Open Research Online

The Open University's repository of research publications and other research outputs

Quality management: an 'essential attributes' approach. A case study towards a sustainable model of course effectiveness evaluation

Thesis

How to cite:

Murphy, Francis Spenser (2005). Quality management: an 'essential attributes' approach. A case study towards a sustainable model of course effectiveness evaluation. EdD thesis The Open University.

For guidance on citations see [FAQs](#).

© 2005 The Author

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Redacted Version of Record

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.21954/ou.ro.000101b8>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

Francis Spenser Murphy

**Quality management:
an 'essential attributes' approach.
A case study towards a sustainable
model of course effectiveness
evaluation.**

DOCTOR OF EDUCATION (EdD)

2005

Abstract

Quality management: an 'essential attributes' approach. A case study towards a sustainable model of course effectiveness evaluation.

An education programme for mechanical engineers should ensure that graduates have a number of 'essential attributes' (high level of mathematical ability, teamwork skills, creativity, etc.) for them to adequately function as professional engineers. This research examines a case study of the BEng (Mechanical Engineering) at Cork Institute of Technology, Ireland. The delivery of essential attributes are proposed as criteria for the measurement of educational effectiveness. From a review of literature concerning organisational/educational effectiveness, the concepts of 'microquality' and 'macroquality' are developed. Redefining these concepts, facilitates an examination of the case study (microquality) in determining 'fitness for purpose' and the wider debate on engineering higher education (macroquality) in determining 'standards of excellence'. The BEng course is compared with both 'fitness for purpose' and 'excellence'.

Gathering of data utilises qualitative interviews of stakeholders, documentation analysis and some workplace observation. Data analysis of interviews, course and wider debate documentation is undertaken using QSR NUD*IST version 4 software. Following preliminary data gathering, theory building produces an engineering concept of excellence (a sustainable world). A causal model is developed with this concept as the aim, which links standards of excellence, essential attributes, educational factors, student

intelligences, learning theories and staff training. Modifying this model by including the influences of documentation and interviews, leads to a model of course effectiveness evaluation, which is offered as a method suitable for other courses. This model extends existing employability theory by providing it with an alternative structure.

The case study examines the BEng course for 'fitness for purpose' and 'excellence'. Improvements are recommended in both cases. The core stakeholder group (graduates and students), are found to have provided standards of excellence with the most impact on the engineering concept of excellence and course sustainability. The wider debate documentation does not have as much impact as originally thought. The core stakeholder group appears to be demanding excellence from the course and not just fitness for purpose. It will be interesting to see if this is the case for other disciplines.

Acknowledgements

I would like to thank everyone who helped me complete this work.

My first debt of gratitude is to Dr. George E. Holmes (Principal of Doncaster College, Chief Executive of the Doncaster Education City Project, Tutor Supervisor at the Open University) who supervised this study. His experience and insight have contributed significantly to the thesis.

I am also indebted to Dr. Nigel Bennett (Line Co-ordinator E906), Dr. Neil Moreland (Open University) and Sandy Sieminski (Staff Tutor EdD) for their comments, suggestions and advice.

My sincere gratitude goes to the former and current students of the BEng (mechanical engineering) at Cork Institute of Technology, who agreed to be interviewed as part of the case study.

I wish to thank the staff at Cork Institute of Technology who participated in various stages of the case study and contributed with advice and suggestions.

I would particularly like to thank my wife, Máire, who constantly gave me support and encouragement.

Francis S. Murphy

February 2005

Quality management: an 'essential attributes' approach. A case study towards a sustainable model of course effectiveness evaluation.

CONTENTS

	Page
Abstract:	1
Acknowledgements:	2
Chapter 1 - Introduction.	7
What is it that I am researching?	7
Research questions:	7
Why is it worth researching?	8

(Briefly) How have I gone about researching it?	8
How do you measure course success?	10
Success in engineering degree courses:	11
What is quality in education?	12
Thesis route map:	13
 Chapter 2 - Literature Review.	 15
Literature priority:	15
Course effectiveness evaluation:	29
Definition of quality in education:	49
Total quality management:	49
Quality engineering course requirements:	49
Quality course requirements:	50
 Chapter 3 - Research Issues.	 52
Research methodology:	52
Qualitative research:	55
Insider research:	57
Sustainable world:	58
Case study:	60
 CONTENTS (cont.)	
	Page
Educational factors:	61
Collecting the material:	66
Why did I do it like this?	68
Software limitations:	69
Observation techniques:	71
What have I done and why?	73
N4 coding:	74
Theory building:	78
 Chapter 4 - Quality Analysis.	 84
Fitness for purpose:	84

Standards of Excellence:	91
N4 project QMt4:	95
Interviews:	96
Causal flowcharts:	98
'Essential attributes' theory:	109
Thesis criteria:	119
Empirical 'educational factors':	123
Empirical 'standards of excellence':	127
Empirical/theoretical comparison:	129
Chapter 5 - Stakeholder Analysis.	134
Past graduates:	137
Present students:	138
Non-completing students:	138
Lecturers:	139
Employer representatives:	139
Differences:	140
Implications for the provision of quality courses:	143
Final outcome:	146
Minimalist quality concept:	147

CONTENTS (cont.)

	Page
Maximalist quality concept:	147
Concepts applied:	147
What factors ensure quality courses?	149
What can one country learn from another?	151
Chapter 6 - Conclusions.	154
Research questions answered:	154
Research questions changed:	161
Tangible recommendations:	164
Relating findings to literature:	167
Data collection review:	170

Research limitations:	170
Learning:	170
Future development:	171
Wider Issues:	174
Approach:	174
Outcomes:	175
Implications for course evaluation:	176
 Appendices:	 179
 References:	 239

List of figures:

Figure 2.1:	Conceptual map.	16
Figure 2.2:	Effectiveness evaluation methods.	48
Figure 4.1:	Ideal case flowchart.	102
Figure 4.2:	External influence flowchart.	105
Figure 4.3:	Minimal external influence flowchart.	106
Figure 4.4:	Increased external influence flowchart.	108
Figure 4.5:	'Essential attributes' approach flowchart.	115

CONTENTS (cont.)

	Page	
Figure 6.1:	'Essential attributes' model.	163
Figure 6.2:	Logical 'AND' diagram.	173
Figure 6.3:	Logical 'OR' diagram.	173
Figure 6.4:	Predicted effect diagram.	173

List of tables:

Table 3.1:	Respondent groups.	79
Table 3.2:	'Educational factors'.	80
Table 4.1:	Second iteration: respondent groups.	99
Table 4.2:	Second iteration: 'educational factors'.	100
Table 4.3:	Third iteration: respondent groups.	130

Table 4.4:	Third iteration: empirical 'educational factors'.	131
Table 5.1:	Stakeholders interviews.	135
Table 5.2:	Stakeholder positive responses.	136
Table 5.3:	Positive response per stakeholder.	137
Table 5.4:	Documentary references.	145

List of appendices:

Appendix 1:	Framework of quality dimensions.	179
Appendix 2:	Critical success factors.	180
Appendix 3:	Academic plan.	182
Appendix 4:	Nodes.	190
Appendix 5:	Interview transcript.	197
Appendix 6:	Observation transcript.	203
Appendix 7:	Essential attributes reports.	204
Appendix 8:	Standards of excellence reports.	222
Appendix 9:	QMt4 reports.	227
Appendix 10:	N4 reports - course expectations.	237

Chapter 1 - Introduction.

What is it that I am researching?

This research is concerned with developing a method of course effectiveness evaluation that can be applied to any course. The method entails comparing the essential attributes imparted to course graduates with:

- (a) those advocated in the course documentation,
- (b) those advocated in some wider debate documentation and
- (c) those advocated by some course stakeholders.

Using this comparison, the method can assess the fitness for purpose of the course and how far the course aspires to excellence. The concepts of 'essential attributes' and 'standards of excellence' are developed, along with some other variables to produce a model or (integrated set of relationships among the variables). This model is used in establishing a theory of

essential attributes, by building on and extending existing work done in this area (Harvey *et al* 2002).

To develop the method, this research examines the fitness for purpose of an engineering course and attempts to determine standards of excellence with which to compare the course standards. The educational effectiveness of the course is therefore being researched as a case study.

Research questions:

This research focus generates the following research questions:

1. What are the 'essential attributes' that a professional mechanical engineering degree course should provide to graduates, in order to meet international standards of excellence?
2. What are the 'essential attributes' that the Cork Institute of Technology (CIT) BEng in mechanical engineering should provide to graduates, in order to meet 'fitness for purpose' standards?
3. To what extent does the Cork Institute of Technology BEng in mechanical engineering provide the 'essential attributes' in order to meet:
 - (a) international standards of excellence,
 - (b) fitness for purpose standards?
4. Should the quality of the BEng course be raised in relation to:
 - (a) international standards of excellence,
 - (b) fitness for purpose standards?
5. To what extent can the 'essential attributes' approach of evaluating course effectiveness, contribute to the higher education sector?
6. Is it possible to establish a theory of 'essential attributes', or are there other theories emerging from the data?

Why is it worth researching?

According to Creemers (1998:109), not much research has been completed in this area. A literature review of educational effectiveness, particularly in relation to engineering higher education, tends to support this view (chapter 2). Creemers (1998:120) emphasises the need for research into educational effectiveness so that the body of knowledge in educational effectiveness will increase and create a starting point for future theory development.

Both Scott (1998:96) and Creemers (1998:110) propose 'multiple outcomes' as criteria for effectiveness. Higher order skills (such as problem solving) meta cognitive skills, creativity, social and aesthetic skills, etc., are suggested by Creemers (1998:112) as criteria for future research, which will help to enhance educational effectiveness. These ideas are in line with the essential attributes approach used in this research.

(Briefly) How have I gone about researching it?

Education of potential, professional engineers should take account of the type of employment that they will eventually obtain. Among the requirements of this employment, the ability to solve problems and the ability to reason is considered to be important. Among all the engineering disciplines (aeronautical, electrical, mechanical, manufacturing, etc.), a high level of mathematical ability is considered necessary. According to Denning (1992:87), many engineering employers look for engineers with innovative flair, creativity and the ability to invent new products or processes. Much of this work is carried out by groups; hence teamwork or the ability to work with others is desirable. Many engineers will obtain managerial positions and knowledge of management subjects (such as finance, legislation, organisation, managing people, quantitative methods, information systems, etc.) is considered necessary. Engineers will need to update, as their careers progress, thus self-directed learning abilities and lifelong learning awareness are desirable attributes.

The quality of an engineering degree course can be judged by assessing whether the correct balance of these essential attributes have been effectively obtained. The case study is concerned with assessing the balance of essential attributes, on an existing Bachelor of Engineering degree

course, within the Mechanical and Manufacturing Engineering Department, Cork Institute of Technology, Ireland. This will be done, with a view to recommending changes, which could improve course quality. The research methods consist of interviewing mainly past graduates, but also some present students, non-completing students, employer representatives (engineering managers), lecturers and managerial staff. Results of these interviews will be compared with internal documentary data relating specifically to the course, but also to documentation obtained from the wider debate on engineering higher education.

This research builds on existing work to develop a theory of essential attributes. By examining the 'educational factors' that need to be implemented at course level in order to generate essential attributes in students, a deeper understanding of the causes of essential attributes in students is obtained. Thus a causal model of the essential attributes approach is produced which may be of use to other courses. Prominent in the developing theory is the emergence of past graduates as the dominant feature in providing the appropriate data necessary to drive towards excellence. Not only do past graduates generate new essential attributes, but they also provide a strategic view of the course, which may be useful in providing sustainability. This should ensure that courses responds to new developments in the real world.

Course Success:

One of the main features of a successful course is the employability of the graduates. If the graduates are in demand then the course can be said to be successful and fit for purpose. However, to maintain this success, the course has to respond to changes in the environment, such as new types of industry and changing work practices in existing industry. It may also be possible for a course to reach out for higher standards of excellence and attempt to instill in graduates a higher quality, such that they always produce best practice in their everyday work. This research is attempting to produce a method of course effectiveness evaluation, which will determine

- (a) whether a course is 'fit for purpose',
- (b) the extent to which the course has 'standards of excellence',
- (c) the course response to changes in the environment.

The case study location, Cork Institute of Technology (CIT), offers undergraduate and postgraduate courses in Business, the Humanities, Science, Engineering, Art and Music. The three campuses of CIT are the Crawford College of Art and Design, the Cork School of Music and the Bishopstown Campus. At CIT there are six research centres, which offer services to industry as well as promoting research and development activity. The Institute has approximately six thousand full time students and over five thousand part time students.

CIT is currently operating in an expanding economy with graduates obtaining employment across the full range of manufacturing and service industries, including financial and business sectors. The Cork region has a strong computer software industry, together with an expanding chemical industry. This has resulted in the current skills shortage with CIT rapidly expanding its capability for the education and training of apprentices. Enticed by attractive remuneration packages, many graduates obtain employment in the USA, Australia, Asia and Europe, even though there are sufficient jobs in Ireland.

The organisational structure at CIT seems to approximate to a *professional bureaucracy*, which was first described by Mintzberg (1983). According to Fidler (1998:59), the *professional bureaucracy* consists of three groups who carry out the work. These are the strategic apex, the middle line managers and the operating core. There are also groups who provide assistance to these three groups called the technostructure and the support staff. So in the case of CIT, the strategic apex would have the board of governors, the director of the Institute and the assistant principal. The middle line of managers would include the heads of departments, the heads of research centres and senior lecturers. The operating core would consist of lecturers and assistant lecturers. The technostructure would include the financial controller, development office, office of the registrar and the academic council. Support staff would consist of laboratory technicians, craft assistants, building maintenance staff, caretakers, accounts office, purchasing office, personnel office, computer services, catering, etc.

Officially, there are five people at CIT engaged in strategic management and these are the director, the assistant principal, the financial controller, the registrar and the head of development. Usually these five are termed “senior management”. The organisation at CIT is presently in the process of change, with re-arrangement of departments and the formation of schools. However, it will be several months before these changes take effect.

The BEng in mechanical engineering degree case study course began in the early 1980s with the first cohort of students graduating in 1985. From the start the graduates found employment fairly easily, both locally and abroad. In the late 1980s the course was accredited by the Institution of Engineers of Ireland. This enabled those graduates with the necessary industrial experience, obtain the title of 'Chartered Engineer' and 'European Engineer' if they so desired.

Success in Engineering Degree courses:

One of the key concepts in this research is 'effectiveness'. How effective is the Bachelor of Engineering (BEng) in mechanical engineering degree course at Cork Institute of Technology (CIT), Cork, Ireland? How effective is the organisation responsible for developing the CIT BEng (mechanical engineering) degree course? Examining the literature concerning organisational effectiveness provides a means of locating this research into the 'Quality Management' body of knowledge.

Quality in education:

Scott (1998:104) discusses the ideas of 'microquality' and 'macroquality'. The following question is used to define microquality:

"Is the organisation doing the thing right?"

Another question is used to define macroquality:

"Is the organisation doing the right thing?"

We can expand on these two questions. If we first look at microquality, we can say that:

"The effectiveness of an organisation providing professional engineering education might be assessed in

terms of the engineering educational status of the clients who had received services".

Alternatively, expanding on the macroquality question, we can say that:

"The effectiveness of an organisation providing professional engineering education might be assessed in terms of the engineering educational status represented amongst the population residing within the service area of the organisation".

Thus we can use these concepts of microquality and macroquality to frame this research and locate the work within the Quality Management body of knowledge. The microquality concept is useful in determining the 'fitness for purpose' of the course. The macroquality concept can be used to compare the course with 'standards of excellence' obtained from a literature review of the wider debate on engineering higher education. Graduates from the BEng (mechanical engineering) course obtain employment worldwide, so the service area of the organisation will be the world. Hence, the CIT BEng (mechanical engineering) should be compared with the highest worldwide standards of excellence. The case study of the BEng (mechanical engineering) degree course can be assessed for fitness for purpose and then compared with worldwide standards of excellence.

Thesis route map:

The literature review, chapter 2, establishes a conceptual map aimed at prioritising the various influences on the CIT BEng course. The order, with which the literature review is undertaken, is then guided by the conceptual map. Thus the first priority is a review of the quality management literature concerned with engineering higher education. The second priority is a review of BEng course literature. The literature review concludes by placing the 'essential attributes' approach amongst other course effectiveness evaluation methods, whilst predicting possible results.

Chapter 3 provides a rationale for utilising qualitative research methods. Conflicting definitions of educational theory, the literature concerning the development of qualitative research methods and the problems of insider

research are examined. From this review, a basis for theory building from qualitative research data is provided. A 'sustainable world' is established as a concept of excellence for engineering education and the theoretical model builds from this point. The nature of data gathering is described, including the software coding of the first iteration of interview data and the documentation data. The resulting emergence of essential attributes from this process is described. Examination of the literature concerning the educational factors that will have an impact on each essential attribute continues the theory building. How essential attributes and educational factors interact with each other is then illustrated.

In chapter 4, the iterative approach of chapter 3 is developed. Eventually, the essential attributes and standards of excellence emerging from both interview and documentation data are displayed alongside empirical educational factors emerging only from interview data. Causal models are developed into an 'essential attributes' flowchart, which is the basis of a theory of 'essential attributes'. This model is assessed for its effectiveness and its contribution to the practice of education.

Chapter 5 examines more closely the nature of stakeholder interview responses, in order to explain the skewing of the original sample towards the past graduate group. The results of the final fourth data iteration are discussed, together with some of the implications for the future of this research. The source from which each essential attribute and standard of excellence derives is also highlighted. Particularly interesting is the emergence from the past graduate group of the more important standards of excellence, which appear to be more relevant to a sustainable world and a sustainable course.

Chapter 6 concludes the thesis by providing answers to the research questions posed in chapter 1. An 'essential attributes' model is proposed as a basis for a theory of essential attributes. With regard to the case study of the CIT BEng course, some tangible recommendations are provided. A possible change of research questions is also suggested for the case study, but not necessarily for other courses. Again with regard to the case study, some of

the more recent work on 'sustainability competences for engineers' is reviewed, together with literature on engineering ethics. Some related higher education research is also examined. Comparisons are made with all of these documents and the case study results. Possible future developments and fine-tuning of the 'essential attributes' model are considered. The implications of this research on existing models of course effectiveness evaluation are also highlighted.

Chapter 2 - Literature Review.

Literature priority:

According to Scott (1998:104), a researcher assessing the effectiveness of an organisation should address the following two questions:

Is the organisation doing the thing right (microquality)?

Is the organisation doing the right thing (macroquality)?

These two questions are useful in framing the concepts involved in this research. A conceptual map of the research is shown in figure 2.1 and from this diagram, it can be seen that the three ellipses at the centre of the diagram relate to the CIT BEng course. Around these ellipses are rectangles, which indicate the various influences on the course, and these influences will affect the three ellipses. Around these rectangles and the three ellipses, a microquality rectangle can be drawn. This rectangle indicates that up to this point, the process is concerned with a particular case study, i.e. the CIT

BEng course. The organisation, CIT, must be seen to be "doing the thing right", if fitness for purpose is to be achieved.

Outside of the microquality rectangle, another influence will be the international debate on engineering higher education, which impacts on the national debate. This is shown by a rectangle at the top of the diagram. A macroquality rectangle can now be drawn around this rectangle and the microquality rectangle. This is because the wider debate on international engineering higher education will ultimately influence the BEng course at the centre of the diagram. The "right thing", which CIT aspires to do, could possibly change, if "excellence" is to be achieved. Inside the macroquality rectangle is the conceptual map of the case study, which is now called the essential attributes approach. The macroquality rectangle is also enclosed by a box, labelled the essential attributes approach. The essential attributes approach is just one of many course effectiveness evaluation techniques. Hence, another box is placed around the essential attributes approach box and this outer box can be labelled, 'Methods of course effectiveness evaluation'. Several methods of course effectiveness evaluation will emerge from the literature review, which could be placed in this outer box.

Figure 2.1 - Conceptual map.

Methods of course effectiveness evaluation.

The 'essential attributes' approach.

Macroquality - Are we doing the right

Wider debate - quality management - engineering
higher education - nationally, internationally.

1

Microquality - Are we doing the thing

CIT BEng stakeholders:- employers, professional
bodies, graduates, students, non-completing
students, parents, lecturers, managers,
government.

Learning
styles,
learning
theories,
learning
strategies,
educational
technology.

6

Delivery of
BEng
"essential
attributes".

Equality:
stakeholders.

7

Course
Board.

3

BEng curriculum

Internal
review
group.

5

BEng
"essential
attributes".

Employer
committee

4

Higher Education Training and Awards Council,
Institution of Engineers of Ireland,
Higher Education Authority.

2

The conceptual map, shown in figure 2.1, can be used to direct the literature review. A priority of the literature review will be the wider debate on engineering higher education; hence the rectangle containing this is marked with number 1. The next most important area for review will be literature from the degree awarding body, the degree accrediting body and the higher education authority. Hence the rectangle containing these organisations is marked with a number 2 in the conceptual map. This process is continued in figure 2.1 as far as number 7, which is positioned in the rectangle containing stakeholder equality. Thus, the literature search can now be undertaken in the order of the numbers.

From figure 2.1, it can be seen that the first priority is a review of the quality management literature concerning the wider debate on engineering higher education. Owlia and Aspinwall (1998:503) examine various definitions of quality. For manufactured goods, they describe how, in recent years, quality definitions have moved from "meeting specifications" to "fitness for purpose". However, quality of service is described as being more subjective and can be defined on the basis of customer perception.

Based on the customer perception/quality of service definition, Owlia and Aspinwall (1998:504) discuss their attempt at developing a framework for quality measurement in engineering higher education, which utilised questionnaires for obtaining "a large amount of" quantitative data. The questionnaires were based on a twenty-eight item (six dimension) list, shown in appendix 1. Questionnaires consisted of three sections - perception, importance and overall quality. In the overall quality section, respondents were asked to rate each item on a ten-point quality scale ranging from 'low' to 'high'. The main customers were considered to be students, academic staff and employers. A questionnaire was designed for each group.

In my view, the difficulty with the above survey is that students do not have an appreciation of the value of the course until they have had some experience of postgraduate employment. Employment will indicate to them whether they have been equipped for professional engineering work. It is a

better quality assessment if graduates, following a period of employment, compare what they received from the course in retrospect, with what they now think they should have received from the course.

Another difficulty with the above survey is the use of questionnaires as a research instrument. Table 4 of Owlia and Aspinwall (1998:510) shows clearly that the questionnaire response rates were very low, indicating 31% at the home University. This is a considerable erosion of the original sample and poses a serious threat to the validity of the results. My previous experience of utilising questionnaires gave similar response rates and this is one reason for choosing to use qualitative interviews as a research instrument in the CIT case study. Other reasons are that question ambiguity can be avoided with qualitative interview techniques. Also a better approximation of the number of interviews can be predicted from the start of the case study, although this requires practice.

The six quality dimensions used in the above survey (appendix 1) cover a very wide area, ranging from item 1 (the sufficiency of academic equipment) to item 28 (the extent to which personal confidential information is secure). Hence the CIT study will focus on the essential attributes that are delivered by the BEng course. These essential attributes are mainly equivalent to dimension 5 of the Owlia and Aspinwall (1998:507) study concerning content, which covers six items.

The Owlia and Aspinwall (1998) survey used questionnaires to compare the requirement of respondents from the service, with their perception of what they actually receive. So the 'gap' between course expectations and course perceptions of respondents were studied. In another survey of postgraduate distance education students, Long *et al* (1999:773) used a service template as the main research instrument. This service template allowed students to rate each selected aspect of the course on a scale between two extreme end points. The template proforma was in two sections, one covering experiences, the other covering expectations. Questionnaires were distributed to students in order to determine which aspects of the course should be included in the template. The overall aim of the analysis of the

data was to measure the 'gap' between student expectations and their experiences. Once the 'gap' is identified for each aspect of the course, the course providers are able to act upon this information. This survey was for postgraduate students, most of who were in employment and were covering the costs of their own tuition. Providing a service to these students covers such areas as administration, finance, accommodation and many others. Many questionnaires therefore, would need to be distributed, in order to determine which areas should be included in the template. Only the most important could be in the template, otherwise the template would become unmanageable. The basis of the research therefore started as very wide, but changed focus such that the most popular student opinions were taken into account. This focus is less complex than the Owlia and Aspinwall (1998) framework for quality measurement in engineering higher education.

The Owlia and Aspinwall (1998) framework for quality measurement in engineering higher education, shown in appendix 1, is very wide. It is useful to compare this framework with that developed by Mergen *et al* (2000). They propose a model of quality management, which provides a framework to identify research, teaching and operational improvement opportunities, at the College of Business, Rochester Institute of Technology. Quality of design, quality of conformance and quality of performance are the areas into which quality parameters are grouped. So, for each of the three college missions, in teaching, research and operations, the quality parameters were divided into the three areas, i.e. 'quality of design', 'quality of conformance' and 'quality of performance'.

This framework can be demonstrated by regarding the way it is applied to the mission of teaching. Thus for teaching, according to Mergen *et al* (2000:346), 'quality of design' parameters include the fostering of partnerships with industry, which resulted in curriculum design for some courses. Again, in the case of teaching, 'quality of conformance' parameters include the measurement of teaching effectiveness for each faculty member. This was implemented by using quarter course evaluation, periodic peer review, examining course syllabus, delivery techniques, etc. Finally, for teaching, 'quality of performance' would include alumni feedback. Research

is treated separately and the number of publications by the faculty is considered important in both the 'quality of design' and 'quality of conformance' parameters.

In the CIT case study, the 'quality of performance' parameter is being examined for the BEng course and hence alumni feedback is being considered. In the Mergen *et al* (2000) study, including 'quality of design' and 'quality of conformance' parameters causes the framework to become very wide. In this respect it is similar to the Owlia and Aspinwall (1998) framework. According to Koch and Fisher (1998), this very 'wideness' is a reason why Total Quality Management (TQM) has failed in many higher education institutions. Koch and Fisher (1998:660) suggest that TQM has only contributed to the improvement of administrative tasks in the higher education sector and this improvement has been largely offset by the time/effort expended. They continue by stating that employment security mechanisms amongst faculty are one of the major problems facing higher education in the developed world today and TQM does not address this issue. However, they provide no evidence to support this statement. They also confuse campus leadership with senior management. Research has shown that leadership in educational establishments very rarely emanates from the top (Ogawa and Bossert 1998:10).

Koch and Fisher (1998) continue by suggesting that the curriculum and academic life should be the focus of any higher education quality study. They claim that this is from where most of the problems in higher education will emerge. Kanji and Tambi (1999:129) reinforce this view when describing the UK Quality Audit Agency (QAA). The QAA use a framework of self-assessment, external review and benchmarking to cover such areas as: curriculum design; content and organisation; teaching, learning and assessment; student progression and achievement; student support and guidance; and quality assurance and enhancement. The audit results utilise a narrative style and Kanji and Tambi (1999:149) suggest that the QAA incorporate the Business Excellence model that they have developed, into the QAA framework. The Business Excellence model is a quantitative approach, that measures TQM critical success factors (CSFs).

