COMPUTING SCIENCE COURSES - TRAINING OR EDUCATION?

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INTRODUCTION

The debate about the usefulness or otherwise of Computing Science degrees has raged for some time.

Critics of these degree courses have stated that the courses do not satisfy the needs of commercial and industrial users; that they do not train the graduate to be of immediate use or that the subject is developing too rapidly for degrees to impart any lasting knowledge and so on.

It may be (and is) argued by some, that an Institute of Higher Education (be it College, Polytechnic* or University) should not aim to train students to be of immediate use to industry. However there is obviously a demand for trained personnel in the computing field, as demonstrated by the proliferation of courses run by manufacturers, various professional bodies and commercial organizations, and it is to satisfy this demand that a number of Polytechnics in England, and Sheffield Polytechnic in particular, have designed courses aimed at educating students in the field of computing.

* Polytechnics in the U.K. are institutions created during the 1960's, complementary to the University System. They are very similar except that their courses on the whole reflect a more applied approach.

1. WHAT IS COMPUTING SCIENCE

The very term computing science emphasizes the very practical nature of the subject.

Computing Science is a young discipline which is concerned with the design, construction and use of computing systems. The computing science panel of the Science Research Council define it as follows [1]:

> "An organized body of knowledge concerned with the principles and practice of design, construction, use and application of computing equipment and programs."

Computing science as a discipline is closely allied to engineering because of the strong emphasis on design. Computer systems are highly complex entities that are intended to operate effectively and efficiently over a wide range of problem environments. Consider for example an engineer commissioned to design a bridge. Not only must the bridge be able to withstand the load as calculated from fundamental principles but the design must be pleasing, cost effective and must not infringe any of the laws of the land. So it is with the design of computer systems. We can apply our theories and design very technologically competent systems, but we must also be cost effective and be very aware of the human and legal factors.

Computing science is essentially a "doing" discipline. One cannot afford to be isolated from the practical problems in implementing any computing systems. As can be seen from the definition given, computer systems are very much concerned with applications in other disciplines and at present new applications are being discovered in most aspects of human life. It is therefore essential that computing scientists are trained with a broad understanding of application areas and are able to collaborate with others initiating, promoting and working for change.

There are many examples of very poorly designed computer systems, simply because their designers were not aware of or did not take account of the outside world.

2. WHAT SORT OF COURSE?

One way that knowledge about computing systems can be associated with application areas is by a graduate program at Masters level to take people who have graduated in other disciplines and 'convert' them to computing science. One major problem with this is that although the students have an excellent knowledge base on which to build, the Masters program is relatively short and has to concentrate almost exclusively on aspects of computing science, leaving the poor student to somehow integrate the two bodies of knowledge he now has.

For those people who are going to be involved in the design of computer systems, this is surely better done in parallel. That is, an undergraduate course should develop computing science knowledge <u>alongside</u> the broad framework of some other area. In this way the interaction of the two can be developed and seen as one.

What sort of other areas need to be included within a computing science course of this kind?

A computing scientist must have a good knowledge of the environment in which he is to practise. This can be achieved by incorporating a large element of business studies into the course.

All computer systems have a human interface and indeed human factors are an important consideration in computer system design. This suggests that behavioural sciences should be developed in such a course.

Computer scientists do not exist for themselves. An important part of their work is concerned with designing systems for others and in making it easy for non-computer people to use the computer. Communication skills are therefore also important.

3. THE OUTLINE OF A COURSE

This then is the background to the undergraduate degree course in computing science which exists at Sheffield Polytechnic.

The course is designed to appeal to Arts entrants no less than science entrants and is set within the context of the business and industrial environment because this enables a choice of breadth of applications and because this area accounts for about two thirds of all computer work and computer people (in Britain).

The course should provide for careers in Systems Analysis, Systems Design, Software

Engineering, and research as well as preparing the graduate for general employment outside computing in the business area.

3.1 Aims of the course

To provide:

(a) A sound theoretical basis to the study of the computer and its applications.

(b) A knowledge of the origin, structure and flow of information in a system.

(c) An understanding of the organization of business and practise of management with regard to the cost effectiveness of an information system.

(d) The ability to communicate clearly and to develop a logical and critical mind.

3.2 Course Structure

The four year course is of the sandwich nature, consisting of three academic periods of one year each, sandwiching two six month periods of industrial training (see 3.4).

3.3 Course Contents - An Outline

The course consists of the following disciplines.

3.3.1 Data Processing

This comprises syllabuses such as Data collection and storage, Data Analysis, Information Processing Systems (IPS) in part I and Information Processing Systems in parts II and III. IPS part III is done entirely by case studies.

These areas aim to enable a student to design effective and economic computer systems within the business and industrial context.

3.3.2 Software Engineering

This comprises syllabuses such as Programming in part I (high level languages), Programming (assembler) and Computer Systems (varous aspects of hardware) in part II and Computer Systems and Applied programming in part III.

The aim here is to enable a student to design, construct and maintain cost effective software.

