Careers in Computing

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This document is the paper-based version of the Careers in Computing website, and is expected to be expanded significantly by the end of 2004.

Please visit www.careersincomputing.org.uk to see the latest information on Careers in Computing, or if you have any questions or comments on this document.

Why think about a job in Computing or in Information Technology?

Welcome. I hope you are reading this because you are thinking about some kind of Computing job (not because you are at the dentist's and there is nothing else to read in the waiting room).

There are three main reasons that you should consider a career in the Computing industry

- you will have excellent job prospects
- salary levels can be really rewarding
- it can be very enjoyable and provide great satisfaction

I hope that this booklet will give you a good idea of what working in Computing is like, and whether it is for you. If you still have any questions once you have looked through the booklet, then there is an associated website (www.CareersInComputing.org.uk) where you can ask questions, and receive more detailed answers.

Prospects in the Computer Industry

A wide variety of interesting and well-paid jobs are available to graduates in Computing. The demand for Computing expertise is growing (by 5% last year, according to Computer Weekly, one of the main Computing newspapers), and Computing graduates with a good degree are still much in demand. Many graduates with other types of degree retrain in Computing after their first degree in order to find employment. By doing Computing as your first degree, you get a head start on them.

Salaries in the Computer Industry

A survey at the University of East Anglia found that new Computing graduates were on average better paid than any other type of graduate in their university. At present (2004), starting salaries for new graduates in Computing seem to range between £15,000 (for people who choose to work for small local companies) and £30,000 for specialist skills, with the average starting salary being somewhere in the middle of that range.

Those salaries will increase as experience is gained, and £60,000 and a good company car is possible for high fliers with 5-10 years experience and marketable skills. I know several people who earn over £100,000 per year in the Computing industry. If you own your own business then the sky is the limit. Four out of the world's ten richest people made their money from Computing - Bill Gates (worth $46 billion in 2003), Paul Allen ($22 billion), Larry Ellison ($18 billion) and Michael Dell ($13 billion).

Working in the Computer Industry

The Computing industry has jobs both for those who like to work with people, and for those who prefer to hide away and write programs. My own experience of my first few years working in Computing was amazement that people would pay me for having so much fun.

Whether you like solving problems, or finding out what people need and making sure that it happens, or building something new that no-one else has ever built before, then there are jobs in the Computing industry that are appropriate for you.

What kinds of jobs are there?

There are a wide variety of jobs in the Computing industry. All companies will now have computers in the workplace, but different kinds of companies will need different types of skills.

A reasonable view is to split the types of jobs available according to the type of company that you choose to work for. The three main sources of jobs for Computing professionals are:

- Companies that are users of ICT
- Companies that make products incorporating computers
- Companies that produce and supply software

The characteristics of the different types of company are explored more fully in the section "Structure of the Computing Industry", but here is a quick summary in case you want to rush on and look at the kinds of jobs available.

Companies that are users of ICT. All companies are users of Information and Communications Technology, and will need computer systems to provide information to their employees and their customers (often via web sites). They may have demands for specialist types of software or hardware. They may employ people within the company to provide these things, or may buy them from the two other kinds of company.

Companies that produce and supply software. These kinds of companies range from multi-national companies such as Microsoft that produce shrink-wrapped software for a mass market, through companies that make software for legal practices or hairdressers, to specialist companies that build one-off software for NASA's latest space probe.

Companies that make products incorporating computers. These companies will also be users of ICT, of course, but because they make products that are computers (e.g. Dell) or that contain computers (e.g. Ford Motor Company or Vodaphone), then they have a need for more technical kinds of Computing expertise. Some of the needed expertise is concerned with hardware, and some with the complex software that interfaces to it.

The list of jobs given for each type of company is not exhaustive, but should give you a reasonable idea of the breadth of choice that you might have if you chose to train for a career in Computing. Examples of real people doing the different kinds of jobs are given in the section "Work Stories". They give an idea of how people got to where there are today, and how they feel about what they do.