Kanji and Tambi (1999:139) completed a questionnaire survey of 163 universities and higher education colleges in the UK to determine the CSFs. These are shown in appendix 2. If a higher education institution implements each of these CSFs to a large extent, then according to Kanji and Tambi (1999), it is a quality institution. Of these CSFs, the CIT study will be focusing on two: these are "external customer satisfaction" and "internal customer satisfaction".

In higher education the link between research, teaching and study, I would have thought, should be factor when considering quality. According to Clark (1992:3), the link originated in Germany, with the reform of Universities 180 years ago, when Wilhelm von Humboldt (1767-1835) brought together research, teaching and study. The result was that, towards the end of the nineteenth century, German Universities were models for other countries. Staufanbiel (1993:32) states that even today in the German state of Nordrhein Westfalen, the University law, based on the Humboldt principle, ensures the link between research, teaching and study is maintained. Staufanbiel (1993:33) points out that research offers numerous advantages for improving the quality of teaching, particularly by updating the curriculum from research. This contrasts with the system, which is prevalent in Irish Institutes of Technology. Because of the teaching workload of lecturing staff at these establishments, time for research is limited.

This link between research, study and teaching is also highlighted by the Quality Assurance Agency for Higher Education (QAA), which was established in 1997. It has responsibility for assessing the quality of higher education in England and Northern Ireland, under the terms of a contract with the Higher Education Funding Council for England (HEFCE). Their subject overview report (QO 11/98), concerning the Quality Assessment of Mechanical, Aeronautical and Manufacturing Engineering from 1996 to 1998, introduces some useful findings.

The QAA assessment consists of a self-assessment exercise and a three-day assessment visit. The assessment is carried out in relation to the subject

aims and objectives set by the provider. The QAA assessment looks at six aspects of provision:

1. curriculum design, content and organisation;
2. teaching, learning and assessment;
3. student progression and achievement;
4. student support and guidance;
5. learning resources;
6. quality assurance and enhancement.

The QAA report (QO 11/98:3) highlights the need for students to receive a sound understanding of engineering fundamentals, together with experience of their applications. In most of the institutions assessed, there were industrial advisory committees and these, together with research and consultancy activities of staff, inform curriculum design. This is the Humboldt principle or the link between research, teaching and study.

A reference to 'essential attributes' is also found in the report (QO 11/98:5). Among the objectives of mechanical, manufacturing and aeronautical engineering, a broad understanding of the fundamentals of the subject and the application of these to problem solving is stressed. In many of the institutions surveyed, the development of generic skills is also common. These include: oral and written communication; management; teamwork; information technology skills. Some institutions went further and stressed the development of personal attributes including: confidence, responsibility and an enquiring attitude needed to support continued learning and professional development. The undergraduate MEng programmes assessed by the QAA, stress the additional breadth and depth of knowledge of the discipline, such as increased industrial awareness and understanding of the place of engineering in the economic context (QO 11/98:5).

The UK BEng is of three years duration and there is an extra year for students who are deemed to be suitable as future chartered engineers. These students are awarded an undergraduate MEng after four years of study. The BEng degree in Ireland is a four-year course of study that academically qualifies the graduates for chartered engineer status. The CIT BEng

therefore, must be of the same standard as the UK MEng and must deliver the same essential attributes that are delivered by the UK MEng mentioned above.

These essential attributes are in line with those that were listed in the original research proposal, i.e. the ability to solve problems, a high level of mathematical ability, creativity, teamwork, knowledge of management subjects, self directed learning abilities and lifelong learning awareness. According to the report (QO 11/98:5), an industrial placement year, which some institutions require students to complete, is extremely valuable for enabling students to develop some of these attributes (personal skills, maturity, motivation for further study and preparation for employment). Close involvement of the educational establishment with industry was considered a very important quality factor by the QAA report. These contacts were considered useful in the design and development of the curriculum.

Other factors which the QAA highlight as having a positive effect on the quality of the institution were: - staff development and appraisal, peer review of teaching, double marking of student reports and assignments. Factors which the QAA highlight as having a detrimental effect on quality of the institution were: - lack of intellectual challenge of final year assessments, student absenteeism and late arrival of students. The QAA, therefore, appears to concentrate on student learning as the quality issue and using this learning to develop essential attributes.

Haworth and Conrad (1996:46) also concentrate on student learning and criticise the normal assessments that educational establishments use to indicate quality. They discuss a new view of quality that makes learning central in evaluating quality of educational programmes. The normal educational establishment assessment methods usually examine five propositions: -

1. faculty quality; 2. student quality; 3. resource quality; 4. rigour of curriculum; 5. relative strengths of faculty, students, resources and curricular requirements.

However, Haworth and Conrad (1996:48) maintain that there is no evidence showing that these quality indicators have significant connections to student learning.

Haworth and Conrad (1996:51) introduce five high quality programmes, which they claim enrich student-learning experience. These are "diverse and engaged participants", "participatory cultures", "interactive teaching and learning", "connected programme requirements" and "adequate resources". The first of these programmes "diverse and engaged participants" refers to the investments that faculty make in the learning of their students by devoting time and energy to classroom preparation and teaching. The second of the programmes, "participatory cultures", refers to faculty and administrators, who are serious about quality, actively seeking to develop and sustain collegial and supportive cultures. "Interactive teaching and learning" refers to high quality programmes that are constructed around an interactive model of communication in which faculty, students, administrators, staff, alumni and employers actively contribute to the learning of each other. The fourth programme, "connected programme requirements" refers to faculty and administrators regularly evaluating the knowledge, skills and practices that they expect students to learn. In the light of these, they then produce the required core and specialised coursework. Finally, "adequate resources" refers to both monetary and non-monetary support for students or faculty. Thus adequate resources can do much to facilitate their engagement in the learning process.

The difficulty with these high quality student-learning programmes is the measurement of their effect. The learning process is a difficult process to assess. According to Haworth and Conrad (1996:55), nearly eight hundred interviews were analysed from which the five high quality programmes derive. The interviews were conducted with stakeholders in masters level education. The CIT research programme, by assessing the essential attributes delivered by the BEng course, is also attempting to assess the learning process, but in undergraduate education. Similar research methods are to be used, so it will be interesting to compare the results obtained with those of Haworth and Conrad.

The Haworth and Conrad (1996) study is based on interviews with nearly eight hundred students. It is not clear from the paper whether they used software or index cards for interview coding. In the CIT study, QSR NUD*IST version 4 software (N4) is used for coding of the interview and observation transcripts. NUD*IST stands for non-numerical, unstructured data, indexing, searching and theorising. This software is produced by the Australian company "Qualitative Solutions and Research" (QSR). A review of Gahan and Hannibal (1999) shows that N4 can be useful for:

1. Sorting data into themes;
2. Making categories for thinking about the data;
3. Using the categories to code the data;
4. Exploring the data;
5. Recoding the data;
6. Managing the data.

Software utilisation is examined in more detail in chapter 3.

If we examine the conceptual map, shown in figure 2.1, it can be seen that the box numbered 2 contains the IEI submission (i.e. the Bachelor of Engineering in Mechanical Engineering, Submission to the Institution of Engineers of Ireland for Re-accreditation of the Degree Course in Mechanical Engineering at Cork Institute of Technology, April 2000). This is a document produced by the CIT department of mechanical engineering describing the philosophy and giving details of the BEng course. From the conceptual map, it can be seen that box 2 falls within the microquality rectangle of the conceptual map. Hence a review of the document starts to address the question proposed by Scott (1998:104): "Are we doing the thing right?" We are starting to examine the fitness for purpose of the course. Previous documents have fallen outside the microquality rectangle, but within the macroquality rectangle of the conceptual map, in which case we were addressing the wider debate on engineering education and looking at possible standards of excellence. So, up to this point, we have been addressing the other question proposed by Scott (1998:104): "Are we doing the right thing?"

The IEI submission (2000:1) starts with a preface, which briefly describes the history and development of Cork Institute of Technology. The mission

statement of CIT (appendix 3) is also described and a feature of this is the commitment to research, creativity, as well as the importance of industry links. The document describes how the mission statement underlies the academic plan and the ethos of CIT (appendix 3). The IEI submission highlights the commitment to "quality", described in the CIT ethos, although no definition of quality is provided. Also highlighted and again described in the CIT ethos, is the "co-operative, collegial effort to build a stimulating environment in which students and staff develop their capabilities together". This could be a reference to a link between research, teaching and study (Humboldt principle).

It is interesting to note from the many statistics given in the IEI submission (2000:3), that 41% of full time students at CIT, are involved in engineering disciplines. The document continues by describing how the promotion of Research and Development (R&D) is a vital part of the CIT mission, with the emphasis being on applied research. An R&D committee functions as a specialist committee of the Academic Council (appendix 3), advising on policy, planning, implementation and resourcing. A Research Charter has been developed to further this aim. This Research Charter is included in the CIT Quality manual.

According to the IEI submission (2000:4), R&D at CIT is organised in two ways: -

1. *postgraduate research programmes at Masters and Doctoral levels;*
2. *through a number of specialist centres and units.*

Some recent academic developments at CIT are described in the IEI submission (2000:4), including the recognition by an International Review Group (IRG), appointed by the Minister of Education, that:

1. CIT should make its own awards;
2. CIT makes a strong contribution to the Cork region through research, consultancy, as well as providing a facility for lifelong learning;

3. there is a concern for quality at CIT, which has been demonstrated by the recent publication of a CIT Quality Manual.

The document continues with a description of the main CIT disciplines/areas of study, principle areas of research, library facilities, computing facilities, international links and student services.

A description of the Department of Mechanical and Manufacturing Engineering, which runs the BEng course, highlights a student staff ratio of 12:1 (IEI submission 2000:10). No derivation of this ratio was given in the document, but for some teaching on the course, this figure appears to be higher. Lifelong learning for industry, as well as staff, is mentioned as being supported by the wide range of part time courses run by the Department.

The BEng course is described in the document, as "aiming to produce broad based Mechanical Engineers of high academic standard to meet the needs of Irish and international industry". The broad nature of the course and an emphasis on management subjects is highlighted. Industrial work experience is mentioned in the document as being encouraged at the end of year three of the four-year course, although a minority of students attempt this. The engineering project in year four is allocated on an individual basis and is described as requiring research, design, prototype development and experimental verification.

Following recommendations from previous IEI panels, who review the course from time to time, course improvements are described in the IEI submission (2000:11) as "a greater emphasis on problem solving and design; communications and team working skills; information technology and computing" A departmental five year academic and financial plan was also recommended by previous IEI panels and this has been included in the document.

There are two five-year plans described in the IEI submission (2000:12). The first is for the period 1995 to 2000. The second is from 2000 to 2005.

Included in the first plan are details of student intake, staffing, facilities, research and capital expenditure. Under the heading 'staffing', it is interesting to note the emphasis given to (indicating the importance of) the consulting or industrial experience of staff. Under the heading 'research', another interesting point is the claim that a 'reasonable level' of research has been in progress in the department from 1995 to 1999. It is difficult to define what a 'reasonable level' of research means.

The second five year plan (IEI submission 2000:15) includes details of the proposed building programme and some general information concerning course marketing, renewed research emphasis, other colleges/industry links and an 'Institutional review'. The 'Institutional Review' is intended to include such topics as: - 5-year degree, semesterisation, mandatory industrial placement, CIT quality system. Future policy is expected to emerge from this review.

The IEI submission (2000:22) continues by discussing the possibility of subject options concluding that these will be given further consideration in the 'Institutional Review'. It is proposed that the subject 'German' will be offered as a non-credit option, as it has been dropped as a compulsory subject. The planned aeronautical engineering option has also been dropped.

The importance of communication skills, including teamwork and presentation skills, is highlighted in the IEI submission (2000:23), with the commitment to more formal tuition in this subject. Industrial training and its relevance to achieving chartered engineer status are also discussed, although few students avail of industrial training during the four years of the course.

The importance of staff development is recognised in the IEI submission (2000:24). Future development of the BEng course is discussed in the IEI submission (2000:26) with a commitment to develop creative, critical, problem solving and communicative skills in the students, through the integration of research, teaching and study. This is a direct reference to the Humboldt principle and appears to be a standard, which is targeted for the future. Staff development and developing research are some of the

challenges that the Department has to meet in the future. The need for effectiveness and efficiency is also discussed with performance tracking using the 'points level' of students at entry, to retention rates/award at exit. While these quantitative approaches are useful, more qualitative methods of effectiveness are not discussed.

The IEI submission (2000:28) also briefly describes the CIT Academic Quality System, which is more fully described in the CIT Academic Quality manuals. These manuals have been coded using N4 software and are discussed in chapter 3.

The remainder of the IEI submission describes course promotion, course content including the subject syllabi. Details are also given of entry standards, teaching staff, examination procedures, facilities, research/consultancy and graduate employment. Research and consultancy is described in appendix G of the IEI submission. This shows the departmental research undertaken by each member of staff involved in the BEng course, but does not indicate a link between research, study and teaching.

Course effectiveness evaluation:

The literature reviewed so far has been influenced by the conceptual map shown in figure 2.1. Thus the literature review has tended to concentrate on engineering higher education. One of the aims of this research is to produce a method of course effectiveness evaluation suitable for any course. To ensure the originality of the essential attributes approach, it is necessary therefore to review the literature concerning other methods of course effectiveness evaluation and the general rationale behind all of them.

The effectiveness of a course at achieving its original objectives is probably best measured by feedback from stakeholders. The effectiveness of those who plan and adjust these objectives is again best measured by continuous feedback from stakeholders. Even if the course aim is constant, the objectives that must be achieved before that aim is reached can change. For example, a course aim could be to produce graduates with the necessary

attributes to become professional engineers. However, these attributes can change as the job market changes. It is desirable therefore for each course to have methods of course effectiveness evaluation, which continually obtain feedback from stakeholders. Thus, those who are responsible for courses are provided with information that allow the necessary adjustments to be made. There is also pressure from governments encouraging higher education to become more accountable. Watson (2000a:9) describes some of the arguments received by the New Labour UK government from the NCIHE Dearing Report (1997). Highlighted are the following ideals as in need of attention:

the contribution of higher education to an integrated system of lifelong learning;
a new vision for teaching and learning in higher education;
funding research properly and according to its intended outcomes;
the new compact between students and their sponsors, institutions and government (representing the national interest)

Also described by Watson (2000a:9) is the DfEE Green Paper (1998) setting out a vision for higher education in the UK, which includes:

providing more places to meet demand;
offering a wide range of courses up to postgraduate level;
ensuring high standards so as to enhance the employability of graduates;
improving participation by offering opportunities later in life to those who missed out the first time around;
contributing to the economy and being more responsive to the needs of business;
collaborating effectively with other institutions, other learning providers and the world of work;
making itself more accessible by exploiting new technology and flexible delivery with facilities available at times convenient to students.

The Irish Department of Education and Science (DES) produced a strategy statement in 2001, which has a similar vision. The DES strategy statement (2001:6) describes how quality-learning outcomes are vital for employment. The rapidly changing economic and social environment is considered by the strategy statement (2001:9) to require a much wider range of personal qualities, as well as teamwork and communication. Providing a framework for motivation to learn is considered a necessary objective, together with lifelong learning. Partnerships between business and Higher Educational Institutions (HEIs) are considered necessary as they should enhance high quality learning outcomes, thus helping develop a wide range of personal qualities, teamwork, communication, learning framework, lifelong learning, etc. (DES strategy statement 2001:16). Both the UK and Irish strategies envisage lifelong learning as a challenge for the future. Both see the enhancement of the employability of graduates, by ensuring high quality learning outcomes, as another future challenge. Course effectiveness evaluation techniques should ensure high quality learning outcomes. It is a function of the essential attributes approach of course effectiveness evaluation to examine courses for these high quality-learning outcomes.

For students in the UK, the increasing cost of participating in higher education, together with the sacrifices they must make in order to participate, encourages them to demand customer rights, among which is the accountability of academic staff. Watson (2000b:77) points out that most students, especially those who have paid considerable fees, are keen to be, not just customers of their HEI, but members. Hence some wish to take part in strategic development. Students who wish to obtain a voice in the development of their course can be assisted by a course effectiveness evaluation technique, such as the essential attributes approach. This approach should ultimately give students and indeed other stakeholders, including academic staff, this voice.

Baker (2002:3) describes how in the USA, there has been a decline of public confidence in the ability of HEIs to authenticate the achievement of results. There is public scepticism concerning the relevance of traditional degrees as effective measures of intended outcomes. Public values are now regarding

higher education as an economic resource model that requires a direct return on investment. Hence, as in the UK, the US public demand accountability. To cope with this demand, Baker (2002:6) describes how the traditional methods of accreditation in the USA are expanding their accreditation criteria to include an emphasis on the achievement of outcomes. HEIs are expected to document how data is gathered, evaluated, informs planning and results in improvements to educational programmes. With all this external pressure on HEIs, Watson (2000a:10) envisages competition between models of quality assurance in institutions delivering professional higher education. Competition between frameworks of responsibility for quality assurance is also envisaged. This he predicts will have a negative effect on the esteem of HEIs, as the collaboration between professional bodies and academic staff could be restricted. Again this should emphasise to HEIs, the importance of implementing an independent model of course effectiveness evaluation, such as the essential attributes approach, which should monitor the quality of their courses.

Examining parallel developments of quality assurance in two fields (higher education and environmental policy), Huitema *et al* (2002:198) discuss the variety of European higher education quality assurance arrangements. With most national systems based on the four stage model of external evaluation (co-ordinating agency, self-evaluation report submission, peer visit, public report), the design of a 'next generation' of quality assurance in higher education is developing in some western European countries. A successful first round of evaluation can result in routinisation, bureaucratisation and window dressing at the second round. Huitema *et al* (2002:200) therefore suggest quality assurance systems with a built in facility for positive change and presents a four-phase model. In phase 1 of the model, the government asks the central question:

Does the system, institution or programme satisfy the existing requirements for quality?

In phase 2 the government opens up higher education to public scrutiny by asking whether the system, institution or programme meets the required standards within the prescribed budget. Having met the accountability demands, the question posed in phase 3 is:

Are the traditional and implicit definitions of good quality adequate for the purpose of maintaining good performance?

Huitema *et al* (2002:202) argue that at phase 3, HEIs no longer try to solve quality assurance problems defined by government, but redefine their own problems and start to self regulate. Questions about equal access, flexible workforce, national culture, sustainable education system, etc. are now addressed by HEIs. The compatibility of the strategic goals of HEIs with societal demands is examined at phase 3. To ease public scrutiny, phase 4 ensures that the rules and procedures of these now more autonomous HEIs, are transparent.

In this four-phase model of quality assurance, the essential attributes approach could be useful at the phase 3 stage, by redefining goals of some higher education courses. It is interesting to note that Huitema *et al* (2002: 212) recommend that lessons should be learnt from environmental policy and all major stakeholders should be involved in decision-making. This is already an aspiration of the essential attributes approach.

The Bologna Declaration (1999), which aims to enhance the international competitiveness of the European higher education system, is also discussed. However, according to Huitema *et al* (2002:213) this declaration will not develop the four-phase model of quality assurance, because of the reaction of national governments wishing to focus on unsophisticated phase 1 accreditation mechanisms. Thomas (2001:219) comments on the number of studies, which indicate how national governments should individualise evaluation and accreditation systems to take account of local cultural or national factors. The essential attributes approach, by including interviews with past graduates most of whom obtain employment locally, has this individualistic feature.

In Ireland the cost of participating in higher education has decreased in recent years, with the introduction of free fees. There does not seem to be the same 'accountability' demands on the Irish higher education sector as in the UK. However, recently the Irish government, owing to financial

constraints, has been considering re-introducing higher education fees. It is important therefore for Irish HEIs to seize the initiative, by implementing a course effectiveness evaluation model, such as the essential attributes approach. Hence, they can criticise themselves before this criticism becomes the responsibility of others. Seeking out the views of course stakeholders and subsequently adjusting the course to take account of those views could be a way forward.

Looking at the course effectiveness evaluation methods that are in use at present, it is interesting to note that most of them use questionnaires as their method of obtaining data. Nestel (2002:301) describes how at Imperial College in London, two evaluation methods were used following a three week 'social medicine' module. One method involved discussion of the course with focus groups. These consisted of small groups of students and a facilitator, usually the course organiser. Another method utilised evaluation forms that the students were requested to complete. Nestel (2002:305) concludes that, in terms of subsequently improving the course, the feedback provided by the focus group was of higher quality. This is because the method gave the facilitator the opportunity to probe more deeply, thus obtaining more useful information. The essential attributes approach, has also found that group interviews involving two students presently completing the course, provides high quality feedback. The essential attributes approach, however, intends to go further than just examining the intended outcomes of the course. Interview techniques are used which generate data from past graduates, employer representatives, lecturers, non-completing students, as well as students presently completing the course. Thus the intended outcomes of the course can be examined and also future outcomes, suggested by stakeholders, can be considered.

MacAlpine (2001:564) describes a teaching evaluation index comprising of a weighted sum of three indicators: student feedback questionnaires, in class peer evaluation and teaching portfolio quality. The teaching evaluation index is aimed at providing a reliable indicator of the teaching ability of lecturers at the Hong Kong Polytechnic University. This, taken along with the research output of the lecturer, would provide the basis for assessing

promotion prospects. However, it is not clear from MacAlpine (2001:577) whether the assessment of the teaching portfolio takes account of a link between the research and the teaching of the lecturer, which would ultimately influence the study content of the course.

Coffey and Gibbs (2002:383) describe an attempt to measure the effectiveness of teacher training at producing 'reflective practitioners'. A measure of a 'reflective practitioner' would be the variety of teaching methods implemented. Coffey and Gibbs (2001:385) measured the teaching methods used before training and following training at UK HEIs. They found no significant increase in the variety of teaching methods used. Coffey and Gibbs (2002:386) concluded that the research questionnaire used was defective and hence suggested improving some questions. An approach using qualitative interviews might have yielded more accurate results.

Ballantyne *et al* (2000: 222) describe student evaluation of teaching effectiveness at an Australian university. Two formal systems exist at Queensland University of Technology (QUT), i.e. Student Evaluation of Teaching (SET) and Student Evaluation of Units (SEU). Each system consists of a structured questionnaire that students complete during their classes. Lecturers who wish to evaluate their own teaching chose SET and results were confidential to that lecturer, who decided on any necessary follow up action. The second system, SEU, is used by the QUT Teaching and Learning Plan to evaluate a unit. SEU is used to evaluate each unit at least every five years and results are supplied to the Dean of the faculty in which the unit is offered. Attempts are being made at QUT to link these two evaluative systems to staff development. To measure staff and student perceptions of the need for academic development and course improvement, Ballantyne *et al* (2000:223) produced a questionnaire based on the SET and the SEU questionnaire. Selected staff and selected students across eight faculties received questionnaires, but responses were received from only 87 staff (24%) and 127 students (34%). These low response rates for questionnaires, are a considerable erosion of the original sample and poses a serious threat to the validity of the results. My previous experience of

utilising questionnaires gave similar response rates and this is one reason for choosing to use qualitative interviews as a research instrument. Other reasons are that question ambiguity can be avoided and, with practice, the approximate number of interviews can be predicted more accurately from the start of a case study. However, Ballantyne *et al* (2000:232) focused very much on enhancing teaching and learning and a series of ten booklets was produced. These enabled staff to address the problems identified by student evaluation data.

Spencer and Schmelkin (2002:398) undertook a study to determine student attitudes towards evaluation at the Hofstra University, New York. Again they used Course and Teacher Rating (CTR) questionnaires, but this time managed to obtain a 71% response rate. Interestingly, one of the findings was that the longer students had been on campus, the less idealistic they became about the usefulness of CTRs. The older students would therefore be more likely not to complete questionnaires or at least not take them seriously. By using qualitative interviews rather than questionnaires, attitudes of respondents could have been explored more deeply.

Hernon (2002:228) makes the point that survey response rates need to be at least 50% to carry any credibility with some state governments in the USA. They describe questionnaire design guidelines, which will assist in promoting high response rates. However, Hernon (2002:226) also points out that marketing researchers frequently use focus group interviews to determine the purchasing patterns of the general public. According to Hernon (2002:225), marketing research is also guided by the 'Gap Model of Service Quality'. One perspective of this model attempts to meet or exceed the expectations of customers. The essential attributes approach uses a similar technique. Analysis of gaps between the course literature derived data and that derived from the wider debate documentation can reveal whether standards of excellence are achieved on paper. Analysis of gaps between these documents and the views of stakeholders could produce a different picture.

Welsh *et al* (2001:393) emphasise the need for HEIs to collect data on how students, alumni, employers, faculty and staff perceive the quality and effectiveness of programmes and services. At the University of Louisville in the USA, a quality measurement system (QMS) surveying these groups is described by Welsh *et al* (2001:394). The QMS system uses questionnaires to obtain data. These questionnaires are developed with the assistance of Dey Systems, which is a Louisville company that specialises in survey processing instruments and database creation. The company relates survey data to existing university information. Dey Systems representatives and project team representatives interview focus groups of faculty from each programme, as well as staff from each unit, in order to identify the topics and issues to be included in the questionnaire. According to Welsh *et al* (2001:397), QMS incorporates an automated process for data collection, management and analysis. An indication of the response rate to the questionnaires for each group of respondents, would have given an indication of the popularity of the QMS system, but this was not provided. The groups surveyed, are indeed similar to those interviewed in the essential attributes approach. The difference being that the essential attributes approach also attempts to collect data from students who do not complete the course.

Baba *et al* (2001:162) describe how quality control in corporations takes account of process control, as well as outcomes:

The basic concept is that defining and monitoring the process would automatically lead to improved quality of the output.

Baba *et al* (2001:165), suggest that a process of market research will improve quality control at Universities. Communication with school students, parents, firms, society, etc. is suggested as a possible way forward. Thus process control, in addition to the traditional approaches of entrance control and exit control, is proposed by Baba *et al* (2001:165). The essential attributes approach is designed to be a technique of course effectiveness evaluation which looks at the process, as well as inputs and output factors of a course. It does not discuss the course with school students or parents, but it does attempt to discuss the course with the output of the course, such as

past graduates, some of the input to the course such as the non-completing students and some of the 'process material' of the course, such as the students presently completing the course. The approach attempts to discuss the 'course output' with employer representatives, who use the course 'output product'. Discussions with course lecturers, who Baba *et al* (2001:166) describe as the machinery that operate on the 'input material' of the course to produce the final product, is also a planned feature of the approach. It is interesting that process control does not appear to be in use by any HEI.

