Challenges Facing Higher Education Computing and IT Departments*

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Abstract: Despite the growth of the IT industry and the high demand for IT skills university departments seem unable to attract enough student to cater for the needs of the profession. There seems to be a misconception about the difference between IT user skills and the discipline of Computing. This article attempts to do three things: 1) reinforce the view that a crisis of IT skills shortage is looming; 2) reiterate the fact that computing science is an exciting discipline that is central to the knowledge economy and that career prospects in IT-related jobs are very good despite the fears surrounding outsourcing and 3) suggest that HE computing departments must be flexible enough to embrace a two-facetted challenge: a) the changing landscape of IT Skills and b) the high hopes and aspirations of the first generation of our digital-native student community.

Key words: IT skills; computing; higher education; professional bodies; employers; knowledge economy
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1 Introduction

Ever since Charles Babbage conceived the first computing machine, the United Kingdom has been at the leading edge of the computing and information technology (IT) industry. Babbage, a mathematics Professor, started working on some serious computing developments in Cambridge, England in the 1830's. Babbage's Difference Engines are among the most famous icons in the prehistory of computing. The Difference Engine could manipulate numbers and featured an automatic printing facility. Specimen of its printed output together with a reduced size version of the machine can now be seen in the London Science Museum. The ability of the machine to add numbers and print them in an orderly manner may seem a trivial exercise today but in the setting of early Victorian society, this was regarded as a human ingenuity.

After Babbage, several attempts are recorded trying to build a machine that would mimic aspects of the "intelligence" exhibited by humans. But it was not until a century later, in the 1930's, that the link between human intelligence and machines was really observed. Alan Turing from King's College in Cambridge, started thinking about designing a machine that could tackle the problem of deciding the provability of any mathematical assertion presented to it. In 1937, he published an academic paper on 'computable numbers' in which the concept of the 'universal Turing machine' was introduced.

Since then, and over the years, computing scientists invented the solutions that drive our world and influence the way we do things. The forward-looking minds of the Babbages and Turings of this world meant that the UK enjoyed a clear competitive edge as computing and IT became the key driving force of the knowledge economy. More and more businesses, systems and the everyday devices we use rely on computing to function. Obvious examples include cars, personal data assistants (PDAs), cash withdrawal machines, and automatic pilot systems. Each of these rely on computing science to store, process, transmit and manipulate data and information yielding solutions and models that have had an enormous impact on the way we live, work, play, learn, and socialise.

However, despite the growth of the IT industry and the influence it has on our lives, it does not seem to be enjoying the esteem it deserves. Fewer and fewer high school students are enrolling on university computing courses. Enthusiasm for becoming a computing graduate has waned alarmingly as the discipline is increasingly seen (by potential trainees and university students) as the "stuff" that everyone does anyway! This lack of interest is leading to serious (if not severe) IT skills shortages. Several recent reports seem to indicate that the UK, and Europe, is sitting on "a

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skills gap time bomb", yet a sceptical friend may be forgiven for saying:

"Indeed computing does pervade all aspects of our lives but that's part of the problem! If you are a lawyer you will use a computer, if you are a doctor you are expected to be a computer-literate and even if you are an animator you would still use the machine to support your work. You don't need a degree for that, do you?! So what's so exciting about computing? Furthermore, when it comes to writing code to build sophisticated systems, software companies are shipping the job overseas anyway. Why should students bother enrolling on computing programmes?"

This is a fair reaction engendered by several contributing factors. Several reports, including a research by Forrester[1] that covered the UK, Netherlands and Germany, point at the following factors:

- The loss of trust in the IT industry following the dotcom bubble burst, which led to many enthusiastic computing graduates feeling let down by the IT industry when they failed to secure jobs in the sector.
- The employment uncertainties, further fuelled by the outsourcing/offshoring of IT jobs.
- The "negative image" that computing seems to have developed. This negative image may have been encouraged by: a) the high profile press coverage of IT systems failure; b) the way IT is taught at schools and c) the perception about computing scientists being "nerds".
- The lack of information given to potential students about the content of computing science courses and the diversity of careers open to them with a computing degree.
- The relatively slow response of HE computing departments to embrace the fast changing needs of the IT sector.