Training in Computing can also be an excellent grounding for work outside the Computing industry, and so I also outline some of the other common job choices that are made by people with Computing degrees.

Jobs with ICT users

Data analysts / programmers. Traditionally (20 year ago - tradition is short in the Computing industry), these jobs were entry-level positions, often done by people who joined a company straight from school after A-levels. That is becoming much more rare. Either the job is simple enough it can be outsourced overseas, or it demands the kinds of skills that Computing graduates are trained to have. People in data analyst / programmer jobs today need to be able to implement computer-based systems for their company, to explain to users how the system they are programming will work, to understand how the system they are building fits with the needs of the company, and to be able to produce a system that can be maintained over many years.

Web developers. Over the past ten years, almost every company has developed a web presence - including schools and universities! A mixture of Computing, graphical, commercial and presentation skills are needed to provide a successful web site. Typically, no one person will have all of these skills. The Computing graduate may be called upon to provide several of these skills as part of a larger team, or within a smaller company may be the only employee in this area, perhaps working with outside graphical experts.

Telecommunications/network specialists. The need for this kind of skill will depend on the company. Most companies will have their computers linked to each other, with central file servers, so that files can be accessed from anywhere. They will also have links to computers outside the company, so that other companies and customers can access information. Many companies are moving to broadband, and upgrading their internal facilities to match. Network specialists have the knowledge to configure and maintain the quality of service on such networks of computers.

User training / technical support. Within many modern companies, everyone will be a computer user. They will often have a computer on their desk, and will use it to access company information, or to write letters or read email, or to record what has been produced or sold. When they do not know how to perform some task, or when the computer does not work as they expected, they turn to the computer professional. This type of job needs someone who understands the technicalities of what the computer is doing, but who is also able to explain to users what is happening and what they should do next.

Security specialists. I observed earlier that computers are being linked both within companies and to the outside world. One consequence of that is that it makes computers vulnerable both to malicious threats such as computer viruses and worms, and also to criminal threats such as stealing information or money. Security specialists are able to assess the threats to a company and to put in place procedures and software that protects the company's computer systems against such threats.

Database administrators. Much of the information within a company will be held in databases. For some companies that might be as simple as an Access database, and little administration of such a database would be needed beyond occasionally backing it up in case the system crashes. However, take the extreme example of amazon.co.uk. They will have a database containing the details of perhaps a million customers in the UK, and another database containing details of the hundreds of thousands of products that they sell. Because of the number of sales that they make at one time, they cannot run those databases on one computer - they will have a cluster of server computers containing copies of the databases, interfacing to a cluster of web server computers sending web pages to people's desktops.

Every time a customer purchases a book or DVD, a change needs to be made to a database, and all of the database server computers need to be consistent in the information that they hold. The database and web server machines must be available 24 hours per day, seven days a week, or amazon.co.uk will lose money through not being able to sell goods. The database administrator is responsible for the availability of the database service and for it providing the correct information.

Information Systems manager. Within many user companies, this used to be called the data processing manager. It is traditionally portrayed as the top of the tree for a computing career, and within many user companies, it is. The information services manager is responsible for all of the ICT provision within the company (or at a lower level, within one site of the company). This will include considering all of the individual areas of computing (such as security, networking, databases, user training, provision of new systems), along with making sure that the computing provision meets the business needs of the company, and planning how much ICT provision will cost the company. In many companies, this position is so important that the information services manager reports directly to the board of the company.

Jobs with software suppliers

Most companies do not write all of their own software. For some of their needs, they buy packages (e.g. Microsoft Office) and configure them to their own requirements. For other needs, often the more complex ones, they pay other companies to build or adapt software to their requirements.

