have and how they can best prepare themselves for entry.

Recommendation: Careers advisers and counsellors need to develop a greater awareness of the new and changing career possibilities within ITEC work. This could be done, for example, in conjunction with professional and scientific associations, which provide careers advice services in relation to their specialist areas.

The new ITEC occupations highlighted in this report are considerably more diverse than the conventional image of ITEC work tends to suggest, ranging as they do from jobs concerned with digitising artistic or literary content, to jobs concerned with analysing and transmitting information about microscopic biological cells, to those concerned with interpreting meteorological data and presenting weather forecasts. Because they are so diverse, so too are their routes of entry, skills requirements, and pathways to develop these skills. In terms of skills requirements, scientific and technological knowledge are crucial to most jobs, but equally important for all ITEC jobs are skills in management (of strategies, programmes, projects and people), co-ordination, communications, business analysis and other organisational skills. Indeed, with career progression, hands-on technical skills decline in importance, though solid technical understanding remains critical.

It is clear that women have an enormous contribution to make to these new work areas, and have many of the relevant and necessary skills for these jobs. It is important that these skills are acknowledged and fully credited in job profiles and in careers advice.

There are many ways to acquire the skills needed for new ITEC professions, and it is important that women considering entering them are aware that not all of these are conventional, formal educational channels. Aside from on-the-job skills acquisition (or learning by doing) which is common to almost all areas of working life, women report learning their skills through their hobbies, through sports, even – in one case - through volunteer work in the armed forces. These experiences provide women with a series of different competencies: as well as the management skills and discipline needed for scientific or technical professions, they acquire interpersonal and relational skills, organisational and communications skills through these informal routes.

Recommendation: Informal routes of skills acquisition need more explicit recognition as valuable and valued learning channels, in order to encourage women who may be considering entering scientific and technical professions through non-traditional routes. This recognition of the role of life experiences already exists in many large employing organisations, but needs strong emphasis in many other spheres, including in educational institutions, careers advisory and information services, professional associations and awareness campaigns.

Just as there is a general lack of clear information about the diversity of ITEC jobs on offer, and the skills needed for entry into them, so too, more clarity is needed about progression pathways and career development routes for ITEC professionals once in employment. If career progression and continuous professional development are to be ensured, and offered to women as attractive reasons for entering these professions, then clear frameworks for these need to be set out.

Recommendation: Frameworks for skills requirements, professional development and career progression prospects in new ITEC professions need to be elaborated and clarified. Important work has been started on skills frameworks for these professions in the NHS, by e-skills UK, and by the British Computer Society. These are valuable tools which (with the exception of the NHS Health Informatics framework) are generic and can be used across sectors and organisations. However, there are also development and progression pathways specific to particular sectors and employers, and it is important that employing organisations (particularly large employers), employers' associations, and trade unions work to develop similar frameworks which are applicable to specific sectors or organisational environments.

Employment practices

Employing organisations need to be supported in the implementation of coherent equality/diversity policies

The most 'women-friendly' ITEC employing organisations are, not surprisingly, those which have clear, coherent and thoroughgoing equality or diversity frameworks encompassing their employment policies and practices. These frameworks underpin and support a variety of practical initiatives which help organisations to attract, promote and retain women – professional development, career progression systems, flexible working arrangements, and so on. Some of the strongest examples of good equality practice are not always labelled as such, but what distinguishes them is a coherence of approach to staff development and progression, and the express inclusion of all employee groups. Moreover, they are strongly linked to principles of customer service delivery, making the link between developed and highly satisfied employees on the one hand, and improved organisational performance on the other.

Recommendation: This kind of coherence of approach – and an understanding of the connection between employee development and good customer service delivery – is vital not only for the pursuit of greater equality in ITEC professions, but also for greatly improved business performance. Many employing organisations need much more support in making this link and putting these employment policies into practice. Examples of best practice always need to be promoted and highlighted through many channels to help others develop similarly strong practices. Networks of best practitioners run by third party organisations and professional bodies are helpful here.

Women undertaking postgraduate research need to be supported during maternity

There is currently no system of financial or other support for female students who need to break their postgraduate research for maternity. **This effectively means that such students are generally** forced to drop out of their postgraduate studies, sometimes permanently, with the consequence that the potential of women researchers may be wasted.

