CONTENTS

A number of quantitative terms are used in the report. In percentages, the terms correspond as follows:-

More than 90%	-	almost/nearly all
75%-90%	-	most
50%-74%	-	a majority
30%-49%	-	a significant minority
10%-29%	-	a minority
Less than 10%	-	very few/a small number.

PART 1

1.1 INTRODUCTION

1.1.1 This report presents the findings of a survey of the provision for software engineering in the further education sector in Northern Ireland. It is intended to support colleges of further education in the process of devising and implementing clear policies and strategies to identify and meet the skill needs of the software industry sector. The survey was undertaken by the Education and Training Inspectorate during the 2000/01 academic year.

1.1.2 The Government's strategic aim of developing a new culture of Lifelong Learning throughout Northern Ireland presents a major challenge to the further education sector which is the main provider of vocational education and training for young people and adults. As a result, new demands have been placed on colleges of further education to increase provision and to widen access to education and training. In 1999, the Department of Economic Development published 'Strategy 2010' which lists recommendations for education services and outlines targets for the economy by the year 2010. These recommendations support the concept of Lifelong Learning, and provide for stronger links between education and training policy and economic development strategy. They also aim to promote in other areas such as teacher training and careers guidance a better understanding of business and employment opportunities. The 'Strategy 2010' outlines challenging targets for the economy which are critically dependant for their achievement on the efficiency and effectiveness of the education services in Northern Ireland.

1.1.3 Since 1999, the Government has made available to colleges of further education additional funding to develop new provision and to increase participation in six skill areas identified by the

Training and Employment Agency (T&EA) as vitally important for the Northern Ireland economy. These are computing, construction, electronics, hospitality, catering and tourism, manufacturing engineering and software engineering. The then Department of Education for Northern Ireland (DENI) made available to the further education sector 600 additional publicly funded full-time higher education places in the six skill areas, including 140 for software engineering. In addition, the Chancellor's Initiative Skills Fund provided for another cohort of up to 100 full-time higher education places in the vocational areas of software engineering and electronics for the academic years 2000/01 and 2001/02. In the year 2000, colleges were invited by the Department of Higher and Further Education and Training and Employment (DHFETE) to bid for recognition as centres of excellence in the six skill areas. No college was awarded centre of excellence status in software engineering.

1.1.4 The software sector is characterised by strong international competition, rapid technological innovations, advances in telecommunications, and new product development. It is one of the most important contributors to national economies, and is one of the fastest growing industries in Northern Ireland. With the decline of traditional industries, the software sector is strategically important to opening up new opportunities for the labour market and making a significant contribution to the overall economy in Northern Ireland. The success of the software sector is, however, critically dependant on the availability of sufficient people with the right skills in software engineering. In the main, the software sector recruits university graduates, and does not have a clear understanding of the capability of non-graduates from colleges of further education to work competently in software development and support services. It is therefore essential that colleges identify and address appropriately skill shortages and recruitment difficulties in software engineering, and ensure these do not inhibit the development of the software industry.

1.2 PURPOSE AND SCOPE

1.2.1 The purpose of the survey was to evaluate:

- the quality of the provision for software engineering in the further education sector;
- the standards achieved by the students;
- the effectiveness of the provision in identifying and meeting the needs of industry.

1.2.2 In preparation for the survey, all colleges completed a questionnaire to provide information on the range and quality of the computer hardware and software, networks and communication systems used to support teaching and learning in software engineering. In addition, the arrangements for students to access the computer facilities were surveyed. The further education sector comprises 17 colleges of further education which vary considerably in size, from the largest college with about 25,000 students to the smallest with 650 students. The survey included visits by inspectors to 12 colleges during the 2000/01 academic year. Five colleges were identified at the start of the survey as having little or no provision for software engineering and were not inspected. The inspection focused on higher education programmes in software engineering, and in computing, business information technology and electronic/telecommunication engineering which included units in software engineering. Level 3 programmes in computing, and information and communications technology (ICT) were also included in the inspection. Approximately 260 lessons at higher education level and 80 lessons at level 3 were inspected. Basic ICT skills requirements of students were not included in the survey. Samples of students' work were reviewed, and examples of good practice identified. Discussions were held with students and staff, and senior management who have responsibility for software engineering and computing. Students on the higher

education programmes were visited in work placement. In addition, 15 manufacturing or commercial companies whose principal activity is software development were visited and discussions held with management and software engineers from junior to senior levels.

1.2.3 For the purpose of this survey, the software sector in Northern Ireland is defined as local or international companies for which software development and support services are their main or a substantial part of their work. The sector includes companies involved in the manufacture of telecommunication and electronic products, and the delivery of financial and multimedia services. As a working definition for the survey, software engineering is understood to be the application of engineering principles and techniques to software development. Although software engineers work in a variety of industries which use different sets of work-based competences, they also employ a common set of occupational standards based on emerging technologies and software methods. Software engineers need to develop and use a combination of technical, transferable and interpersonal skills. They will be required to investigate a problem and draw up a specification to solve it using an appropriate software design. A cost benefit analysis of the software solution is often carried out, and a final specification documented. After the software has been designed, the software engineers will write the code to implement it, and carry out preliminary testing for possible 'bugs' in the system. Software engineers will also have responsibility for designing testing procedures to check every possible hardware and software configuration.

1.3 MAIN FINDINGS

1.3.1 The main provision for software engineering in the further education sector comprises the Edexcel BTEC Higher National Diploma (HND) and Higher National Certificate (HNC) programmes in software engineering offered by six colleges;

the HND in electronic engineering with units in software engineering or industry-standard proprietary qualifications offered by three colleges; and a one-year 'fast-track' HNC in telecommunication engineering with units in software engineering offered by one college.

1.3.2 The HND and HNC programmes in two colleges are well designed and planned to meet the needs of the software industry. In addition, the HNDs in electronics, and the HNC in telecommunication engineering meet effectively the needs of multi-national companies for higher technicians with software development skills. In the majority of colleges, however, the HND and HNC programmes provide students with only a limited range of learning experiences in software development which do not effectively meet the needs of the software industry.

1.3.3 In most of the 12 colleges inspected, the Advanced Vocational Certificate in Education (AVCE) in ICT has replaced the National Diploma in computing as the main qualification provided for students studying computing at level 3. About 80% of the students on the ACVE ICT programme select the AVCE single award in business as an additional study. In addition, only one college offers the AVCE in ICT which includes a unit in mathematics. The design of the AVCE ICT programme inhibits the progression of the students to higher education programmes in software engineering.

1.3.4 The level of recruitment in software engineering is low across the further education sector. In 1999, there were 108 full-time and 67 part-time enrolments in software engineering. They accounted for less than 0.2% of the total enrolments in all vocational areas, and for less than 1% of the total enrolments in the six skill areas identified by the T&EA as vitally important to the Northern Ireland economy. Although figures supplied by the colleges show that enrolments increased to 216 in the year 2000, no college achieved its target recruitment

level. Only 174 of the additional 291 full-time higher education places made available by the Government since 1998 for software engineering were filled. In contrast, recruitment to programmes in computing is generally excellent across all colleges. There are almost 2000 full-time students and 11,500 part-time students studying computing programmes from basic to higher education levels. They account for about 15% of the total enrolments in the further education sector, and for 50% of the total enrolments in the six skill areas.

1.3.5 In 2000, there were no enrolments to the specialist higher education programmes in software systems and electronics offered by two colleges.

1.3.6 The recruitment to HNDs and HNCs in electronics is good. There is an excellent level of recruitment to the HNC in telecommunications engineering. Enrolments in the evening programmes in the industry-standard proprietary qualifications, such as those awarded by Cisco Networking Academy or Microsoft, are excellent.

1.3.7 Women account for about 10% of the students recruited to full-time higher education programmes in software engineering compared to 25% of the students in computing and 55% in business information technology. Most colleges have not reviewed their recruitment and selection procedures to ensure they do not inhibit women from selecting software engineering and computing programmes.

1.3.8 Most students report that they received insufficient careers information and guidance on software engineering before leaving school and during enrolment in colleges. They have a poor understanding of the range of competences and personal skills needed to work successfully in the software engineering industry.

1.3.9 Further education colleges lack a set of occupational standards which outline the technical, transferable and interpersonal skills required to work competently in software engineering at higher technician level. This inhibits the quality of the careers information and guidance provided for students.

1.3.10 The marketing of software engineering by almost all colleges is inadequate. The students report they received little information on the provision for software engineering across the further education sector.

1.3.11 The quality of the teaching and learning varies considerably across and within the colleges. It ranges from good to excellent in about 90% of the lessons in three colleges, 80% in three, 70% in four and 55% in two. In half of the colleges, the weaknesses significantly outweigh the strengths in about 25% of the lessons.

1.3.12 In two colleges, the students on the HNDs and HNCs in software engineering are provided with good learning experiences in software development which are essential for them to work competently in industry. In the majority of colleges, however, the students study a narrow range of specialist units which do not provide the full breadth of knowledge and skills in software development needed for industry. The students on the HNDs and HNCs in computing and business information technology are provided with a range of learning experiences which limits the development of their skills in software engineering.

1.3.13 The quality of the project work provided for the students on the HND in software engineering ranges from excellent to good in three colleges, and is satisfactory in three. Only two colleges use work-based problems to allow the students the opportunity to plan their work under the normal pressures of the workplace.

1.3.14 The quality of the teaching and learning is good in almost all of the lessons in the colleges offering the HND electronic engineering programmes with software engineering units or proprietary qualifications. The students have good opportunities to extend their knowledge of software and hardware systems. The majority of colleges providing HNDs and HNCs in engineering, however, do not offer the students optional units in software engineering. As a result, they have few opportunities to develop the skills in software development which are in high demand from the new emerging technologies industries.

1.3.15 Industry-standard proprietary qualifications complement effectively the HND programmes in software engineering in two colleges. They provide students with excellent opportunities to develop and apply their knowledge and understanding of modern software and hardware techniques to realistic industry-based problems.

1.3.16 The quality of the teaching and learning in the AVCE ICT and National diplomas in computing programmes are good or better in the majority of lessons. In a minority of lessons, the learning experiences are not well planned, and do not provide the students with sufficient challenge. In two colleges, the students use an out-dated programming language.

1.3.17 In most colleges, there are few opportunities for the students to develop their interpersonal skills to the level needed to work confidently in the software industry.

1.3.18 Almost all colleges do not have a coherent plan for the development and assessment of the students' communication skills to higher education level in software engineering.

1.3.19 Only three colleges have an effective strategy for the development and assessment of competence in using an

appropriate range of skills in mathematics within software engineering programmes.