Starapoli (1991a:50) discusses various approaches to evaluation in higher education. One of the models described is a pairing of 'users' and 'peer evaluation'. So uniting the peers or the evaluators (the most eminent members of the scientific and academic community) with the 'users' (students, families, business enterprises) and comparing how their views of the quality concept differ, should produce dividends in the evaluation process. Starapoli (1991b:96) is particularly in favour of peer evaluation, when it comes to research evaluation. Emphasising the need for a strong qualitative element in the evaluation of the quality of research he remarks upon the unreliability of statistical methods in this area. There is some similarity between this approach and the essential attributes approach. Qualitative techniques and the views of 'users' are common to both approaches. However, the essential attributes approach does not go so far as to discuss the course with 'peer evaluators', although this could be achieved by presenting a conference paper on the essential attributes approach, following which there could be many questions. It is interesting to note that this method does not appear to be in use by any HEI. So the last two methods, 'users and peers' and 'process control', both of which advise the use of qualitative techniques for gathering data, do not seem to be used by any of the HEIs. Can the essential attributes approach succeed in establishing itself as a usable model?

Pounder (2000:82) describes the 'Competing Values Model of Organisational Effectiveness' and how this may be applied to higher educational organisations. In a test carried out in Hong Kong HEIs, self-assessment scales in four effectiveness dimensions (cohesion, productivity-

efficiency, planning-goal setting, information management-communication,) were used. These four effectiveness dimensions were developed from the nine contained in the 'Competing Values Model'. The model applies to the whole organisation and the treatment is quantitative. The scales are set for each of the dimensions and in the Hong Kong test, participants (162 academic and administrative staff) rate the organisation on each scale. Pounder (2000:88) recommends the model for comparative assessments of HEI effectiveness. From a student point of view, the competing values model examines the whole HEI for effectiveness and usually most students are interested in one course. Courses vary to such an extent that a set quantitative scale would not pick up unexpected student criticisms of the course. A qualitative approach to course effectiveness evaluation may therefore be more suitable.

Belfield and Fielding (2001:589) investigated the relationship between educational resources and labour market outcomes for higher education graduates in the UK. Educational resources included staff, equipment, and general expenditures. Labour market outcomes were graduate earnings. The hypothesis tested was:

a statistically and substantively significant positive relationship exists between the amount of resources devoted to higher education and graduates' earnings.

(Belfield and Fielding 2001:589)

Utilising university statistical records and postal survey data of past graduates, Belfield and Fielding (2001:592) could find no substantively significant results to support the hypothesis. It was interesting to note that no other conclusions could be formulated from the data. If a more qualitative approach had been undertaken using 'thick description' or a deeper probing of the past graduate careers, then maybe other educational theories could have been derived and use made of the data, because a lot of work went in to its production.

In a study of economics students in the USA, Becker and Powers (2001:387) found that initial class size is negatively related to learning. Using instructor questionnaires, student questionnaires and course data,

Becker and Powers (2001:378) found that students in larger classes were more likely to withdraw from the course before taking the final test, than students in smaller classes. It was speculated that reasons for withdrawal could be that:

1. students in large classes get less attention from teaching staff and are less likely to bond with other members of the class;
2. large lecture halls can make students feel detached;
3. disruptive students can sometimes convey a congestion effect, which increases with class size.

Some of these large class size points have already emerged from qualitative interviews conducted as part of the CIT case study.

It is interesting at this stage to try and predict the ultimate results of this CIT case study, by examining some higher educational problems highlighted by the literature. Katz (2000:20) describes the latest UK review of the engineering profession, which took place in 1997. An MEng qualification following four years of study was introduced and this qualification would fulfill the academic requirement for Chartered status in the UK. The BEng qualification, following three years of study, would then satisfy the academic requirement for Incorporated status. Katz (2000:20) suggests that these changes were triggered by:

the internationalisation of standards;
a perceived dilution of entry mathematics standards;
a mass higher education system requiring other appropriate exit points;
doubts about equivalency across the universities;
the emergence of occupational standards.

Implementing a model, such as the essential attributes approach should allay doubts about the equivalency of a BEng course, because past graduates should be in a position to state how they compare with graduates from other HEIs working with them. The four-year BEng course is still the academic requirement for Chartered status in Ireland and should be comparable to the UK four-year MEng course. Many CIT past graduates are employed in the

UK, so interviews with these graduates should give some interesting results on the internationalisation of standards.

Katz (2000:20) continues by suggesting that the learning process within engineering higher education tends to be the transmission model. This is described as being a didactic style with lecturers very much in control. Criticising this style, Katz (2000:28) maintains that generic skills are poorly developed, with scant regard taken of autonomous learners, student experiences, personal or emotional maturity. A more proactive approach to student difficulties is suggested, rather than the remedial response provided by the transmission model. Bolton (2000:83) describes how it is common in HEIs for staff development to be ineffective. Neglecting staff development is described as bad management and can be open to criticism from quality assurance bodies. Evaluation of staff training and development is an equally important procedure and could be included in staff appraisal activities. This raises the question: how common is staff appraisal in HEIs? Staff appraisal, training and development are emerging from the CIT case study as needing attention.

Bolton (2000:96) also considers staff development as the key to the maintenance of academic standards when he describes the management of quality in UK HEIs. The reluctance of these HEIs to introduce systems for the management of teaching quality is considered by Bolton (2000:93) to have encouraged the development of external quality auditors, such as the Quality Assurance Agency (QAA). However, Bolton (2000:93) bemoans the fact that these external academic audits compare policies with practices, but can neglect what is actually taught. They can also neglect the importance of non-documented scholarly dialogue. The inability of academic audits to appreciate this dialogue is given by Bolton (2000:96) as the reason why Oxford and Cambridge receive such negative audit reports. Bolton (2000:98) suggests that satisfying the criteria, which appear on a quality agenda, should not prevent academic leaders from implementing innovative ideas for assessing quality.

The essential attributes approach could be one such innovative idea, which utilises two definitions of quality, viz. 'fitness for purpose' and 'standards of excellence'. Barnett (2000:99), when looking for a suitable ethos for universities, describes the concepts of 'quality' and 'excellence' as empty concepts. He describes them as:

*contained within ideologies that are hardly up for
debate* (Barnett 2000:117)

Citing the UK Quality Assurance Agency as forcing through a proposed policy, which was resisted by the higher education sector, Barnett (2000:179) maintains that the criteria and procedures they produce demand compliance. However, Barnett (2000:105) describes how universities have a responsibility to make possible systematic self-scrutiny within themselves. He maintains that this scrutiny should cause universities to creatively generate new perspectives for their activities. Hence, as part of this self-scrutiny, there is nothing stopping universities from producing their own definitions of 'quality' and 'excellence'.

HEIs could have their own course effectiveness evaluation systems in place, as well as responding to external bodies, such as the QAA. When problems, such as deficiencies in academic staff are highlighted, solutions could be provided. Describing the professionalism of academics in education, Watts (2000:13) states that they need both educational expertise and subject expertise to be truly professional in terms of their specialist knowledge base. Autonomy of academics has recently been threatened by an emphasis on accountability. Academics regard accountability as an external control mechanism. The implementation of appropriate support services should help in reducing the fears of academics. Harrison (2000:194) describes academic support services in HEIs, the main purpose of which should be to provide an educational development service. Among the main aims that are suggested, are the provision of staff development short courses and an educational development consultancy service. Eastcott and Farmer (2000:214) describe how most HEIs in the UK, now run programmes to develop the teaching role of lecturers. The Staff and Educational Development Association (SEDA) accredit some of these programmes in the UK. Academic support services could be a recommendation that the essential attributes approach

will eventually propose, emphasising the importance of staff training needs assessment and staff development needs assessment.

A course effectiveness evaluation technique, such as the essential attributes approach should also indicate the type of education received by the graduates. Waghid (2000:262) describes three educational paradigms - behaviourist, interpretive and critical. The behaviourist paradigm, when applied to engineering education, is described as simply depositing information in passive receptacles. The form of teaching is very didactic with the lecturer as an expert operating in lecture mode. There is no time for complex mental tasks, such as synthesis, analysis or evaluation. In contrast, the interpretive paradigm concentrates on self-understanding of the individual. Methods include inquiry and experiential learning involving non-rote, experiential and non-prescriptive learning. The educator is seen as the facilitator and evaluation methods are qualitative. The critical education paradigm is described by Waghid (2000:263) as striving to engender self-reflective enquiry amongst individuals. In engineering education, the critical approach should be concerned with an expression of the needs of society, collaborative learning and dialogue. Qualitative evaluation of the entire learning process by learners is the aim of the critical approach. The learner engages in experience, reflection, restructuring. This is called 'reflexivity' or 'reflection in action'. The essential attributes approach, with its emphasis on qualitative interviews attempts to investigate how far the education process has gone in reaching the critical education paradigm.

Kirpotin (1999:417) describes how at Tomsk University in Russia, a more active approach to teaching was developed and the problems, which emerged. A more open, friendly, flexible, unauthoritarian attitude was required from teachers and some teachers found this difficult to achieve. When major emphasis is on the activity of students, there is a danger that students will not take the time for the serious preliminary study required. Active learning can then end up as superficial discussion or frivolous games. On the other hand, the teacher may not develop the course adequately and can inappropriately place too much responsibility onto the students to self learn and self understand. At the end of the active learning

session, students like to receive from the teacher, a summary and generalisation of the discussion results. Thus active methods of teaching are more psychologically demanding and more difficult than traditional approaches, particularly for the teacher. Brockbank and McGill (1999:5) introduce the concept of 'reflective dialogue' when attempting to use transformatory learning, rather than transmittive learning, with students. 'Reflective dialogue' is a process where teachers and learners together, actively reflect upon the course material. A dialogue takes place between them and conditions are created for critical reflective learning to take place. Some training in these methods would be advantageous for the teacher and this could eventually be a recommendation of the essential attributes approach when applied to a course.

Investment in employee training and development is supported by Finegold *et al* (2002:155), who state that research indicates that there is a strong case for investment in employee development both in terms of shareholder value and financial performance. The American Society for Training and Development found that firms that spent the most on training outperformed the Wilshire 5000 index by 6.5%. The firms in the bottom 20% in training expenditure earned significantly lower than average returns for shareholders. Finegold *et al* (2002:161) also point out that tuition reimbursement should only be one element in the overall development portfolio, which supports individual and organisational learning. Tuition reimbursement should complement on-the-job development, job assignments/rotations, mentoring, company training courses and other means.

Barnett (2000:163) describes the relationship between teaching and research in higher education, by introducing a concept of supercomplexity. He discusses how lecturers can bring into the pedagogical situation a dimension that comes from coping with supercomplexity.

We are in a situation of supercomplexity when our frameworks for making the world intelligible are in dispute. (Barnett 2000:75)

This dimension is that which researchers are having to deal with on a daily basis. Introducing this dimension into teaching brings about supercomplexity in the minds of the students and enables them to effectively deal with their own personal supercomplexity. Hence the Humboldt principle, or the link between research, teaching and study has been taken as a standard of excellence for the CIT case study. Eastcott and Farmer (2000:210) also describe the impact that research into student learning is having on the way lecturers approach teaching. Two extremes to learning are described. The first is the deep approach, in which the students learn to make sense of the material. The second is the surface approach, in which the students learn to reproduce the subject matter. An assessment system should award marks to the outcomes of a deep approach and ensure that students who adopt a surface approach obtain low marks. Bourner *et al* (2000:236) describe how in the past, this type of research has had little impact on professional practice. According to Bourner *et al* (2000:235), for practitioners to decide whether they can use the research results of others to improve their own practice, it is important that the values and beliefs of the researching practitioner are expressed clearly in their research report. However, it may be the effect of student appeals procedures, which has influenced the reasoning behind non-implementation of new assessment systems.

Employer representatives are one of the stakeholders intended to be interview respondents in the essential attributes approach. Brown and Scase (1997:89) describe how employers require employees with good interpersonal skills to cope with the new demands of the flexible organisation. Hence, the new universities in the UK encourage their undergraduates to develop leadership, team working, creativity and entrepreneurialship. These new university courses have become more project focused requiring students to work both independently and in co-operation with others. However, according to Brown and Scase (1997:93), UK employers think that the best intellectual talent is obtained from the élite 'old universities'. This research indicates that there is evidence to suggest that the élite 'old Irish Universities' are similarly regarded by some Irish employers.

Scott (1997:45) maintains that, because of the volatility and ephemerality of the post-fordist society, the post-welfare state and the growth of mass education, graduates of the future will need to be educated in novel ways. Thus, they should be provided with the skills of lifelong learning, which develop curiosity, flexibility and adaptability. They should also develop a mentality, which is ironic, intuitive and instantaneous. Ball (2000:203) describes a model for viewing personal and professional development as an integral part of the higher educational experience of students. With the unpredictability of the economy these days, responsibility falls on the individual, rather than the employing organisation, to manage their personal development and career progression. Thus the skills of lifelong learning (self evaluation, practice, reflection, setting future goals) become essential for continuing personal development of the individual. Ball (2000: 204) describes how personal and professional development has become a core study in some academic programmes at the University of Brighton. The result of this approach has been that the role of the educator, becomes more of a facilitator, consultant and monitor of student performance. Hence Ball (2000:213) predicts that the student of the future will learn more as an individual, drawing on services offered, than from receiving a prescribed body of knowledge. The academic will become more of a practitioner-consultant, fostering the personal and professional development of students. The essential attributes approach can examine a course for the delivery of a 'lifelong learning capability' and where this falls short, recommendations for course improvement may include these changes in the role of the educator. Because of its emphasis on qualitative interviews, the essential attributes approach, when established and utilised for a few years, should be capable of detecting the changes in attitudes and mentality of graduates.

Albrighton and Thomas (2000:181) discuss how HEIs can create an image for themselves. However, an undeserved good reputation can do much damage to the image of the HEI in the long run. It is important therefore for HEI management to ensure that they have accurate information about performance, which can be passed on to those people concerned with external relations. Feedback from course evaluation systems, such as the essential attributes approach is useful in providing some of this accurate

information. Albrighton and Thomas (2000:191) continue by stating that this type of research should be conducted repeatedly, measuring the general reputation of the institution against defined objectives. The delivery of essential attributes by a course could be one of these objectives. Thomas (2000:36) describes institutional planning as the continuous and collective exercise of foresight in the integrated process of taking informed decisions affecting the future. Judgement about the future is obtained by blending ordinary management and extraordinary management. The essential attributes approach could be described as an extraordinary management exercise. Thomas (2000:37) continues by emphasising that the planning process is a management tool contributing to the decision making process, which should be geared to the objective of excellence in teaching and research. This is what the essential attributes approach is attempting to achieve.

As well as the essential attributes approach, more course effectiveness evaluation methods are now shown in the conceptual map outer box (figure 2.2). Comparisons show that the essential attributes approach attempts to obtain data from a range of stakeholders. Only one other method (QMS) has obtained data from a similar range of stakeholders. No other method reviewed has used similar software techniques for data analysis. It can be concluded therefore that the essential attributes approach has the potential to become an innovative method utilising software for the analysis of data obtained from qualitative interviews. As the literature review develops, the number of course effectiveness evaluation methods should increase and further conclusions can be drawn. The literature review also indicates that to develop essential attributes (problem solving ability, mathematical ability, creativity, team working ability, management knowledge, self directed learning ability, public speaking, information technology skills, individual project skills, individual flair, reasoning, etc.) in students, will require high quality staff. Many of these staff should be engaged in research, thus enabling them to introduce the supercomplexity and the deep approach to learning that comes from research involvement. Staff research, staff appraisal, staff training needs assessment, staff development, are all part of the foundations of a theory of essential attributes.

Figure 2.2 - Course effectiveness evaluation methods.

Definition of quality in education:

From the literature review, it can be seen that a practical method of examining quality in education has been developed. Using the concept of microquality, the fitness for purpose of the course can be determined. Using the concept of macroquality, the course can be compared with standards of excellence obtained from the wider debate on engineering higher education. As will be seen in chapter 4, standards of excellence can also be flagged by interview respondents, particularly past graduates. This group can also indicate the future way forward or strategic management of a course.

Total Quality Management:

Whereas Total Quality Management (TQM) is a very laudable objective, it has a framework, which is all embracing, resulting in time consuming implementation and assessment. The reviews of the Owlia and Aspinwall (1998) framework, the Long *et al* (1999) framework and the Mergen *et al* (2000) framework, show that these are also too wide for the practical quality assessment of a course by an educational institute. The essential attributes approach is more focused, thus enabling quality engineering course requirements to be assessed within a reasonably short time frame. The time frame mainly depends on the time it takes for completion and analysis of interviews/documentation.

Quality engineering course requirements:

From the literature review and the QAA report (QO 11/98), some of the educational establishments that were assessed, delivered to their graduates confidence, responsibility and an enquiring attitude needed to support continued learning and professional development. Others delivered increased industrial awareness and understanding of the place of engineering in the economic context. All of these can be considered as essential attributes. Chapter 4 shows that using theory building techniques, it is possible to produce causal flowcharts, which indicate the conditions necessary for producing essential attributes in students and the conditions necessary to strive for excellence. As well as these conditions, causal flowcharts are developed in chapter 4, which show the factors that impact on essential attributes and supportive standards of excellence. These factors

and supportive standards of excellence develop a course, which is fit for purpose or strives to achieve engineering excellence. Chapter 3 develops the concept of a 'sustainable world' as the equivalent of engineering excellence. Chapter 4 indicates the extent to which CIT past graduates, feel that these essential attributes are important and provided for in the BEng course. Also in chapter 4, analysis of CIT past graduate interviews highlight some quality factors that are not mentioned in any of the documentation. Thus the past graduates are emerging as the predictors of the standards of excellence and not the QAA as originally thought.

The QAA report (QO 11/98) considered that close involvement of the educational establishment with industry were useful in the design and development of the curriculum. Staff development and appraisal, peer review of teaching, double marking of student reports and assignments were other quality indicators, although not essential attributes. Detrimental to quality were the lack of intellectual challenge of final year assessments, student absenteeism and late arrival of students. These quality factors are further clarified and developed by analysis of documentation using NUD*IST software version 4 (N4). This is described in the chapter 3.

Quality course requirements:

One of the objectives of this research is to develop the essential attributes approach so that eventually it can be applied to any course. Some essential attributes are generic and will apply to many job situations and many professions. The only way to determine which essential attributes a course should deliver to students, is to go through the essential attributes approach procedure of analysis of course documentation, wider debate documentation and interviews with stakeholders. The same applies to standards of excellence. In the case study of the CIT BEng course, engineering excellence has been developed in chapter 3 and emerged as the concept of a sustainable world. This concept of excellence may not apply to other disciplines. Each discipline would require a similar amount of research as the CIT case study to determine its own concept of excellence. A course would require a similar amount of analysis as the CIT case study, in order to determine the essential attributes and the standards of excellence necessary

to strive towards a chosen concept of excellence. It is probable that students of various disciplines have differing types of intelligence and therefore each discipline tends to develop a different combination of essential attributes. In chapter 4, how student intelligence type relates to essential attributes is discussed.

Chapter 3 - Research Issues:

Research methodology:

Examination of the literature concerning research methodology will provide a rationale for the location of the project research methods in the quantitative/qualitative research method spectrum. Walker and Evers (1986:375) suggest that the location of any educational research experiment should be located within a wider context of theorising and naturalistic inquiry. Even a quantitative research project will be located in this wider context. They suggest that location in this wider context should be done, not only by scrutinising the epistemic privilege of the researcher, but also the theoretical activity of the subjects of the research. The reason they give for regarding theory as important, is that even from research using the most perfect of research experiments, the inference of conclusions, which are unaffected by the theoretical presuppositions of the researcher, is unobtainable. They regard all conclusions as tainted not only by the researcher, but also by the people being researched (the subjects). Walker and Evers (1986:385) suggest that when the researcher inquires into the social reality of subjects, it causes them to reflect on that reality and, as a result, the reality of the subjects can change.

The social reality of the subjects can change, however, whether there is a researcher inquiring into the situation or not. People will reflect on their social reality to some extent, whether the research is undertaken or not. The researcher tries to eliminate bias by using techniques, such as triangulation and respondent validation, which will enable the point of view of others to be seen. Hence, conclusions are inferred from the data analysis, which should have a minimum of researcher influence. It must also be remembered that research is usually a snapshot in time of a particular situation and situations can change rapidly. Longitudinal research attempts to examine these changing situations.

The researcher can minimise the effect of research methods and the theoretical presuppositions used. Prior to the start of the research project, it is important for the researcher to state, as far as possible, the theoretical presuppositions, which have influence on the research methods. It will then

be possible for the reader of the research report to estimate the extent to which the theoretical presuppositions have influenced the researcher.

Before my theoretical presuppositions as researcher in the CIT case study are considered, it is necessary to examine the definition of theory. Evers (1987) discusses the O'Connor-Hirst debate on this issue. This debate, between Professor D. J. O'Connor and Paul Hirst, started in the late 1950s and continued into the 1970s with many publications from each of them concerning the development of educational theory.

According to Evers (1987:3), O'Connor defines a theory as "a logically interconnected set of hypotheses confirmed by observation and which has the further properties of being refutable and explanatory". O'Connor considers that educational theory, with its ethical and metaphysical statements, does not comply with this definition and hence the word theory cannot be generally used in the educational context. The view of O'Connor is that only if well-established experimental findings are applied to education can the word theory be justified (Hirst 1993:149). On the other hand, according to Evers (1987:4), Hirst regards educational theory as drawing heavily upon various disciplines, such as psychology, sociology, philosophy and history, to promote its central principles. Thus, Hirst considers that a theoretical synthesis is unnecessary and too difficult in establishing these principles and regards the principles themselves as establishing the educational theory. The educational theory therefore can be considered as consisting of normative principles, which Hirst (1993:155) states can be developed from the analysis of current educational practice. This analysis Hirst (1993:155) calls "operational educational theory".

However, Evers (1987:10) regards both Hirst and O'Connor as mistaken. Contrary to O'Connor, Evers (1987:10) claims that ethical and metaphysical statements can be included in educational theory. Evers also claims that the epistemic components of disciplines such as psychology, sociology and history, which Hirst regards as important in influencing the normative principles of educational theory, should be denied. Evers therefore, regards the denial of the ideas of both O'Connor and Hirst as paving the way for a

unity of educational theory. With this unity, the normative principles of Hirst, will have a theoretical justification and the positivist approach of O'Connor will be included (Evers 1987:11).

The varying approaches of Evers, O'Connor and Hirst, towards educational theory have implications for this research project. If we agree with O'Connor, then the project methods would be quantitative. If we agree with Hirst, then the project methods could be qualitative or quantitative and the principles deduced from the data would be regarded as normative. If we agree with Evers, the project methods could be qualitative or quantitative, but the principles drawn from the data should have a basis in theory. Based on a previous study (E835) in which the returning of questionnaires was found to be a problem, the methods to be used for this research project have already been established as qualitative interviews, with some observation techniques. The best way forward, therefore is to take the same approach as Evers, by first establishing principles from the qualitative data and then attempting to justify them with a theoretical basis. Theoretical presuppositions of the researcher, however, could influence these results.

So what are the theoretical presuppositions of the researcher? I regard the professional degree course, which embraces the link between research, teaching and study (Humboldt principle), as the ideal or standard of excellence. Other degree courses, which do not have this link, may be "fit for purpose", but are not as rigorous as those courses that reach this standard of excellence. These presuppositions emerge from the fact that in this case study, I am an insider at CIT and hence part of the "teacher as researcher" movement.

The subjective reality of the research subjects (past graduates) should emerge through the use of qualitative interviews based on ethnographic techniques. This subjective reality exists in the mind of the past graduate and emerges from their personal tastes. It is possible that the interviews will cause these subjects to reflect on this reality thus changing their reality. This will affect interview data, when more than one interview is completed with each subject, as reflection on the first interview will affect the second

interview data. Other subjects, such as present students, teaching staff, etc. will be interviewed in order to obtain an alternative viewpoint, hence attempting to eliminate bias. Again their social reality may change as a result of the research techniques and the influence of the researcher. Their social reality is not due to solitary experience, but emerges from contact with others. However, in all these cases, the reflection of the interview subjects on their reality could be discussed at a second interview. This approach could provide some assessment of the theoretical presuppositions of the subjects, although time factors are going to mitigate against second interviews.

Qualitative research:

The essential attributes approach is a qualitative research method of analysing interview and documentation data. The purpose of the method is to discover the essential attributes required for a workplace situation. The factors necessary for nurturing essential attributes in students at a higher education institute (HEI) may be found by deeper research of literature and interview data concerning each essential attribute. By discovering and reflecting on these 'educational factors' it may be possible to start building a theory of essential attributes. This chapter examines the methodological components of the essential attributes approach, including the approach to the building of theory, in more depth.

Cassella (1999:110) describes how educational research developed in the 1970s. At this time, qualitative research emerged as an ethnographic and phenomenological alternative to positivism and these new researchers were influenced by symbolic interactionism. Ethnography can be described as the study and systematic recording of human cultures. Phenomenology is the study of the structures of consciousness that enable consciousness to refer to objects outside itself and hence should clarify what is hidden in ordinary, everyday experience. Symbolic interactionism, originated from the work of the American George Herbert Mead, who believed that symbols were the basis of individual identity and social life. Mead maintained that as infants grow, they start interacting with others and acquire their own mind and self. With increasing interactions, they mirror the behaviour of others,

developing language and unique ways of communicating symbolically. Listening to students therefore, could assist in the development of educational theory. Hicks (1999:252) emphasises the need for educational theory to come from the practitioner who should listen to students, taking account of the passions of the students. Thus a 'subjective' view from students can be considered, along with their objective views.

According to Jarvis (1987:57), the implications of symbolic interactionism for learning include the development of critical minds; hence students should be able to respond to their experiences in a critically aware manner. Jarvis (1987:46) also makes the point that mind and intelligence can develop throughout life, with language being very important in the development of the mind. Using language in an interview process in order to determine the feelings of past graduates and other stakeholders towards the BEng course, fits in with these ideas. The interaction of course outcomes with the subsequent workplace experiences of past graduates, is particularly important in determining essential attributes which need further development at the HEI. Direct face-to-face contact with past graduates, engaging in language and symbolic forms of communication, could be the key to determining course effectiveness.

An example of how qualitative research methods are increasing in importance is highlighted by Webb (2002:27) when describing health service research, which has previously relied heavily on quantitative methods. These methods have produced information in a systematic, objective and measurable way, but have become increasingly less useful to organisations in resolving practical problems. Webb (2002:30) describes how focus groups were used to investigate the reluctance of nursing staff to attend courses, which would enable them to convert to a higher level. Focus groups have between four and ten people. They differ from group interviews in that the researcher is more concerned with obtaining data from the interaction between the group members, than with the views of individual members. So far, the group interviews undertaken in the essential attributes approach have been limited to two people and this has provided excellent data, with the two people 'bouncing' ideas off each other. Webb (2002:28)

describes a great strength of qualitative research as the determination to 'see through the eyes' of people, improving comprehension of the whole, by exploring the depth, richness and complexity of a particular phenomena.