Development of new software packages. Software is produced for many purposes - office productivity software, games, software to support hobbies such as making genealogies, internet browsers, educational software. All these types of software need people to decide what the software should do, to design how it will do it, to implement it, to test whether it works properly, and to keep it up to date as changes in the software package are needed. Computing jobs exist in all of these areas of software development. Often, you will work with a team of software developers that cover the different roles outlined here.

Operating system level design and programming. There is a more technical level of programming that involves knowing about how things work in the depths of the computer's operating system. For example, a software development team building software which enables a computer to print to a new type of printer would need to understand how the computer deals with printing queues, and how the printer deals with characters that are sent to it, and then would write software to make what is shown in a document print correctly on that type of printer. Such work can be very challenging, but is also very rewarding for those who enjoy complex technical puzzles.

Bespoke development. Some software is too specialist to be developed as a package sold shrink-wrapped to everyone who wants it. For example, an air traffic control system (software to help people track and land planes), or software to run the rides at Disneyland, would be developed specially for each customer. Software companies in the bespoke business need to have people capable of understanding the customer's requirements, of stating them in a way that an agreement to develop the software can be made, of working with the customer during the development, as well as all the other skills needed in software development (see "Development of new software packages").

Human factors. How do you design your software so that it is easy to use, and make sure that your design decisions are correct? Human factors experts are skilled at designing interfaces appropriate for a particular task, and at evaluating those interfaces with a group of representative users of the software in order to make sure that the design decisions are correct.

Sales / marketing. Software can range in price from £4.99 for a budget game to many million of pounds for a purpose-built air traffic control system. At the lower price levels, little support is expected, but for more expensive and more complex software, sales and marketing needs people who understand the technical details of the software, at least in outline, as well as the business context in which the software will be used. Computing graduates are frequently encouraged to move into such jobs if they show an aptitude and an enthusiasm for working with customers.

Customer support / technical support. This term covers a variety of jobs, from being on the end of a phone advising customers on problems with the software supplied by your employer through to working on site at a customer company, adapting the software to meet the customer's changing needs.

Consultancy. To some extent, consultancy is a posh way of saying technical support. It suggests a higher level of technical expertise than customer support. If a company wants you to change a computer package to produce a report in a slightly different format, that is technical support. If it wants you to recommend what its strategy should be for developing a high profile new web site, that is consultancy. The importance of the consultant's role is often reflected in high salaries. This means that being a consultant is not really a job you can start in as a new graduate in Computing. As you develop expertise that is highly valued, it may become an option as your career progresses.

Quality assurance. Quality assurance staff are responsible for ensuring that the quality of the software produced by the company is appropriate - that it is safe, secure, reliable, maintainable and usable.

Project management. Large software projects can have 50 or 100 people working on them. The best people to run such projects are ones that understand how software developers work, and the processes for making sure that the software is built properly. This means that one career path for Computing staff is into project management - managing other people building software. This tends to happen gradually, perhaps beginning by leading a small team of 2 or 3 other, less experienced project people, then increasing the size of the team supervised and the project tackled as experience and training are gained.

Running a company. A surprising number of our graduates end up starting a company at some point in their lives. Sometimes, this is just a convenient way of working as a consultant to other companies, but sometimes it is because they have seen a niche in the market for some specific software product or some skill that they have. In the latter case, the company may employ a number of other people, and they may then spend their time as Managing Director rather than as a programmer. It is not a career path for everyone, but for those who are attracted to it, a degree in Computing provides good opportunities.

Jobs with manufacturers of products incorporating computers

Almost all of the job areas outlined for software systems also exist within companies that manufacture products containing computers, but there are also some specific skills in this area.

Embedded systems analysts / designers. The modern motorcar can contain up to 100 computers. These are *embedded systems* - rather than having keyboards and screens, they have memory and CPU on a chip in a box. They perform tasks such as monitoring the wheels to detect when they are slipping, or controlling the timing and amount of diesel fuel being used. In such systems, having the correct information and performing actions at exactly the correct time are important issues, and so this is an important specialised area of computing.