1.3.20 The standards achieved by students on the higher level programmes in software engineering vary considerably across the colleges. In two colleges, the students develop a wide range of competences in software development at higher technician level, and have the confidence to progress to employment in industry.

1.3.21 In the majority of colleges, the students on HNDs and HNCs in software engineering achieve competence in only a limited range of software development skills, and few have the confidence to progress to employment in industry.

1.3.22 Most students on the HNDs in software engineering, computing and business information technology achieve good standards in the common units in computing.

1.3.23 The students in most colleges develop a wide range of skills in visual programming to a good standard. Most also develop good website design and management skills. In only two colleges, the students on software engineering programmes display a sound knowledge of the concepts and techniques of object-orientated programming.

1.3.24 The students on the HND programmes in electronic engineering and the HNC in telecommunication engineering produce good standards of work, and make good progress towards acquiring the competences needed to work as higher technicians in industry with appropriate software skills.

1.3.25 In most colleges, the average rates of retention of the students on the full-time HND and part-time HNC programmes in software engineering are poor. Over the last two years, they ranged from 0% to 59%. In two colleges, the average rates of retention ranged from modest to satisfactory; from 67% to

73%. The average rates of retention of the students on the HND electronic engineering programmes is satisfactory at 78%.

1.3.26 In the two colleges where students have completed their HNDs in software engineering, the average rates of success vary from good to excellent. Over the last three years, they ranged from 80% to 100%. The average rates of success of the part-time students who complete their programmes vary from satisfactory to good. Over the same period, they ranged from 75% to 84%.

1.3.27 Approximately 75% of the students, who successfully complete their HND programmes in software engineering, progress to degree programmes. The remainder progress to employment, mainly in computing-related jobs. In contrast, 75% of the students who successfully complete their HND programmes in electronic engineering progress to employment.

1.3.28 Over the past three years, colleges of further education have invested significant funds to develop their ICT provision and to upgrade their infrastructures, computer systems and specialist teaching accommodation. In the majority of colleges, the range and quality of computing resources are now good.

1.3.29 Approximately two-thirds of the personal computers (PCs) in use are up-to-date high specification computers, at least Pentium II/MMX. Around one-third of the computers in use are, however, older PCs.

1.3.30 All colleges make use of local area networks. Around 87% of the overall computer provision is networked. Only a minority of students have been assigned, however, network passwords and storage space. Almost all networked computers provide students with access to the Internet.

1.3.31 All colleges provide open access facilities during weekdays. Twelve provide access during weekday and evening sessions, and two also provide access on Saturday mornings. There is a high level of demand for access to computer facilities in all colleges. Around 12% of total college computer stock is located in open access areas. In half of the colleges, less than 10% of the stock are available to students in open access areas.

1.3.32 In most colleges, there is a shortage of lecturers with suitable qualifications and experience in software engineering. A significant minority lack the expertise to deliver effectively the specialist units in software development, and are not sufficiently competent to teach software engineering to a high standard. Colleges have difficulty in recruiting both full-time and part-time lecturers with specialist skills in software engineering.

1.3.33 Although a significant minority of lecturers have benefited from staff development programmes in some areas of software engineering, this does not ensure that the lecturers are fully competent to deliver a wide range of higher education units in software engineering.

1.3.34 Only a few lecturers across the colleges have benefited from curriculum development initiatives in software engineering.

1.3.35 Most colleges have weak links with the software industry including the Software Industry Federation which is the sectoral body in Northern Ireland.

1.3.36 Only two colleges implement policies to ensure effective links are developed and maintained with the software industry, and relevant programmes in software engineering are delivered to a high standard.

1.3.37 Only two colleges have, and use, staff with sufficient expertise to carry out competently an analysis of the training needs of

individual software companies. These colleges have appropriate departmental policies in place to ensure staff organise their time in order to collaborate effectively with local employers.

1.3.38 Further education colleges require a set of occupational standards agreed with industry to identify effectively the training requirements of individual employers in the software sector.

1.3.39 Only a minority of further education colleges recognise that the software sector does not have a clear understanding of the capabilities and potential of students with HNDs in software engineering to work competently in software development and support services.

1.3.40 In the further education sector in Northern Ireland, there are no centres of excellence in software engineering. This contributes to the software industry's lack of understanding of the potential of further education colleges to provide non-graduates with HNDs to work competently in software development or support services.

1.3.41 In two colleges, the senior management implement clear policies and strategies to identify and meet the skill needs of the software industry. They reflect Government priorities aimed at promoting the concept of Lifelong Learning and implementing recommendations for education services and economic goals of 'Strategy 2010'.

PART 2

2.1 SKILL NEEDS

2.1.1 Forecasting future demand for and supply of software engineers has proved difficult and unreliable for the further education sector. To help identify the nature and extent of skill needs in Northern Ireland, the Government established the Skills Task force in 1999 to advise the T&EA and DENI. The Skills Task Force commissioned the Northern Ireland Economic Research Centre (NIERC) in 2000 to produce a report 'A Study Of The Northern Ireland Labour Market For IT Skills' which investigated the balance in the demand for and supply of skills in the information technology sector. The study did not include the skill needs for electronics and telecommunication engineers in manufacturing industries. NIERC reports that employment levels for IT skills personnel have increased from about 1400 in 1994 to 4325 in 1999. It forecasts the demand for persons with IT skills to continue to rise from the 1999 employment level to 11874 in 2005 based on a high growth scenario. In contrast, the Northern Ireland Software Industry Federation, the representative sectoral body for more than 180 companies involved in software and IT services in Northern Ireland, estimates that the software sector in Northern Ireland will grow from around 4000 employees in 1999 to 18,000 in 2004. This is significantly higher than the level of demand forecast by NIERC, and is more in line with the growth rates expected by other European countries.

2.1.2 According to NIERC, about 16% of employees in IT and software development firms are non-graduates in technical support roles compared to 42% of employees who are graduates with some technical experience. Graduates with no previous experience account for 23% of employees, while graduate project leaders and managers account for 18%. About 30% of firms report they have difficulty recruiting

non-graduate technical support staff compared to 70% for the other categories of staff. The majority of firms report that their production was hindered by shortages of software engineers. NIERC predicts a steady growth in demand for new graduates, and a relatively constant demand for non-graduate technical support staff. The supply of IT graduates is projected to double over the next five years while the supply of technical support staff from colleges is expected to increase by 50%. As a result, a surplus of graduates and technical support staff is forecast over the same period. Some senior managers in colleges with responsibility for software engineering do not expect, however, the numbers of students on software engineering courses to increase sufficiently over the next three years to meet the growth in demand.

2.1.3 Figures supplied by DHFETE show that only 25% of students achieving higher education qualifications from colleges of further education progress to employment with local companies; most progress to degree courses at university. As a result, expanding enrolments on to higher education programmes in software engineering would not necessarily supply significant numbers of employees for local companies. Higher education qualifications in software engineering are generally considered by industry as suitable for employing staff in non-graduate technical support roles. As the software sector expands, however, the difficulty faced by employers in recruiting graduates with experience may make it more attractive for them to recruit non-graduate technical staff.

2.2 THE SOFTWARE INDUSTRY IN NORTHERN IRELAND

2.2.1 The software sector is of strategic importance to Northern Ireland as the traditional heavy engineering and textile firms continue to decline. In other countries, the Government has played an important role in promoting the growth of the software industry, and ensuring it makes a significant contribution to the economy. Further advances in technology

such as digital cable television and interactive services will continue the growth in the global market for software engineering services. The software sector in Northern Ireland is becoming increasingly alert to the need for effective research and development programmes, and for investment in new technologies. There is the potential to position Northern Ireland as a centre of innovation, with strong links to international industry and impacting on the competitiveness of other industries. Countries which have experienced dramatic growths in the Software Industry, including the United States of America, have achieved these successes through partnerships between Government, education and industry.

2.2.2 International companies located in Northern Ireland employ large numbers of workers from operative to project manager levels. The reasons reported by these firms for coming to Northern Ireland include technological advances such as the Internet and e-commerce, the new international markets for software products, the well educated workforce and the high standard of the education system. Northern Ireland has approximately 200 firms involved in software development, most of which are internally-owned. Only a minority of internally-owned firms, however, have more than 100 employees. Most focus on the local market, though, there are a few which have established overseas offices and concentrate on export activities. These firms have generally experienced large growths in revenue and increased investment in research and development using emerging technologies.

PART 3

3.1 PROVISION AND PROGRAMME DESIGN

3.1.1 The main provision for software engineering in the further education sector consists of programmes leading to the award of the HND and HNC in computing, with a pathway in software engineering (HND/HNC software engineering); there are also pathways in computing (HND/HNC computing) and business information technology (HND/HNC business information technology). These are normally of two years duration for full-time and part-time students. Six colleges offer all three pathways. One further college offers the HND/HNC programmes in only computing and business information technology. There are units in software engineering on the HND/HNC in computing. One college has designed a one-year 'fast-track' HNC in computing, with an emphasis on software engineering. Four colleges also provide the full-time HND in computing franchised from the University of Ulster. This is a three year programme and includes a year in workplace training with an employer.

3.1.2 The HND/HNC pathways in software engineering, computing, and business information technology have common core units: computer platforms; software constructs & tools; systems analysis; quality management principles; and a software engineering implementation project. There is also an extensive range of optional units across the pathways to allow the design of programmes that meet the individual needs of students and industry. The majority of colleges provide, however, only a limited range of optional units, with little choice for the students. In three colleges, there is no difference between the optional units provided for students on the software engineering, business information technology and computing pathways. As a result, students on the software engineering pathway have no opportunity to study

important specialist units including software engineering techniques and object-orientated programming. Only three colleges provide students with the optional unit of mathematics for software engineers. One college has designed a full-time programme which comprises the HND software engineering, the industry-standard proprietary qualification awarded by the Cisco Networking Academy, and work placements. One other college complements the HND in software engineering with a Microsoft proprietary qualification. The students on the HND in computing franchised from the Ulster University are not provided with a choice of optional units including mathematics. Except for the second year of work placement, much of the programme reflects the Edexcel BTEC HND in computing.

3.1.3 Three colleges provide HNDs in electronic engineering, with units in software engineering or industry-standard proprietary qualifications. One offers a one-year 'fast-track' HNC in telecommunication engineering, with units in software engineering. Four colleges also offer the Cisco Networking Academy Programme in the evening for adults working in industry. One college offers the Diploma in Higher Education in Electronics and Software Systems franchised from the University of Ulster, and one has designed a specialist HND in electronics and software engineering. These programmes are designed to provide students with modern programming software methods needed for the development of electronic systems. One college has also designed a specialist HND in the built environment with information technology (IT) which includes specialist units in software development and applications. This is in response to local employers from the construction industry.