This article attempts to do three things: 1) reinforce the view that a crisis of IT skills shortage is looming; 2) reiterate the fact that computing science is an exciting discipline that is central to the knowledge economy and that career prospects in IT-related jobs are very good despite the fears surrounding outsourcing and 3) suggest that HE computing departments must be flexible enough to embrace a two-facetted challenge: a) the changing landscape of IT Skills and b) the high hopes and aspirations of the first generation of our digital native student community. To do this the paper is organised as follows: Section 2 presents recent findings from a number of survey confirming the high demand for IT skills. Section 3 attempts to distinguish between the IT user skills and the discipline of computing which fuels the knowledge economy. Section 4 reinforces the view that career prospects for computing graduates are good while section 5 gives seven reason why a high school student, or indeed any other potential student, should choose to read computer science at university. Section 6 highlights the need for computing HE departments to change and become, structurally and culturally, more flexible to meet the challenges of a demanding industry and a "shrinking" student body. Concluding remarks are to be found in section 7.

2 The Skills Shortage is Real and the Demand for IT Professionals is High

In a major survey conducted over the summer of 2004 with employers of IT professionals and users of IT systems, e-skills findings were fairly alarming[2]. Of an estimated 1.92 million establishments that employ IT users, 26% reported gaps in the IT skills of these workers, with a fairly low uptake for specialist software applications such as supply chain management or enterprise resource planning. The survey found that public establishments and large organisations are more likely to have skills gaps amongst their IT professionals, while over 34% of establishments that had IT vacancies said that they are finding it hard to recruit IT staff. A 2005 research, focusing on the East Midland region in the UK, finds that[3]:

- 7% of companies in the East Midlands that employ IT professional report that they have skills gap.
- the most significant shortage is in the area of developping IT systems and services.
- over the next ten years, the region is expected to see growth in its share of total IT employment.

This situation is not peculiar to the UK nor is it restricted to the region of the East Midlands. The American Association for Computing Machinery (ACM) published a report in which it recommends that in order to stay competitive in a global IT environment, countries must adopt policies that enable them to attract, educate and retain the best IT talent. The report advocates an investment in a pertinent education as core to these policies[4].

This recommendation is reiterated by a more recent review carried out by the UK Engineering and Physical Science Research Council (EPSRC, www.epsrc.ac.uk). The review[5], published in December 2006, draws attention to the dangers of a weakening IT research base while the number of students choosing to study computing courses continues to decline, as depicted in figure 1 below. EPSRC's review observes: "The worlds of ICT and the career opportu-

nities in ICT have expanded enormously over the years as ICT has become in many cases the "nervous system" of enterprises, government and social systems."

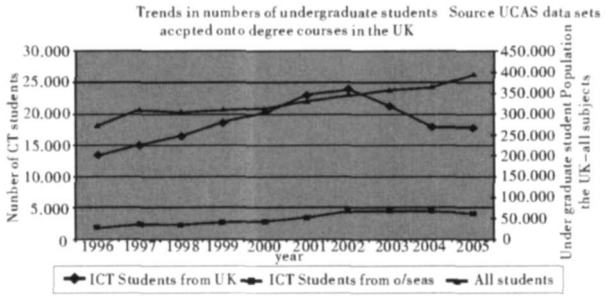

Fig. 1 (Courtesy of EPSRC's report on International Perceptions of the UK Research Base In Information and Communications Technologies December 2006)

Clearly there is a mismatch between the supply of trained/qualified IT professionals and the market/industry demand. As outlined above, there may be several factors contributing to students turning their back to Higher Education (HE) computing departments. One of the potential reasons could be that the subject or the discipline itself may have become "dull" and lost its glamorous image (our sceptical friend would refer to it as the "stuff" that everyone does anyway). Potential students seem to confuse IT (or ICT) user skills with the discipline of Computing whose role is fundamental to the knowledge economy. Potential students need to be inspired and informed of the opportunities and excitement that a career in computing offers. The next section attempts to address this particular misconception.