Development of new products. A team developing a product containing software will need all of the skills that we mentioned for purely software products. In addition, it will need people who understand how the hardware linked to the software works (whether it is a child's toy or a motorcar braking system). There can be extra challenges in getting the interface correct between the hardware and the software, and in proving that it is correct.

Safety-critical systems design. Some of the software embedded in a motorcar or a plane or nuclear power plant has the potential to injure people if it goes wrong. The level of care taken in designing such systems must be greater than for less dangerous systems. There are tools and techniques for such work that aren't used for simpler systems.

Jobs outside the computer industry

The skills acquired on any good degree will fit you for a wide range of graduate-level jobs. Even there, a Computing degree can be an advantage. Computing is so pervasive in our world, that a good understanding of its potential gives you an advantage in many jobs.

Some jobs outside the Computing industry that do depend directly on the skills acquired on the course are teaching at school and university level, and doing academic research.

School teaching. There is a demand for schoolteachers in Computing and IT, and at present there are special financial arrangements to encourage people to work in this area. The holidays are good, but it can be very hard work during term-time.

Academic research. If you want to work on the systems of the future, and expect to get a top class degree, then this is the job for you. In Aberystwyth at present, we have researchers investigating:

- improving the way cars are designed
- building autonomous mobile robots
- making systems to help detectives solve crimes
- constructing flying robots to explore Mars
- learning more about what is important in genomes

- designing advanced scientific databases
- inventing robots that can learn how to do new tasks

University lecturer. Unlike a schoolteacher, teaching is not the prime task carried out by university lecturers. The students are only present during 30 weeks of the year. An equally important task is carrying out advanced research. University lecturers carry out some of that research themselves, but many of them also supervise post-graduate students and academic researchers employed to work full-time on specific problems. (See above).

Getting jobs in Computing

There are a number of ways to start working in the Computer industry:

Just start doing it! This used to be much more common in the Computer industry when there was much less experience of and knowledge about computers. People would learn a little about programming, and take on a programming task for a local company, and find that they were suddenly the Computing expert. An example nowadays might be that you build web pages for people you know, and it gradually turns into a business. One drawback of this approach is that many people find later on in life that the lack of a degree can hold them back when they apply for more challenging jobs. It is possible to go back and get a degree later on (we have had around 100 such mature students in our department over the last ten years), but it is much harder to study when you are older and perhaps have a family to support.

Get a job from school. A number of employers such as the Civil Service and Local Government have made a habit of taking on people straight after A-levels and training them to do the more menial kinds of Computing jobs - less challenging computer support jobs or simple programming. If the job includes day release to study for degree level qualifications, then this can be a good route into the Computing industry (although doing a degree and a job at the same time can be very hard work). If it does not include time to study for qualifications, then you may end up in the same position as those who just start doing Computing - looking to study for a degree later in life.

Get a degree in Computing. This is now the standard route into the Computing industry. From a good degree, a graduate should be useful to their company on their first day in the job. Indeed, we find that our students that take an industrial year in the middle of their course have the skills needed to be useful immediately they arrive in a company. There are a range of degrees available to allow you to choose one that will suit your particular interests (see "Degree Courses in Computing and IT"). My own advice would be that you study for a degree at Aberystwyth (ref Aber site), but I freely admit to being biased. I have tried to compile a list of questions for you to ask that will help you assess any Computing degree scheme.

Do a postgraduate taught Computing Masters. Some people choose to do a first degree in history or zoology because that is what they were best at or most interested in at school. Many of them find at the end of their course that there are not many jobs as historians or zoologists, and decide at that point to retrain for jobs in Computing. There are a variety of 12 month or 18 month postgraduate courses that give a grounding in Computing to graduates from other subjects. (Bizarrely, national figures imply you are more likely to get a job immediately if you are a history or biology graduate than if you are a Computing graduate, but to a great extent that is due to the way they collect the figures. Further study counts as a job for the figures, and many more historians and biologists feel the need for further study in order to be employable. We do not see our graduates rushing to retrain as historians in order to get a job.)