3.1.4 All of the colleges inspected offer the National Diploma course in computing or the AVCE in ICT. They provide students with a progression route to higher education programmes. The National Diploma has essential and optional units in

mathematics to ensure students have suitable levels of attainment in mathematics on entry to the higher education courses, particularly in software engineering. In contrast, only one college offers the AVCE in ICT which includes a unit in mathematics. Students on the AVCE in ICT also select, as an additional study, an AVCE single award in another vocational area or a GCE A level subject. Two colleges provide National Diplomas in engineering with specialist units in computing and microelectronics. There is little provision for National Vocational Qualifications (NVQs) at level 3 in IT in the further education sector.

3.2 RECRUITMENT AND SELECTION

3.2.1 The level of recruitment in software engineering is low across the further education sector. In 1999, there were 108 full-time and 67 part-time students enrolled on software engineering programmes (Appendix, Table 1). They accounted for less than 0.2% of the total enrolments in all vocational areas, and for less than 1% of the total enrolments in the six priority skill areas which include computing, hospitality, catering and tourism, electronics, construction and manufacturing engineering. (Figure 1). These six skill areas have been identified by the T&EA as vitally important to the Northern Ireland economy. There are very few enrolments to software engineering programmes below higher education level. Three colleges provided higher education programmes in software engineering for the first time in 1999. Although figures supplied by the colleges show that enrolments increased to 216 in the year 2000, no college providing the HND in software engineering achieved its target recruitment level (Appendix, Table 2). Of the 140 additional places made available by DENI in 1999, and the 68 places that had already been allocated in 1998, for full-time higher education programmes in software engineering, only 131 were filled. The uptake for the additional full-time places in software engineering, awarded to colleges under the Chancellor's

Initiative Skills Fund, was also low; only 43 out of the 83 places awarded were filled. Approximately 90% of the students on the higher education programmes in software engineering are men and are young people from 18 to 21 years of age. Enrolments on the one-year 'fast-track' HNC in software engineering are excellent and are mainly adults.

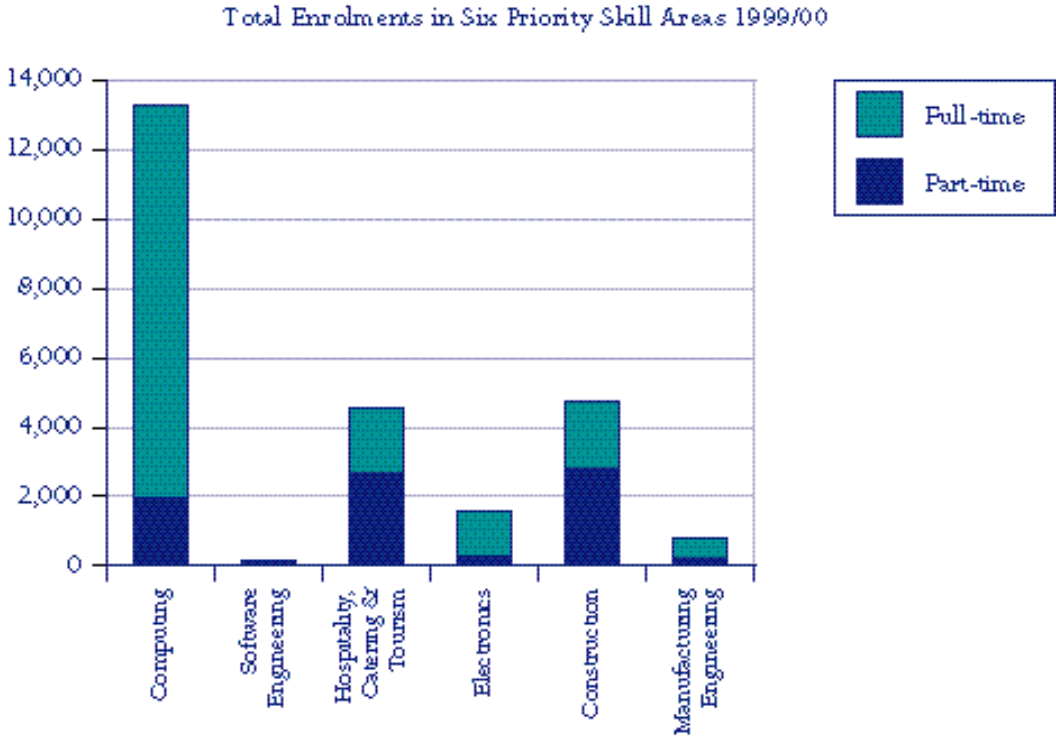


Figure 1

3.2.2 Over the past three years, there has been a large increase in the number of enrolments to computing programmes; from 1314 in 1997 to 1940 in 1999 for full-time students, and from 6669 to 11357 for part-time students. These account for 15% of the total enrolments in the further education sector and for 50% of the total enrolments in the six priority skill areas (Figure 1). Recruitment to the HNDs in computing, including those franchised from the University of Ulster, and in business information technology is generally good. Approximately 70% of the enrolments on the higher education programmes in computing are men. Figures supplied by the colleges for the academic year 2000/01 show that there are a total of around

800 enrolments for higher education level programmes in computing and business information technology (Appendix, Table 3).

3.2.3 The three colleges offering HNDs in electronic engineering with specialist units or additional industrial-standard proprietary qualifications in software engineering have a good level of recruitment. During the evening classes, the enrolments for adults wishing to retrain or update their skills using the proprietary qualifications are excellent. There is an excellent level of recruitment in one college which provides a one-year 'fast-track' HNC in telecommunication engineering. In two colleges, there was no uptake for the specialist full-time higher education programme in software systems and electronics.

3.2.4 Almost all colleges have introduced AVCEs in ICT over the past three years, and in most, it has replaced the National Diploma in computing. There are excellent levels of recruitment to these AVCE programmes (Appendix, Table 4). Over 80% of the students taking the AVCE in ICT also select, as an additional study, the AVCE single award in business. This inhibits, however, the progression of these students to higher level programmes in software engineering. Only two colleges provide, as an additional study with the AVCE in ICT, an AVCE single award in engineering to give students a suitable progression route to higher education programmes in software engineering. Approximately 80% of the students achieving National Diplomas progress to higher level programmes in software engineering or computing. In two colleges, there are excellent levels of recruitment to the National Diplomas in electronic engineering which have specialist units in software engineering. These courses allow students the choice of progressing to higher level programmes in electronics or software engineering. Approximately 10% of students progress from GCE A levels to the HNDs in software engineering. A minority of students are recruited to the

National Diploma or AVCE programmes with less than GCSE grade C in English and mathematics. Almost all students are young people aged between 16 and 19 years of age, the majority are men.

3.2.5 The majority of colleges select students for higher education programmes in software engineering on the basis of the information in their application forms; only a minority carry out interviews with prospective students. Most students report that they were given little information and guidance when deciding which of the pathways in computing to select, particularly on the career opportunities available to them in the software industry sector. Many students on the AVCE in ICT were not content about the level of guidance they received when selecting the single award AVCE as their additional studies, particularly on how this affected their opportunities for career progression. During the survey, a significant minority of students on the computing, and business information technology programmes reported they did not select software engineering because they considered it too technical and mathematical, and required working in an uninteresting environment. Women account for about 10% of the students recruited to the higher level programmes in software engineering compared to 25% of the students in computing and 55% in business information technology. They do not have a clear understanding of the demands, challenges and benefits of studying higher level programmes in software engineering, and most of them select business information technology as a first preference. Most colleges have not reviewed their recruitment and selection procedures to ensure they do not inhibit women from selecting software engineering programmes.

3.3 CAREERS INFORMATION AND GUIDANCE

3.3.1 The marketing of software engineering by almost all colleges is inadequate. Students report that they received little

information on the provision for software engineering across the further education sector. Most learned about their higher education programmes in software engineering when they studied on National Diploma computing or AVCE ICT programmes, through informal contacts, or by general enquiries at enrolment times. Few students were aware, for example, that two colleges offered a specialist higher education programme in software systems and electronics. Most students also reported they received limited information and guidance on career opportunities in software engineering before leaving school and during enrolment in colleges. There is a need for careers advisors in schools and colleges, employers, parents, students and the public to receive better advice on software engineering. This should inform and guide students on the higher education qualifications on offer, the range of available job opportunities, career progression routes, and the technical skills and personal attributes required in software engineering.

3.3.2 In general, students have a poor understanding of the combination of competences and interpersonal skills required to work successfully in the software engineering industry. Colleges lack of a set of occupational standards, which outline the range of technical, transferable and interpersonal skills required to work competently in the software engineering industry. This inhibits the quality of the careers information and guidance provided for students.

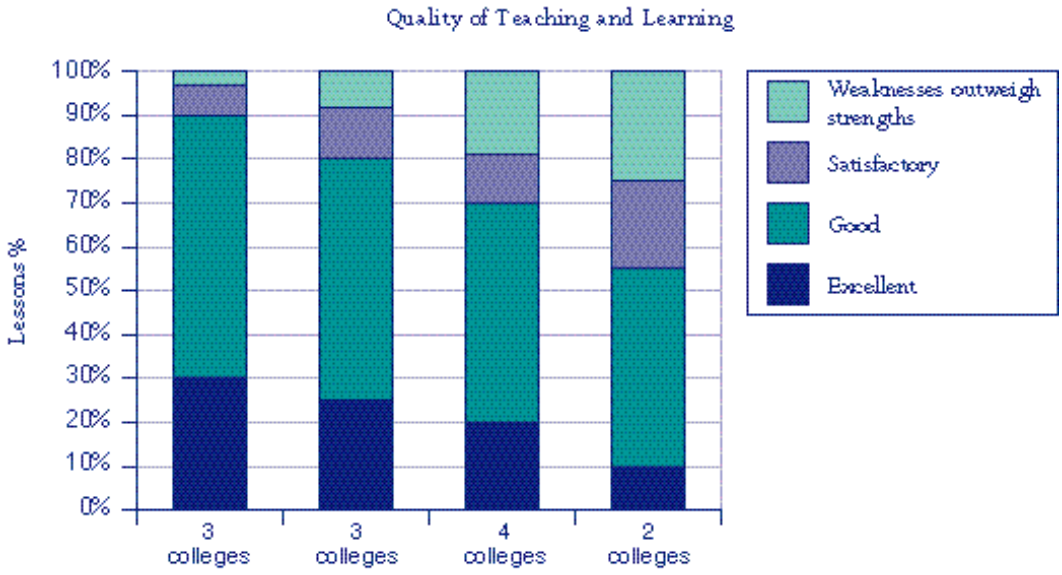
3.3.3 Only a small number of women study higher education programmes in software engineering. Most, who selected higher education programmes in computing or business information technology, reported that the careers education they received in their schools did not inform them of the job prospects and progression routes available in software engineering. They also reported that, during recruitment time in the colleges, they did not consider software engineering because they considered it too difficult an option, and were

given minimal guidance by lecturers. In one college, where women members of staff interviewed all prospective students for computing related programmes and explained the job opportunities available across the various options, the recruitment level of women to software engineering was much higher, at 25%, compared to the average of 10%.