3.3.3 Theoretical Studies

These comprise the syllabuses in Mathematics, Probability and Statistics in part I, Principles of Computing Science (Data Structures) and Mathematics and Operational Research in part II and Principles of Computing Science (formal languages and translators) in part III.

3.3.4 Business and Management Studies

This includes Business Organization and Finance in part I and Environment Studies in part II.

The aim of these studies is to enable a student to become familiar with the problem environment in which they are to work.

3.3.5 Behaviourial Science

This includes Communications in parts I and II.

The course aims to create a broad social perspective of the communication process examining the verbal and non verbal aspects of communication. It also aims to make a student a more effective member of a work group by providing an understanding of the sociology and psychology of groups and work organizations.

3.3.6 Projects and Options

In the final part of the course the student is required to do a project. This is a piece of work (not necessarily original) on a topic or area not covered in formal lectures (sometimes, though not always, involving a substantial amount of program writing) which is to be written up in the form of a project report.

The student is also required to study two subjects from a list of options.

Options are offered in two main areas - business studies and particular computer applications. Those intending to pursue a career in systems analysis would be advised to opt for the business studies area whilst those intending to pursue a career in software engineering or computer research would benefit from the further study of computer applications.

Thus through the choosing of a suitable project and options the student is able to orient his studies in one direction or another.

3.4 Industrial Training

As indicated in 3.2 the course includes some industrial training. Here, the student spends two periods of six months working in a computing environment in industry, commerce or government establishment. Generally, the student will spend the first period of training programming, but the second training period (which may or may not be at the same establishment) may be in many areas of software or systems. Students are employed in a wide variety of fields, all of them on worthwhile projects (i.e. none of them are given trivial training tasks to keep them quiet).

The work that a student is to do is the subject of discussions between the training organizations and a member of faculty from the Computer Studies department, who has either special knowledge of the organization or industry.

Virtually all faculty staff in Computer Studies have had industrial experience and contact with industry is stimulated by encouragement of joint research projects and by becoming involved in running specialist short courses for the immediate needs of industrial staff.

Computer Studies staff visit each student twice during each of their six month periods and discuss a student's progress with both the student and the internal supervisor appointed by the organization.

This industrial training is considered to be an integral part of the course (which the student has to 'pass' in order to proceed in the course) and to be a very valuable experience. It does make a noticeable difference to students returning to parts II and III of the course.

Response from industry is very good. We experience no difficulty in placing students and indeed, some major industrial concerns have started to encourage their staff who wish to pursue a course in Computing science to do so at Sheffield Polytechnic.

4. FUTURE DIRECTION OF COMPUTING SCIENCE EDUCATION

It must be recognized that much work has been going on recently [2,3] to formulate degree courses in 'Data processing'. There will surely be quite a number of such courses proposed. However, it should be possible to combine parts of such a course with a 'computing science' course.

A further academic opportunity which can now be offered in Britain is that of a Diploma in Higher Education. This is offered after a two year course for those people not able to or not wishing to proceed to a bachelor's degree.

The possibility exists then of a two academic year common scheme (at the end of which the Dip H.E. student leaves) followed by two separate final academic years, one which leads to a degree in Computing Science, the other leading to a degree in Data Processing.

To indicate why this is viable, examine the requirements of the two areas.

Computer Science is concerned essentially with the design of programming systems (software) and with the formal descriptions of computational processes. It requires a greater ability in formal logic processes than data processing and is less concerned with computer applications although the biggest growth areas area likely to be in software systems not concerned with the machine itself. Its clear focus is in the design and building of the system.

Data processing is concerned with the dual aspects of Analysis and Design, most commonly within a business environment. It is as much concerned with information requirements as it is with information provision although a clear focus is again seen in the design and building of a system. The design process is becoming much more quantitative and statistics and OR techniques are very important here. Data processing is intimately concerned with the functioning of business and the practitioner requires a wide knowledge of business concepts.

In considering the requirements of both areas it is clear that the following elements are present to a greater or lesser degree.

a. A thorough grounding in Programming and Computer Systems.
b. A substantial development of quantitative technique.
c. A good understanding of the application environment. In this case data processing students require a much deeper understanding of business than the computer science students. One can envisage a common core in the Dip H.E. programme with extensions in the Data Processing programme.
d. A highly developed awareness of the behavioural aspects of systems since human beings are a primary component of all computer systems.

It would therefore seem reasonable to construct a two academic year course (leading to a Dip H.E. award), with final year courses developing a degree in Computing Science or a degree in Data Processing, building on these elements in different proportions.

5. CONCLUSION

The type of computing courses described here developed as a result of first hand knowledge of the needs of industry and of many hours of fruitful discussion with industrialists.

This type of computing science course is still relatively novel but is being followed by a number of academic institutions.

REFERENCES

[1] Computing Science Review: Education and training, Panel of Science Research Council, 1972.

[2] ACM Curriculum recommendations for undergraduate programs in Information Systems (1974).

[3] BCS Report on Degrees in Data Processing (1975).