

# The Development of Courses for the NDT Industry in Collaboration with the Industry Body and the Students Themselves

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**Abstract** - *The Engineering Division at the University of Northampton provides a range of courses at both undergraduate and postgraduate level, in full-time, part time and distance learning modes. In 2005 the British Institute of Nondestructive Testing (BINDT) approached the University with a view to developing an academic qualification that could be gained by people in the NDT industry specifically in the UK. A proposal was made to develop a Foundation Degree in NDT, which would be distance-taught and would be closely linked to the practical certification that NDT practitioners have to undertake. Over the next two years the material was developed and the course started in September 2007. Since then there has been a steady increase in student numbers, and in 2009 the first group of students completed the course. In 2009 a top-up BSc was approved and this year it recruited the first cohort of students. The BSc was designed in consultation with the existing Foundation Degree students and members of the BINDT. Beyond undergraduate level, we have also recruited a number of students who are undertaking research degrees, and future plans include the development of a Masters level course. We conclude that the courses have been successful due to the close relationship with the relevant industry body. The result has been a unique set of courses which are still growing in popularity.*

**Index Terms** – Curriculum Development.

## INTRODUCTION

The Engineering Division of the University of Northampton (UoN) runs a number of courses included a full-time classroom delivered BSc degree and at sub-degree level, a Higher National Diploma (HND) in Engineering, and 2 part-time Higher National Certificates (HNC) in Engineering awards. It has also been running distance learning courses since 1983 in the specialist area of Lift Engineering. Initially this was a Professional Development Certificate in Engineering designed and taught for the Lift and Escalator Industry Association (LEIA). In 1999 this was extended when a masters degree called the MSc in Lift Engineering was produced, which is also taught by distance learning. More recently the distance learning provision in the Engineering was expanded following two successful bids to the European Social Fund (ESF) to fund the production of a Foundation Degree in Lift Engineering, and a BSc (Hons) and Foundation Degree in Electronics for Computing. These courses have been running since 2003. A further award was added to the portfolio in 2005 with the validation of another foundation degree, the FdSc High Performance Engineering (Motorsport). In all cases, the Foundation Degrees have been relatively unsuccessful, attracting very small numbers of students. In 2005 the British Institute of Non-Destructive Testing approached us and suggested that with their help we might like to produce a Foundation Degree in Non-Destructive Testing. The production of this course was described in an earlier paper [1].

## THE POTENTIAL MARKET

Non-Destructive Testing (NDT) is a field of engineering which cuts across many industries, from power generation to aviation. It employs in excess of 25,000 individuals in the United Kingdom alone, many of which are based in small to medium size enterprises (SMEs). Education provision within this sector has traditionally focused on the technician level and there has been no graduate level provision. This has placed a major barrier to advancement and continuous lifelong-learning.

The BINDT has indicated that there is a significant market, both in the UK and abroad for an academic qualification which expands upon the practical certification that all NDT engineers have to undertake to continue practicing. This certification is the Personal Certification in NDT (PCN) which is awarded by the BINDT in the UK. In addition, many of the larger companies run their own equivalent certification which is accredited by the BINDT.

A recent survey of the members of the British Institute of NDT [1] which is considered to be representative of the 25,000 or so individuals working in the UK NDT industry, revealed that there are two significant problems adversely affecting the construction, fabrication and in-service plant maintenance sectors:

1. A lack of new entrants into the NDT profession, resulting in an acute shortage of inspection personnel available to service cyclic peaks in demand (such as experienced in power station maintenance during outages, major plant construction projects, overhaul of offshore oil and gas installations).
2. A demographic problem of ageing NDT professionals caused by the lack of new entrants to the profession, which is in turn caused by a poor perception of engineering as a profession and, for NDT in particular, the lack of any available foundation or first degree courses.

This is illustrated in Table 1, which shows the demographic distribution of NDT employees in the UK and other countries.

	- 30	30-39	40-49	50-59	60-69	70-79	80 +	Age
Czech Republic	12	31	25	27	5			Percentage
France	16	29	33	21	1			
Germany	1.5	15	30	32	17	4	0.5	
Slovakia	13	28	41	25	2			
South Africa			Majority					
Spain	12	37	25	23	3			
Sweden				Majority				
UK BINDT	4	9	27	37	18	4	1	
UK PCN	15	25	32	23	5			

TABLE 1  
AGE PROFILE OF NDT PERSONNEL (FEBRUARY 2007)

A further hindrance to the development of any undergraduate courses in NDT is the fact that NDT engineering individuals and businesses are geographically widespread. The proposed distance learning solution is the only viable option. There are principally two target groups:

1. Existing industry professionals vocationally qualified to Level 3 NVQ, whose careers are stagnating because of the lack of a recognised academic degree level qualification that would enable them to progress into middle and upper management;
2. Younger entrants to the NDT profession who, unlike their forbears, have little or no engineering skills and background, and lack higher education qualifications such as to properly equip them for a career in NDT – a consequence of which is that they leave the profession early to seek a career where advancement through gaining one or more readily available academic educational qualifications is a real prospect.