Insider research:

There are problems, however, particularly with the research being conducted at the workplace of the researcher (insider research). The researcher could be seen as a potential threat to some research participants and this is reflected in the difficulties that Webb (2002:33) experienced in trying to recruit sufficient numbers to form the focus groups. Webb (2002:29) also highlights the risk to the researcher if the organisation rejects the research findings, as this could impact on promotion prospects.

On the other hand, there are also advantages to insider research. Newton (2002:185) used insider research at a UK college of education with interview data obtained from 'front line academics'. He concluded that to be able to manage effectively, institutional managers should assess the current and emerging climate of operation by paying attention to the views of key external stakeholders, regulatory bodies as well as staff within the institution. The essential attributes approach could be a method of achieving this effectiveness assessment, obtaining data from all of these groups. Anderson and Jones (2000:430), consider that insider research has great potential for extending current theory and encouraging educational administrators to engage in action research. Thus administrators could experience the same empowerment that teachers have received from teacher research. However, whereas the decision of a practitioner to study their workplace is convenient, it raises epistemological problems. Insider bias, prejudice, assumptions, political issues, ethical issues, will need to be addressed as part of the research. Reactivity (changing the setting as one studies and acts within it) and distortion (position of authority distorting the responses of subordinates) are also areas that require examination. The essential attributes approach uses triangulation and respondent validation to mitigate against these problems and Anderson and Jones (2000:445) describe the usefulness of validation meetings, for the purpose of addressing problems of bias and distortion. Ongoing findings can be defended before

critical friends at such meetings. Presenting interim research findings at one or more conferences during the research period may also be helpful in this regard.

Alternatively, according to Anderson (2000:450) bias may not be so bad, as the theories of Habermas (1971) regard the separation of bias from research methodology as an illusion. Because knowledge is generated through the interest of the mind, knowledge and interest cannot be unattached. Hence three distinct interests of the researcher are presented in the pursuit of knowledge generation: technical, practical and emancipatory. Knowledge generated from technical interest takes on the form of causal explanations. Practical interest refers to gaining an understanding through interpretation, generating knowledge that informs and guides practical judgement. Emancipatory interest, however, orients the researcher towards the release of human potential, emancipating them from the dictates of tradition, precedent, habit, coercion or self-deception. Critical self-reflection will examine current practices, unexamined assumptions and generate emancipatory knowledge. If a researcher can be sufficiently critical of his own work, maybe the need for anti bias techniques, such as triangulation and respondent validation can be reduced. This level of critical self-reflection should be desirable in the researcher, but generating such attributes in students could be an aim of a high quality course.

Sustainable world:

Wals and Jickling (2002:224), in defining the concept of sustainability in higher education, describe how educating for sustainability does not mean that the sustainability is fixed by experts or academics. Rather that a more emancipatory view should be taken of the relationship between education and sustainability. Education would then contribute to the creation of a world, which is more environmentally just and democratic. Students would become proactive members of society, looking for meaning, developing their own potential and creating solutions. Wals and Jickling (2002:225) continue by suggesting that decisions about the content and direction of the learning taking place in HEIs, should be influenced by answers to the following questions:

To what extent are learners and facilitators of learning involved in such decisions?

To what extent does higher education respond to the challenges identified by the community?

To what extent is the learning process and content sensitive to the ideas, values, interests and concepts embodied by the learners themselves?

Implementing the essential attributes approach could answer these questions. The essential attributes approach attempts to ask opinions of students and lecturers (*learners and facilitators of learning*). Therefore their opinion should ultimately influence decisions of the HEI. If we take the community to consist of stakeholders (past graduates, present students, non-completing students, lecturers, employer representatives) of education, then by attempting to ask opinions of stakeholders, the essential attributes approach does take note of the *challenges identified by the community*. Therefore the HEI should ultimately respond to these challenges. By taking note of the *ideas, values, interests, etc.*, of present students, non-completing students, as well as past graduates, these views should ultimately influence the learning process and content of the HEI course. The essential attributes approach should be able to recommend course modifications promoting the creation of a world, which is more environmentally just, democratic and sustainable.

A theory of essential attributes should analyse each essential attribute for its contribution towards this emancipatory view of sustainability. As Wals and Jickling (2002:224) state, HEIs have a role in developing qualities in students that allow them to critique, construct and act with a high degree of autonomy and self-determination. Competencies should be developed which enable students to cope with uncertainty, poorly defined situations, conflicting/diverging norms, values and interests. Students should be able to look beyond everyday situations and search for ethically acceptable options for responsible action. Each essential attribute should make its contribution towards these competencies, which will assist in moving towards the emancipatory definition of sustainability, i.e. the creation of a world, which is more environmentally just and democratic. Some essential attributes,

which make the greatest contribution towards the emancipatory view of sustainability, could be considered to be standards of excellence.

Case study:

In this research, the essential attributes approach is to be tested by means of using the BEng (mechanical engineering) course at Cork Institute of Technology (CIT) as a case study. Yin (1994:3) discusses the distinctive need for case studies, when complex social phenomena have to be understood. Case studies are empirical inquiries that investigate real life contemporary phenomenon. Yin (1994:13) describes how case studies are generalisable to theoretical propositions and not to populations. One goal of the investigator is to expand and generalise these theories. The case study should, however, benefit from the prior development of theoretical propositions to guide data collection and analysis. According to Yin (1994:35), knowing whether the findings of a case study are generalisable is referred to as external validity. It is one of the four tests commonly used to establish the quality of empirical social research. The other three tests are construct validity, internal validity and reliability. These three tests are normally applied at the data collection stage, data analysis stage or at the draft report stage. External validity, however, can be applied at the research design stage.

For the essential attributes approach, a certain amount of work on external validity has been completed. Generalising the essential attributes approach to other courses has already been discussed in chapter 2. The essential attributes approach is a model of course effectiveness evaluation, which will develop and ultimately be useful for assessment of any course. The approach is such that each course feature can be prioritised and then investigated. Thus the approach can focus on specific areas of a course or can analyse every aspect of the course. The approach starts by prioritising essential attributes, which should be imparted to students, if the course is to be successful. Another aspect of the essential attributes approach that could be generalisable to other courses is a theory of essential attributes. From the literature reviewed so far, a theory of essential attributes could be rooted in

staff research, staff appraisal, staff training needs assessment and staff development.

Easton (1992:7) describes the skills that can be developed by the case study method. Among these are analytical skills. Case studies provide data and data analysis provides information. Information handling is another skill. Classifying, organising and evaluating information, facilitates the finding, as well as the solving of problems. With information the situation becomes understood and models are built. Miles and Huberman (1994:4) describe how the aim of qualitative research is to build theories, which account for the real world. The researcher may start by knowing something conceptually about the phenomenon, but not enough to house a theory. A conceptual framework, a set of general research questions and some notions about sampling and data gathering, could be the starting point. The conceptual framework or map, plus the research questions attempt to explain the theoretical assumptions of the researcher. The research questions and the conceptual framework can change as the research proceeds. Miles and Huberman (1994:27) explain how qualitative researchers usually work with small samples of people and because of this, these samples are not usually random. Samples can be theory driven, either at the start or as the research proceeds. Generalisations are not 'sample to population', but sample to existing theories (or new theories) and tending to be analytical.

Educational factors:

To develop a theory of essential attributes, the educational factors, which influence each essential attribute, should be examined. One of the essential attributes identified from the literature is 'lifelong learning ability'. A theory of essential attributes would have to examine the origin of lifelong learning ability as a desirable attribute. According to Taylor and Henry (2000:497) human resource development as a key to a competitive economy, has become policy in first world countries, third world countries, European Union, UNESCO, World Bank and the OECD. Taylor and Henry (2000:498) raise the questions: why has such policy convergence come about and what are the implications for national policy making? Using the Australian educational system as a case study, Taylor and Henry (2000:503)

concluded that global policies and Australian policies of vocational education and training have managed to exist side by side. Australian policies of vocational education and training have traditionally been designed to address social problems, as well as take account of the economic situation. Taylor and Henry (2000:504) therefore suggest that national policies should temper globalisation policy to take account of social as well as economic capital. Therefore, in attempting to develop lifelong learning ability in students, they should be made aware of the need to enhance their skills relating to the social problems that can arise, as well as the need to enhance other more pragmatic skills.

Another essential attribute identified from the literature is 'reasoning'. Trifonas (1998:396) describes how the principle of reason gave rise to the original idea and ideal of the University. Hence any course operated by a HEI, should examine educational factors, which influence the ability to reason. Kramarski *et al* (2001:292) describe how metacognitive processes can enhance reasoning, recommending that teachers should receive metacognitive training. This will enable them to enhance student task understanding and make them aware of strategy application. Kramarski *et al* (2001:298) continue by describing how metacognitive training of students is effective for developing the 'problem solving ability' of students. Problem solving ability is also one of the essential attributes that have emerged from the literature.

According to Kramarski *et al* (2001:292) metacognitive instruction emphasises reflective discourse by providing each student with the opportunity to ask questions about (a) the nature of the problem, (b) the use of appropriate strategies, (c) the relationship between previous and new knowledge. Kramarski *et al* (2001:293) explain how students worked in small mixed ability groups, following an initial presentation by the teacher. Each student in turn read a problem aloud and the group discussed the issue until a solution was found. Students were encouraged to talk about the problem, explaining it to each other, hence providing differing perspectives. This method therefore enhances another essential attribute emerging from the literature and that is 'team working ability'.

The essential attribute of 'critical review/thinking' emerged from the work of Waghid (2000). To develop this type of essential attribute, Johnston and Olekahns (2002:103) describe an Internet based assignment delivery and assessment system (CALM) at the Faculty of Economics, University of Melbourne. Johnston and Olekahns (2002:105) describe how the aim of CALM is to develop in students a deep approach to learning. They describe how too much assessment can inculcate in students a surface approach to learning. Development of critical thinking can be enhanced by subjects that are assignment oriented, rather than lecture or text oriented. Therefore goals, methods and evaluation should emphasise the use of knowledge, rather than simply acquiring knowledge. With CALM, this is done by assigning students to real life problems and issues. On line tutors are available to answer questions and because the system is Internet based, students who are uneasy about asking questions during a lecture, have no problem with posting a question on the web site. Student work is also posted, anonymously, on the web site and it is therefore possible for other students to post comments on the work of each other on the web. Hence, a student can compare work with the work of other students. This peer evaluation can cause students to reflect critically on their work, learning critical skills in the process. As a result students do not have to rely on the critical comments of the tutor.

The problem of too much assessment or workload is further illustrated by Lawless (2000:97) when describing a study at the Open University of mathematics student workload. Workload is defined as the time taken on learning activities and is considered to be the most significant factor causing drop out by Open University students. Lawless (2000:100) found that the time taken was strongly related to how students approached study of course material. The two main approaches identified were: (1) students whose main aim was to learn the subject and (2) students whose main aim was to pass the course. Students whose main aim was to learn the subject spent longer on learning activities and reached a higher level of attainment. Lawless (2000:109) concluded that greater emphasis is needed on explaining the purpose of learning activities, to students with a 'pass the course' attitude. Lawless (2000:110) also concluded that course designers should recognise

that students have limited time. Whether a greater availability of time leads to a deeper approach to study is a topic for further research.

Mann (2001:7) describes similar research findings to those of Lawless (2000). Many learners adopt a surface approach to study with a focus on rote learning, memorisation/reproduction, lack of reflection and a preoccupation with completing the task. Others adopted a strategic approach to learning, with a focus on assessment requirements, lecturer expectations and high-grade aims. Mann (2001:8) maintains that both approaches express an alienation from the subject and the study process. Higher education should be developing a critical being with personal engagement in the learning process, as well as lifelong learning ability, but according to Mann (2001:13), research findings show that this is not being achieved. To promote the creativity of the student, Mann (2001:13) states that the teacher needs to provide just enough support - not too much or not too little. Mann (2001:18) concludes that higher education needs to inspire in students criticality and the will to engage in thinking.

Reynolds and Trehan (2000:268) also discuss aspects of criticality and focuses on how assessment practices in higher education can assist in the development of critical thinkers. Describing participative assessment schemes utilised on postgraduate management courses at the University of Central England and the University of Lancaster, Reynolds and Trehan (2000:270) highlight the problems, many of which arose from the social dynamics of the learning groups during their assessment process. Differences in gender, race, class, intellect, etc. of the group members, who are attempting to develop skills in critically evaluating the work of each other, could generate power differences, which can influence the assessment process. According to Reynolds and Trehan (2000:275), these problems emphasise the need for the tutor to be prepared and able to work with these complex social processes. It is interesting to compare these participative peer assessment schemes with those described by Johnston and Olekahns (2002), which avoided many of the social problems by using the Internet.

Durkin and Main (2002:24) describe how the Quality Assurance Agency (QAA) have identified a number of 'intellect' skills (analysis, synthesis, evaluation, problem solving, etc.) and 'transferable' skills (oral/written communication, teamwork, research skills, etc.), which they regard as essential for higher education development. They discuss a project at the University of Bournemouth to develop such skills in undergraduate students involved in two courses. One was workshop led by a study skills tutor. The other course was a peer-mentoring course, for which second year students were trained by the study skills tutor to mentor the first year students. Durkin and Main (2002:28) describe how six students from the second year volunteered to be mentors and they were each teamed up with three first year students. The mentors found that their knowledge and understanding was consolidated through having to teach others. The mentored groups performed better in the examinations than the workshop group. Both groups performed better than those who did not attend either course. In assignments, which involved analysis and evaluation, it was found that the workshop groups improved their marks, whereas there was no appreciable improvement for the mentored groups. The overall conclusions of Durkin and Main (2002:37) include that a combination of specialist led workshops and peer-mentoring sessions are beneficial to students.

One can compare the aim of instilling teamwork ability skills in the students at HEIs with the lack of teamwork among staff at HEIs. Bolton (1995:15) discusses how the development of teams in HEIs is not well advanced and describes the Fender Report (1993). This shows how the Committee for Vice Chancellors and Principals advocated performance related pay for teams, rather than for individuals. The proposal encountered objections from those who see HEIs as still anchored to individual performance for academic staff. A change of organisation culture is called for, if the approach to teamwork is to be fully instilled in the students.

The educational factors, which have been highlighted by the previous cases, will be included in the theory building towards the end of this chapter.

How did I go about collecting the material?

By reading the relevant, substantive and methodological literature, criteria for the evaluation of the BEng course have been developed. A strong conceptual/theoretical position for the research has also been developed. This locates the research into the effectiveness/quality management body of knowledge.

Stage one of the research strategy included an initial study, which contributed to the design/development of the research instruments and provided initial estimates of the scale of the fieldwork. The iterative nature of a grounded theory approach with the qualitative interview process has resulted in a reduction of interview numbers from that originally estimated. This was mainly to include more interviews with past graduates, where it will be shown in chapter 4, that the richest seam of data exists. Most interviews with past graduates were completed at their place of work where some observation data of their workplace can also be found. Arranging convenient appointments and travelling to and from the various industries, although very interesting, was found to be time consuming.

This case study has conducted and analysed thirty interviews. The interview analysis took place in four stages over the research period. The thirty processed interviews consist of sixteen interviews with past graduates, four with non-completing students, three with lecturing/management staff, two with employer representatives and five with students presently completing the course.

Contact with most past graduates was first established by telephone and a convenient meeting time mutually arranged. The interview was conducted at their workplace and it was agreed that field notes would be taken during the interview. Most past graduates felt that a tape-recorded interview would restrict their responses. Observation of differing industrial environments and the type of work in which the past graduates were engaged, was used to provide further data.

A group interview was also conducted with two female students, presently completing the course. These students were easily contacted and the interviews were conducted at CIT. Following consultation with these students, field notes were taken during the interview. This group interview was very successful. The two female students seemed to assist each other in their responses and hence generate more data.

The four non-completing students, who took part, were in favour of telephone interviews and these proved to be fruitful. Again field notes were the result of these interviews. One female non-completing student, who was contacted by telephone, indicated that her experience of the first year of the course was so bad, that she did not wish to discuss the course at all. Another male non-completing student agreed to a telephone interview at a later date, but subsequently was found to be difficult to contact to finalise a meeting time.

Lecturing staff, also have difficulty with audiotape interviews. Past experience of this group have indicated that they are sometimes mistrustful of research motives. Field notes were taken during these interviews. Contact with lecturers was relatively easy and the venue for the interviews was CIT.

Past experience of employer representatives has indicated that, sometimes staff from the personnel department of a company, have difficulty discussing the essential attributes required from engineering employees of the company. Contacts built up over the years with engineering managers, indicated that this group were better candidates for interviews. Most engineering managers have more of an idea of engineering graduate industrial requirements. Contact with this group was made initially by telephone and a meeting arranged at their workplace. Of the two engineering managers chosen for interview, there was difficulty in arranging a suitable time with one of them. However, the iterative nature of the grounded theory approach with the qualitative interview process, has subsequently slanted the process towards an increased number of interviews with the past graduate group. Some of these past graduates are in an

engineering management position and have been found to provide good quality data.

Why did I do it like this?

The rationale behind this research strategy is based on the E835 *Educational Research in Action* study guide. According to the E835 study guide (1997:25), research into curriculum evaluation indicates that quantitative research alone cannot be effective. The reaction against this positivist approach to curriculum evaluation, has caused a number of approaches to emerge, which are collectively termed anthropological evaluation. These approaches use qualitative methods modelled on the ethnographic approach.

The methods used in this research, are qualitative interviewing for data gathering, with some observation where the opportunity arises. It is intended that the interviews would be semi-structured, as interview time constraints may be a problem when talking to busy people. Collecting data using questionnaires has been considered, but past experience has shown that there is a problem in obtaining sufficient returned questionnaires from the original population sample. Also the quality of the data is restricted by the questions, predetermined at the questionnaire design stage. Open questions at interviews are therefore considered to be the best way forward. These provide the opportunity to follow up with new questions, whenever an unexpected line or topic emerges during the interview.

As an employee of CIT, bias may be a problem for objectivity. Methods for combating bias (respondent validation, triangulation, etc.) are used at each stage of the research. Transcripts of interviews are returned to the respondents following the interview, hence any alterations to these transcripts can be made if necessary. By continuing with interviews of the different groups, over the three-year period, i.e. present students, non-completing students, lecturing/management staff, employer representatives, as well as the past graduates, this will assist in eliminating a biased view of the results.

Ethical considerations in relation to colleagues, could become a problem, particularly if recommendations are made, which target specific subjects or lecturing staff. This requires a very sensitive approach, which will ensure that recommendations are made in a general sense. At the same time, it is important not to stifle some of the debates about important issues, such as the level of interaction between students and lecturing staff, which may improve the teaching of certain subjects.

Software limitations:

Lewins and Silver (2004:6) summarise six software packages suitable for computer assisted qualitative data analysis (CAQDA). These are: ATLAS.ti V5, HyperRESEARCH V2.06, MAXqda, N6, NVivo V2 and QUALRUS V2.0.4.0. The summary is divided into main headings:

Minimum specifications

Structure of work - how work and data is managed by software

Data types and format

Closeness to data and interactivity

Coding schema - coding structures and organisation

Coding processes

Basic retrieval of coded data

Searching and interrogating the database - basic tools

Teamwork

Going beyond code and retrieve.

Missing from this summary is a price comparison and whether there is a student version available at a lower price.

According to Lewins and Silver (2004:3), the key principles behind each of the reviewed packages are similar in many ways. Thus the limitations of the computer hardware of the researcher, as well as the software price, is going to be more of a deciding factor in choosing the software package. So if we look at the first main heading of minimum specifications, it can be seen that the required random access memory (RAM) recommendations in megabytes (Mb) are as follows:

Software	Recommended RAM
ATLAS.ti V5	256Mb
HyperRESEARCH V2.06	64Mb
MAXqda	64Mb
QSR N6	128Mb
NVivo V2	256 Mb
QUALRUS	128 Mb

At the start of data gathering, the computer available for coding the interview data was an ACER TravelMate 510DX with 32 Mb of RAM. Thus all of the above software can be seen to be unsuitable. Earlier software versions, however, have a lower RAM requirement. Earlier software versions have also a lot more information support and recommendations from available literature. This then is a weakness of CAQDA. If the earlier software versions are unavailable, then one might have to upgrade computer hardware and peripherals, which could be very expensive.

Following the literature review of chapter 2, in which Gahan and Hannibal (1999) favourably describe QSR N4 software, it was decided to purchase this package at a reasonable student price of sixty pounds sterling. The student version does not provide the user with the updates, which are occasionally issued by QSR, but it does operate as the standard N4 version. QSR N4 software has a recommended RAM requirement of 16Mb and is therefore within the capacity of the ACER TravelMate 510 DX computer with 32 Mb of RAM. Successful use of QSR N4 software is also evident from Okamoto (2003:306), who analysed interview data from sixteen social work practitioners, as well as Arcidiacono *et al* (2001:467), who analysed interview data from seventy youth/labour market experts. Reid *et al* (1999:301) describe using the earlier version of the software, QSR N3, with which thirty interviews from mental health professionals were successfully analysed.

The E835 study guide (1997:102) describes how a researcher can take field notes at an interview, writing them up the same evening. A few days later the researcher can browse through the interview transcript reflecting on the interview and adding some notes. The object of the notes could be to

suggest lines of analysis, to connect with other data, or to indicate the direction of future enquiries. The next step is to order the data by classifying and categorising. A strength of N4 software is that it is very useful in this latter procedure of classifying and categorising. However, it is up to the researcher to take the time to browse and reflect on the interview transcript. This is best done by printing off a copy of the interview transcript and adding pencil notes to the hard copy. N4 software provides a very useful memo facility for attaching memos to each interview and to each node. However, browsing through interview transcript hardcopy and N4 node report hardcopy may be the best way of noticing 'signposts' indicating theory building blocks.

The N4 software was used in the CIT research as a convenient method of managing the interview and documentation data. Using the memo capacity within the software, enabled workplace observations to be stored against each past graduate, as well as the 'educational factors' to be stored against each 'essential attribute'. Thus all the data is stored within the software for future reference. The interview transcripts stored within the software can be browsed and reports on each essential attribute can be browsed. It was this technique that highlighted the importance of 'safety, health and welfare of the public' and 'course strategy'. These are further discussed in chapter 4.

Observation techniques:

According to the E835 study guide (1997:187), observation is a common form of data production in educational research. It is usually divided into two groups, i.e. structured (or systematic) observation and unstructured (or ethnographic) observation. Structured observation has explicitly defined categories against which behaviour can be coded. Thus structured observation tends to be used in quantitative studies. Early in the research, the researcher must be clear of what is relevant to the research process in order to use systematic observation. An example of this type of observation is the 'Flanders Interaction Category System' (FIAC). Drudy and Úi Chatháin (2002:38) discuss a teacher self-analysis method, which adapts FIAC, claiming that the acknowledged limitations of FIAC are minimised

when used in teacher self-analysis. These limitations concern the multiple interpretations by researchers of the coding categories used in FIAC.

Unstructured observation is more complex. Torrance and Pryor (2001:616) describe classroom observation, which yielded a description and analysis of the informal assessment practices by teachers in infant classrooms. Thick description and analysis of classroom interaction was used, with close attention to linguistic structures. Hargreaves (1993:79) shows that obtaining data from existing data may also be described as observation. At the outset the researcher was interested in the relationship of 'preparation time' to 'the culture of teaching' and collected data using semi structured interviews. By observation, the data collected was subsequently found to be pertinent to the recent 'intensification of the work of teachers' (Hargreaves 1993:80). Atkinson *et al* (1993:5) describe ethnographic observation of an industrial training unit in South Wales. They not only observe the machine tasks/teaching methods that take place within the unit, but also the unit geographical situation within an industrial site, workshop facilities, canteen facilities, etc. It is this latter type of low-level observation that is used in the CIT case study.

Philips (1993:62) distinguishes between high-level and low-level observation. Whereas with high-level observation the results are influenced by the background theories of the researcher, with low-level observation, this is not the case. People with a variety of theoretical frameworks will all agree on whether an object is a certain colour or not. In the CIT case study the observations are limited to describing the type of working environment of the interview respondent. The results are therefore towards the low-level observation end of the spectrum and should not be influenced by the hopes of the researcher. These observations are used to determine whether a connection can be made between the 'essential attribute' and a particular type of industry. So far in the CIT case study no connection has been established. However, it has been noted that the standards of excellence of 'course strategy' and 'safety, health and public welfare' seem to emanate from the graduates who are employed by organisations offering consultant-engineering services. This will be further discussed in chapter 4.

What have I done and why?

To control the data using the N4 software, it was decided to schedule interviews in blocks of ten. Thus for the stage one final report, nine interviews of the scheduled 10 were completed and analysed using N4 software. This analysis of the nine interviews was given the name 'QMt project' in the N4 software. Of the next scheduled block of ten interviews, eight were completed and these have been analysed and given the name 'QMt2 project' in the N4 software. Of the next block of ten scheduled interviews, seven have been completed and these have been given the name of 'QMt3 project' in the N4 software. Of the next block of ten scheduled interviews, six have been completed, processed using the N4 software and this constitutes 'QMt4 project'.

N4 projects QMt, QMt2, QMt3 and QMt4 will be kept as separate projects. Following completion of project QMt, the QMt nodal structure was maintained in the QMt2 project. This was done by copying QMt project as QMt2 and deleting the documents from the project. The QMt project, however still remains intact under its old name. New interview documents were then imported into QMt2 and coding of these commenced. This increased the number of nodes in project QMt2 as new nodes were created. Once QMt2 project was complete, the QMt2 nodal structure was maintained for the QMt3 project. Again this was done by copying QMt2 project as QMt3 and deleting the documents from the project. Again the QMt2 project still remains intact under its old name. This procedure has also been carried out for QMt4.

Utilising four separate N4 projects, rather than one N4 project, for data analysis means that there is less likelihood of accidentally losing or deleting substantial amounts of data. Each of the four projects should also take up less computer memory and be subsequently faster at loading and responding when software is manipulated. There is also the advantage of being able to look back, with a better perspective, at the state of the research data, as each N4 project will represent a timely point in the research. QMt project represents the state of the research data at the end of the Stage 1 final report (April/May 2002). QMt2 project represents the state of the research data at

the end of analysing the interviews carried out during the initial study and this was undertaken at the end of PR07 (May/June 2003). QMt3 project represents the state of the research data approximately at the end of PR08, (September/October 2003). QMt4 project represents the state of the research data at the end of PR11 (Summer 2004). Browsing, coding and reflecting on this data, with the subsequent editing of N4 reports, meant that the full analysis of all four projects QMt, QMt2, QMt3 and QMt4, was not available until the end of PR11 (June/July 2004). Parallel with coding, theory building involves analysing the data further to develop a causal flowchart. This is briefly described later in this chapter and further developed in chapter 4.