***Recommendation:** Research councils and academic institutions need to develop arrangements which support young women researchers when they become mothers, and allow them to return to their research without penalty for late completion, and perhaps with similar flexible working arrangements to those which operate in many employing organisations.*

Women returners need particular support with skills maintenance

In ITEC professions, skills atrophy very quickly and need constant updating if the professional is to maintain her or his position in the labour market. The currency of their skills been consequently identified as a major obstacle to women's progression in ITEC careers. A great deal of skills development is done by individuals in their own time or at their own expense. Both the expense and the time demands are problematic for women during maternity, or returning to the labour market after maternity or another form of career break. During maternity, women themselves find it difficult to maintain their skill levels while caring for very small children, so there is a strong case for developing extra support for them among employers, professional associations and trade unions. Paradoxically, they also have difficulty in attending specially-timetabled networking and development activities for women, so considerable thought needs to be taken in the design and timing of such activities.

***Recommendation:** In order to overcome this problem, considerable attention needs to be paid to the issue of skills maintenance for women on career breaks to stop their skills from becoming outdated while they are out of the labour market. This may need to be done in several ways and by different agencies. Employers could put in place arrangements to involve women on leave on a periodic basis, say, monthly, to prepare them for return to work and to alert them to the technical changes which they will need to prepare for. There are organisations which have developed good practices in this area, such as Happy Computers in London. Professional associations and trade unions could put in place arrangements for staying in contact with women members and providing them with skills support while they are on their career breaks.*

Flexible working arrangements which support women need more extensive implementation

The experiences of the women working in the new ITEC professions highlighted in this report indicate that, generally speaking, there is much greater scope for flexible working in their employing organisations (which span many economic sectors) than there is in the IT sector generally, where some of the more established ITEC occupations are located.

This may be due to the fact that scientific and technical occupations are now evolving in organisations such as libraries, museums, local government, and financial services which, unlike the IT sector, have traditionally employed women in significant numbers. These organisations have developed policies which respond to women's needs and requirements, including working time requirements. Flexible working arrangements now seem to be the main ways in which employing organisations support women and men with children. Workplace-based childcare, once a central element in workplace equality campaigns by women's organisations, remains very rare, and where it exists, is extremely expensive. In only one employing organisation was workplace-based childcare both available and affordable. Women now find it more feasible to adopt flexible working arrangements, or even to move into self-employment in order to achieve a balance between their ITEC work and other areas of life. This latter is an option which is also promoted by IT recruitment agents.

There is encouraging evidence of good practice, particularly in relation to flexible working, in employing organisations covered in this report, and there are notable examples of good practice in the wider community of employers. These are highlighted periodically by organisations like Aurora Women and Opportunity Now, through initiatives such as the DTI's Work-Life Balance campaign, and through the work of the UKRC for Women in SET and its partner organisations. However, it is also clear that many employing organisations have yet to develop policies and practices designed to attract, retain and support women returning to ITEC occupations after maternity, and also men with childcare responsibilities. Moreover, even in organisations which declare a commitment to flexible and supportive working time arrangements, there is evidence of a mismatch between these declarations and their actual practices – so that ITEC professionals still work long hours.

***Recommendation:** A considerable amount of work remains to be done to develop good practices among those employing organisations which have not yet put in place strategies to attract and retain female employees through their working time policies and practices. Employers' organisations and trade unions have a key role to play here in promoting and supporting working arrangements which are compatible with women's lives.*

The intellectual property of junior (female) researchers needs to be better protected and promoted

Scientists and technologists often begin their careers in academic research, for masters or doctoral degrees. This is a critical phase for them, providing experiences which shape their whole approach to their field and their peers in their later careers. In addition to some of the problems of sexism evident in some university departments, junior researchers sometimes complain of the lack of respect for, and protection of, their intellectual property as a result of their weak institutional position. This can demoralise and discourage vulnerable individuals from pursuing their research and subsequent careers in science or technology, and may even ultimately result in the depletion of the stock of scientific expertise in the UK.