Degree Courses in Computing and IT

There are many different names for degree courses in Computing and IT, and this section is intended to give you an idea of what you might expect from a degree with a particular title. However, there is considerable overlap between degree schemes with different titles, and you will want to be asking the questions in the section on "Questions to ask about university computer courses" in order to decide whether a particular degree scheme is for you.

Computing / Computer Science

This used to be the name of the degree that you did in a Computer Science department 20 years ago. With greater specialisation in the subject, it now tends to be the degree that you do if you study Computing and don't specialize in something. That's not a bad thing - it means you should come out of the course with a broad coverage of the subject, and perhaps been able to choose topics that interest you, rather than ones that fit into a particular brand of degree.

There is also a difference in emphasis between departments on whether their Computing degrees are fairly mathematical or whether they take a more vocational emphasis. Many Computing departments originally emerged from Mathematics departments, and some of them still have quite a strong mathematical bias. Others have taken a more vocational emphasis, and tend to only include the mathematics needed for someone following a career in the Computing industry. See the question on "how much Maths is there?".

Software Engineering

This title reflects a degree with a stronger emphasis on preparing you to work on challenging problems in the Computer industry. Such degrees will tend to have an industrial year included as part of the degree, because the experience of working in the industry is an important part of understanding the education you are being given. Graduates will tend to work for software suppliers or companies making products that incorporate computers, as those areas need people who can build software with a strong engineering approach.

Internet Computing / Internet Engineering / E-commerce

Internet degrees usually have an emphasis on the kind of technologies and skills needed to develop internet-based systems. I would expect them to have a strong emphasis on web technologies, on databases (to provide the behind-the-scenes support to the web technologies), and on telematics. There is a second strand of e-commerce degree, usually from business schools, concentrating more on the business and financial implications of e-commerce. You should be able to tell the difference between the two by the content of the degree (lots of business and accounting modules or an emphasis on the design and implementation of systems). Graduates from these degrees are needed by both software suppliers and ICT user companies.

Information Technology / Business Information Technology / Business Computing / Information Systems

I would expect these degrees to have less emphasis on programming than Computing degrees or software engineering degrees, (although you will still need to be able to do some programming) and rather more on building software out of components (e.g. databases and interface building systems). They should have a greater emphasis on analysing business processes in order to make sure the software that is produced fits the exact business need. Some of the degrees may have a much greater emphasis on "business" and less on "computing". You should look at the modules listed for each particular course, and try to decide whether the mix of the two is correct for you.

Graduates from such degrees will tend to work directly for user companies.

Other Flavoured degrees

If you already know the area of Computing that you are interested in, then it is possible to choose a degree that emphasizes your interests. To some extent, good degrees are organised in this fashion anyway. In the case of the Computing degree in my own department, you can choose a number of optional modules in the area that interests you (graphics, artificial intelligence, internet and distributed systems) and combine them with a large final year project in that area. This means that by the time you complete your degree, you already have a good deal of specialist expertise in an area that interests you. It helps you to get the job you want after you finish.

Some of these sets of choices are packaged into degrees with titles that reflect what has been studied - Computing with Multimedia, Computer Science with AI, Computing with Internet (also Internet Computing - see above).

Another strategy is to mix a Computing major with a non-computing subject, for example Computing with French, or Computing with Business. Typically, Computing would take two-thirds of your time, with the minor taking the other third.

Questions to ask about university computing courses

There are hundreds of different Computing degrees at many universities. How do you find the one that is right for you?

Here are some questions that you might ask when looking at the prospectuses of different universities, or even better, in person when you visit them.

Many of the questions do not have one correct answer - you need to think what kind of a career you want and what kind of things interest you, and then select a course that fits your needs.