N4 coding:

For project QMt, interview transcripts were imported into the software as internal documents and subsequently coded. There were nine interviews completed at that time: - two with past graduates; two with present students; two with lecturing staff; two with non-completing students and one with an employer representative. These interviews were subject to respondent validation. Copies of the interview transcripts were returned to the respondents with a request for any necessary changes to be made. As well as these transcripts, some large documents were added to the project as external documents. These were: -

1. Bachelor of Engineering in Mechanical Engineering
Submission to the Institution of Engineers of Ireland for Re-
accreditation of the Degree Course in Mechanical
Engineering at Cork Institute of Technology, April 2000.
2. The Quality Assurance Agency for Higher Education Subject
Overview Report QO 11/98 - Quality Assessment of
Mechanical, Aeronautical and Manufacturing Engineering -
1996 to 1998.
3. Cork Institute of Technology - Academic Quality System
(CIT 2000)
 - (a) Book 1 - Introduction and Overview.

- (b) Book 2 - Procedures.
- (c) Book 3 - Post-graduate study by Research - The CIT Research Charter.

The nine interviews, which were imported into N4 as internal documents, were automatically divided up into text units by the software. A unit of text was defined by each carriage return when typing text. This could be adjusted if required. Each unit of text was then coded to a node or nodes. The nodes for the nine interviews and the external documents are shown in appendix 4 as QMt project.

The large documents, added to the project as external documents, were also divided up into text units, but for convenience, each page was defined as a text unit. Each page or text unit was then coded against a number of nodes, using N4. The text coded against each node can be browsed using N4 for the interviews. For the external documents, the text coded against each node can be browsed only if the documents are available.

This research dissertation is mainly concerned with essential attributes, but by examining project QMt appendix 4, it can be seen that essential attributes amount to about one quarter of the data. Following analysis of essential attributes, nodes coded under 'standards of excellence' are analysed. Analysis of other 'fitness for purpose' nodes of a lower priority could then be analysed. This process could be continued until the data are exhausted or until time runs out. If there are more data generated than necessary for the purposes of this research dissertation, it can be utilised for future research.

From QMt project of appendix 4 it can be seen that nodes have been categorised under 'fitness for purpose' or 'standards of excellence'. In QMt project, all the essential attributes are categorised under the 'fitness for purpose' category. However, as the research proceeded, it became necessary in QMt project to place some of the essential attributes under the 'standards of excellence' category. The essential attributes nodes that have derived from the QAA document are an example of possible standards of excellence, but were subsequently found to be not as significant as some

essential attributes deriving from experienced past graduates. One of the advantages of N4 is that it is easy to move the nodes and recategorise them under a different family.

Using N4 reports to browse through each node draws together the text coded to each node. From this examination it can be seen that there is a gap between the nodes that emanate from the nine interview transcripts and those nodes that derive from the documentation. In N4 project QMt, there is a particular gap between the nodes deriving from the QAA document and the nine interviews.

One of the disadvantages of utilising the four N4 projects is that to gather together the data on each essential attribute will mean generating four reports from the four N4 projects, rather than just one report from one N4 project. This should not be too difficult and, as the research can be continued indefinitely, it remains to be seen whether any other problems with the software arises.

A transcript of a completed interview is shown in appendix 5. This interview is before processing with the N4 software, as the respondent had not validated the transcript. The interview transcript is sent by E-mail to the respondent, usually within two days of the interview taking place, requesting modification if necessary. Sometimes replies to this type of validation are slow, particularly during the holidays. Following respondent validation, some minor changes and additions are made. For this particular interview, the respondent validation, also shown in appendix 5, gave some important pointers towards the concept of a sustainable course responding to its environment. This concept will be developed in chapter 4.

During the holiday period, it was decided to interview past graduates. Trying to contact lecturing staff, present students, non-completing students, and even employer representatives was found to be difficult during holidays. Hence, between June and September 2003, 5 past graduates were interviewed and one student, who was presently completing the course. This still gave the 6 interviews, which was scheduled for the June/September

period. It is easier to contact the other groups from September onwards, when most are back at the College.

Another reason for perhaps concentrating on this past graduate group, relates to the rationale behind this research, which was originally to obtain feedback from this group. Past graduates, have experienced the course directly and have, in most cases, spent considerable time in employment subsequent to the course. This research is trying to identify essential attributes that past graduates have found to be useful in their day-to-day work, subsequent to completing the course. These essential attributes may not be sufficiently developed by the course and improvements may be required to teaching methods to rectify the situation. Past graduates may also be in a better position to identify educational factors, which could be the key to developing specific essential attributes in some students.

In the N4 software, educational factors are attached to each essential attribute in the form of a memo. This is explained in detail on page 82. Thus, when the research is complete, it will be possible to determine which educational factors should be put in place to ensure that the more popular essential attributes are developed by the course. The more popular essential attributes are those mentioned in a more favourable light by respondents, as indicated by table 3.2, below. This will be further developed in chapter 4. Another feature of this research is that a description of the working environment of each past graduate is completed following each interview. In the N4 software, this working environment description is attached to each interview transcript, again in the form of a memo. Thus, it will be possible to determine the type of industry that highlights a particular essential attribute. The more popular essential attributes may relate, therefore, to particular industries. The least popular essential attributes may relate to specific types of industry. This relation between essential attribute and particular industries may emerge as the research proceeds and more interviews are completed. This could be important in terms of future course planning, as it may be possible to determine which educational factors should be established in a course in order to develop the essential attributes necessary for a particular industry. This relationship will be examined

further in chapter 4. A working environment observation transcript, relating to the appendix 5 interview transcript, is shown in appendix 6.

Theory building:

Having looked at some of the educational factors that each essential attribute will require to adequately develop it in students, we can now look more closely at theory building. Miles and Huberman (1994:144) discuss theory and data. Conclusions are usually supported by three features: (a) a theory is evolved and tested (b) available and relevant data, (c) the theory categories fit the data. A worked out theory is called a model and is a predicted pattern of events that can be put alongside what really happens, to see whether the pattern matches. A useful theory is said by Miles and Huberman (1994:147) to apply to more than one case. Miles and Huberman (1994:222) describe causal models. These are a network of variables, with causal connections, drawn from multiple case analyses. A testable set of propositions about a complete network of variables and their interrelationships can be attempted, with the aim of building theory.

This can now be applied to the essential attributes approach. Following the approach of Miles and Huberman (1994:222), we can ask the question: “From which ‘respondent group’ do the ‘essential attributes’ emerge?” Using the spreadsheet shown below, which summarises data from the first nine interviews, we can attempt to answer this question. In tabular form, we can put the groups of respondents along the top of the table as shown.

Table 3.1: ‘Respondent group’ from which ‘essential attributes’ emerge.

	A	B	C	D	E	F	G	H
1		Past	Present	Non-com	Lecturers	Employers	Total	Desire
2	Essential Attributes							
3	Creativity	1			2		3	m-h
4	Individual flair	1	1			1	1	l-m
5	individual projects	1	1			1		
6	Information research	1	1			1		
7	I.T. skills	1	1			1		
8	Management	1	1		2	1	3	m-h
9	Mathematical ability		-1	1	2		2	m
10	Personal Attributes				2		2	m
11	Problemsolving							
12	Public speaking	1	1		1		2	m
13	Reasoning	1	1		2		2	m
14	Self directed	1	1		2	1	5	m-h
15	Teamworking ability	2	2	2	2	1	10	h
16	Time management							
17	Written							

So the respondent groups of past graduates, present students, non-completing students, lecturers/managerial staff and employer representatives are listed along the top of the table in row 1. The essential attributes are listed in column A. The numbers in the boxes indicate the number of positive responses about the essential attribute. A minus sign indicates a negative response to the essential attribute. The total number of positive responses, minus the number of negative responses, is shown in column G. The desirability of each essential attribute from the respondents can then be judged. This is shown in column H as highly desirable (h), moderately to highly desirable (m-h), moderately desirable (m), or low to moderately desirable (l-m).

Thus some essential attributes are considered more desirable than others. Another table can therefore be produced, which shows the magnitude of the desirability of the essential attributes down the left side of the table. Along the top of the table are shown educational factors, which have been indicated by the literature review, to be important in enhancing essential attributes in students. Some of these educational factors are common to more than one essential attribute. If the educational factor makes a major contribution to the essential attribute the term *major* is shown in the table. If

the educational factor makes a moderate contribution, the term *moderate* is shown in the table.

Table 3.2: ‘Educational factors’ influencing ‘essential attributes’.

<u>Magnitude of the desirability of 'essential attributes':-</u>	Metacognitive instruction	Mentoring by older students	Students desire to achieve	Assessment practices	Social and economic HRD awareness
<u>Highly desirable:</u>					
Teamwork	major	moderate			
<u>Medium to high desirability:</u>					
Creativity			moderate	major	
Management knowledge					moderate
Selfdirected learning					major
<u>Medium desirability:</u>					
Mathematical ability	major				
Personal attributes					moderate
Public speaking					
Reasoning	major				
<u>Low to medium desirability</u>					
Individual flair					
Individual project skills					
Information research skills					
I.T. skills					
Problemsolving ability	major				
Time					
Written communication					
Critical evaluation				major	

Metacognitive instruction emphasises reflective discourse by providing each student with the opportunity to ask questions about (a) the nature of the problem, (b) the use of appropriate strategies, (c) the relationship between previous and new knowledge.

Personal attributes include confidence, responsibility and an enquiring attitude needed to support continued learning and professional development.

As more interviews are completed, more essential attributes may emerge from the interview data. The subsequent literature investigation of each essential attribute, or a particularly informative interview, can highlight educational factors, which may be the key to developing essential attributes in students. Following each block of approximately ten interviews, these two tables can be redrawn. Thus the order of desirability of the essential attributes can change and educational factors can increase.

By indicating on the second table, the effect of each educational factor (major, moderate, minor) on each essential attribute, a picture of the relative importance of the educational factors in the development of essential attributes can be produced. According to Miles and Huberman (1994:224), this type of 'causal model' can be built up by reflecting on how the two displays can be integrated into a meaningful explanatory model. The final result could be a model in the form of a causal flowchart.

This theory building is continued in chapter 4 by including more interviews into the two tables. From these tables, the basis for the development of causal flowcharts is provided, both for 'fitness for purpose' and for 'engineering excellence' using the concept of a sustainable world. This process is continued in chapter 4 along with the search for educational factors from the interview data, rather than the literature, which was the case in table 3.1 and table 3.2.

We can obtain from table 3.1 a hierarchy of essential attributes and from table 3.2, the corresponding educational factors. Thus in the causal flowchart, we can indicate what may be the more important of the essential attributes and educational factors. It should be noted, however, that the iterative nature of the interview process could result in a change of questioning. This change in questioning could be due partly to reflection on the theory building process described above. The result may be more essential attributes and more standards of excellence with the corresponding educational factors. These essential attributes may not figure highly in the hierarchy of essential attributes described in table 3.2, but because they emerge from past graduates, who have considerable industrial experience

since graduation, they must be given consideration. This will particularly be so, if the essential attributes can be shown to contribute to a sustainable world.

Table 3.2 was produced from data analysis of the first nine interviews (QMt) and table 4.2 in chapter 4 was produced from data analysis of a further eight interviews (QMt2). Comparing these two tables, it can be seen that 'teamwork ability' remains the most highly desirable essential attribute mentioned by interview respondents. It is interesting to see that, following seventeen interviews, 'mathematical ability' seems to be the least desirable of the essential attributes.

One of the objectives of the schedule of interviews, following the first seventeen interviews (QMt2) was to attempt to, not only obtain information about essential attributes, but use a line of questioning that obtains information about the educational factors that the respondents think improve essential attributes. These educational factors could then be considered for inclusion in the top line of table 3.2. This will be further discussed in chapter 4.

It will also be seen in chapter 4 that following QMt2, the top five most desirable essential attributes highlighted by respondents, were found to be teamwork, self-directed learning, management knowledge, public speaking, and personal attributes. The first interview in QMt3 attempted to obtain respondent opinion on the educational factors that enhance any essential attribute, which was described as important. The success or otherwise of this approach was assessed following the interview and modifications to the approach was attempted at the next interview. If, following a number of interviews, this approach was found to be unsuccessful, then another approach was attempted. This also entailed re-examining the QMt interviews and the QMt2 interviews for any mention of educational factors, which could influence essential attributes. These could then be included in the causal model.

To keep a record of the educational factors that relate to each essential attribute, a memo has been created along side each essential attribute listed in the N4 software. The memo lists the educational factors, which according to respondents, could be useful in inculcating essential attributes in students. So for the first nine interviews, named as QMt project in the N4 software, no memos were created. For the eight interviews, named as QMt2 project in the N4 software, memos have been created alongside each essential attribute. Similarly for the seven interviews named as QMt3 project and for the six interviews named as QMt4 project, memos were created alongside each essential attribute. If the research proceeds beyond this final thesis, these memos could be continued, keeping a strong record of the research findings within the software. The list of educational factors listed in these memos for each of the essential attributes may increase as the research proceeds.

Chapter 4 - Quality Analysis.

Fitness for purpose:

Chapter 2 has indicated that there are gaps between ‘standards of excellence’ obtained from the wider debate and the ‘fitness for purpose’ standards set by the course literature. The stage 1 final report revealed that this gap could be highlighted more clearly by analysis of documentation using the N4 software. Also highlighted was a gap between the nodes derived from interviews and the documentation. What is emerging from the field work undertaken more recently, is that the interview data from the more experienced past graduates, are more likely to indicate essential attributes that can be classed as standards of excellence. These standards of excellence should have a direct impact on a concept of engineering excellence, which we have described as a sustainable world.

Following the coding of the first nine interviews and the external documents listed in chapter 3 (N4 project QMt), the essential attributes created as nodes in the N4 software were examined. Fifteen nodes emerged from N4 project QMt as essential attributes. These were: creativity, individual flair, individual projects, information research, information technology skills, management knowledge, mathematical ability, personal attributes, problem solving ability, public speaking, reasoning, self directed learning ability, team working ability, time management and written communication. Following a review of the work done in the three N4 projects QMt, QMt2, QMt3, the number of essential attributes increased by one and the number of standards of excellence increased by two. These new nodes were critical evaluation, ‘safety, health and welfare of the public’ and course strategy. As will be seen later in this chapter 4, the literature indicates that ‘safety, health and welfare of the public’, has a direct impact on a sustainable world. Also, for a course to be sustainable and react to its environment, course strategy must be frequently reviewed. Therefore, in N4 project QMt4, ‘safety, health and welfare of the public’ and course strategy have been categorised as ‘standards of excellence’ nodes. In chapter 3, critical evaluation emerged from the literature as an essential attribute. Therefore, in N4 project QMt4, critical evaluation has been categorised as an essential attribute. Thus in N4 project QMt4, the number of essential attributes increases, from the fifteen

in the previous projects (QMt, QMt2 and QMt3) to sixteen. The number of standards of excellence, however, increases from the thirteen in projects QMt, QMt2 , to fourteen in QMt3 and fifteen in QMt4.

From the N4 software, reports were produced for each of the ‘essential attributes’ nodes and the ‘standards of excellence’ nodes. These reports are shown in appendix 7 and appendix 8. Appendix 7 shows the essential attributes report from QMt, QMt2 and QMt3. It can be seen that this report is divided into a further fifteen reports on each essential attribute. From the ‘**creativity**’ report (report 1 of appendix 7), it can be seen that in QMt project, three respondents, i.e. one past graduate and two lecturers, have mentioned that the course is delivering on the essential attribute of creativity. Creativity is also mentioned in two of the CIT academic quality books, the IEI submission and the QAA subject overview report. The IEI submission was produced by the CIT Department of Mechanical and Manufacturing Engineering. The QAA report relates to the wider debate on engineering higher education. In QMt2 project, an employer representative highlights the importance of creativity and a lecturer indicates that it is not possible to teach creativity. In QMt3 project, a past graduate indicates that creativity could be enhanced by ‘more emphasis on coming up with ideas’ being implemented in the course. This has been listed in the footnotes of appendix 7 as an educational factor. So N4 report 1 indicates that the course is delivering on the essential attribute of creativity, but this could be improved.

Moving on to N4 report 2 concerning ‘**individual flair**’, it can be seen that in N4 project QMt, individual flair was mentioned by just one employer representative, who highlighted the danger of smothering this essential attribute. Two more past graduates indicated in QMt3, the importance of individual flair. Individual flair can, however, be linked to the next essential attribute discussed in N4 report 3 and that is ‘**individual projects**’. Performance in individual projects could assess the individual flair of the student. Individual projects is mentioned in the QAA subject overview report and therefore is relevant to the wider debate on engineering higher education. Individual projects is also mentioned in the IEI submission and

has been discussed previously in chapter 2 (the literature review), although it was not picked up by the N4 coding of the IEI submission document. The analysis so far of individual flair does indicate that it is adequately assessed by the course.

N4 report 4 indicates that the QAA subject overview report regards **‘information research’** as an essential attribute. It was not coded from any of the other documents. From QMt2 an employer representative mentions the importance of graduates having both information research and information technology skills.

‘Information technology’ skills are shown in N4 report 5 to be regarded as an essential attribute by the QAA subject overview report. Information technology was also discussed in the IEI submission. Three past graduates from QMt3, highlight the importance of information technology skills and indicate two educational factors that should be implemented by the course. These are ‘using common computer packages/the internet’ as well as ‘more use of multi-media/computers for report writing’.

The essential attribute of **‘management knowledge’** is discussed in N4 report 6. It can be seen from QMt that the two lecturers, who were interviewed, were not sure whether the course was delivering on this essential attribute. An employer representative, who was also interviewed, stated that there was a lack of knowledge in this area amongst all engineering graduates. The IEI submission and the QAA subject overview report mention management knowledge as necessary for graduates. From QMt2, a past graduate indicated that management skills were not adequately developed at CIT and suggested the educational factor of ‘role play’ would improve the situation. Another past graduate suggested leaving out management completely from the course and attending a course on the subject subsequent to leaving CIT. An employer representative regarded ‘finance, legislation and general management skills’ as necessary. Two female students, who both had some previous industrial experience and were presently completing the course, also suggested general management skills. A lecturer highlighted the difficulty of implementing these skills in

students if they do not have industrial experience. From project QMt3, past graduates indicated a number of educational factors that could improve management knowledge. They suggested that the course should explain to students ‘how to manage getting something done?’ and that an ‘introduction to project management in first or second year (assisted by former graduates)’ would be the way forward. Another past graduate suggested a ‘modular approach’ to the subject.

N4 report 7 indicates that there were some mixed feelings regarding mathematics. In QMt project, the QAA document does mention ‘**mathematical ability**’ as important and the lecturers who were interviewed, thought that mathematics was taught to a sufficiently high level. One student presently completing the course thought that the subjects of computers and mathematics were of limited relevance. This student felt that teaching mathematics over the full four years of the course was excessive and more industry related topics should be taught. In QMt2, a female student presently completing the course indicated that the educational factor of ‘more examples’ should be implemented for the statistics section of mathematics. She also suggested ‘tutorials’ as another educational factor. Another past graduate suggested more ‘practical examples’ as an educational factor and this was reiterated by a non-completing student. The past graduate and present students interviewed in QMt3 indicated that the mathematics was of a sufficiently high standard. Hence we can deduce from N4 report 7 that the course is delivering mathematics to a sufficiently high level, but some students disagree with the methods, content and quantity of the material taught.

N4 report 8 shows that ‘**personal attributes**’, such as confidence and responsibility, are mentioned in the QAA subject overview report, but were not highlighted by any of the interviews coded in QMt project. In QMt2 however, a female student presently completing the course, suggested the educational factor of ‘work placement’ as a method of building these personal attributes and this was also mentioned by a past graduate interviewed for QMt3. Other educational factors suggested by past graduates were ‘communicating professionally’, ‘a personal development

course from the Irish Management Institute', the 'chairing of meetings' and 'individual presentations to the rest of the class followed by a question and answer session'. Some of these educational factors for promoting 'essential attributes' are already included in the course. The 'chairing of meetings' and 'a personal development course' may need to be included in the course. The educational factor of 'work placement' could also be applied to all students and not just to some students, which is presently the case.

'Problem solving ability' is examined in N4 report 9. In QMt project this was mentioned by the lecturers who were interviewed, but not by the past graduates. It is highlighted in one of the CIT Academic Quality books, as well as the IEI submission document and the QAA subject overview report. In QMt2, a lecturer suggested the educational factor of 'smaller tutorial groups' for promoting problem solving ability, but was wary of the cost implications. Past graduates interviewed as part of QMt3 indicated that as an educational factor there should be 'more problem solving' throughout the course. One of them suggested the 'use of teamwork' to solve problems, as another educational factor. The general conclusion on 'problem solving ability' is that more could be done on the course to improve this essential attribute.

'Public speaking' seems to be adequately delivered by the course as indicated by N4 report 10. In QMt project, a past graduate felt that public speaking should be introduced earlier in the course and one lecturer considered the course to adequately teach this topic. This essential attribute is mentioned in the IEI submission and the QAA subject overview report. In QMt2, two female students presently completing the course indicated that more should be done to promote public speaking by the course. One of these students suggested the educational factor of 'mentoring by senior students in conjunction with laboratory work presentations'. Past graduates interviewed in QMt3, indicated that the course generally is delivering on this essential attribute. However, they do suggest, as additional support for this essential attribute, the educational factors of

- (a) 'lecture time allocated to the final year preparation for project presentations and exhibition work' and

- (b) 'the latest engineering advances presented to the class by each student, followed by questions'

N4 report 11 indicates that '**reasoning**' is poorly dealt with by the course as far as the lecturers are concerned. It was not mentioned by any of the past graduates or employer representatives. The CIT academic quality book 3 mentions reasoning, as does the QAA subject overview report. In QMt3 project, a more direct question on this essential attribute was asked of a student presently completing the course, who also felt that reasoning is poorly promoted. This student suggested an educational factor of 'reduction of intense classes' for assisting in promoting reasoning.

There were some interesting responses concerning '**self directed learning ability**', shown in N4 report 12. In QMt project, the employer representative and one lecturer thought that its importance depended on the type of industry. Another lecturer stated that we should do more on the course to encourage this essential attribute. A past graduate felt that it suited some people, but not others. A student presently completing the course considered that more guidance should be given concerning self-directed learning. Both the IEI submission and the QAA subject overview report mention this essential attribute. In QMt2 an employer representative regarded this essential attribute as very important. A lecturer indicated that self-directed learning should be more widely introduced throughout the course. In QMt3, a student presently completing the course indicated that there was a lack of direction from academic staff on this essential attribute. There are indications that the course should try to develop self-directed learning ability.

All the respondents in QMt project had an opinion regarding '**team working ability**' as N4 report 13 shows. Past graduates considered this as an important area, which should be encouraged. The two students presently completing the course, had doubts about teamwork. One student stated that sometimes one person ends up with most of the work. The two non-completing students had similar doubts. The two lecturing staff felt that the course was adequately addressing this issue. One employer representative

stated that an over emphasis on teamwork was undesirable, as it tends to smother individual flair. Team working ability is mentioned in both the IEI submission and the QAA subject overview report. In QMt2, one past graduate suggested the educational factor of 'role play' would promote this essential attribute. Another past graduate suggested the 'use of teamwork to solve problems' as another educational factor. The evidence suggests that more could be done on the course to promote teamwork ability.

N4 reports 14 shows that the essential attribute of '**time management**' has been highlighted by the QAA subject overview report. It is not highlighted by any other source. A more direct question in future interviews may shed light on this essential attribute.

N4 report 15 shows that the essential attribute of '**written communication**' is mentioned in the QAA subject overview report. In QMt2 project, an employer representative stressed the importance of report writing and suggests the educational factor of 'laboratory work and reports' as a method of enhancing written communication. A past graduate suggests 'the use of multi-media/computers for report writing' as an educational factor for promoting written communication. Again, it can be concluded that more could be done by the course to promote this essential attribute.

Summarising the above findings it can be deduced from the evidence presented so far, that the course is delivering on the essential attributes of creativity, individual flair, individual projects and public speaking. The course documentation and the interview evidence produced in N4 projects QMt, QMt2 and QMt3 support this conclusion.

Essential attributes mentioned in the wider debate documentation, but not highlighted by the course documentation are information research, personal attributes, time management, written communication. More could be done to promote these essential attributes by the course, thus improving course quality. Since these essential attributes have derived from the wider debate documentation, consideration was given to moving these nodes from the 'fitness for purpose' side of the node tree, to the 'standards of excellence'

side of the node tree. In N4 project QMt, all the essential attributes are shown together on the 'fitness for purpose' side of the node tree. For N4 projects QMt2, QMt3, after due consideration, no transfer of essential attributes to the 'standards of excellence' side of the node tree was made. However in QMt4, safety and course strategy were placed on the 'standards of excellence' side of the node tree.

The essential attribute of information technology skills is highlighted by the wider debate documentation and is mentioned in the course documentation as important. The interview evidence indicates that more could be done to promote this essential attribute.

The essential attribute of reasoning has been highlighted by the wider debate documentation and interview evidence. However, course documentation does not mention reasoning. More could be done by the course to give this essential attribute some consideration.

Interview evidence produced so far indicates that the essential attributes of management knowledge, problem-solving ability, self-directed learning ability and team working ability are not adequately delivered by the course. The course and wider debate documentation highlight these essential attributes as very important. Interview evidence suggests that attention to their delivery could improve course quality.

The wider debate documentation does suggest that a high level of mathematical ability is important, but interview evidence indicates that the teaching approach could be improved to make it more relevant to industry. It can be concluded that more attention to the teaching of mathematics should be considered by the course.

Standards of excellence:

Of the nodes shown in appendix 4, some have been categorised under standards of excellence. These nodes are: aims and objectives, development of consultancy activities, requirement of employers, response to reports of external examiners, Humboldt principle, local and regional needs, the effect

of a mission statement on excellence, national and international needs, requirement of professional bodies, quality assurance, development of research activities, 'CIT research charter' and 'student - staff liaison committees'. Also emerging from the data, following a review of N4 reports QMt, QMt2 and QMt3, are the standards of excellence of 'safety, health and welfare of the public' and course strategy. N4 reports on these nodes are shown in appendix 8.