PART 4

4.1 TEACHING AND LEARNING

4.1.1 The quality of teaching and learning varies considerably between and within the colleges. It ranges from good to excellent in over 90% of the lessons in three colleges, in about 80% in three, 70% in four and 55% in two (Figure 2). In half of the colleges, the weaknesses significantly outweigh the strengths in about 25% of the lessons. In the remaining colleges, there are significant weaknesses in only a small number of lessons.



Programmes inspected across 12 colleges: HNDs and/or HNCs in software engineering, computing, business information technology and electronics/ telecommunication engineering; National Diplomas in computing and AVCEs in ICT; industry-standard proprietary qualifications.

Figure 2

Overall across the colleges, 25% of the lessons were excellent, 40% good, 15% satisfactory and in 20% there were significant weaknesses (Figure 3).

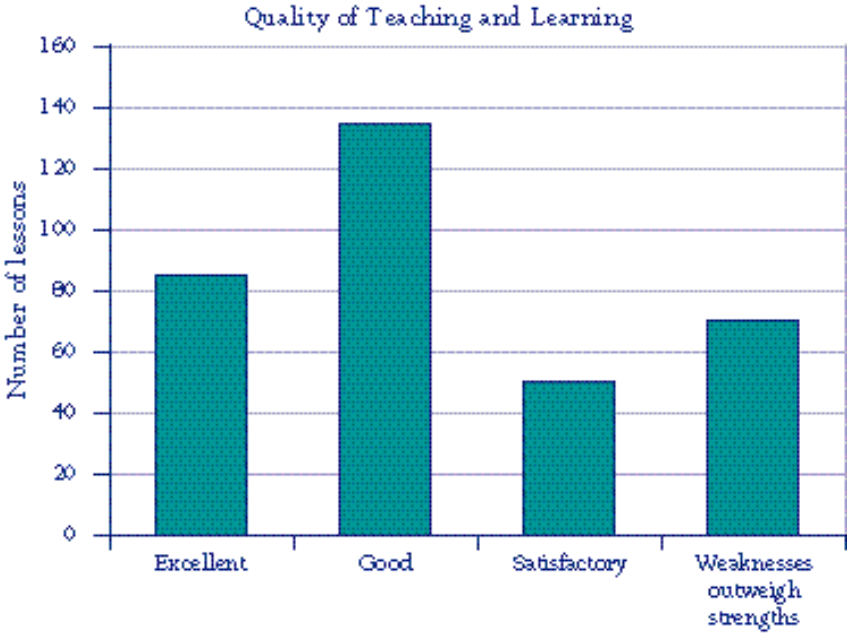


Figure 3

4.1.2 The students on the HND programmes in software engineering, computing and business information technology study common units in computing which provide good opportunities to develop relevant knowledge, understanding and skills in computer systems, network installation, quality management, implementation of data modelling techniques, and information processing. In the majority of lessons across all colleges, a variety of teaching and learning approaches are used to motivate the students, including theory sessions, practical exercises, project work, case studies, assignments and tutorial support. The majority of lecturers have a good level of expertise in computing which they use well to prepare appropriate practical activities in programming methods. They set clear learning objectives, and expect high standards of work from the students. The students are encouraged to investigate and evaluate new hardware and software developments and to fully engage in their own learning. They

also learn to use operating systems to create customised operating environments. There are good opportunities to develop programming methodology and to perform coding including testing programs to meet a specification. Arrangements for assessment of the student's progress are implemented effectively in most colleges. Their work is checked regularly, and they are given appropriate feedback on their achievements.

4.1.3 A minority of lessons are not well planned and organised, and do not sufficiently challenge the students. The lecturers use a narrow range of teaching approaches which have an over-reliance on reading from books, copying notes from overhead slides and undertaking routine and undemanding practical tasks. They rely too much on whole-class teaching, do not sufficiently motivate the students, and do not take account of their different capabilities and levels of prior attainment in computing. The students are given too much information without sufficient opportunity to engage in discussion, and they are not encouraged to take initiative or to co-operate in groups. As a result, the students passively respond to their tasks and do not participate fully in their learning. In the practical sessions, a minority of lecturers do not set and expect high standards of work from the students, and provide insufficient feedback on their progress. They do not have sufficient competence in computing and software engineering to prepare good quality learning materials, particularly in modern programming methods and languages.

4.1.4 Only two colleges provide students on the higher education programmes in software engineering with an appropriate range of optional units including software engineering techniques and object-orientated programming. The students benefit from essential learning experiences in specialist areas of software development which are needed to work successfully as a software engineer. In these colleges, the majority of lecturers are competent in software development,

and devise a wide range of tasks which are relevant to the needs of industry. They provide the students with good opportunities to engage in relevant and purposeful practical exercises which are effectively integrated with the theoretical learning. In four colleges, the learning materials are available to students on an Intranet. Software development is given a high priority, and there is excellent support for the students to develop programming skills in important languages including Visual Basic and Java. In the practical exercises, the students work independently and co-operate in groups to develop important problem-solving skills. In the majority of colleges providing higher education programmes in software engineering, the students study a narrow range of specialist units which do not provide the full breadth of knowledge and skills in software development needed to work competently in industry. The HNDs in computing and business information technology provide students with a limited range of learning experiences in software engineering. In three colleges, there is little difference between the optional units provided for students on the HND pathways in software engineering, business information technology and computing. Although, the optional units provide the students with good opportunities to develop competence in database design, human computer interfacing, and multimedia and Internet development they do not focus sufficiently on software engineering techniques. As a result, the students have limited experiences in the use and application of relevant programming skills for software development. The opportunities for problem-solving are also limited, and students do not engage in industrially relevant assignments and project work.

4.1.5 The quality of the projects provided for the students in software engineering is satisfactory in three colleges, good in one and excellent in two. In the excellent practice, the project work provides the students with opportunities to integrate the skills and knowledge they have acquired and to produce a

software-based solution to a realistic problem. Only two colleges use work-based problems which allow the students to plan their work under the normal pressures of the workplace. Most lecturers in these colleges have up-to-date industrial experience, and have a high level of skills in software development. They encourage the students to work in teams to produce practical solutions to problems, and to develop the interpersonal skills needed to work successfully in industry. The students in two colleges make good use of industry-standard project management software and computer-aided software engineering tools to enhance the management, design and presentation of project work. In three colleges offering software engineering, the lecturers have limited experience of modern software industrial practice, and provide the students with projects that lack challenge, normally uncomplicated coding problems involving relational database solutions. In two of these colleges, there is little difference between the projects in software engineering and business information technology. They provide few opportunities for the students to co-operate in groups and to use their initiative in evaluating and selecting alternative solutions to the problem.

4.1.6 The quality of the teaching and learning in the AVCE ICT and national diploma in computing programmes is good or better in about 70% of the lessons across the colleges. In the best lessons, the students are provided with a well balanced programme of practical and theory work. The practical tasks are planned thoroughly by the lecturers, and provide the students with good opportunities to use software application packages for creating databases, designing interactive web pages, spreadsheet modelling, multimedia presentations and manipulation of computer graphics. There are also good opportunities to develop to an appropriate level, the technical knowledge and understanding of computer communications and networks, operating systems and systems design. In a minority of lessons, the learning exercises are not well

planned, and do not provide the students with sufficient challenge. The work is routine, and the students have little scope to generate their own ideas to the solution of problems. The students on most national diploma programmes benefit from good experiences in modern event-driven programming languages such as Visual Basic. In two colleges, the students use an out-of-date programming language. The students on most AVCE programmes have few opportunities to develop an appropriate range of skills in programming. This inhibits their progression to higher education programs in software engineering.

4.1.7 In two colleges, the students on the HND software engineering programmes also study industry-standard proprietary qualifications which provides them with a wide range of additional learning tasks. Students are provided with high quality online learning and assessment using the Internet, and engage in well-planned hands-on practical exercises. For example, the Cisco Networking Academy Programme teaches students to design, build and maintain computer networks, and covers a broad range of topics from basic networking skills to advanced troubleshooting tools. They have excellent opportunities to develop and apply their knowledge and understanding of modern software and hardware techniques to solve a range of problems while working on modern industry systems. Proprietary qualifications complement effectively the HND in software engineering particularly by providing students with additional competences in the application of hardware systems. They provide students with wide scope to use their own initiative and to extend their skills in software engineering. In addition, students consider their job prospects are significantly improved if they apply to industry with up-to-date specialist skills provided by proprietary qualifications.

4.1.8 The quality of the teaching and learning is good in almost all of the lessons on the HND and HNC engineering programmes

in electronic/telecommunications which have specialist units in software engineering. Lecturers plan and prepare challenging learning tasks mainly in Visual Basic or website management and create a supportive learning environment in their classes. Students have excellent opportunities in their assignments to develop software for electronic/ telecommunication applications. They engage in problem solving activities using up-to-date software techniques, and extend their knowledge and understanding of software systems. In addition, the students develop software for microprocessor based systems and programmable logic controllers using appropriate programming control languages, and further improve their competence in software development. The experiences in software development are integrated effectively with the work in electronics, the students are motivated and respond at an appropriately high level. The majority of colleges providing HNDs and HNCs in engineering, however, do not offer the students optional units in software engineering. As a result, they have few opportunities to develop the skills in software development which are in high demand from the new emerging technologies industries.

4.1.9 The quality of the teaching and learning on the HND in the built environment with IT is excellent. The programme is well balanced, with vocationally relevant units in software and the built environment. Students are provided with a wide range of opportunities to develop and apply software relevant to the needs of the local construction industry. The expectations of the lecturers are high, and the work is demanding. They have good expertise in the use of software, and devise well planned assignments in the built environment to motivate the students. The learning tasks provide the students with good experiences in networking and web page design.

4.1.10 In most colleges, the higher education programmes in software engineering provide few opportunities for the students to

develop their interpersonal skills to the level needed to work effectively in industry. Only two colleges provide the students with work placements which are well matched to the learning experiences on the HND in software engineering, and which develop effectively the students' personal attributes and team working skills. The employers work with these colleges to ensure the students engage in suitably demanding work-based tasks and develop the confidence needed for the workplace. There is excellent scope for the students to work with others and to develop effective working relationships. The students appreciate the opportunities provided by good quality work placements, and most are keen to develop the personal skills essential to effectively working in the software industry. Although, the students on the HND in computing franchised programme are provided with a sandwich year in industry, the work placements are generally with public service bodies which do not provide the normal pressures of modern software industries. As a result, there are insufficient opportunities for the students to develop the full range of personal skills needed to work in commercial software development.