3 Computing Science: An Exciting and Stimulating Discipline

A fuller description of the Computing subject is beyond the scope of this article but can be found in the Quality Assurance Agency Subject Benchmark[6]. Computing is about finding innovative solutions and discovering new facts using problem-solving techniques, critical analysis and logical thinking. Almost every major challenge facing our world is turning to computing for a solution, from curing diseases to eliminating hunger, from improving education to protecting the environment. Computing science is diverse and involves many areas of study. Depending on personal interest one can combine computing science with other domains, such as law, geology, games and entertainment, business or medicine.

A graduate in computing is able to be more than a user of the tools and solutions provided to him/her. He or she is in a position to influence how we do things by developping (or overseeing the development of) creative solutions and systems that make a positive difference and contribute to economic prosperity and social welfare. For example, one can build assistive technology systems to support dependent people become more self-reliant and therefore enjoying a more private life at home. One can develop tools for medicine, solutions for crime prevention, systems for online communities, techniques for safety-critical applications or design and develop the next gaming product.

In order to do the above, and in addition to knowledge and understanding of fundamental concepts and underpinning theories, a computing degree course enables students to acquire two types of skills: computing-related skills and general professional (transferable) skills.

The technical computing-related skills include:

- the ability to specify, design and construct computer-based systems
- computational problem-solving ability, recognising levels of abstraction in software and hardware systems
- critical evaluation and testing to assess the extent to which the computer-based system fulfils the needs for which it was developed
- practical skills such as building and using database management systems, computer networks and other sophisticated software and hardware tools
- programming skills leading to developing the ability to write programs in more than one language and the ability to learn new languages quickly
- effective use of existing software libraries to carry out a variety of computing tasks, such as creating three-dimensional (3D) graphics models, an intelligent multimedia interface for an electronic commerce application or a guitar tuning facility
- understanding the context and the environment in which computers are used and recognising the security and safety aspects involved
- recognising the social, legal and ethical implications of using computers and computer systems and being guided by the adoption of professional practices.

General professional skills include the ability to:

- learn and adapt quickly to new environments
- communicate clearly and effectively
- solve complex problems and think "outside the box"
- be an effective team member
- understand the special requirements of international projects and the increasingly global and distributed nature of software and systems development

◦ keep up-to-date with developments and recognise the need for life-long learning.

The above two sets of skills (technical and professional) are much more than the user skills such as intelligently surfing the web, developing a multimedia application or using an excel spreadsheet. University departments (including Marketing) and employers need to work together and creatively to come up with ways of getting the message through.

4 IT Career Prospects are Very Good

Our skeptical friend may rightly suggest that the opportunities in the field disappeared ever since the dotcom bubble collapsed in 2000. This is a justified view particularly that we know of several graduates who found themselves jobless and when they found a job it was not IT-related. However, and although there was a slight dip in IT employment in 2001 and 2002, recent data show that this trend has reversed and that there are now more computing jobs than at any time in history. According to e-skills survey on IT employment forecasts[2], IT employment in the UK is going in one direction and one direction only upward. The growth of IT employment over the next decade is set to outstrip equivalent employment growth across all industries. This growth coupled with the relatively low number of trained IT professionals and the high number of people retiring will lead to IT professionals being in very high demand. In fact most analysts predict that the number of people trained for jobs in the computing industry will fall far short of the employment demand. The message is very simple: the country is just not producing enough IT specialists to meet the increasing demand.

According to research sponsored by Lancaster University, the British Computer Society and Microsoft[7], the UK economy needs over 100 000 IT staff every year, at a time when only 20 000 students are graduating from IT-related courses. This leaves a large number of IT jobs unfilled leading to a huge demand for IT professionals.

This demand is global and not specific to the UK. An article in the July 24, 2006 issue of the American magazine Forbes cites statistics indicating that "U.S. businesses will need 135 000 new computer professionals each year, but colleges and universities are graduating only about 49 000 computer science majors annually" — less than half the number needed.