The BINDT is a Charitable organisation and is the Professional body for the NDT industry within the UK. It is not part of their remit to hold and run HE level courses and they receive no direct funding to undertake such activity. Given the particular need and uniqueness of this new qualification they have received the commitment from their Governing Council to provide support in 'In kind'.

The BINDT would be keen to accredit an academic qualification as part satisfaction of its educational requirements for professional status and upon completion of the course graduates would be able to seek Engineering Council UK (ECUK) registration through the BINDT at EngTech or IEng level. This would create a properly educated and motivated pool of management potential personnel, and encouraging new entrants at Level 1 and 2 as defined in EN 473, which will feed into the higher education system in due course. The following table shows the relationship between PCN certification, academic awards and Engineering Council status.

WORK BASED	VOCATIONAL	ACADEMIC	PROF. REG	NQF EQUIV
WORK BASED LEARNING - APPRENTICESHIPS		Engineering Doctorate		8
		Masters Degree	Chartered Engineer	7
		BSc (Hons) NDT	Incorporated Engineer	6
	PCN Level 3	Foundation Degree Y2		5
				4
	PCN Level 2	Foundation Degree Y1	Engineering Technician	3
	PCN Level 1			
SCHOOL LEAVER OR OTHER ENTRY LEVEL				

TABLE 2  
RELATIONSHIP BETWEEN ACADEMIC AND VOCATIONAL QUALIFICATIONS

## THE PROPOSED QUALIFICATION

This proposed solution was a Foundation Degree (FdSc) in Non-Destructive Testing (NDT) which was the first academic qualification in NDT at this level in the UK (and possibly further afield). The FdSc was a highly flexible, part-time modular based course which met the needs of the industry.

The FdSc in NDT overlaps the PCN Certificate in terms of academic level, but extends to second year degree level. As part of a career progression, it aims to enhance the breadth of the student's knowledge and academic skills to an extent where

- the engineering responsibility of a successful student can be expanded with confidence on the part of both the student and the employer
- the student is capable, if she/he so wishes, of benefiting from entry into the final year of the BSc Non-Destructive Testing (more on this later)
- given appropriate additional experience, the student can apply for recognition by the Engineering Council to the level of Engineering Technician (Eng Tech), Incorporated Engineer (IEng) and possibly Chartered Engineer (CEng).

The course delivers a flexible industry focused qualification which is strongly supported by the vision of the Vice Chancellor at The University of Northampton who in a paper stated "...we must address as a matter of urgency, the development of mixed-mode delivery across all our provision utilising web-based and other technologies" and that we must "...deliver to the students place of employment or home the requisite course materials...". This vision forms a key part of the University's mission statement and corporate goal. Furthermore the strategic 5 year plan of the School of Science and Technology identifies the development Centres of Excellence in the areas of Lift Engineering and NDT as key to the development of the Engineering Division. Over the past six years through support from the New Technology Initiative the Division has invested in significant NDT equipment. To support this activity the Division has also employed staff in some of the specialist NDT disciplines. More recently, through Government Funding, the School has invested in 3D Immersive Technology and created the Centre for NDT Education, with Dr Muhammad Zaid as Director.

The links between this Foundation Degree and current Government policy are strong. This is evidenced by the partnership strategy used to develop the course, the method of delivery and the target beneficiary groups. The Department for Trade and Industry in the UK (DTI) in their report "Engineers for the 21st Century Inquiry Launch" [2] regarded the need for developing new engineering provision within Universities and promoting Continuing Professional Development (CPD) amongst engineers as vital for the advancement engineering profession. The current policy voiced by the Department for Education and Skills (DfES), in their report "The Future of Higher Education" [3] argues that to increase HE uptake and close the current skills gap which exists (particularly in Technical areas) HEIs are going to have to offer more flexible, part-time, industry and work focused courses which encourage CPD and Life-long Learning. They state: "There are not enough choices for flexible study - including part-time courses, sandwich course, distance learning, and e-learning - and there must be an increasingly rich variety of subjects to study, which keep pace with changes in society and the economy." The DfES further states: "Higher Education should be a choice open to everyone with the potential to benefit - including older people in the workforce who want to update their skills." The proposed Foundation Degree addresses most if not all of these current concerns and will go some way to assist in the educational challenges outlined by both the DTI and the DfES.

## BSC TOP-UP

All Foundation Degrees must have a progression route onto a BSc top-up. Given the nature and structure of the FdSc in NDT, it was inevitable that the BSc top-up would also be distance learning and modular. The question was, what should the content be? Rather than decide ourselves, we decided to ask the students, since they were fairly representative of the industry itself.

The Foundation Degree students were given a list of topics to rank order. These topics had emerged after discussions with BINDT and representatives of the NDT industry. After receiving the replies and scoring the topics, the results were rank ordered, as shown in Table 3, where the lowest scores are best.