4.1.11 On most AVCE courses in ICT and National Diplomas in computing, there are weekly timetabled classes in communication skills. The students on the AVCE courses work towards the achievement of the key skill at level 3 in communication, and those on the National Diploma courses work towards the common skill in communication. The majority are provided with good opportunities to respond to and present written and graphical information in relevant vocational contexts. In the best practice, the lecturers mark the students' work rigorously, identify weaknesses and suggest how they can improve their communication skills. In a significant minority of lessons, however, the communication lecturers prepare discrete tasks which are not well integrated into the vocational units, and do not provide the students with challenging learning experiences. There are limited

opportunities for students to participate in formal discussion and to develop the ability to work and co-operate in a team.

4.1.12 Most colleges do not have a coherent plan for the development and assessment of the students' communication skills to higher education level in software engineering. The lecturers deliver the units in software development using practical activities and theory sessions which provide little scope for the students to develop their communication skills. Insufficient account is taken of the students' prior achievements and capabilities in communications, and there is little feedback on their progress towards developing the skills needed to communicate effectively as software engineers in the workplace. In two colleges, classes in life skills provide the students with a wide range of activities including visits to industry, talks from visiting speakers and preparation of job applications. They provide, however, few opportunities for the students to engage in discussion, debate, make presentations or to give sustained responses to questions. The students on the HND in computing programmes, franchised from the University of Ulster, study a unit in communication and professional issues. The students engage in vocationally relevant activities including well structured presentations, writing minutes of meetings and evaluation of research findings. In general, the work is challenging and provides good opportunities for most students to improve their skills in communications to the level expected by the computing industry. In one college, the students benefit significantly from the provision of an additional unit in computer-based technical report writing. They use effectively a wide range of advanced presentation techniques to enhance project work and assignments to a professional standard. Most of these students are able to use the advanced features of software applications to produce high quality technical documentation and reports.

4.1.13 The quality of the provision for students to develop competence in using an appropriate range of skills in mathematics within software engineering programmes varies considerably between colleges. Timetabled classes in mathematics or quantitative studies are provided for all students on national diploma programmes in computing. In most colleges, the quality of the teaching is good. The students are provided with challenging learning activities across a broad range of mathematics and work towards the common skill applying numeracy. They are encouraged to use and apply mathematical techniques in relevant vocational contexts, and are expected to achieve high standards in their work. The majority of students on the AVCE programmes in ICT make satisfactory progress in improving their use and application of number to level 3. In general, lecturers plan and prepare their work well, and set the learning activities in vocational contexts. On occasions, however, they use a limited range of teaching approaches, and do not take account of the wide range of the students' abilities in mathematics. As a result, a minority of students who enter AVCE courses with poor levels of achievement in mathematics do not develop their competence in application of number to an appropriate level. Only one college provides students on the AVCE course with an optional unit in mathematics which enhances their progression to higher education programmes in software engineering.

4.1.14 Three colleges have an effective strategy for the development and assessment of mathematics on higher education programmes in software engineering. They provide students with a choice of the optional units, mathematics for software engineering and discrete mathematics. One college has amended these units to ensure the students are able to progress on to the software engineering or computing degrees in both local universities. The quality of the teaching ranges from excellent to satisfactory and is mainly good. In the best lessons, the lecturers use well planned learning tasks to

provide the students with good opportunities to develop appropriate mathematical skills to the level required by software engineers. They set high standards of achievement for the students, monitor what they have learnt, and provide effective feedback where necessary. A minority of students enter, however, their programmes with a poor understanding of algebra and trigonometry, and do not develop the mathematical concepts and techniques needed to work successfully in software engineering. In particular, they have difficulty applying the fundamentals of formal methods including transposing matrices, vector addition and inverse transformations. As a result, they are passive in class, and their pace of work is slow. A small number of lecturers do not plan and organise their work to ensure the less able students have the opportunities to cover all of the content of the optional unit in mathematics for software engineers. In three colleges offering the HND in software engineering, the students do not study mathematics for software engineering, and have few opportunities to develop relevant mathematical skills in the specialist units in software development.

4.2 STANDARDS AND OUTCOMES

4.2.1 The standards achieved by students in software engineering vary considerably across the colleges. In two out of the six colleges providing HNDs in software engineering, the students develop a good range of competences in software development at higher technician level, and have the confidence to progress to employment in the software industry. Students in one other college develop a satisfactory range of competences, but few achieve the level of interpersonal skills needed to work confidently in the software industry. In three colleges, the students achieve competence in only a limited range of software development skills. Few develop the ability to work as part of a team and have the confidence to progress to employment in industry.

4.2.2 In all colleges, there are excellent relationships between most lecturers and students. The lecturers provide students with good support and encourage them by providing appropriate responses to their work. A minority of lecturers, however, do not expect and receive high standards from students, and do not respond appropriately to their work. As a result, the students are not motivated during lessons, and are not clear about the standards required by industry.

4.2.3 Most students on the HNDs in software engineering, computing and business information technology achieve good standards in the common units in computing. They develop a broad knowledge and understanding of the theory and concepts of computer systems including architecture, storage, and a wide range of peripheral devices. They are able to use and apply their knowledge and understanding to specify competently, plan and implement standard computer, telecommunications and network systems. In one lesson, the students worked in groups to produce comprehensive and accurate multimedia presentations of a specification for a realistic client-server network. Almost all students can use effectively the advanced features of software applications such as spreadsheets and relational databases to implement basic data models and generate meaningful reports. The majority are able to evaluate effectively the application of information systems in industry and commerce. They do not have, however, sufficient practical expertise to plan and set up complex computer networks, including the selection of appropriate server configuration, installation of the operating system and other software applications, provision of security, and the customisation of the network to support a variety of users.

4.2.4 The students in software engineering and computing programmes, in most colleges, develop a wide range of skills in visual programming, mainly using Visual Basic. The standards of the students' work varies from satisfactory to

excellent, and is mainly good. Almost all the students understand the different data types and data structures in visual programs, and are able to create and customise visual objects such as forms, buttons, menus, frames and dialogue boxes, and can interface a visual program with relational database tables. The majority can use appropriate design techniques to produce solutions to problems involving the use of selection, repetition, arrays and subprograms. Only a minority of the students make good use, however, of the advanced features of visual programming such as simple animation, and the development of Internet applications.

4.2.5 In two colleges, students on software engineering programmes display a sound knowledge of the basic concepts and techniques of object-orientated programming. Most students competently create programs, and are able to solve basic problems in Java using programs which implement switch statements and error-handling routines. Only a small number of the students are able, however, to use Java to create animations or implement a graphical user interface and for software engineering project work. A minority of students lack an understanding of important programming concepts such as control flow statements and the programming of data structures, and demonstrate limited competence in the programming units.

4.2.6 Most students develop good website design and management skills. They have good expertise in hypertext marking language (HTML) coding and web authoring applications, and are able to plan and create websites of a generally good standard. Only a minority of the students have achieved extensive HTML and JavaScript development skills, and are able to design websites of a professional standard. The majority of students demonstrate sound technical skills in the use of lists, tables, frames, and images to create web pages, and are aware of the main graphics formats used in web design. In three colleges, the students are able to add complex interactive

elements to their web page designs, and can create on-line data entry forms. In two colleges, the students use animations to enhance the presentation and functionality of web pages. In addition, the students use JavaScript well to design event-handling features which enhance web pages. While most of the website design work is of a good technical standard, the majority of students lack the communication skills needed to convey the visual display effectively to the intended audience.

4.2.7 The standards of the students' project work in software engineering is good or better in three colleges, and satisfactory in the remainder. In the best practice, the students use their systems design and programming skills to analyse, design, code, test and document realistic software and e-commerce applications. They have developed project-management skills to a good level, including the use of modern software tools to support planning and track their progress. The students produce technical documentation of a high standard, and are able to create and implement rigorous testing strategies. Most of the students implement effectively a wide range of complex programming routines, mainly in Visual Basic or Java. The students' project work in three other colleges, however, lacks complexity in terms of software design, and is not to a high standard. It consists mainly of simple relational database solutions with a user interface coded in Visual Basic.

4.2.8 Almost all the students on the HND in the built environment and IT achieve high levels of competence in the use of computers systems, and the development of specialist software for the construction industry. They are able to design and create good quality websites, a small number of which have been used commercially by local construction and architecture firms, and have a good knowledge of network installation and maintenance. During work placements, the students develop excellent relationships with their employers, and gain the

confidence to progress to employment when they complete their qualification.

4.2.9 The students on the HND programmes in electronic engineering, and on the HNC in telecommunications, produce good standards of work and make good progress towards acquiring the competences needed to work at higher technician level in industry. They develop and use a range of software engineering techniques including software for controlling microcomputer-based systems and object-orientated programming concepts. Good standards of design capability are achieved by most students in their projects, and they are able to carry out appropriate test procedures on hardware and software, and diagnose faults. Most students attain a suitable level of mathematical competence needed to solve realistic engineering problems. Written and oral reports on assignments and projects are logical and well presented. Graphical communication techniques are used effectively in practical tasks, and are to a good technical standard. The students enrolled in the industry-standard Cisco Networking Academy Programme achieve competence in network design, construction, maintenance and diagnosing problems. They also acquire the ability to manage effectively their own learning through an Internet-based programme.

4.2.10 The standards of work produced by most students on AVCE ICT and national diploma computing programmes are satisfactory or better, and are generally good. The students have a good knowledge and understanding of the hardware and software components of computer systems and networks, and can apply appropriately the principles of systems analysis and design to solve simple problems. They also have a good understanding of database concepts and structures, and apply this well to implement, test and document relational database tasks. In addition, almost all students have well developed practical skills in the use of web authoring tools and HTML coding, and most can plan and create good quality websites.

The majority of students have the competence to install, configure and test new hardware and software, including the customisation of operating systems. They also use the complex features of spreadsheets, including macros, links, data entry forms and data validation, and are able to implement spreadsheet models to meet a specification. Most students on national diploma programmes develop programming skills to a good standard, mostly in industry standard visual programming languages. These students are aware of the basic concepts of program design, and are able to use a range of programming tools to produce solutions to given problems. In contrast, only a minority of students on the AVCE ICT develop a suitable range of programming skills using relevant languages.