The first N4 report in appendix 8, is N4 report 16 concerning '**aims and objectives**'. From the QAA subject overview report (1998:4), the definition of 'aims' is given as "the broad educational purpose of the provision set out in the self assessment document". The definition of 'objectives' is given as "the learning outcomes of each programme". From N4 report 16, it can be seen that 'aims and objectives' is mentioned by the QAA report. It has also been mentioned by the IEI submission, although not coded in N4 as such. Aims and objectives are indeed implemented for each subject, throughout the IEI document. The aims and objectives of each self-assessment document, provided by an institution, could eventually include some of the essential attributes listed in this research report.

N4 report 17 concerns the '**development of consultancy activities**', which has also been coded as a standard of excellence. Consultancy has been mentioned in CIT Academic Quality Book 2, the IEI submission and the QAA Subject Overview Report. This last report mentions consultancy on three occasions and emphasises the importance of academic staff involvement in consultancy.

The '**requirement of employers**' is coded as a standard of excellence and N4 report 18 shows that the requirement of employers has been highlighted by CIT Academic Quality Book 2 and the IEI submission. As stated previously, employer representatives are one of the groups targeted by the interview data gathering of this research.

N4 report 19 shows that the '**response to reports of external examiners**' has been highlighted by the QAA Subject Overview Report. This has been

coded as a standard of excellence. The QAA report emphasises the importance of responding to reports of external examiners.

The **‘Humboldt principle’** was already discussed in the literature review and is defined as the link between research, teaching and study. N4 report 20 shows that the Humboldt principle has been coded as a standard of excellence and that mention of this link is made in the CIT Academic Quality Book 3, the IEI submission and the QAA Report. The interdependence of research and teaching are mentioned in the CIT research charter (CIT Academic Quality Book 3 page 7). The IEI submission (2000:26) also mentions that the future of the BEng course will include the integration of research, teaching and study.

N4 report 21 gives **‘local and regional needs’** as a standard of excellence and this can be linked to N4 report 23, which also shows **‘national and international needs’** as a standard of excellence. These two nodes have been mentioned in the QAA report. Most institutions assessed by the QAA attempt to meet the academic requirements of professional bodies. Also some of these institutions aim to meet ‘local and regional needs’ and/or ‘national and international needs’.

The **‘effect of a mission statement on excellence’** has also been coded as a standard of excellence in N4 report 22. This standard of excellence has been mentioned by the QAA report. The report highlights how the emphasis of the course should be reflected in the mission of the institution.

N4 report 24 shows that **‘requirements of professional bodies’** has been coded as a standard of excellence. This standard of excellence has been mentioned in CIT Academic Quality Book 2 and the QAA report. Most institutions assessed by the QAA are attempting to meet requirements of professional bodies.

‘Quality assurance’ defined as an ‘Institution review of programmes’, is shown in N4 report 25 to be coded as a standard of excellence. This standard of excellence has been mentioned in the QAA report. The QAA

would like to see in most institutions assessed, a more analytical and self-critical appraisal of the quality of provision.

The **‘development of research activities’** is shown in N4 report 26 to be coded as a standard of excellence. This standard of excellence has been mentioned in the three CIT Academic Quality books, as well as the IEI submission and the QAA report. Active engagement of the staff in research and consultancy, with these activities informing the curricula, is encouraged by the QAA. Also mentioned in CIT Academic Quality Book 3, is the **‘research charter’** and this is shown in N4 report 27 to be coded as a standard of excellence.

N4 report 28 concerns **‘safety health and welfare of the public’**. This standard of excellence derives completely from interview data involving students, an employer representative and past graduates. The literature review also highlights the importance of safety in contributing towards the chosen concept of engineering excellence - a sustainable world.

The final standard of excellence coded in N4 project QMt is shown in N4 report 29 to be **‘student - staff liaison committees’**. This standard of excellence is mentioned in the QAA report. The QAA report also encourages effective informal contact between staff and students, as well as student representation on programme committees.

As well as these thirteen standards of excellence, which contribute towards an engineering excellence concept of a sustainable world, another standard of excellence has emerged from interview data. Following a second scan of the QMt3 interview data, it was noticed that one past graduate, with considerable consultancy experience, gave an opinion concerning the type of pharmaceutical industry that would be establishing in Ireland in the next few years. Thus, it was suggested that the nature of the course might change to cater for this new type of industry. In QMt3 and QMt4 therefore, the new standard of excellence of **‘course strategy’** has been added to list. This increases the number of standards of excellence nodes to fifteen. Information on course strategy could ensure that the course is sustainable in

the sense that it can respond to changes in the environment and not be found to be out of date in a few years.

From the above standards of excellence reports, it can be seen that the ‘requirement of employers’ has been coded as a standard of excellence. The reason for this coding was that the ‘requirement of employers’ was highlighted by the wider debate QAA documentation. Hence any essential attributes, which emerge from interviews with employer representatives, could be coded under the ‘standards of excellence’ side of the node tree. This has been considered, but so far has not done. It was decided to only move essential attributes to the ‘standards of excellence’ side of the node tree, if they have a direct impact on the chosen concept of engineering excellence (sustainable world). So even though essential attributes are derived from documentation from the wider debate that does not automatically mean that they are standards of excellence. What is interesting is that the essential attributes, which can be classified as standards of excellence, appear to be emerging from past graduate data, particularly those past graduates that have varied industrial experience.

Interviews with employer representatives are usually in Ireland, hence these interviews are also reflecting, local and regional needs, which is another standard of excellence. However, there has been difficulty in arranging interviews with this group. Experienced past graduates, who have reached senior positions, can be regarded as equivalent and will give similar data to employer representatives.

The ‘requirements of professional bodies’, coded above as a standard of excellence indicates that more literature from professional bodies should be reviewed. This could be included in a future stage of this research and this is addressed in chapter 5.

N4 project QMt4:

So in N4 project QMt4, we have created an essential attributes category on the ‘standards of excellence’ side of the node tree. In this essential attributes category the node safety, has been be relocated from the ‘fitness for

purpose' side of the node tree to the 'standards of excellence' side of the node tree. It is interesting to note that safety emerged from the past graduate data, rather than wider debate documentation and is the only essential attribute that is considered to be worthy of reclassifying to the standards of excellence side of the node tree. This is because 'safety' has a direct impact on the chosen concept of engineering excellence - a sustainable world. Course strategy has also been added to the 'standards of excellence' side of the node tree, as it is important that the course should be able to react to a changing environment. Frequent checking of this standard of excellence will ensure that the course is sustainable. Also from the literature examined in chapter 3, critical evaluation has been coded as an essential attribute. For the moment, this essential attribute will remain on the 'fitness for purpose' side of the node tree.

Interviews completed recently, have been imported into N4 project QMt4 and coding has taken place. N4 project QMt4 reports are shown in appendix 9. The findings of these QMt4 reports are discussed in chapter 5 (Differences). When data analysis is complete, with the findings adequately assessed, the nodes will, if necessary, be re-arranged once more. This will form the basis for N4 project QMt5 and future research. More interviews will be imported into this further refined version of the software model in future research. More coding, analysis, assessment of data and rearrangement of nodes will again follow. The rearranged nodes will form the basis of N4 project QMt6 and this iterative process will continue.

Interviews:

Ball (1993:46) points out that every ethnography should be accompanied by a "research biography", or a reflexive account of the conduct of the research. In this account, the problems, choices, errors, etc., could be described and may, according to Carr (1993:164) transform the theory that guides the research.

Nine interviews were processed as part of N4 project QMt. These were: two interviews with graduates who had completed the course, two interviews with students presently completing the course, two telephone interviews

with students who had not completed the course, two interviews with lecturers and one interview with an employer representative. Eight interviews were processed as part of QMt2. These were: two interviews with graduates who had completed the course; one group interview with two students presently completing the course; two telephone interviews with students who had not completed the course; two interviews with lecturing staff; one interview with an employer representative. Seven interviews were processed as part of QMt3. These were: six interviews with graduates who had completed the course and one with a student who is presently completing the course. As part of QMt4, six interviews have been completed with graduates who have completed the course. QMt4 interviews have now been coded and in chapter 5 (Differences), the findings from the QMt4 reports shown in appendix 9 are discussed. If the research is to progress beyond this final thesis, more reflection would be required on these QMt4 reports, in order to prepare the nodes for QMt5.

At the start of all interviews, the respondents were told the aim of the research (BEng course improvement). They were assured of the anonymity and confidentiality of the interviews. With regard to the past graduates interviewed, there were observation notes of their workplace taken, as well as field notes of the interviews. The group interview with the two female students, presently completing the course, proved to be very successful. These two students tended to 'bounce' ideas off each other, thus generating more data. As part of future research, this method of interviewing, with students presently completing the course, will be continued.

There was difficulty experienced with some employer representatives. During the E835 pilot study, employer representatives chosen for interview were from the personnel department of the organisation. These representatives were reluctant to talk and seemed suspicious of interview motives. For the remainder of this research therefore, it was decided that engineering managers would be selected for interview. However, one of the engineering managers, chosen for interview, suggested that a subordinate would be a more suitable candidate for interview and would know more about the organisational requirements needed from past graduates.

Unfortunately, this subordinate was very difficult to contact and the interview had to be re-scheduled to a future date. At the moment, the way forward with this group is based on perseverance. If this is still unsatisfactory, then invitations for employer representatives, to a function at CIT may be the way forward for future research. At these functions, interviews with employer representatives could then be arranged. As the BEng course has been in existence since 1985, many of the graduates have reached senior positions in industry (engineering managers, associate directors, etc.). These more experienced graduates are therefore a suitable substitute for employer representatives and this is the best way forward. There is no problem organising interviews with graduates from the course, as I know them all personally, having lectured to them on the course for at least three years.

There was also reluctance for non-completing students to meet face to face for interview, particularly at their place of work. Telephone interviews were the preferred method for this group. One female non-completing student stated that she did not wish to discuss the course as it had bad memories for her. Another non-completing student stated that he would discuss the course at a later date, but so far he has not agreed to a mutual time. Another non-completing student, who had subsequently changed courses and successfully completed a degree in applied physics, did not wish to meet at his workplace to discuss the BEng course. The impression given was that a certain amount of shame was felt at non-completion of a course. Non-completing students may not want their present work colleagues to discover their previous lack of success. Again this may be examined more fully in future research.

Causal flowcharts:

This section continues the theory building, which was started in chapter 3 and resulted in table 3.1 and table 3.2. Using the spreadsheet shown in table 4.1, which summarises data from the first seventeen interviews, the causal model is extended from that described in chapter 3, to that shown in table 4.2. These tables can then be utilised as the basis for a causal flowchart.

Table 4.1: Second iteration after 17 interviews - 'Respondent group' from which 'essential attributes' emerge.

	A	B	C	D	E	F	G	H
1		Past	Present	Non-com.	Lecturers	Employers	Total	Desire
2	Essential Attributes							
3	Creativity	1			2-1		2	m
4	Individual flair					2	2	m
5	individual projects							
6	Information research						1	1 l-m
7	I.T. skills						1	1 l-m
8	Management	1-1	2		3		2	7 m-h
9	Mathematical ability	1-1	-1	1-1	3			0 l-m
10	Personal Attributes		2		2		1	5 m-h
11	Problemsolving				1			1 l-m
12	Public speaking	1	3		1		1	6 m-h
13	Reasoning				3			3 m
14	Selfdirected	1	1		3		2	7 m-h
15	Teamworking ability	3	2	2	3		2	12 h
16	Time management							
17	Written		2				1	3 m

The respondent groups of past graduates, present students, non-completing students, lecturers/managerial staff and employer representatives are listed along the top of table 4.1, row 1. The essential attributes are listed in column A. The numbers in the boxes indicate the number of positive responses to the essential attribute. A minus sign indicates a negative response to the essential attribute. The total number of positive responses, minus the number of negative responses, is shown in column G. The desirability of each essential attribute from the respondents can then be judged. This is shown in column H as highly desirable (h), moderately to highly desirable (m-h), moderately desirable (m), or low to moderately desirable (l-m).

Thus it can be seen that some essential attributes are considered more desirable than others. Table 4.2 can therefore be produced, which shows the magnitude of the desirability of the essential attributes down the left side of the table. Along the top of the table are shown educational factors, which have been indicated by the literature review, to be important in enhancing essential attributes in students. Some of these educational factors are common to more than one essential attribute. If the educational factor makes a major contribution to the essential attribute the term *major* is shown in the

table. If the educational factor makes a moderate contribution, the term *moderate* is shown in the table.

Table 4.2: Second iteration after 17 interviews - 'Educational factors' influencing 'essential attributes'.

	<u>Magnitude of the desirability of 'essential attributes':-</u>	Metacognitive instruction	Mentoring by older students	Students desire to achieve	Assessment practices	Social and economic HRD
	<u>Highly desirable:</u>					
1.	Teamwork	major	moderate			
	<u>Medium to high desirability:</u>					
2.	Self directed learning					major
2.	Management knowledge					moderate
2.	Public speaking					
	<u>Medium desirability:</u>					
3.	Personal attributes					moderate
3.	Reasoning	major				
3.	Written communication					
3.	Creativity			moderate	major	
3.	Individual flair					
	<u>Low to medium desirability</u>					
4.	I.T. skills					
4.	Problemsolving ability	major				
4.	Mathematical ability	major				
	Individual projects					
	Information research					
	Time					
4.	Critical evaluation				major	

As more interviews are completed, more essential attributes may emerge from the interview data. The subsequent literature investigation of each essential attribute, or a particularly informative interview, can highlight educational factors, which may be the key to developing essential attributes in students. Following each block of approximately ten interviews, these two tables can be redrawn. Thus the order of desirability of the essential attributes can change and educational factors can increase. This hierarchy of

essential attributes will develop as the research proceeds, evolving from wider debate documentation, course documentation and stakeholders. Because of this wide ranging source, it is hoped that implementation of educational factors from a fully developed table will promote in graduates essential attributes, which will have a positive effect on the creation of a more environmentally just, democratic and sustainable world. As stated previously, a theory of essential attributes should analyse each essential attribute for its contribution towards this emancipatory view of sustainability. Those with the most significant contribution could be re-classified as a standard of excellence.

By indicating on table 4.2, the effect of each educational factor (major, moderate, minor) on each essential attribute, a picture of the relative importance of the educational factors in the development of essential attributes can be produced. According to Miles and Huberman (1994:224), this type of 'causal model' can be built up by reflecting on how the two displays can be integrated into a meaningful explanatory model.

For each essential attribute, it is possible to produce a causal flowchart, with the educational factors from table 4.2, shown as having a direct impact on the successful production of the essential attribute in students. Rather than do a causal flowchart for each essential attribute, a general causal flowchart for all of the essential attributes has been produced. If a specific essential attribute flowchart is required, the educational factors necessary can be obtained from table 4.2 and placed in the educational factors box of the general causal flowchart. It should be remembered that the educational factors shown in table 4.2 are derived from the literature. Educational factors can also be obtained from interview data and these could also be placed along the top of table 4.2, along with those derived from the literature. This process is developed in later in this chapter. Thus from table 4.2, a model in the form of a causal flowchart is shown in figure 4.1.

Figure 4.1:

CAUSAL MODEL: - The Ideal Case. The influence of ‘educational factors’ on ‘essential attributes’ to produce a ‘sustainable world’.

In the centre box of figure 4.1 some of the essential attributes, which may be influenced by those educational factors that have emerged from the literature, are shown. These essential attributes are numbered according to their position shown in the hierarchy in table 4.2. The educational factors

that affect these essential attributes are shown in the left hand box of figure 4.1. The ideal case would be that, if these essential attributes are adequately promoted in graduates, then the overall chosen concept of engineering excellence, a sustainable world, would be approached. As will be seen later in this chapter, some of the essential attributes, such as 'safety, health and welfare of the public' can have more of an influence on a sustainable world than others.

Drawing on the external influences of student multiple intelligences and learning theories, a general causal flowchart can be further developed into that which is more likely to aspire towards a sustainable world. In this flowchart the importance of the Humboldt principle (link between research, teaching and study) and staff training/development is highlighted. If these external influences are missing from the causal flowchart, then it may be that the most a course can achieve will be fitness for purpose. Students have various capabilities, so some will be more drawn towards developing certain types of essential attributes than others. The type of intelligences that these students display will have an effect on the causal flowchart

According to Hyland (1999:32) there is a theory of multiple intelligences, which defines intelligence as the ability to solve problems that are of consequence in a particular cultural setting. There are considered to be at least eight autonomous, but interconnected intelligences including: linguistic, logical-mathematical, spatial, bodily kinaesthetic, musical, naturalist, interpersonal and intrapersonal. This theory was first proposed by the American Howard Gardner in 1983 who divided intelligences into three main groups: object-related intelligence (mathematics, logic), object-free intelligence (music, language, spatial, bodily-kinaesthetic, naturalist) and personal intelligence (interpersonal, intrapersonal). The creativity of young children and how it decreases as they mature is a particular research interest of Gardner.

From the point of view of increasing the range of essential attributes in students, it is important that teaching staff have an appreciation of intelligences. Particularly important is an appreciation of learning theories,

which will make the best use of intelligences for increasing essential attributes. The ideas of Vygotsky (CLMS 1993), who stressed the importance of selecting a method of learning to suit a particular situation, have been gaining increasing recognition. 'One to one' teaching is suitable for imparting a procedure, following which a student may be left to practice the procedure alone. In other situations 'groups' may be a suitable way of teaching. Two people, who individually cannot solve a problem, can work together and emerge with the problem solved. It is well known also that people learn through teaching, hence the importance of students giving presentations of their work at regular intervals. Another Vygotskian idea is the 'zone of proximal development' or the gap between student achievement alone and student achievement with help (THES 1987). This is useful across all learning methods, including individual or group methods.

The experiential learning theories of Kolb (1988), relating to the learning cycle, could be particularly useful in problem solving. Those of Freire (1972) should also have an impact on sustainability, as he attempted to teach a process, which could influence the environment of the student. The causal model, shown in figure 4.1, can now be modified to show some of these external influences (figure 4.2).

Figure 4.2:**Causal Model: - external influences.**

Figure 4.2 shows external influences on the causal model. This model is the basis of a theory of 'essential attributes'. The sustainable world and hence excellence is more likely to be achieved if the Humboldt principle exists, i.e. the mutually supportive relationship between research, teaching and study. The sustainable world is a concept of engineering excellence and the Humboldt principle (link between research, study and teaching) has also been chosen as a standard of excellence, which should contribute to the concept. Hence the arrows linking excellence, a sustainable world and the

Humboldt principle are shown in figure 4.2. These arrows are the only form of feedback in this model, unless of course staff training and development can be linked to excellence. However, depending on the type of staff training and development available, this is debatable.

If staff training and development are missing from the model, then there is less likelihood of students making a contribution to a sustainable world. The judicious application of learning theories by lecturers, when they attempt to develop essential attributes in students, should make a contribution to a sustainable world. If learning theories, the Humboldt principle or staff training and development are missing from the model, then the goal of excellence in the form of a sustainable world may be reduced to fitness for purpose or even less, as shown in figure 4.3.

Figure 4.3:

Causal Model: - minimal external influence.

In the figure 4.3 flowchart, the delivery of essential attributes is very much up to the teaching staff and relies heavily on student capability. There is no feedback of any kind into this model.

Alternatively, the amount of external influence on the model can be increased. For example, the influence of professional bodies, such as the Institution of Engineers of Ireland (IEI) or the Engineering Council (UK) could be taken into account. The influence of quality assurance agencies, such as the Higher Education and Training Awards Council (HETAC), can also have an effect. A committee of local employers can meet regularly to advise a course on outcomes and this can have influence. Each of these can be included in the model and this is shown in figure 4.4.

Following the first run of nine interviews, quality assurance systems, professional bodies and employers, have all been listed as standards of excellence in the N4 software. By including these sources of influence in the figure 4.4 model, it enhances the likelihood that by following the model a course would be guided towards excellence, thus contributing towards world sustainability. Research and consultancy are also categorised in the N4 software as standards of excellence, hence these are included in the figure 4.4 model.

Quality assurance systems, professional bodies and employers are external sources of influence on the model. They may indicate essential attributes from a national or international basis. To obtain a more local indication of essential attributes, the model obtains data from stakeholders, i.e. past graduates, present students, non-completing students, etc., most of whom will be locally based. This is the originality of the model. It goes directly to the product of the course and obtains data from the utilised product, which can be fed back into the model as new essential attributes. These could then generate educational factors, which will need to be implemented by teaching staff, if new essential attributes are to be included in the next cohort of graduates emerging from the course.

Figure 4.4:

Causal Model: - increased external influence.

Teaching staff may require training to enable them to adequately implement the necessary educational factors, including the application of learning theories to produce the required effect on the student. Figure 4.4 shows that the essential attributes are predominantly produced in the student by teaching staff. The teaching staff have direct contact with the student. Type of intelligence is the only other factor, which will have an impact on essential attributes generated in students.

Figure 4.4 also shows how interview data may be obtained from graduates most of whom have been in employment. The essential attributes and educational factors, which they discuss during the interview process, may be fed back into the model at the 'staff training and development' stage. Thus the model shown in figure 4.4, takes account of local needs as well as national and international needs.

Theory of 'essential attributes':

This developing theory of essential attributes uses interview techniques to obtain essential attributes from past graduates and also attempts to obtain from the same interviews, the educational factors necessary for producing the essential attributes in students. These educational factors may be obtained either from interviews or from a study of literature on the essential attribute. Essential attributes and the educational factors necessary to produce them are then fed back into staff training and development, such that teaching staff can utilize the educational factors in the production of essential attributes. Teaching staff are the key to ensuring that essential attributes are developed in students. It is important in a higher education theory of essential attributes that teaching staff are of the highest quality. This means they should be engaged in research or consultancy, which informs their teaching in some way. Any gaps in their capability could be filled with staff training or staff development. Capability gaps could be measured by regular staff appraisal.

To continue in the development of this theory of essential attributes, the way forward is to continue with the identification of essential attributes

from interviews, particularly with past graduates. Building on the model shown in figure 4.1 is the aim. This may ultimately lead to figure 4.4 as more standards of excellence and essential attributes emerge from the data. The educational factors, which influence the production of these essential attributes in students, should also be identified. By ensuring that teaching staff can implement these educational factors, local needs will be fulfilled and this has already been listed as a standard of excellence. Other standards of excellence relate to fulfilling the needs of the wider debate, i.e. professional body (IEI) requirements and quality assurance (HETAC) requirements. The requirements of employers, many of which are multinational companies, are also listed as standards of excellence.

A theory of essential attributes should not just develop or update a course curriculum. It stimulates some of the multiple intelligences of students by using educational factors in the development of essential attributes. The essential attributes that a particular student acquires during a course will depend, to some extent, on the combination of multiple intelligences with which the student is endowed when entering the course. Gardner (1993:366), when describing a number of creative lives (Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, Gandhi), notes that a characteristic of creativity is an amalgam of the childlike and adult like, both in terms of personality and ideas. Educational factors, which prevent the stifling of these features, would need to be enhanced to encourage creativity.

By using the N4 software for analysis of interview and documentary data, it is possible to determine whether a course is close to figure 4.3 (fitness for purpose) or figure 4.4 (excellence). The course may be between the two models, more like figure 4.2, which is producing quality graduates, but without a great deal of external influence. With regard to the CIT BEng course, the way forward is to continue with the N4 analysis of interview data and determine whether any more essential attributes emerge. If so, the educational factors necessary to develop these essential attributes in students, will need to be highlighted.

This aim of developing in professional engineering students a level of criticality such that they will aspire towards a sustainable world is clarified by Savin-Baden (2000:124) when describing five models of problem-based learning (PBL) in higher education. The five models are PBL for epistemological competence, PBL for professional action, PBL for interdisciplinary understanding, PBL for transdisciplinary learning and PBL for critical contestability. In the last model, students are encouraged to make knowledge claims that are presented to their peers for examination, thus developing a critical spirit. In this model, students are expected to develop qualities of moral, intellectual and emotional independence. They are also required to set their own goals and their own processes for learning and, according to Savin-Baden (2000:133), the problem based learning programme gives them the opportunity to do this. The aim is to develop students into questioning, critical practitioners able to evaluate themselves and their peers, whilst analysing the shortcomings of policy or practice. Savin-Baden (2000:134) maintains that this model can only be enacted within the context of postgraduate programmes. With the UK academic requirement for chartered engineer now being a four-year MEng, the development of criticality in graduates from the course appears to be the ultimate aim. In Ireland, the four-year BEng is the academic requirement for chartered engineer, but this must have the same aim of criticality, as does the MEng in the UK.

According to Jackson and Lund (2000:218), there are two fundamental purposes of any method of self-evaluation in higher education:

1. to facilitate improvement - development - change and
2. to satisfy expectations and requirements for professional accountability.

Jackson and Lund (2000:219) continue by describing four approaches to effective self-evaluation in higher education:

1. Measurement of the achievement of stated intentions.
2. Measurement of the adequacy of functions or processes.
3. Measurement of the extent of compliance with externally set standards.

4. Measurement of the extent to which practice matches up to acknowledged 'best' practice.

Bearing these points in mind, it is now useful to recap on this research. The following research questions have been posed:

1. What are the 'essential attributes' that a professional mechanical engineering degree course should provide to graduates, in order to meet international standards of excellence?
2. What are the 'essential attributes' that the Cork Institute of Technology BEng in mechanical engineering should provide to graduates, in order to meet 'fitness for purpose' standards?
3. To what extent does the Cork Institute of Technology BEng in mechanical engineering provide 'essential attributes' in order to meet:
 - (a) international standards of excellence,
 - (b) fitness for purpose standards?
4. Should the quality of the BEng course be raised in relation to:
 - (a) international standards of excellence,
 - (b) fitness for purpose standards?

Fifth and sixth research questions are also to be considered and these questions, which widen the focus of the research, are:

5. To what extent can the 'essential attributes' approach of evaluating course effectiveness, contribute to the higher education sector?
6. Is it possible to establish a theory of 'essential attributes', or are there other theories emerging from the data?

In the CIT case study, research question 1 is answered by using the QAA document as the international standard of excellence and searching the document for references to essential attributes. Research question 2 is answered by deriving the essential attributes from interview data obtained from course stakeholders.

The case study of applying the essential attributes approach to the CIT BEng, should show that, by comparing the essential attributes obtained from the interview data with those described in the QAA document, research question 3a is addressed. By comparing the essential attributes obtained from the interview data with those described in the course documentation, then research question 3b is addressed. By addressing the gaps found when answering question 3a and question 3b, it is possible to find an answer to research question 4. Later in this chapter, a method for the determination of the educational factors from interview data, which facilitate the production of essential attributes in students, is discussed. In chapter 3, educational factors were derived from the literature. This contributes to the assessment of the process. Hence this process assessment, together with attempting to answer the first four CIT case study research questions, should fulfill the effective self-evaluation criteria for all four approaches listed by Jackson and Lund (2000:219).