"OK" our skeptical friend would say, "but aren't IT companies moving their software development projects to India and China?" Again this is a fairly justified concern, partly fuelled by the alarming stories in the media on overseas outsourcing of IT related jobs, allegedly resulting in a significant loss of UK IT jobs. Yes some jobs are being moved overseas and the impact of offshoring should not be understated but the number of new computing jobs created in the UK is substantially higher. This is true for the USA too. The New York Times observed in its editorial of 1st March 2006, that the real threat to the U.S. computing industry is not offshoring but the fact that so few students are getting the necessary training in the field. "The industry isn't gone, but it will be if we don't start generating the necessary dynamic work force." The same applies to the UK and Europe!

In short, job prospects for graduates in the computing disciplines are expected to remain excellent throughout the next decade. Alas, this message does not seem to have filtered down to prospective students thus failing to stimulate excitement and interest in Computing education.

5 Seven Reasons Why to Study Computing

(1) Computing is one of the most rewarding and challenging fields around. It drives innovation, it is key to economic prosperity and has increasing influence on social well-being. Computing Scientists have a great impact on businesses and society and the knowledge economy overall.

(2) In addition to a firm grounding in principles and methods, a Computing degree enables students to have well-developped powers of problem solving, logical thinking and critical analysis. These skills are well-sought after by all businesses and are extremely useful to anything we do in life.

(3) Computing jobs are among the highest paid and have the highest job satisfaction. Computing graduates can see the positive impact they make to people's lives straight away.

(4) The demand for IT professionals is on the increase, both in the UK and internationally.

(5) Computing is about being part of a team and an effective member of the society. It requires people with many different kinds of social skills.

(6) Creativity and innovation are two key characteristics of Computing. As such, boredom is not part of the menu since it is almost impossible to predict what will happen next.

(7) Contrary to what some people believe, computer scientists are not nerds. They are highly intelligent people who have lives, friends, relationships and

families.

While there is no way of ensuring lifetime IT employment, there are steps that one can take to improve their chances of long-term employment in IT occupations. These include obtaining a strong educational foundation, learning the technologies used in the global software industry, keeping skills up to date throughout one's career, developing good teamwork and communication skills, and becoming familiar with other cultures, particularly as software development becomes an international activity. A good and stimulating university computing course prepares graduates for most, if not all, of these steps.

6 Computing Departments Must Change

It would be fair to say however, that although many HE computing departments are changing their computing academic portfolio in line with the rapidly changing needs of the IT sector, many are still legging behind, thus failing to fully adopt and embrace the increasingly pervasive nature of the discipline. Whilst it is necessary to preserve the academic grounding required by the discipline computing departments (market intelligence permitting) should look at where the market is going and design stimulating and interesting courses that can support the specialities that are in demand. Often this may require collaboration with other disciplines, or even other departments located in geographically remote areas. Computing departments, in the age of global knowledge society, can no longer afford to exist in isolation. Cross-faculty collaboration to design well-integrated multidisciplinary courses will be primordial to providing world-class education of computing. An education that reflects the ubiquitous, and increasingly international, character of the discipline.

In its second report in the series "Developping the Future"[8], the report notes that:

"Students need to be inspired and informed of the opportunities and excitement that a career in computing offers, and yet collectively we have convinced them neither exists."

On the one hand, computing departments must be flexible enough to be able to adapt quickly to the changes in skills requirement. On the other hand, the structures of these departments must embrace the web-enabled world in which their potential students are already fully engaged. The "digital-immigrants", that most of us are, must organise their departments to provide a competitive computing education that attracts a new type of students who happen to be "digital-natives". In doing so, the role of the IT profession and industry as well as professional bodies such as the British Computer Society and the Association for Computing Machinery will be central.

7 Concluding Notes

It is hoped that this article has shed some light on some of the reasons behind the concerns and the hesitations as well as the excitement and the opportunities associated with the study of Computing. It would be fair to state that studying Computing could not be more important now than ever in the past. There is a clear need for highly skilled IT professionals, but HE computing departments must be able to adapt quickly to meet a two-fold challenge: a) the rapidly changing needs of the profession and industry and b) the high expectations and the aspirations of the first generation of our digital-native student community. The rewards for meeting this challenge are great: an inspiring and stimulating learning experience for students and a healthier IT profession yielding greater prosperity for all.

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