4.2.11 In most colleges, the average rates of retention of the students on the full-time HND and part-time HNC programmes in software engineering are poor. Over the last three years, they ranged from 0% to 59%. In two colleges, the average retention rates of the students on the full-time programmes ranged from modest, at 66%, to satisfactory, at 73%. Over the same period, the average rates of retention of the students on part-time HNC programmes in two colleges ranged from satisfactory to good; from 71% to 82%. The average retention rates of the students on the HND electronic engineering programmes are satisfactory at 78%. On level 3 programmes, the average retention rate ranged from modest to good across the colleges inspected, and in the main is satisfactory. Over the last three years, it ranged from 65% to 84%.

4.2.12 In the two colleges, over the last two years, where students have completed their HNDs and HNCs in software engineering, the average rates of success ranged from good to excellent; from 80% to 100%. Over the same period, the average rate of success for students on level 3 programmes was good at 82%. The average rates of success of the part-time students who have completed their programmes ranged from

satisfactory to good; from 75% to 84%. The majority of students have good records of attendance and punctuality.

4.2.13 Approximately 75% of the students who successfully complete their HND programmes in software engineering progress to degree programmes, usually in computing. The remainder progress to employment usually in computing. In contrast, approximately 75% of the students who successfully complete their HND programmes in electronics progress to employment in industry.

PART 5

5.1 RESOURCES AND ACCESS ARRANGEMENTS

5.1.1 An evaluation of the range and quality of the ICT infrastructure to support teaching and learning in software engineering was carried out in all colleges. Information was collected on the availability and standards of the computers being used, the capacity, extent and performance of the college computer networks, Internet connectivity and communication systems, and access arrangements for staff and students.

5.1.2 Over the past two years, the Government has invested significant funds in colleges of further education to develop their ICT provision and to upgrade their infrastructures and computer systems. In the majority of colleges, the range and quality of computing resources are now good. The students on almost all AVCE ICT, computing and software engineering programmes have good access to high specification computers, modern programming languages, and industry standard web authoring tools and software applications. The ratio of full-time-equivalent students (FTEs) to networked computers ranges from 3:1 to 10:1, with an average of approximately six FTE students for every computer. Five colleges provide more than one networked computer for five FTE students.

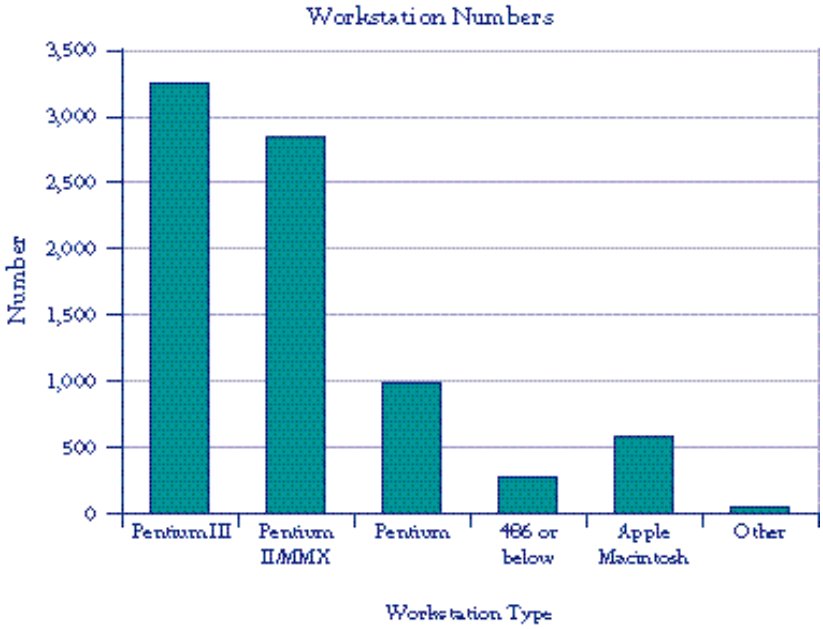


Figure 4

5.1.3 PCs make up about 96% of the computer stock in colleges. Approximately two-thirds of the PCs are up-to-date high specification computers, at least Pentium II/MMX standard (Figure 4). Around 30% of the computers in use, however, are older PCs. In five of the colleges, these older computers represent over 40% of their total computer stock. In contrast, in three colleges up-to-date computers make up more than 90% of total computer stock.

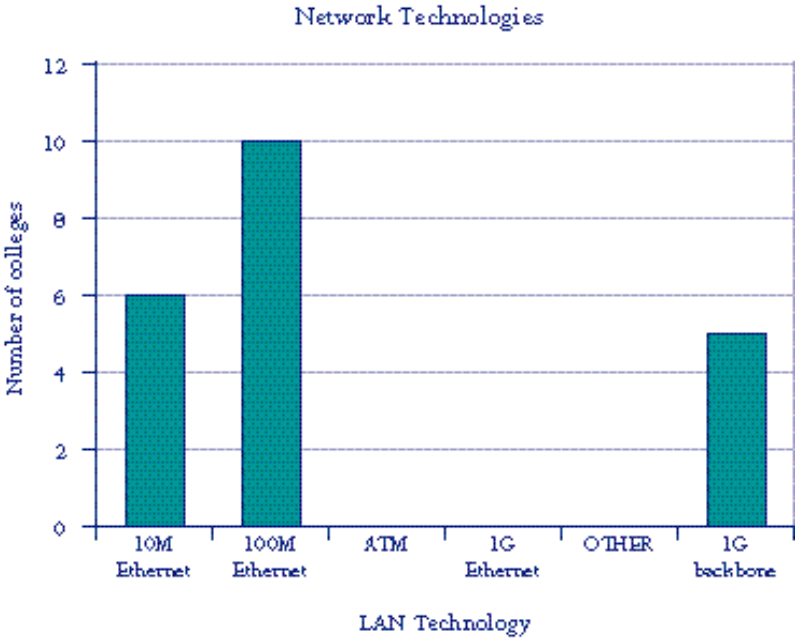


Figure 5

5.1.4 All colleges make use of local area networks of varying extent and capacity. Around 87% of the overall computer provision is networked. Fast Ethernet (100Mbps) network cabling connections are used by ten colleges, half of these have also installed gigabit backbone infrastructures (Figure 5). The remaining colleges make use of 10Mbps Ethernet technology. The performance of existing local area networks at current levels of demand is perceived to be good or better by all the colleges, eleven report that their networks always work smoothly (Figure 6). Six colleges have implemented fully integrated network infrastructures, and a further seven have linked network infrastructures in place. In contrast, three colleges have separate local area networks in operation, with no links between them. Almost all colleges have multiple sites, the majority use permanent connections such as leased line or cable to connect these remote sites to their computer networks.

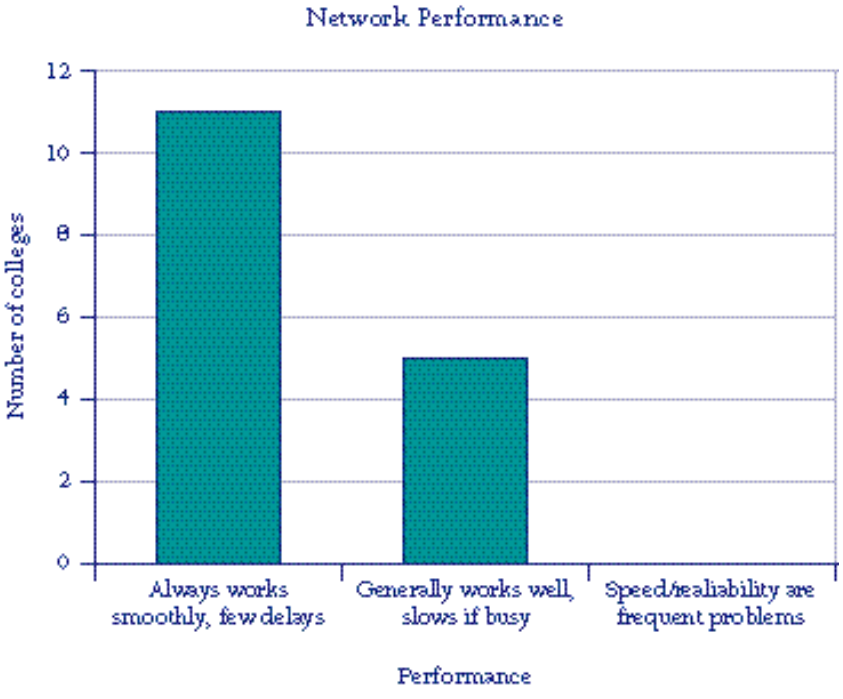


Figure 6

5.1.5 The proportions of staff and students with access to college networks varies greatly. Only a minority of students on

computing and software engineering programmes have been assigned network user identifications and passwords; the majority of them rely on floppy discs to store and backup files. In three colleges, almost all students have been assigned network passwords and storage space on the college networks (Figure 7). This facilitates the tracking of student activity, enables lecturers to place files in students' folders, and gives them access to saved work on any networked workstation, including those in open access areas. In contrast, in four colleges no students have been assigned network passwords or storage space. While 12 colleges have Intranets in operation, many of these are at an early stage of development and of limited benefit in supporting students' learning. Only four colleges make effective use of Intranets to support learning on higher education computer and software engineering programmes. In these colleges, the students have flexible access to learning materials, lecturer notes and multimedia presentations, assignments, unit specifications and links to relevant technical Internet sites.