In addition, students were asked to suggest other topics if they were not included in the list. No other suggested topics were received. Of the first five items, Advanced Inspection, Corrosion Analysis and Thermographic Imaging, were clear cut. NDT Applications was less so, and in the end we concluded that this topic would be covered by an undergraduate project. The fifth topic, Condition Monitoring caused more of a problem. Condition Monitoring covers a number of techniques, which include Vibration Analysis, Thermographic Imaging and Corrosion Analysis. Since the latter two are already selected, that left Vibration Analysis. This makes up the five modules in the BSc as shown in Table 4.

Topic	Score
Advanced Inspection	28
Corrosion Analysis	54
NDT Applications	61
Thermographic Imaging	71
Condition Monitoring	75
Planning	84
Modelling	92
Acoustic Emission	107
Radar and Microwave Testing	117
Advanced Sensor and Imaging	126
Advanced Electronics	130

TABLE 3  
RANK ORDERING OF SUBJECTS

Code	Title	Number of Credits
ENG3010	Corrosion Analysis	20
ENG3012	Thermographic Imaging	20
ENG3014	Vibration Monitoring and Analysis	20
ENG3017	Advanced Inspection Methods and Techniques	20
ENG4005	Technology Project	40

TABLE 4  
BSC MODULES

The first four modules are 20 credit modules, and the project is a double module worth 40 credits. These topics were shown to the students who were very happy with the range of subjects that would be available.

The project would be assessed mainly by a report. The course team decided that the report should be designed so that it is very similar to the Technical Report used by the Engineering Council to assess candidates for Chartered Engineer status. In that way, students who take the BSc will be able to use the project report as the Technical Report if they choose to apply for CEng status.

## STRUCTURE OF THE COURSE

The BSc is modular in structure and runs over an academic year. Initial entry points to the course is in January and students complete all work by September. There are regular assessments which will take a variety of forms suitable to distance learning courses. The benefit to industry and specifically small businesses is that an individual can take any module at any time to satisfy a specific skills requirement. The benefit to the individual is that they can accumulate modules and ultimately acquire a HE level 6 qualification. The BSc course covers the training and examination syllabus published in support of European standard EN 473:2000 (Non-destructive testing – qualification and certification of personnel), and will be aimed at the highest level – Level 3 – available under this vocational qualification standard.

Degrees are to have a number of principles within their design, which were specified by Higher Education Funding Council for England (HEFCE). These are:

- 360 CATS (Credit Accumulation and Transfer System) points
- Equivalent of three years full time, but can be part time.
- Partnerships between institutions are encouraged.

The BSc top-up follows the Foundation Degree, where students will have already accumulated 240 points. Therefore the BSc top-up consists of 120 CATS points, and could be studied in one year full-time, or up to 3 years part-time.

## ADMISSIONS POLICY

A specific admissions policy has been developed for this award in conjunction with the British Institute of Non-Destructive Testing. In the first instance it is assumed that the target audience will be existing practitioners in NDT who

will have practical certification, PCN, at level 1, 2 or even 3. The PCN scheme is run by the BINDT who, in addition, accredit other qualifications from around the world and can give specific advice, if necessary, on the level of equivalent qualifications.

In the simplest case, a student who completes the Foundation Degree can automatically progress onto the BSc. However, direct entry is possible for students who hold PCN level 3 in 4 relevant subjects. Usually “relevant” means ultrasonic, radiographic, eddy current testing and some form of visual inspection. Unlike the Foundation Degree, no exemptions are given automatically. However, students can apply for exemptions through the APL (Accredited Prior Learning) route if, for example, they hold a PCN level 3 or equivalent in one of the BSc topics e.g. Thermography.

## **LEARNING AND TEACHING STRATEGY**

Each module is assessed by coursework only. The coursework usually consists of tutor-marked assignments (TMAs) and computer marked assignments (CMAs) or examples for the student to work through. The CMAs are normally multiple-choice questions that are aimed at giving the students feedback on their progress quickly and are therefore primarily formative although a mark is still awarded.

Modules consist of an appropriate number of learning packages (LPs) and other materials such as reference texts, with self-assessment questions at relevant points in each LP, in order to assist students in monitoring their own progress. In a distance learning programme, it is essential to provide the student with a framework for study. Consequently, each module is provided with a timetable indicating the expected rate of progress through the material, together with key dates for the submission of assignments. The cut-off dates of TMAs and CMAs is fixed, but in order to allow a more flexible study pattern, these cut-off dates can be interpreted as the latest dates for submission. In other words, students can submit and expect to get feedback on assignments at any time up to the cut-off date.

## **CONCLUSIONS**

When the University of Northampton launched its new distance-learning FdSc in Non-Destructive Testing in 2007 it confidently expected to attract a significant number of students. The BSc top-up provides a progression route for these students and it is hoped that in time a Masters level course will be produced as well.

In the first year of operation, 38 students started the year. The following year the number went up to 82 students at the beginning of the year. Of those, 20 were awarded the Foundation Degree. This academic year, another 82 students have started the year. In addition, 28 people started the BSc, of which 19 are FdSc graduates, together with 9 new direct entrants. Looking at applications for next year we are confident that the numbers will keep on growing.

## **REFERENCES**

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