***Recommendation:** Consideration needs to be given to ways in which junior researchers' intellectual property can be better protected, acknowledged and rewarded during their period of study, perhaps through the regular intervention of the research councils or grant awarding bodies concerned.*

Workplace cultures

Persistent culture of discrimination and sexism in some employing organisations need to be addressed

Despite encouraging developments in the equality practices, in many employing organisations both overt and hidden forms of sex discrimination are still played out through organisational practices and cultures. Equality policies are vital to tackle the problematic aspects of formal and procedural discrimination against women, and experience shows that organisations which operate such policies are more likely to recognise the existence of exclusionary practices. Even here, however, the explicit cultural dynamics (such as the persistence of informal 'men's clubs', or the systematic undervaluing of women employees) which serve to make women feel uncomfortable or alien in their own workplaces, are often overlooked or unaddressed.

Recommendation: Equality policies in ITEC organisations need to recognise and address the informal and hidden ways in which women are still excluded from work-groups and consequently from the mainstream of organisations.

Universities have a particular task to improve their equality practices

Formal efforts to attract more women into scientific research and engineering training by universities are undermined by organisational cultures and the behaviour of university staff. Universities maintain a culture of patronage which retains an element of feudalism and is antithetical to gender equality. This is particularly evident in scientific, engineering and technology research where institutional sexism is still particularly explicit. Moreover, even where equality policies are starting to be addressed, there is no sense of a clear and coherent approach to equalities in universities, aimed at changing the practice and culture of teaching and research across the board.

Recommendation: Universities can learn from the equality policies and practices adopted in other employing organisations. There is a need for systematic equalities initiatives and piecemeal initiatives, for example, in promoting images of women in minority subjects, need to be converted into coherent policies and practices which address practices across institutions. These need to be supported by equalities monitoring exercises to assess progress against targets, and training among university staff to ensure they do not discriminate or exhibit sexist behaviour. Support networks that extend to students in science, engineering and technology subjects would also be helpful, and to connect students to staff to share experiences.

The professional culture in ITEC work

Several women have drawn attention to a tendency among some ITEC workers to operate a 'culture of pretence', in which uncertainty is disguised and the raising of questions discouraged, even though technical solutions depend crucially upon clear communication and understanding of user needs. Some see this as a predominantly masculine practice. By the same token, several top-performing women report being stigmatised or undermined by their male colleagues. Clearly, both types of behaviour are seriously counter-productive to the effective delivery of work.

Recommendation: Cultural practices are nebulous and subtle, and far more difficult to change than policies or structures. Nevertheless, much more could be done to expose and challenge these types of behaviour, where they occur. Professional associations and employers have a particularly important role to play here, but educational institutions and training providers could also make it their business to address these issues and discourage these practices among ITEC professionals at the vocational education stage of their development.

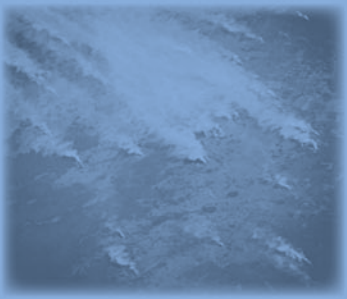
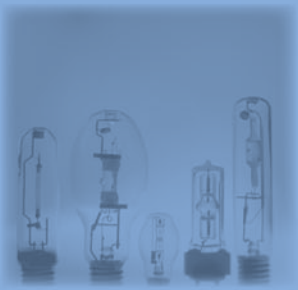
Support for innovation and innovators

The UK infrastructure for supporting new and talented scientists and technologists needs to be enhanced and extended culturally

Despite advances in support institutions and networks for UK scientists, technologists and innovators, it is still felt that more needs to be done to support talented young women who are poised to enter newly-emerging scientific areas, particularly where they have promising ideas for scientific development.

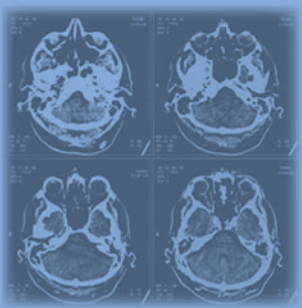
Recommendation: In particular, stronger mechanisms for the recognition and financial support of new talent (within academia, within companies and by government) need to be developed. This needs to be supplemented by a cultural environment which recognises, encourages, supports and rewards new talent, and is geared to the empowerment of scientists.