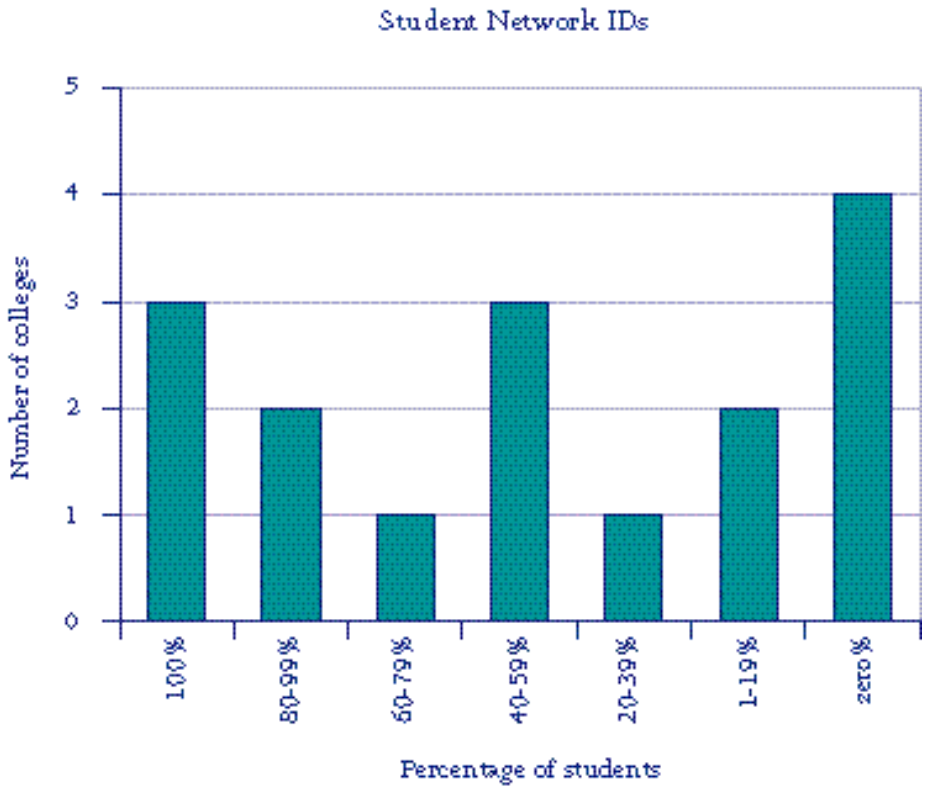


Figure 7

5.1.6 Almost all networked computers provide students with access to the Internet. All colleges have broadband leased line connectivity provided by UKERNA with JANET as the Internet service provider. Four colleges have a 2Mbps connection, three have a 1Mbps connection and the remainder have 512Kbps connections. Only one college reports that the JANET Internet connection does not meet current demand, eleven colleges are not using all the bandwidth available and for the remainder, the connection is meeting demand for Internet services although working at capacity (Figure 8). A small number of colleges are not making effective use of the JANET connectivity and still rely on ISDN connections to individual networks within the college. All the colleges have written Internet user policies in place.

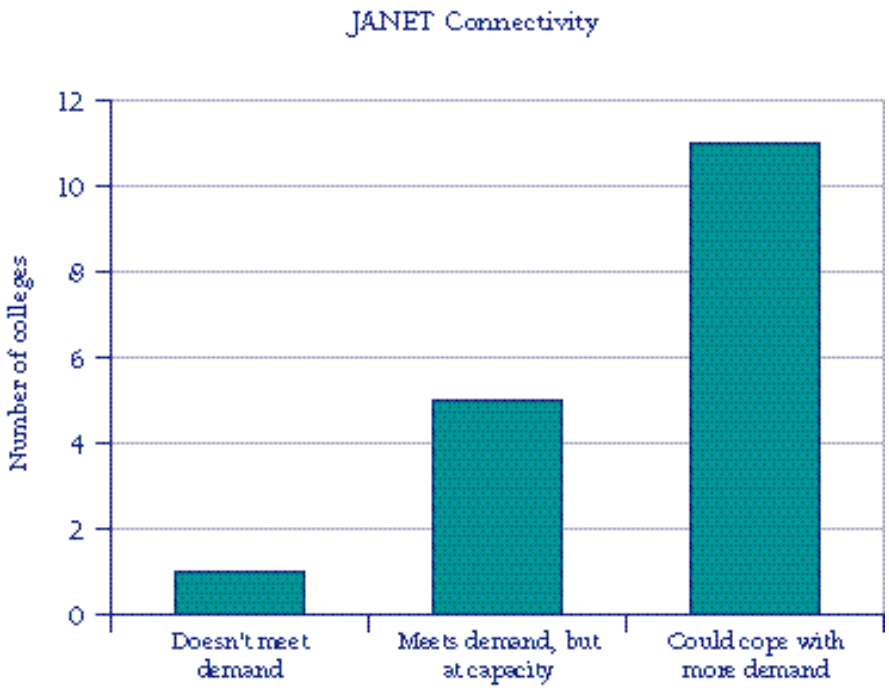


Figure 8

5.1.7 A significant minority of students make effective use of the Internet to support development of programming and web design skills. These students access technical websites which offer good on-line information, sample coding and tasks to support the development of competence in object-orientated

and event-driven programming languages such as Java and Visual Basic, and also web authoring skills in HTML and JavaScript. Only three colleges provide internal e-mail accounts for students, the majority of them still rely on Internet based e-mail service providers. In contrast, 14 colleges provide internal e-mail accounts for staff. Two colleges do not have a college website.

5.1.8 All the colleges use a range of technology-based equipment for supporting teaching and learning on computing and software engineering programmes. Despite significant levels of investment in ICT resources, only a minority of lecturers regularly use data projection equipment and presentation software to support learning and teaching. In the majority of colleges, the integration and use of the Internet and CD-ROM materials to enhance teaching strategies is underdeveloped. In those lessons where data projection equipment is used effectively, the students benefit from detailed demonstrations of programming functions and concepts, and become more involved in class discussions and interaction with peers. Further, the lecturers work well with small groups of students to extend learning or to provide support for students experiencing difficulties with any concept or task.

5.1.9 While all the colleges provide open access facilities during weekdays, twelve provide access during weekday and evening sessions and two provide access on Saturday mornings. There is a high level of demand for access to computer facilities in the colleges, and computer rooms and open access area utilisation rates are high. The number of computers available to students in open access areas varies considerably across the colleges. Around 12% of total college computer stock is located in open access areas. In half the colleges, however, less than 10% of the total computer stock is in open access areas. In contrast, in three colleges over 20% of computers are placed in open access areas. In a small number of colleges, the computing and software engineering students have insufficient access to specialist software and programming

languages in the open access areas. As a result, the students in these colleges are unable to use effectively the open access areas to engage project work and other learning activities, for example, programming work in Java or Visual Basic.

5.1.10 The quality of specialist teaching accommodation for computing and software engineering programmes varies across and within colleges. In most colleges, the specialist computer rooms are equipped with furniture designed for computer work, appropriate carpets, blinds, and trunking for electrical and data cables. The staff and students would benefit, however, from improved layout of specialist computer rooms; often the staff have inadequate access to the students' workstations, and in most specialist rooms there is insufficient space for the students to undertake paper-based design work away from the machines. In a small number of colleges, the students are constrained by outdated hardware, and are located in rooms with poor layout of workstations, unsuitable furnishings and inappropriate lighting. In these colleges, more attention should be paid to providing a comfortable and stimulating working environment for the students. In five colleges, there are well-equipped laboratories where the students can undertake hands-on practical work such as the design and installation of a variety of network infrastructures along with relevant switches, hubs, routers and PC hardware components and cards. In seven colleges, however, access to computers for practical hardware-related tasks is limited. As a result, the students have few opportunities to install hardware and software components as well as design and implement more complex computer network configurations.

PART 6

6.1 COLLEGE/INDUSTRY LINKS

6.1.1 Most colleges have weak links with the software industry including the Software Industry Federation. Only a small number of lecturers collaborate effectively with employers to determine their training needs, and to develop a good understanding of modern industrial practice. Few colleges consult employers or the Software Industry Federation in the design and review of new programmes in software engineering. As a result, most students on software engineering programmes are not provided with relevant work-based tasks, and do not learn to apply their skills in the workplace. They do not develop the confidence needed to work competently with employers, and do not gain an understanding of employment. Almost all of the students on the HND franchised programmes in computing are placed in their second year with employers in the public service sector for workplace training. These students do not experience, however, the working environment of modern software industry, and do not gain practical experience of up-to-date software development techniques.

6.1.2 Only two colleges implement policies to ensure that effective links with the software industry are developed and maintained, and that relevant programmes in software engineering are delivered to industrial standards. They recognise, in their strategic planning, the need to identify and respond to the changing needs of the software industry. Lecturers establish strong links with employers through regular visits and identify good opportunities to provide students with high quality work placements. Employers are encouraged by the lecturers to visit their colleges to talk to the students, and to give them an understanding of the demands and benefits of careers in the software industry.

6.1.3 Only a minority of colleges recognise that the software industry does not have a clear understanding of the capabilities and potential of HND students in software engineering to work competently in software development and support services. These colleges are also aware that the software industry employs mainly graduates with degrees in computing or software engineering, and only a minority of employees are recruited with HNDs, usually for technical support jobs. They implement appropriate departmental policies to ensure staff organise their time effectively in order to establish good links with the local software industry. The staff have good opportunities to collaborate with employers, and to inform them of the competencies of students with HNDs, and also to market the software programmes. They also benefit through an improved understanding of the standards of work expected from the software industry and the career opportunities available to students.

6.1.4 Many software firms consider colleges of further education to have out-dated facilities, inflexible provision and an unwillingness to identify and meet effectively their training needs. Although all colleges have significantly improved their computing facilities and network infrastructures, most are not able to identify clearly the current and future needs of employers, and to meet them effectively. Only two colleges have and use staff with sufficient expertise to be able to carry out an effective analysis of the training needs of individual employers in the software industry based on a wide range of information collection techniques. Most colleges determine the training needs of industry largely on the subjective views of lecturers; these are generally based on superficial contacts, and are usually inaccurate. They do not use a set of occupational standards, which clearly outlines the interpersonal skills and competences required to work in software engineering, to identify effectively the training requirements of the software sector.

6.2 ADDRESSING NEEDS OF INDUSTRY

6.2.1 If colleges wish to identify and respond effectively to meet the needs of the software industry, they need to ensure they have sufficient suitably qualified staff and high quality resources to provide industry-standard programmes. Staff need the time to liaise with the software engineering industry, and should be able to forecast reliably future demand for and supply of appropriately qualified software engineers for their respective colleges. They also need to have the competence to carry out professional evaluations of the training needs of individual firms. Colleges need to respond quickly to industry's needs, and should have the expertise in software development to ensure suitable training courses are designed and delivered to a high standard.

6.2.2 In Northern Ireland, there are no colleges of further education which have centres of excellence in software engineering. This contributes to the software engineering industry's lack of understanding of the potential of non-graduates from colleges to work competently in software development or support services. It also inhibits the further education sector from improving its image with the software sector and forming effective links with individual firms. As the sector expands, the establishment of centres of excellence would enhance the quality of the software engineering programmes, and make the recruitment of students with HNDs more attractive to firms. Centres of excellence in software engineering must have competent staff and ensure there is scope for high levels of collaboration with local industry, particularly to address areas of skills shortage. They can also involve the software industry in the review and evaluation of the relevance of their curriculum in software engineering, and the standards achieved by students. Strong links between colleges and the software sector will ensure the sector is in a position to contribute, when required, to staff and curriculum development. In particular, the software industry can advise

the further education sector on the specific technical, transferable and interpersonal skills essential to work successfully in software development or support services. This includes the place of the industry-standard proprietary qualifications in enhancing the employability of students on HND programmes in software engineering.