The CIT BEng course documentation is approved professional engineering accreditation documentation. Thus the essential attributes approach applied to the CIT case study, takes heed of professional accountability. Addressing the first four research questions should also ensure improvement, development and change. Hence, the two fundamental purposes of self-evaluation methods in higher education, described by Jackson (2000:218), have been fulfilled when the essential attributes approach is applied to the CIT case study. Research question 5, concerning the extent to which the essential attributes approach of evaluating course effectiveness can contribute to the higher education sector can now be answered. If the wider debate documentation is wisely chosen and course documentation addressing the concerns of professional bodies is available, then these can be analysed using the essential attributes approach. All the necessary criteria for effective course self evaluation methods, highlighted by Jackson (2000:218), will then be addressed. The essential attributes approach has the potential therefore to make a significant contribution to the higher education sector.

Examining research question 6, which concerns the establishment of a theory of essential attributes, this can now be examined by the use of the causal flowchart shown in figure 4.5. By listening to the voices and feelings of interacting individuals, it is possible to obtain information about the process of education. Although this research started by being concerned with determining essential attributes necessary for professional engineers, research question 6 has expanded this concern. In attempting to establish a theory of essential attributes, a new feature of this research has developed. This feature is to determine the educational factors necessary to establish essential attributes in students, as they work through their course. Figure 4.5 indicates the importance of teaching staff in implementing educational factors, such that essential attributes will be established in students. The effect on teaching staff of influences such as the Humboldt principle, staff training (including training in the use of learning theories) and staff development, will determine whether a course is fit for purpose or is capable of reaching a higher level. Possibly the course can aspire towards producing graduates capable of reaching out towards a sustainable world. The influence of professional bodies or quality assurance systems/agencies should encourage teaching staff to reach out for training and development. This could help to promote student excellence.

Figure 4.5 has modified figure 4.4 with the addition of a box representing course and wider debate documentation. This additional box will have an influence on educational factors and essential attributes. The interview data was shown in figure 4.4 to derive from past graduates only. This is now shown in figure 4.5 to also derive from teaching staff, employer representatives and students. This new interview data is for the purposes of triangulation. This means that stakeholders at other vantage points may have a different perspective on the data. So as well as past graduates, who are the main product of the course, other stakeholders, who may have a differing vantage point, are lecturers, employer representatives, non-completing students and students presently completing the course. The difficulties associated with arranging interviews with some of these groups have already been discussed in this chapter.

Respondent validation is also in use in this model, although not indicated in figure 4.5. It is possible during the interview process, that a response is misinterpreted. Hence respondent validation, whereby the interview transcript is returned by E-mail to the respondent within a few days of the interview, is used. On the receipt of the transcript, the respondent can make changes or additions and then return the transcript again by E-mail.

Other types of interview bias are respondents stating what they think the correct response should be. This sometimes can be the case when questionnaires are in use, but with interviewing, it should be relatively easy to detect. Sometimes this type of response is given by teaching staff, who are occasionally suspicious of the motives of a researcher. Fortunately however, past graduates rarely give this type of response. They do not always give positive responses concerning the course, but do tend to be critical of the course, suggesting improvements at the same time.

Louisy (1997:202) describes the inconclusive debate concerning insider research and considers that concentrating on in-depth interviews and documentary analysis as methods of inquiry lessens the probability of bias. The significant advantage of insider research for the CIT case study is the

ease with which interviews with graduates from the BEng course can be arranged. This is simply because the graduates know the researcher and are enthusiastic about giving their opinions of the course. In the case of non-completing students, most of whom leave the course during their first year, this group would not have met the researcher. Those briefly contacted, to try and arrange an interview, appear to want to forget the bad experience of the BEng course. Thus they turn down the opportunity to discuss the course. Similarly most employer representatives would not have met the researcher and do not regard discussions of a BEng course as a high priority. Interviews with teaching staff can also be slightly tentative as this group can be suspicious of research motives, which they feel may threaten their position. This raises ethical issues, such as anonymity and confidentiality. As Louisy (1997:204) points out, in a small research setting such as a course, it is difficult to keep research records confidential, if they are to be open to scrutiny by other researchers.

Therefore leaving out some of the scheduled interviews with non-completing students, employer representatives, or even teaching staff may avoid some of these issues and not be so significant. This point is emphasised by the iterative nature of the data analysis, which indicates that an increase in interviews with graduates employed in organisations offering consulting engineer services, may be advantageous to the research objectives. Reducing the number of interviews with the groups, which were originally intended for triangulation purposes in an attempt to eliminate bias, may not affect the data quality. Louisy (1997:214) also makes the point that documentary data can provide triangulation. Course documentation and the wider debate documentation are contributing to triangulation in this research.

Interviews with students presently completing the course have proved to be very successful in providing data. The interview schedule with this group should therefore be completed if possible. The 'grounded theory' approach to the treatment of data may also influence the next group to be interviewed. With this research the essential attribute of 'safety, health and welfare of the public' has been derived from the data. Scanning the data shows that this

essential attribute has emerged predominantly from a particular type of past graduate employed with organisations offering consultant engineer services. The data from this particular past graduate group also indicate that a standard of excellence, important to strategic planning could emerge. Further interviews with this group are therefore the way forward, in an attempt to provide data more relevant to this standard of excellence. In this way the creativity of the essential attributes approach can operate.

Harvey *et al* (2002:21) describe how higher education in the UK is attempting to enhance student employability in a more explicit and systematic way by collaborating with employers. Employability is described as attribute development, building confidence, self-promotional skills and encouraging lifelong learning. Although a number of examples of developing employability in students are given, including a strategic approach from some HEIs, excellence does not appear to be considered. Employability is a worthwhile objective to develop in students. However, a course aim of the development of student excellence, based on more ethical grounds, such as the achieving of a sustainable world, could be a secondary objective. The essential attributes approach does give the concept of employability a structure by adding the concepts of 'fitness for purpose' and excellence. These additional concepts assist in developing the approach towards a method of course effectiveness evaluation.

In the examples given in Harvey *et al* (2002), most of the information on employability of graduates is obtained from employers. The collaboration with employers is useful, but even more useful may be feedback from graduates, particularly those who have several years work experience and have reached senior positions in industry. Indeed many of the older graduates would have reached very senior positions and are in effect equivalent to employer representatives with the same outlook on the requirements of a course. These older graduates are much easier to approach and much more agreeable to responding to the interview process.

Figure 4.5 also includes some of the standards of excellence, which are considered to assist the course in attaining the chosen concept of

engineering excellence of a sustainable world. These are the boxes showing: professional bodies, quality assurance, employers, research, consultancy and the Humboldt principle (link between research, study and teaching). As will be seen later in this chapter, some of the essential attributes can also be redesignated as standards of excellence. Without these standards of excellence it will be difficult to reach the sustainable world.

For other disciplines, a concept of excellence would have to be chosen and there would be other standards of excellence to assist the particular course in reaching out for excellence. Some of the essential attributes would change for a different discipline. However, overall the shape of the essential attributes approach would remain very similar to that shown in figure 4.5. Therefore, figure 4.5 indicates how the essential attributes approach extends the existing theory of employability discussed by Harvey *et al* (2002).

Thesis criteria:

The final thesis criteria listed in the E990 mailing SUP 712263, “Doctorate in Education Part B (Stage 2, Year 2)”, lists four main headings against which the final thesis will be assessed:

1. demonstrates reflection on the relationship between theory and practice in education
2. makes a significant contribution to the theory and practice of education
3. shows an ability to select and apply appropriate research methods
4. exhibits a high level of critical analysis.

Bennett *et al* (2000:176) make the point that there is little evidence that teachers espoused or actual theories of teaching are underpinned by understandings of learning theory and therefore advocates central policy initiatives in training of teachers, which will improve generic skills teaching. Bennett *et al* (2000:177) continue by describing how theories provide the rudder for effective policy implementation. One aim of this research is to show that the essential attributes approach is grounded in a theory, which will provide the rudder for effective development of essential attributes in students. By going to the stakeholders of the course,

particularly past graduates, essential attributes and educational factors necessary for promoting essential attributes in students may be determined. Using the essential attributes approach a comparison can be made between the views of stakeholders and statements given in various policy documents. Thus reflection on the relationship between theory and practice can take place.

The essential attributes approach, if applied to a course should make a significant contribution to the practice of education. This is shown in figure 4.5. The feedback loop from the interview data may influence staff training and development. Staff training and development may also be influenced by the requirements of professional bodies, quality assurance agencies and employers. Figure 4.5 indicates that the essential attributes approach can take account of course documentation and wider debate documentation. Interview data, course documentation, wider debate documentation may influence educational factors, essential attributes and ultimately the graduates. From the interview or documentation data, an essential attribute may emerge, which is capable of ensuring the eventual contribution of graduates towards a concept of excellence (sustainable world). This essential attribute could therefore be classified as a standard of excellence. An interview may also highlight some suggested educational factors, which could promote the essential attribute in students. Figure 4.5 therefore indicates the theory behind the essential attributes approach. Applying this theory to the CIT case study and taking the time to process data with N4 software, is starting to produce results. These results show that this theory can make a significant contribution to education.

This contribution can be further illustrated by examining existing research, thus determining the research areas left incomplete. In chapter 2, the literature review described three educational paradigms - behaviourist, interpretive and critical (Waghid 2000:262). The behaviourist paradigm, when applied to engineering education, is described as simply depositing information in passive receptacles. In contrast, the interpretive paradigm concentrates on self-understanding of the individual. Methods include inquiry and experiential learning involving non-rote, experiential and non-prescriptive learning. The educator is seen as the facilitator and evaluation

methods are qualitative. The critical education paradigm strives to engender self-reflective enquiry amongst individuals. In engineering education, the critical approach should be concerned with an expression of the needs of society, collaborative learning and dialogue. Qualitative evaluation of the entire learning process by learners is the aim of the critical approach. The learner engages in experience, reflection, restructuring. This is called 'reflexivity' or 'reflection in action'. Brown and Scase (1997:89) reinforce this view and describe how the new universities in the UK encourage their undergraduates to develop leadership, team working, creativity and entrepreneurialship. The Irish Department of Education and Science (DES) strategy statement (2001:6) describes how quality-learning outcomes are vital for employment. The rapidly changing economic and social environment is considered by the strategy statement (2001:9) to require a much wider range of personal qualities, as well as teamwork and communication. Providing a framework for motivation to learn is considered a necessary objective, together with lifelong learning. Partnerships between business and higher education institutions (HEIs) are considered necessary as they should enhance high quality learning outcomes, thus helping develop a wide range of personal qualities, teamwork, communication, learning framework, lifelong learning, etc. (DES strategy statement 2001:16). The strategy envisages lifelong learning as a challenge for the future. It sees the enhancement of the employability of graduates, by ensuring high quality learning outcomes, as another future challenge.

However, all of these sources {the Irish strategy, Brown and Scase (1997) and Waghid (2000)} are vague on how a course can be evaluated. There is no indication from these sources as to the extent to which the critical paradigm can be reached in an educational programme. Furthermore, Brown and Scase (1997) and Waghid (2000) do not indicate how methods for producing 'self reflective enquiry amongst individuals' may be found. This aspect of the enquiry is therefore left open to this research. As well as determining essential attributes, it is possible from some interviews to determine the educational factors necessary for promoting essential attributes in the student population.

Toohy (2000:71) provides a list of goals for graduates that university teachers have identified:

- *to understand that knowledge is not fixed and that they can contribute to it*
- *to think, question and challenge,*
- *to solve problems, both familiar and unfamiliar*
- *to make informed choices*
- *to have a rich cultural and intellectual life*
- *to be critical and to question their surroundings*
- *to be aware of their own values and beliefs in dealing with other people*
- *to treat others humanely*
- *to be able to interpret and evaluate research findings*
- *to be able to analyse increasingly complex problems and to work towards increasingly better thought-out answers*
- *to be able to communicate effectively in all ways*
- *to be able to integrate personal experience and theory*
- *to work efficiently and safely*
- *to act with integrity*
- *to have confidence*
- *to have acquired the knowledge base of the discipline*
- *to continually seek out knowledge*

Toohy (2000:72) describes how most academics consider that these generic skills are the by-product of a university education, but also makes the point that there is no evidence of this. This therefore leaves this aspect of evaluating a course (i.e. the imparting of generic skills to students) open to this research. The essential attributes approach should be able to help determine which of these generic skills need development and indicate the educational factors necessary to impart these skills to students.

Toohy (2000:78) continues by discussing the importance of determining a graduate profile when designing a course. A graduate profile is described as

a capability statement for graduates. Although Toohey (2000:169) actually gives an example of a graduate profile from the engineering department at the University of South Australia, she does not indicate how the engineering department arrived at this profile. Furthermore she does not indicate how the profile may be updated. Again this leaves this aspect of educational research open to the essential attributes approach.

Empirical ‘educational factors’:

The interview and documentation in this research has been analysed using N4 software in four stages: - N4 project QMt, N4 project QMt2, N4 project QMt3 and N4 project QMt4. The analysis is therefore iterative, because a review of data analysis takes place after each stage. The final stage of the analysis is N4 project QMt4 and, following a review of the previous three stages, it can be seen that some modifications to the types of interviews undertaken have influenced QMt4. It has already been seen that, following the analysis of N4 project QMt2, an increased number of interviews were carried out with past graduates in QMt3, than was originally planned. Observations, together with interview data, enabled the effect of workplace on the type of essential attribute required from past graduates to be assessed. As will be seen from the following analysis of data, a further ‘fine tuning’ of the interview process was carried out in QMt4.

Appendix 7 shows an N4 software report concerning ‘essential attributes’. In this report, interview and documentation data are coded to each of the essential attributes using N4 projects QMt, QMt2 and QMt3. These three projects covered the fieldwork and documentation analysis completed at that time. N4 project QMt4 was the next iteration. Appendix 7 starts by giving a brief description of the workplace observations of the past graduates that were interviewed for N4 projects QMt2 and QMt3. There were no workplace observations completed for project QMt, as all of the QMt interviews were undertaken at CIT or were telephone interviews. Following this ‘key to the workplace observations’, each of the essential attributes so far identified, are reported in alphabetical order. Thus the first essential attribute report is creativity. From the QMt3 project section of this report, footnote 1 indicates that an educational factor, which may contribute

towards creativity, has been identified. The text unit indicating the educational factor is highlighted with an asterisk and with bold text in the creativity report. The educational factors are also listed in the footnotes at the end of appendix 7. So looking at footnote 1, at the end of the appendix 7 document, it can be seen that the educational factor is: *there should be more emphasis on coming up with ideas*. This educational factor could be considered for possible implementation when a course review takes place. The next essential attribute report shown in appendix 7 is individual flair, but at the time of this analysis, there were no educational factors emerging which would promote this attribute. Thus this process can be continued and from appendix 7, each of the essential attributes can be examined for educational factors. The following table indicates the result:

Essential attribute	Educational factor
Creativity:	<i>there should be more emphasis on coming up with ideas.</i>
Individual flair:	
Individual projects:	
Information research:	
Information technology skills:	<i>the use of common computer packages/internet and the development of IT skills; more use of multi - media/computers for writing reports.</i>
Management knowledge:	<i>role play (each part of the class playing a different role in the team to show the frustration of group interaction and the need for flexibility); how to manage getting something done? (progress, costs, etc.);</i>

*the introduction to project management in first or second year (assisted by former graduates);
a modular approach.*

Mathematical ability: *small group tutorials, practical examples, more examples.*

Personal attributes: *work placement in industry as part of the course;
a personal development course from the Irish Management Institute;
confidence through chairing of large meetings;
confidence building by the latest advance in a particular area presented to the rest of the class.*

Problem solving ability: *small tutorial groups;
the use of teamwork to solve problems;
more problem solving.*

Public speaking: *mentoring by senior students (e.g. laboratory presentations);
a lecture in final year concerning preparation for the exhibition and project presentation;
the latest advances in a particular area presented to the rest of the class by one student (followed by a question and answer session).*

Reasoning: *Reduction of intense classes.*

Self directed learning ability: *More self-directed learning guidance from academic staff.*

Team working ability: *role play (each part of the class playing a different role in the team to show the frustration of group interaction and the need for flexibility);
the use of teamwork to solve problems.*

Time management:

Written communication: *laboratory work and laboratory reports;
more guidance on report writing;
more use of multi-media/computers for writing reports.*

Looking back at this table, it is noticeable that the essential attributes of individual flair, individual projects, information research and time management, have not generated educational factors from data. Amalgamating the two essential attributes of individual flair (which originated from the literature review) and individual projects (which originated from the QAA subject overview report) may be worth considering at this stage. However, it was decided to keep them separate in N4 project QMt4, during which an attempt was made to tease out from interview data, the educational factors that help in promoting these essential attributes during the course. This technique was found to be reasonably successful, as will be seen in chapter 5 (Differences). Information research was also mentioned in the QAA subject overview report. Furthermore, an employer representative considered information research to be a very important essential attribute. Hence, in QMt4 an attempt was made to tease out educational factors for the promotion of information research. Time management originated from the QAA subject overview report, but has not been mentioned in any of the interviews. Again this essential attribute was mentioned during the QMt4 interview process, in an attempt to generate educational factors. The following table shows the workplaces that have generated educational factors, which could promote essential attributes. At this stage of the research, there does not appear to be any pattern emerging, which could link the essential attribute to the type of workplace. However,

as will be seen later in this chapter, there is emerging a connection between respondents with industrial experience and the generation of new essential attributes and standards of excellence.

Workplace	Educational factor	Essential attribute
Bourns Electronics	Practical examples	Mathematical ability
Fujisawa Pharmaceuticals	Writing reports	Written communication
Freefoam Plastics	Producing ideas	Creativity
	Getting something done	Management knowledge
	More problem-solving	Problem solving ability
	Communicate professionally	Personal attributes
	Project management early	Management knowledge
	Report writing guidance	Written communication
Pfizer Pharmaceuticals	Project management early	Management knowledge
	Personal development course	Personal attributes
	Multi media report writing	Written communication
		IT skills
EMC	Presentation lecture	Public speaking
	Industrial experience	Personal attributes
PM Consultants	Chairing meetings confidence	Personal attributes
	Presentation to the class	Personal attributes
		Public speaking
	More problem-solving	Problem solving ability
	Teamwork to solve problems	Problem solving ability
		Team working ability
RPS-MCOS Consultants	Modular approach	Management knowledge

Empirical ‘standards of excellence’:

Noticeable from appendix 7 is the number of interview references made to safety. Safety is also a node in the N4 software and so far there have been several text units coded to safety. Vesilind and Gunn (1998:62) discuss the American Society of Civil Engineers (ASCE) code of ethics and describe how they have linked sustainable development to safety. The first principle in the ASCE code of ethics reads:

Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.

(Vesilind and Gunn 1998:63)

The study of ‘safety, health and welfare of the public’ has implications for the achievement of a sustainable world. Hence, along with other standards of excellence, safety, as a standard of excellence, is now shown in the nodes of N4 software project QMt4.

Appendix 8 shows an N4 software report concerning standards of excellence. In this report, interview data and documentary data are coded to each of the standards of excellence using N4 projects QMt, QMt2 and QMt3. These three projects cover the fieldwork and documentation analysis completed at that time. N4 project QMt4 was the next iteration. Similar to appendix 7, appendix 8 starts by giving a brief description of the workplace observations of the past graduates that were interviewed for N4 projects QMt2 and QMt3. There were no workplace observations completed for project QMt, as all of the QMt interviews were undertaken at CIT or were telephone interviews. Following the ‘key to the workplace observations’, each of the standards of excellence, so far identified, are reported in alphabetical order. Noticeable from the list of standards of excellence in appendix 8 is the safety report. This report is noticeable because, like most of the essential attributes and unlike the other standards of excellence, it generates educational factors.

Hence from report 11 of appendix 8, it can be seen that this standard of excellence entitled safety, does not appear to have been mentioned in any of the documentation coded externally in the N4 software. Safety appears first in QMt2 project, where two students presently completing the course as well as an employer representative mention it. From the data, footnote 1 highlights the emergence of an educational factor, which will promote safety. This educational factor is stated in the footnotes at the end of appendix 8 as: *Lecture time should be allocated to safety, health and*

welfare of the public. Reinforced in QMt3, safety is again mentioned by two past graduates as important. The text from which these educational factors emerge is highlighted, in report 11 of appendix 8, with bold print and with an asterisk.

From the ‘key to workplace observations’ shown at the start of appendix 8, it is interesting to conclude that the two past graduates who have regarded safety as important, have positions within companies that provide consulting engineer services. This may be because consulting engineers provide services to many different types of industry. These past graduates could therefore see more clearly the importance of the safety issue, because of their wider range of experience. Hence, for further interview data, it may be worth focusing interviews more towards past graduates from organisations that provide consulting engineer services.

Empirical /theoretical comparison:

Table 4.3 continues the theory building, which was started in chapter 3 and resulted in table 4.2, various causal flowcharts and the essential attributes approach flowchart (figure 4.5). Using the spreadsheet shown in table 4.3, it is possible to renew the hierarchy of essential attributes based on more respondent comments from QMt3. A negative comment is indicated in the spreadsheet by a minus sign. The highest figure in the total column is considered highly desirable (h). Other levels of desirability are medium to high (m-h), medium (m), low to medium (l-m) and low (l). This hierarchy is transferred to table 4.4 where, from the data shown in appendix 7, empirical educational factors influencing each essential attribute are shown.

It is now possible to compare the educational factors obtained from the literature, with the empirical educational factors obtained from the data. From chapter 3 the literature highlighted five educational factors, which are displayed in table 3.2 and again in table 4.2 of chapter 4. These educational factors are: metacognitive instruction, mentoring by older students, students desire to achieve, assessment practices, social and economic HRD awareness. From table 4.4 it can be seen that there are twenty empirical educational factors obtained from the data. Many of the empirical

educational factors correspond to those obtained from the literature. For example from table 4.4, it can be seen that empirical educational factor 16 is ‘mentoring by senior students, (e.g. laboratory presentations)’. This is similar to the educational factor obtained from the literature of ‘mentoring by older students’.

Table 4.3: Third iteration after 24 interviews - ‘Respondent group’ from which ‘essential attributes’ emerge.

	A	B	C	D	E	F	G	H
1		Past	Present	Non-com	Lecturers	Employers	Total	Desire
2	Essential Attributes							
3	Creativity	2	1		2-1			4 m
4	Individual flair	2					2	4 m
5	individual projects							
6	Information research						1	1 l-m
7	I.T. skills	2					1	3 m
8	Management	6-1	2-1			3	2	11 h
9	Mathematical ability	1-2	1-1	1-1		3		2 l-m
10	Personal Attributes	5	2			2	1	10 h
11	Problemsolving	2	1			1		4 m
12	Public speaking	6	3			1	1	11 h
13	Reasoning		1			3		4 m
14	Selfdirected	1	2			3	2	8 m-h
15	Teamworking ability	7-1	3	2		3	2	16 h
16	Time management							
17	Written	3	2				1	6 m-h
18	Safety	2	2				1	5 m-h

Again from table 4.4, empirical educational factors 4 and 5, which are ‘role play’ and ‘how to manage getting something done’ are very similar to the techniques used in the educational factor, obtained from the literature of metacognitive instruction. As stated in chapter 3, metacognitive instruction encourages reflective discourse amongst students to solve problems.

Empirical educational factor 18, which is ‘reduction of intense classes’, was suggested by a student as a way of promoting ‘reasoning’. A similarity can be seen between ‘reduction of intense classes’ and the educational factor obtained from the literature of ‘assessment practices’.

The ‘students desire to achieve’ was also obtained from the literature and this is echoed in the empirical educational factor number 1 of ‘more emphasis on coming up with ideas’.

Table 4.4: Third iteration after 24 interviews - Empirical ‘educational factors’ influencing ‘essential attributes’.

Empirical 'educational factors' for 'essential attributes'.																			
		More emphasis on coming up with ideas Use of common computer packages/internet Use of multi - media/computers for writing reports Role play (each part of the class playing a different role in the team) How to manage getting something done? (progress, costs, etc.) Project management in first/second year (assisted by former graduates) Modular approach Small group tutorials Practical examples/more examples Work placement in industry as part of the course Personal development course from the Irish Management Institute Confidence through chairing of large meetings Confidence building - presentations to the rest of the class Use of teamwork to solve problems More problem solving Mentoring by senior students (e.g. laboratory presentations) Lectures/preparation for the exhibition/project presentation/safety Reduction of intense classes More self directed learning guidance from academic staff Laboratory work and laboratory reports																	
Desire	'Essential attribute'	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H	Teamwork ability				X									X					
H	Management knowledge				X	X	X	X											
H	Public speaking												X	X			X	X	
H	Personal attributes									X	X	X	X				X	X	
M-H	Self directed learning ability																		X
M-H	Written communication			X															X
M-H	Safety, health, public welfare																X		
M	Creativity	X																	
M	Individual flair																		
M	Problem solving ability							X						X	X				
M	Reasoning																	X	
M	Information technology skills		X	X															
L-M	Mathematical ability							X	X										
L-M	Information research																		
L	Individual projects																		
L	Time management																		
L	Critical evaluation																		

With regard to the essential attribute of ‘self directed learning ability/lifelong learning ability’, the literature emphasises the importance of knowing the reasons why self-development is necessary, both in terms of economic terms and for social reasons. It is interesting therefore that the empirical ‘educational factor’ that has emerged for self directed learning ability is ‘more self directed learning guidance from staff’. If self-directed learning ability/lifelong learning ability is to be encouraged in students, the literature emphasises the need for ‘social and economic HRD awareness’ among students. Hence ‘guidance from academic staff’ on ‘social and

economic HRD' will be necessary to ensure graduates are adequately prepared for the workplace.

All of the educational factors derived from the literature are represented in some form by some of the empirical educational factors listed in table 4.4. There are more empirical educational factors listed than educational factors found from the literature. In the same way as standards of excellence are emerging from the data, as having a direct impact on a sustainable world and a sustainable course, so are empirical educational factors. Whereas it was originally thought that the wider debate documentation would set the standards of excellence, the educational factors and the essential attributes, this is no longer the case. What now appears to be happening is that the past graduates, particularly those with considerable industrial experience, are able to state what the essential attributes are that have a direct impact on excellence. They are able to state the strategic direction that the course should take. They are also able to give the educational factors that will enable essential attributes to be delivered to students.

To recap on this research, it is possible to obtain essential attributes from documentation data. From interview data, it is possible to clarify which essential attributes course stakeholders, particularly past graduates, consider to be the most important. Thus more essential attributes can be added to the list. From the interview data, it is possible to determine educational factors, which will help in promoting some of the essential attributes. Emerging from the interview data and the literature review is the concept of 'safety, health and welfare of the public' as a standard of excellence. The contribution that 'safety, health and welfare of the public' can make to the ideal of obtaining a sustainable world is the reason that it may be categorised as a standard of excellence. The interview data concerning 'safety, health and welfare of the public' also indicate educational factors, which may help in promoting these safety skills in students. Another standard of excellence emerging from the data is course strategy. The past graduates that have considerable industrial experience, particularly those employed with engineering consultancy organisations, seem to be in touch with the movement of industry into Ireland. This will be important data to

retrieve for the purposes of ensuring that a course can respond to a changing environment and be sustainable.