Links and Resources

Association of University Research and Industrial Links	www.auril.org.uk
Athena Project	www.athena.ic.ac.uk
Aurora Women	www.auroravoice.com
Association for Women in Science and Engineering (AWISE)	www.awise.org
British Computer Society - BCSWomen	www.bcs.org.uk/bcswomen
Careers Partnership (UK)	www.careers-partnership-uk.com
Daphne Jackson Trust	www.daphnejackson.org
DTI website for women in Science, Engineering and Technology	www.set4women.gov.uk
Engineering Employers Federation	www.eef.org.uk
Engineering Technology Board (ETB)	www.etechb.co.uk
Equalitec	www.equalitec.org.uk
e-skills UK	www.e-skills.com
Global Women Inventors and Innovators Network	www.gwiin.com
Higher education and research opportunities in the UK	www.hero.ac.uk
Information service on EU research and higher education	www.ukro.ac.uk
Institute of Electrical and Electronic Engineers	www.ieee.org
Institute of Mechanical Engineers	www.imeche.org.uk
Institute of Physics	www.iop.org
Institution of Engineering and Technology	www.theiet.org
Intellect	www.intellectuk.org
Involvement and Participation Association	www.ipa-involve.com
London Mathematical Society Women in Mathematics Committee	www.lms.ac.uk
MentorSET	www.mentorset.org.uk
Opportunity Now	www.opportunitynow.org.uk
Portia	www.portiaweb.org
Prospect	www.prospect.org.uk
Research Career Re-entry Fellowships in Basic Biomedical Science	www.wellcome.ac.uk/en/1/biosfgcdpfunsumbbs.html
TUC	www.tuc.org.uk
UK Resource Centre on Women in Science, Engineering and Technology	www.setwomenresource.org.uk
WISE (Women into Science and Engineering)	www.wisecampaign.org.uk
WiTEC – the European Association for Women in Science, Engineering and Technology	www.witec-eu.net
Women's Engineering Society	www.wes.org.uk
Women in Physics Group, Institute of Physics	http://groups.iop.org/WP
Women in Science, Engineering and Technology	www.shu.ac.uk/witec
Womenintechnology	www.womenintechnology.co.uk
The Women's Workshop	www.womensworkshop.org.uk

List of Project Participants and their Organisations

ITEC Application Area	Participant Name	Job Title	Organisation
e-logistics			
RFID development	Suzanne Stewart-Smith	RFID Consultant	GS1UK
e-Science			
Photonics	Ruth Woodward	Company Director and Science and Technology Advisor	HT Consultants
Bio-imaging	Raffaella Carzaniga	Project Leader	Centre for BioImaging, Rothamsted Research
Weather forecasting	Helen Willetts and Penny Tranter	Meteorologist and weather forecaster	BBC Meteoro logical Office
e-Content			
Art digitisation	Jemima Rellie	Head of Digital Programmes	Tate Galleries
Library digitisation	Ruth Jones	Head of Product Development	British Library
Interactive news	Christina Scott	Head of Software Development	BBC
Health Informatics			
Telemedicine development	Kate Caldwell	Telemedicine Developer	Cambridge e-Science Centre
Standards Management	Diane Benjamin	Head of Health Informatics Standards	NHS Health & Care Social Information Centre
Electrical and electronic engineering			
Power electronics	Ellin Barklund	Undergraduate student and Siemens prize-winner	Imperial College
Strategic ICT			
IT Security	Kathryn Moore	IT Security contractor	Major international

e-Government			
Public information service provision	Angela Clements	Head of ICT and Business Development	West Dunbarton shire Council
Financial Services			
Systems infrastructures	Juliet McMullen	Unix Team Leader	CitiGroup
IT analysis	Clare Foster	IT analyst	Lehman Brothers

" ....over the past decade increased female participation in the paid labour force has contributed more to the growth of the world economy than either booming China or new technology"

(Economist, April 2006)

“no one can make you feel inferior without your consent”

Eleanor Roosevelt

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