Where do course graduates typically get jobs?

If you want to work for a software supplier, and all the graduates work for ICT users (or vice versa), then is probably not the right degree for you. This is a question you can actually ask a university if you are visiting them. If the staff aren't able to answer the question, then that is a bad sign…

Do the staff have industrial experience?

If you intend to work in the Computing industry after graduation, then at least some of the people teaching you should have experience of that industry. I'd look for at least a third of the staff with at least three years experience of industry, and some with senior experience (running project teams or companies). That is enough of a percentage that the Department will be able to run the practical part of the degree properly, and will understand professional issues thoroughly.

Is this degree an education or just training?

A university education in Computing is a difficult balance. On the one hand, we could just teach you guru-level use of Access and Java, and you might be unemployable in 5 years as the popular skills change. On the other hand, we could teach you the Lambda calculus, Church's thesis and complexity theory, and you would be unemployable as soon as you complete the course (or at least need further training).

The ideal course will fit you for useful work as soon as you finish (by including state of the art tools and practical work), but give you the theoretical underpinnings to adapt to change in a rapidly-changing Computing industry. (See question on "What is the mix of theoretical/practical work?").

What is the mix of theoretical/practical work?

(See question on "Is this degree an education or just training?"). A good degree will have a mixture of theoretical courses, along with practical work that uses state of the art tools.

Does the course include any team working?

Much work in the Computing industry is done in teams. This means that realistic team working during the degree course, where you can point out how you fitted in the team and how well you fitted in, may well help you get a better job afterwards.

How easy is it to change courses if I choose wrongly?

Some degree schemes have more flexibility than others. For example, if you are not sure how much programming you want to do, or whether you want to specialize in internet-related topics, then is it possible to change between courses once you have started? What is the range of courses between which you can change?

How much hardware teaching is there?

There's no right answer to this question. It depends how interested you are in the hardware side of Computing rather than the software side. Computing degrees can differ quite a lot in how much hardware teaching there is.

How much Maths is there?

There is no right answer to this question. Some Computing degrees can have quite a lot of Mathematics, and even ask for Maths A-level. If you like Maths and want to do more of it, then go for those courses (or even a joint degree in Maths and Computing). My own opinion is that the Maths needed by the average Computer practitioner is only one or two modules, so if you are not a Maths enthusiast, choose your course appropriately.

Is there opportunity for industrial experience?

In my university department, more students graduate from degrees having done an industrial year than originally applied for a degree that included an industrial year (they change degree registration at the end of the first year), and on average their degree is a grade higher than people who did not do an industrial year. There are two reasons why they do better. The first is just that they learn good work habits in industry, and keep them during their final year. The second is more important. They gain experience in industry that helps them to understand better what they are being taught in university - it makes the information relevant. The year's experience also makes getting a job at the end of the course even easier.

Does the course include professional issues?

If you are intending to work in the Computer industry, then one of the things that is needed is an understanding of the legal, professional, social and ethical issues involved in such work.

Is the course accredited (by BCS, IEE)?

Especially at the more challenging levels, Computing is becoming a profession, and like other professionals (lawyers, doctors etc.), there is a growing need for both recognized qualifications and professional experience to show that you are qualified. The British Computer Society (BCS) and the Institute of Electrical Engineers (IEE) are two institutions that accredit Computing and IT degree courses in the UK. Each organisation visits UK

universities to assess their courses, and say that their students have an education fitting for someone who wants to be a member of the society and/or a Chartered Engineer.

Another advantage to you of accreditation is that it answers positively some of the other questions listed. They will have investigated whether the accredited degree is appropriate in the following areas for future Computing professionals:

- Does the course have sufficient coverage of Computing topics?
- Does the course have sufficient coverage of professional issues?
- Is it an appropriate mix of theoretical and practical work?
- Are the students reasonably happy with the education they are receiving?

If a Computing course is not accredited by one of these organisations, I would be asking why not.