6.2.3 Starting in 2001, Queens University and the University of Ulster will each lead two separate pilots to develop Foundation Degree models which will target areas of skills shortages including software engineering. The pilots involve local further education colleges and relevant industrial sectors, and will support the concept of lifelong learning and provide opportunities for progression to an honours degree. They are aimed at equipping students with the combination of technical skills, academic knowledge and transferable skills that employers are increasingly demanding. An essential feature of Foundation Degrees will be employer involvement in the design and review of the programmes, and the requirement for students to apply their skills in the workplace. To ensure their success in addressing the requirements of industry, colleges need to establish effective collaboration with employers who will provide students with appropriate experiences.

PART 7

7.1 STAFFING

7.1.1 In general, there are sufficient suitably qualified staff in most colleges to deliver courses in computing and ICT from basic to higher education levels. The majority of lecturers have degrees in computing-related subjects, and a minority have completed conversion courses from other subject areas. In most colleges, however, there is a shortage of lecturers with suitable qualifications and experience in software engineering. A significant minority lack the expertise to deliver effectively the new units in software development, and are not sufficiently competent to teach to a high standard. This includes departments of engineering delivering higher education programmes. About 70% of full-time lecturers, delivering software engineering and computing programmes, have at least 20 years teaching experience and most have little relevant industrial experience in software development. Less than 10% are 'new blood' appointments with up-to-date industrial experience. Part-time lecturers, with recent industrial experience, are used in a few colleges to deliver specialist units and to support the full-time lecturers. In general, colleges have difficulty in recruiting both full-time and part-time lecturers with specialist skills in software engineering. A number of lecturers who have left colleges to work in industry have not been replaced. In the majority of colleges, there is also a shortage of well-qualified technician support staff.

7.2 STAFF AND CURRICULUM DEVELOPMENT

7.2.1 In the past three years, approximately 50% of lecturers in departments of computing and 30% in departments of engineering have benefited from staff development programmes in software engineering. These include courses on software development tools such as Visual Basic and Java

which were delivered in the colleges by lecturers with appropriate expertise or at local universities. These staff development programmes went some way to meet the lecturers' needs, but did not ensure, however, they were fully competent to deliver higher education courses in software engineering to a high standard. The majority of colleges provide students with a narrow range of optional units, with few opportunities to engage in important experiences in software engineering techniques. In these colleges, there is a need to provide lecturers with staff development in a wider range of software development tools. Lecturers from six colleges have been seconded to industry for periods ranging from six to 12 weeks in the 'Lecturers into Industry' initiative. This initiative has provided excellent opportunities for lecturers to gain up-to-date industrial experience, and to ensure their teaching methods are relevant to the needs of the students. Three colleges which selected lecturers to participate in the initiative were unable to release them from their teaching duties because they could not find suitably qualified temporary cover. Only a minority of colleges have established appropriate procedures for the review and evaluation of the effectiveness of the staff development programmes in software engineering.

7.2.2 In most colleges, only small numbers of lecturers have benefited from curriculum development initiatives in software engineering. In two colleges, lecturers have engaged in curriculum development projects to develop software to provide students with relevant and challenging interactive learning materials in programming techniques. Curriculum development initiatives funded through the Department of Education Further Education Programme included, in 1999, a project in software engineering. This involved six colleges collaborating to produce CD-ROMs which allowed students to take responsibility for their own learning, and to work independently to develop their skills in manufacturing engineering.

7.3 MANAGEMENT

7.3.1 The senior management in two colleges implement clear policies and strategies to identify and meet the skill needs of the software industry. They reflect Government priorities aimed at promoting the concept of Lifelong Learning, and implementing the recommendations for education services and economic goals of Strategy 2010. Heads of schools and course co-ordinators, in these colleges, strongly support the development of programmes in software engineering, and manage them well to provide students with high quality teaching and to maintain industry-standards. Their roles and responsibilities are clearly defined, and they provide good leadership for lecturers involved with the delivery of the programmes. Priorities for action have been identified including the development of appropriate links with the local software industry, and the recruitment of new staff with suitable qualifications and experience in software development. Realistic targets and timescales have been set for the implementation of the strategic objectives. There are also effective channels of communication between the computing and engineering departments which facilitate a common approach to the delivery and quality assurance of software engineering programmes. Appropriate procedures have been established to monitor and evaluate the relevance of the provision and the standards of the students' work. The ICT infrastructure, computing facilities and access arrangements are co-ordinated and utilised effectively to support teaching and learning.

7.3.2 Two colleges have made a good start to devise written policies and strategies for software engineering, and are at an early stage of their implementation. Senior management has established suitable departmental structures to support the provision, including programme teams, and has set realistic targets for the development of relevant programmes. The senior management ensures that staff within the programme

teams communicate effectively and have clearly identified responsibilities. Arrangements for reviewing and evaluating the programmes are not, however, implemented effectively to identify weaknesses in provision, including the effectiveness of the links with industry, the quality of the teaching and the standards achieved by the students. In the remaining colleges, offering software engineering programmes, there are no effective policies and strategies to improve the provision for students and to develop programmes that are relevant to the needs in the local software industry.

7.3.3 Most colleges, in their strategic planning, do not ensure that sufficient funding and resources are available to programme teams to allow them, without significant delays, to design and deliver specialist training programmes to meet employers' needs. Only two colleges implement policies which allocate sufficient resources for staff to collaborate effectively with the software industry, and to develop the skills needed to carry out professional training analysis of employers' needs. These colleges also devise suitable staff development policies to provide lecturers with a wide range of appropriate software development skills and allocate funds for the appointment of lecturers with up-to-date industrial experience. In general, colleges place insufficient emphasis on the development of suitable strategies for marketing, recruitment, careers guidance and retention rates.

PART 8

8.1 CONCLUSIONS

8.1.1 The provision for software engineering in the further education sector is generally weak. Only two colleges provide the students with the wide range of learning experiences in software development which are essential for them to work competently in industry. In these colleges, the students also develop their interpersonal skills effectively, and have the confidence to progress to employment in the software industry. In the majority of colleges, the students study a narrow range of specialist units which do not meet sufficiently the needs of the software industry. They achieve competence in only a limited range of software development skills, and few have the confidence to progress to employment in the software industry. All colleges have not met their target recruitment levels, and the average rates of retention are poor. The success rates of those students who complete their studies are mostly good.

8.1.2 Most colleges do not collaborate effectively with employers to identify and meet their training needs. Only a minority consult with employers on the design and review of their higher education programmes in software and electronic engineering. As a result, these programmes are well planned and organised, and delivered to high standards. Only three colleges have evaluated the effectiveness of their provision in electronic engineering at higher education level. As a result, they have amended successfully the design of their programmes by including units in software engineering or industry-standard proprietary qualifications to meet the needs of new technology firms. Students in these colleges develop appropriate competences in software development, and have the confidence to progress to employment in electronics industries.

8.1.3 Software engineering is well managed in two colleges which implement clear policies and strategies to identify and meet the skill needs of the software industry. The programme managers provide effective leadership to ensure the quality of the teaching and learning is good, and high standards are maintained. In addition, good channels of communication have been established between the computing and engineering departments to facilitate the management, delivery and quality assurance of programmes. These colleges review and evaluate the quality of their provision and implement realistic action plans. Although two colleges have made a good start to devise written policies and strategies for software engineering, arrangements for the review and evaluation of the quality of the programmes are weak.

8.1.4 This report confirms there are no centres of excellence for software engineering in the further education sector in Northern Ireland. The quality of the provision is, however, good in two colleges and they are progressing well towards achieving excellent standards. There are weaknesses in the provision for higher education programmes in software engineering which generally have not been addressed by colleges. These include the failure to achieve recruitment targets, the limited careers guidance in software engineering, poor retention rates, the low proportion of women, the lack of a set of occupational standards to identify industry training requirements, and deficiencies in computer facilities and ICT infrastructure, despite recent improvements. To achieve centre of excellence status, further education colleges need to devise suitable action plans to address these issues.

APPENDIX

Table 1 Six Priority Skill Areas 1999/00

Keyskill Areas 1999/00	Full-time Enrolments	Part-time Enrolments	Total Enrolments
Computing	1940	11357	13297
Software Engineering	108	67	175
Hospitality, Catering & Tourism	2705	1881	4586
Electronics	306	1294	1600
Construction	2832	1947	4779
Manufacturing Engineering	180	632	812

Enrolments 1999/00	Full-time Enrolments	Part-time Enrolments	Total Enrolments
Total keyskills enrolments	8071	17178	25249
Total FE enrolments	24132	65247	89379

Figures supplied by DHFETE

Table 2 Full-time HND Software Engineering Programmes 2000/01

College	Software Engineering	
	Men	Women
Belfast IFHE	85	7
North West IFHE	7	0
North East IFHE	21	4
North Down & Ards IFHE	26	0
Newry/Kilkeel IFHE	40	10
Upper Bann IFHE	14	2
Total	**193**	**23**

Figures supplied by college to DHFETE as part of higher education monitoring process

Table 3 Higher Education Programmes in Computing/Business Information Technology

College	Computing		Business Information Technology	
	Men	Women	Men	Women
Belfast IFHE	114	37	50	60
North West IFHE	52	22	24	31
North East IFHE	48	14		
North Down & Ards IFHE	56	16		
Newry/Kilkeel IFHE	13	11	17	30
Upper Bann IFHE	30	5	21	27
Fermanagh College	47	36	2	2
Omagh College			5	5
East Antrim IFHE			20	7
Total	**360**	**141**	**139**	**162**

Figures supplied by colleges during inspection

Table 4 Higher Education Programmes in Electronics and Telecommunications With Software Units or Industry Standard Proprietary Qualifications

College		
	Men	Women
North West IFHE (HND and HNC Electronics)	32	2
Causeway IFHE	24	8
North Down & Ards IFHE	34	4
Castlereagh CFE (Fast track HNC Telecommunications)	64	0
Castlereagh CFE (Day release HNC Telecommunications)	19	2
Total	173	16

Figures supplied by colleges during inspection

Table 5 Level 3 Programmes

College	AVCE ICT/GNVQIT		National Diploma Computing	
	Men	Women	Men	Women
Belfast IFHE	50	3	55	7
North West IFHE	14	39	18	3
North East IFHE			124	30
North Down & Ards IFHE	51	9		
Newry/Kilkeel IFHE	67	32		
Upper Bann IFHE	35	1	36	
Fermanagh College	45	19		
Omagh College			44	33
East Antrim IFHE			45	8
Causeway IFHE	47	7	25	5
Castlereagh CFE	40	5		
Limavady CFE	10	0	49	7
Total	**359**	**115**	**396**	**93**

Figures supplied by colleges during inspection