The development of a theory of essential attributes, which possibly extends the existing work on employability done by Harvey *et al* (2002), has taken place alongside the case study data gathering and analysis. This theory development has culminated in the essential attributes flowchart shown in figure 4.5. The flowchart, along with the concepts of ‘standards of excellence’, ‘fitness for purpose’, ‘essential attributes’ and an overall concept of engineering excellence as a ‘sustainable world’, gives a structure to the existing work described in the literature.

Chapter 5 - Stakeholder Analysis.

Stakeholders in the BEng course in mechanical engineering are:

- (a) the students presently completing the course,
- (b) the lecturers who are employed to educate the students,
- (c) the employers who use the skills from the graduate output of the course,
- (d) the graduates from the course,
- (e) the parents of students who sometimes pay for the student to complete the course,
- (f) the government who need the graduate skills to ensure that the economy of the country will flourish.

In this research, it was decided that the bulk of the feedback from the course should be obtained by interviewing past graduates. To obtain a different vantage point on the data, it was decided to also interview students presently completing the course, students who do not complete the course, lecturers/managers and employer representatives. Difficulties were experienced in obtaining interviews with some of these groups, but the enthusiasm of the past graduates and the students presently completing the course, more than compensated for this difficulty. In N4 project QMt there were two past graduates, two present students, two non-completing students, two lecturers and one employer representative. In N4 project QMt2, there were two past graduates, two present students, two non-completing students, one employer representative and one lecturer. In N4 project QMt3, there were six past graduates and one present student interviewed. In N4 project QMt4 there were six past graduates. At the time of the following analysis, the QMt4 block of interviews were still ongoing, so they were not included in this stakeholder analysis. Hence there were twenty five of the thirty interviews completed, with twenty four interviews processed. This information can be put in tabular form as shown in table 5.1. A non-processed interview is indicated by (np).

Table 5.1: Stakeholders interviewed in each N4 project.

	Past graduates	Present students	Non-completing	Lecturers	Employers	Total
QMt	2	2	2	2	1	9
QMt2	2	2	2	1	1	8
QMt3	6	1				7
QMt4	1(np)					1(np)
Total	10	5	4	3	2	24

From table 5.1, it can be seen that as the research has progressed, the iterative nature of the qualitative process has skewed the original sample of stakeholders away from an almost balanced sample (shown in N4 project QMt), towards the past graduate group (QMt3). However, this is to be expected with qualitative research. Apart from the difficulties in obtaining interviews with the non-completing students and the employer representative groups, as the research proceeded there were indications that there might be a link between the essential attribute and the type of industry in which the past graduate was employed. So far, from the data, this has proved not to be the case, but there are indications that there is a rich seam of data to be exploited from those past graduates who have varied industrial experience. It is mainly these past graduates who have highlighted ‘safety, health and welfare of the public’ and course strategy as standards of excellence. A particularly rich seam of data may be with past graduates who are employed by organisations offering engineering consultancy services. In N4 project QMt4 therefore, this skewing of the interview sample towards past graduates with varied industrial experience, was continued.

From table 4.3, the positive responses from each of the stakeholders can be added to produce a total for each stakeholder. By dividing this total by each total number of stakeholders shown in table 5.1, then the positive response per stakeholder can be calculated. For example the total number of positive responses for past graduates is shown in table 5.2 to be 35. The total number of past graduates interviewed, from table 5.1, is shown to be 10. Hence dividing 35 by 10 gives 3.5 as the positive response per past graduate. This is shown in row 20, column B, of table 5.2.

All of the positive responses per stakeholder are shown in row 20 of table 5.2. It is noticeable that the positive response per stakeholder is higher for the employer representatives and lecturers than the other groups. The lowest positive response per stakeholder is from the non-completing students. From the table it can be seen that there are more mixed responses from the past graduates and present students, indicated by the inclusion of negative signs in their columns. For the total number of all of the stakeholders, the positive response per stakeholder is calculated to be 3.7, which is similar to that for the past graduate (3.5) and present student (3.6) group. Thus regarding the total of stakeholder data as similar to past graduate data appears to be reasonable. As the research proceeds and more stakeholders are included, it would be interesting to see how these figures change.

Table 5.2: Stakeholders positive responses.

	A	B	C	D	E	F	G	H
1		Past	Present	Non-com	Lecturers	Employers	Total	Desire
2	Essential Attributes							
3	Creativity	2	1		2-1		4	m
4	Individual flair	2	1			2	4	m
5	individual projects	+	+			+	1	
6	Information research	+	+			+	1	1-m
7	I.T. skills	2				+	1	3
8	Management	6-1	2-1			3	2	11
9	Mathematical ability	1-2	1-1	1-1		3		2
10	Personal Attributes	5	2		+	2	1	10
11	Problemsolving	2	1			1		4
12	Public speaking	6	3			1	1	11
13	Reasoning	+	1			3		4
14	Selfdirected	1	2			3	2	8
15	Teamworking ability	7-1	3	2		3	2	16
16	Time management							
17	Written	3	2		+		1	6
18	Safety	2	2		+		1	5
19	Total	35	18	2	20	14	89	
20	+resp./stakeholder	3.5	3.6	0.5	6.7	7	3.7	

It is interesting to note that the only essential attribute that obtained a positive response from every stakeholder group, is team working ability, although one past graduate did give it a negative response.

The positive response per stakeholder can be calculated for every essential attribute. For example, in the past graduate column B, each figure should be

divided by the number of past graduates interviewed, i.e. ten. In the present students column C, each figure should be divided by the number of present students interviewed, i.e. five. This process is continued throughout table 5.2 and table 5.3 is the result.

Table 5.3: Positive response per stakeholder.

	A	B	C	D	E	F	G	H
1		Past	Present	Non-com.	Lecturers	Employers		Desire
2	Essential Attributes							
3	Creativity	0.2	0.2		0.33			m
4	Individual flair	0.2					1	m
5	individual projects							
6	Information research						0.5	l-m
7	I.T. skills	0.2					0.5	m
8	Management	0.5	0.2		1		1	h
9	Mathematical ability	-0.1	0	0	1			l-m
10	Personal Attributes	0.5	0.4		0.67		0.5	h
11	Problemsolving	0.2	0.2		0.33			m
12	Public speaking	0.6	0.6		0.33		0.5	h
13	Reasoning		0.2		1			m
14	Selfdirected	0.1	0.4		1		1	m-h
15	Teamworking ability	0.6	0.6	0.5	1		1	h
16	Time management							
17	Written	0.3	0.4				0.5	m-h
18	Safety	0.2	0.4				0.5	m-h
19	Total	3.5	3.6	0.5	6.7		7	
20	+resp./stakeholder	3.5	3.6	0.5	6.7		7	

Past graduates:

Column B, table 5.3, shows the positive response per past graduate for each of the essential attributes. This group of stakeholders were very enthusiastic, with no member of the group refusing to take part in the research. From column B, it is noticeable that mathematical ability has a negative response. Also noticeable is the high positive response per past graduate for team working ability as well as, on the other hand, the positive response rate for individual flair.

Present students:

The positive response rate per present student is shown for each essential attribute in column C of table 5.3. Again, this group were very enthusiastic, with no member of the group refusing to be interviewed. Again noticeable is the less than enthusiastic response for mathematical ability. In contrast is the high response rate for team working ability. When interviewing students, it is important to be aware of the influence that the 'power' of the researcher might have on the outcome of the interview. It was important, therefore to inform the student of the anonymity of the interview and the reasons for the research.

Non-completing students:

There was difficulty experienced in arranging interviews with this group. One female student, who had left the course during the first year, was contacted by telephone, but she simply stated that the course had too many bad memories for her and therefore she did not wish to discuss the course. She had found a more enjoyable computing course and was progressing quite well. A male student, who had transferred to a civil engineering course after leaving the first year of the mechanical engineering BEng, agreed to be interviewed, but would not finalise a time or venue. Another male student, who left the BEng mechanical engineering course following first year, successfully completed an applied physics degree and obtained good employment in local industry. Again it was difficult to arrange an interview with this former student, because he gave the impression of not wanting others to discover his previous lack of success. However, the non-completing students that did respond, re-iterated the positive response to teamwork ability and the indifferent response to mathematical ability of the previous groups.

The reasons for the lack of response of these non-completing students may be a topic for future research. Most non-completing students, leave the BEng course following the first year of the course. I teach students from years two, three and four of the course and all of these students will know me when I approach them requesting an interview. I had not previously met the non-completing students from which interviews had been sought. It may

therefore be a way forward, if a lecturer from the first year of the course, who will know the students, interviews the group.

Lecturers:

All lecturers were agreeable to the interview process and from table 5.3, it can be seen that the positive response per lecturer was the highest for most of the essential attributes. One lecturer seemed slightly suspicious of research motives, which if true of this group, could explain the very positive answers. Hence, they could be stating what they think I wish to know, rather than be critical of the course.

Employer representatives:

This group proved to be difficult for organising interviews. For the first few interviews, personnel department staff at engineering organisations were targeted. However, some of these staff seemed reluctant to talk about engineering. Engineering managers from industry were the next group targeted for interviews and some very useful data have emerged from this group. However, there have still been difficulties with some engineering organisations. They initially agree to the interview process and allocate staff for interview, but these staff regard talking to academic staff as a low priority. Hence organising a sufficient number of interviews from this group is a slow process. Many past graduates have now reached senior positions in industry, such as engineering managers, associate directors, etc. These experienced past graduates could therefore be a substitute for employer representatives. The sample of stakeholders shown in table 5.1, indicates that past graduates are now being targeted for future interviews.

Examining table 5.3, it can be seen that the positive response per employer representative is the highest of all the stakeholders for most essential attributes. This is to be expected, as employers need all the essential attributes in their staff, thus increasing the competitiveness of the engineering organisation.

Differences:

Table 5.3 indicates that the responses from the past graduate group and the present student group are similar, with more mixed responses than the other groups. The lecturing group and the employer representative group are also similar in the way they respond, with more positive responses. Hence the recent targeting of the past graduate group for more interviews, seems to be the appropriate strategy, as more mixed responses are indicative of the real world.

All of the past graduates interviewed have been successful with regard to employment and to a large extent, this is because of successfully obtaining a BEng. Their perceptions of the course are therefore favourable and they will provide the information necessary to improve the BEng course if they can. Similarly, most of the present students interviewed are in the third or fourth year of the course and would be well on their way to achieving a qualification. Their perceptions of the course are mostly favourable and again they will improve the course if they can. The non-completing students have perceptions of the course which are, for the most part, entirely different. Because of their experiences, they would not feel well disposed towards the course or the teaching staff. They probably think that the course needs to be improved, but because of their experiences, they do not care enough to spend time talking to an academic member of staff who they probably have never met.

Most lecturing staff usually just teach one subject on the course. Their perceptions of the course may or may not be favourable. However, they probably would not wish to convey an unfavourable opinion to another member of the academic staff, even though they have been told that the interview is confidential. Many employer representatives have a low opinion of academic staff, as they regard them as not existing in the real world of competitive industry. They wish to waste no time talking to an academic, when the time could be more productively used elsewhere. When I suggested to an employer representative that an interview would take approximately half an hour, he exclaimed that ten minutes was the most he could spare. The skewing of the original sample towards past graduates

appears therefore to have been inevitable. However, this does not prevent attempts being made to interview all the other groups by employing new ideas.

More interviews have been completed since this stakeholder analysis was completed (N4 project QMt4). Figure 4.5 shows how interviews with employer representatives, students (non-completing and present) and teaching staff were originally intended for the purpose of eliminating bias (triangulation), with the bulk of the interview data deriving from past graduates. Because of this and for the reasons given below, it was decided that N4 project QMt4 should hold more interviews with past graduates who are employed in local industries. The reasons for this line of approach are:

1. the enthusiastic response from this group with the resulting quality of the data,
2. a possible link between the workplace and the required essential attribute,
3. a sensible researcher can be a good substitute for triangulation ,
4. in all interviews, respondent validation is carried out and this gives an alternative method of eliminating bias.

However, in future it is intended that interviews with other groups will still be undertaken, but not to the same extent as that originally intended. Interviews with students presently completing the course, have resulted in extremely valuable data, particularly in QMt2 and QMt3. Hence interviews with this group will still be undertaken. Interviews with non-completing students will still be attempted by telephone, but these have proved difficult to arrange. Some potential respondents from this group are reluctant to talk. Interviews with employer representatives have proved difficult to arrange, but the quality of the data provided by this group has been excellent. The number of interviews that can be arranged with this group will be reduced from that originally planned. These can be replaced with interviews with past graduates, who are much more enthusiastic about discussing the course. Interviews with lecturing staff will be continued, but again they will be reduced from that originally planned.

So what was investigated in QMt4? Interviews with past graduates employed with consultant engineers were the preferred option. The QMt4 questions attempted to draw out the opinions of stakeholders concerning the safety aspects of the course and the contribution this makes towards a sustainable world. Appendix 9 shows the N4 project QMt4 report on essential attributes. As can be seen from this report, not all of the 'essential attributes' covered previously, were discussed by the six respondents included in QMt4. However, 'educational factors' influencing 'essential attributes' have again been highlighted in this report. They reinforce the findings given in chapter 4, but there are also a few new educational factors emerging from QMt4, such as: 'team management'; 'methods of personnel management'; 'financial management'; 'General Electric management philosophies' and 'Japanese management skills' all in support of the essential attribute of management knowledge. Appendix 9 also shows how it was possible to draw out information by choosing questions carefully. In QMt4, respondents gave more information concerning the essential attributes of individual flair, individual projects, information research and time management, than in the previous twenty four interviews.

Interesting is the emergence from appendix 9 of 'the ability to field and answer questions under pressure', with the associated 'educational factors'. This has been placed under the essential attribute of 'personal attributes' and 'individual flair'. The question therefore arises: 'Should this be considered as an essential attribute in itself?' Again the emergence of the 'ability to get things right first time' with the associated 'educational factors'. This has also been placed under the essential attribute of 'personal attributes' and 'individual flair', with the same reservations and a similar question mark. It appears as if similar questions will be frequently asked if the research continues into the future.

With regard to 'problem solving skills', the 'educational factors' suggested in QMt4 are in line with those discussed in chapter 4, but those developed by Ford, General Electric and Toyota, have also been highlighted as suitable for structured learning on the course. Particularly highlighted in QMt4 are report-writing skills with the associated 'educational factor' of developing

these skills by 'giving the students a four page document and encouraging them to reduce the document to ten lines'.

Towards the end of appendix 9, is also shown the N4 project QMt4 report on 'standards of excellence'. As well as reinforcing the need for more coverage of safety issues by the course, the six respondents interviewed as part of QMt4, highlighted the standard of excellence of 'course strategy'. 'Automation' was highlighted by two of the respondents as an important issue for the future. Also highlighted were 'environmental engineering', 'renewable energy', 'modular building manufacture' and 'starting your own business'. An educational factor of a 'talk from someone who had experience of starting a business' was also suggested.

What is fascinating about the 'essential attributes' approach is the continued emergence of new essential attributes, with the associated new 'educational factors'. All of these can be added to the table of empirical educational factors, which was shown in chapter 4. This would suggest extending this research beyond the final thesis.

Six interviews for QMt4 was sufficient, given the considerable amount of data obtained from the interviews undertaken so far. This amount of data was not envisaged when the research plan was originally devised. The N4 software generates the maximum amount of data from each interview and can easily pull together data in each of the designated categories. The software report on each category is useful in the generation of educational theory. This is because data are presented clearly in a form enabling the researcher to highlight salient information, such as educational factors.

Implications for the provision of quality courses:

Originally, each essential attribute and each standard of excellence was determined from the wider debate documentation (QAA). Following this, the course documentation and CIT quality documents were then scrutinised for reference to each essential attribute and each standard of excellence. Software analysis was then used to check stakeholder interviews for references to each essential attribute and standard of excellence.

It was originally thought that the wider debate documentation (QAA) was going to be the source of all of the essential attributes and standards of excellence. However, what appears to be emerging is that the stakeholder interviews are a source of essential attributes and standards of excellence having the most impact on our chosen concept of engineering excellence (a sustainable world). This can be seen from table 5.4, where the standards of excellence of safety and course strategy can be seen to derive only from interview data. The stakeholder interviews are also a rich source of information concerning useful educational factors for developing essential attributes in students. The course documentation and the wider debate documentation (QAA) chosen, do not emphasise educational factors sufficiently for them to be useful to practitioners. Educational factor information was obtained from interview data (empirical) and literature.

Table 5.4: Documentary references to ‘essential attributes’ and ‘standards of excellence’ after 24 interviews.

	A	B	C	D	E	F
4	DOCUMENT:----->	Interview	I.E.I.	Q.A.A.	C.I.T.	Literature
5						
6	Essential attributes					
7	Creativity	X	X	X		
8	Critical evaluation		+	+		X
9	Individual flair	X	X	X		
10	Individual project		+	X		
11	Information research	X		X		
12	Information technology	X		X		
13	Management knowledge	X	X	X		
14	Mathematical ability	X		X		
15	Personal Attributes	X		X		
16	Problemsolving	X	X	X		
17	Public speaking	X	X	X		
18	Reasoning	X	+	X		
19	Selfdirected learning	X	X	X		
20	Teamwork	X	X	X		
21	Time management			X		
22	Written communication	X		X		
23						
24	DOCUMENT:----->	Interview	I.E.I.	Q.A.A.	C.I.T.	Literature
25	Stnr.d. of excellence		+	+		
26	Aims/objectives		X	X		
27	Consultancy		X	X	X	
28	Course strategy	X				
29	Employer requirement		X		X	
30	Extern reports		X	X		
31	Humboldt		X	X	X	
32	Local/regional needs			X		
33	National/internl. needs		+	X		
34	Mission statement		+	X		
35	Professional body		X	X		
36	Quality assurance			X		
37	Research		X	X	X	
38	Research charter				X	
39	Safety	X				
40	Student liaison		+	X		
41			+			
42	KEY:					
43	X: essential attribute/standard of excellence mentioned in document					

Final outcome:

In order to provide quality, courses should have a concept of excellence in place. They should adequately support essential attributes with standards of excellence. This can be achieved by:

1. implementing a continuous process of interviews with samples of past graduates, non-completing students, present students, lecturing/management staff and employer representatives,
2. analysing the interviews in order to identify the essential attributes and standards of excellence, which are not adequately included in the course, thus adversely affecting the fitness for purpose of the course, or preventing the course from approaching a chosen concept of excellence.
3. implementing a continuous process of analysis of the wider debate documentation concerning education of the course discipline.
4. analysing the wider debate documentation, in order to identify the essential attributes and standards of excellence, which are not adequately included in the course, thus adversely affecting the fitness for purpose of the course, or preventing the course from approaching a chosen concept of excellence.
5. analysing course documentation to ensure that essential attributes and standards of excellence, identified from interview data and wider debate documentation, are included in documentation updates, enabling a course to aim for either fitness for purpose or a chosen concept of excellence.
6. analysing interviews in order to identify educational factors, which will enhance essential attributes in students.
7. reviewing the literature on essential attributes to identify educational factors which will enhance essential attributes in students.

Minimalist quality concept:

Fitness for purpose is a minimalist quality concept. In course documentation, essential attributes will be listed that should be provided to graduates to increase their employability. The stakeholders of the course, particularly past graduates, will also have an opinion concerning the essential attributes that should be delivered by the course. If the stakeholders are satisfied with the essential attributes that were delivered by the course, then the course can be said to have met this minimalist quality concept of fitness for purpose.

This minimalist quality concept can be attained without a great deal of external influence, as shown in figure 4.3 in chapter 4. However, this model is not sustainable in the sense that it may not adequately respond to its environment.

Maximalist quality concept:

A concept of excellence for a particular course discipline is a maximalist quality concept. In the case of the BEng course in mechanical engineering, the concept of excellence was a sustainable world. For the concept of excellence to be attained then, in addition to the requirements of the minimalist quality concept, the standards of excellence listed in appendix 4 under the 'standards of excellence' side of the node tree must be in place to support the course. The more of these standards of excellence that are in place, then the more the course will move towards attaining this maximalist quality concept.

Concepts applied:

Before applying the above concepts to a particular course then interview data must first be gathered from stakeholders. Chapter 4 described how past graduates emerged as the preferred group for data gathering in the CIT case study. Past graduates and present students were more enthusiastic about taking part in the interview process. They tended to respond sometimes positively and sometimes negatively about the course. Lecturers and employer representatives tended to give more positive responses. The more mixed responses from past graduates would indicate that they are more

realistic about the course and this should be heeded when the stakeholder groups are selected for interview.

With regard to the CIT BEng (mechanical engineering) course, table 4.4 indicates that, by implementing the empirical educational factors, delivery of the listed essential attributes would be improved. The implications of attempting to impart these essential attributes may include drastic changes to the course. For example, as stated earlier, the essential attribute of personal attributes will include confidence, responsibility and an enquiring attitude needed to support continued learning and professional development. To ensure fitness for purpose, then appropriate methods of imparting these essential attributes will need to be developed and monitored over time until they are successful. As well as the empirical educational factors, listed against each essential attribute in table 4.4 being implemented, the educational factors derived from the literature and listed against each essential attribute in table 4.2 could also be implemented. Thus the minimalist quality concept of fitness for purpose may be achieved. This may entail more ‘open learning’ and less ‘spoon feeding’ of students. This could result in less formal lectures. More of the laboratory work of students may take place in an industrial setting, rather than the standard institute laboratories. Thus confidence and responsibility can be developed in students.

To attain the maximalist concept of quality, then a concept of excellence must be established. For the CIT BEng (mechanical engineering) course this has been chosen as a sustainable world. Empirical educational factors and literature derived educational factors necessary to support the essential attributes could be implemented, as was the case for the minimalist concept of quality. However, to attain the maximalist concept of quality, the standards of excellence identified from wider debate documentation and from interview data, would need to be in place to support the course. These could be: aims and objectives, development of consultancy activities, requirement of employers, response to reports of external examiners, Humboldt principle, local and regional needs, the effect of a mission statement on excellence, national and international needs, requirement of

professional bodies, quality assurance, development of research activities, a research charter and student - staff liaison committees. In the CIT case study, emerging from the data are the standards of excellence of 'safety, health and welfare of the public' and course strategy. 'Safety, health and welfare of the public' has also been classed as an essential attribute and is particularly important as it has a direct impact on the chosen concept of engineering excellence (sustainable world). Essential attributes listed by wider debate documentation and not mentioned by the course documentation or interview data, may also be classed as standards of excellence.

Whereas the interview evidence indicates that there is a high level of mathematics on the BEng course, there are doubts thrown up about teaching methods. Again as shown in table 4.4 and table 4.2, the implications of this evidence are that to maintain and develop the fitness for purpose of the course, the teaching approach could include mathematical examples, which are more relevant to industry. More liaison between mathematics lecturers and engineering lecturers may be necessary to implement these changes. From N4 report 7 (concerning mathematical ability) in appendix 7, it is interesting to see the clustering of responses with past graduates, present students and non-completing students, having mixed feelings about mathematical ability, whereas lecturers state that mathematical ability was up to standard. The more critical data seem to emerge from the students and graduates.

What factors ensure quality courses?

With regard to the fitness for purpose of a course, factors, which ensure that this is achieved, will be those educational factors that derive from the feedback obtained from the stakeholders in the education process. The stakeholders in the higher education process are predominantly the past graduates, present students, employer representatives, non-completing students and lecturers/management staff. To ensure a quality course, the results of feedback analysis should be included in any updates of the course documentation. Updates usually take place every five years.

Course criteria can also be compared with standards of excellence obtained from analysis of the wider debate documentation concerning teaching the course discipline. Ensuring that these standards of excellence are in place and operational, should move the course towards a chosen concept of excellence. Standards of excellence can also be derived from interview data, particularly when a concept of excellence has been chosen, which provides an ultimate aim for the course.

However, obtaining these factors, whether fitness for purpose or standards of excellence based, requires people with leadership within the organisation. According to the E838 study guide, leadership should not be associated with positions of authority or seniority. It is a quality that can and should be possessed by people at all levels in an organisation that are able to exert initiative and influence. To engender this quality in the staff of an organisation requires firstly one or two individuals with leadership, who can articulate and share their ideas with others. Their ideas would include the constant striving for excellence, as well as fitness for purpose.

According to the E838 study guide, educational effectiveness is frequently judged in relation to qualitatively assessed processes within educational organisations as well as with respect to outcomes or outputs, some of which can be quantified. Individuals and organisations improve through a systematic process of reflecting on their practice. The essential attributes approach to course assessment is a qualitatively assessed process which can be applied to many educational organisations and enables the organisation to reflect on its practice. Thus the organisation can determine the factors which will ensure fitness for purpose or those factors that ensure excellence.

Decisions have to be made by the educational organisation, regarding whether fitness for purpose is enough or whether excellence should be the ultimate goal. One of the standards of excellence emerging from the findings of this research report is the link between research, study and teaching (Humboldt principle). This link is mentioned in most of the documentation analysed, but it is a long term goal for CIT. Any educational organisation will have to decide whether the time of staff should be spent on

research, or whether the time should be spent teaching. Sometimes this is not a decision that the educational organisation can make. The government may have already agreed the conditions of the staff with the teaching unions and these conditions may not provide for research activities of staff.

If teaching staff are not researching the main subject that they teach and are not at the 'cutting edge' of research in that subject, then they may not be familiar with the latest developments in that subject. It would then be advisable for any educational organisation to ensure that these teaching staff are kept up to date. A programme of staff training and development could be implemented which ensures that teaching staff obtain training in the subjects that they teach. This training could be in addition to training in safety procedures, or updating skills in the latest computer software, etc. To ensure that fitness for purpose of the course is reached, it is important that each member of the teaching staff is subject to a 'training needs assessment'. This will avoid the educational organisation being tempted into paying only 'lip service' to training.

What can one country learn from another?

Many BEng (mechanical engineering) degree graduates from CIT, obtain employment overseas in such locations as England, Scotland, Wales, France, Germany, USA, Japan, China, etc. Some graduates will obtain employment in Ireland with multi-national organisations, the parent company of which is in these other countries. It is important therefore to analyse as much of the documentation, concerning engineering education in these other countries, as possible. The documentation from English speaking countries are the easiest to analyse, hence in future research, it will be important to analyse documentation from North America, Australia, South Africa and New Zealand. So far the documentation examined relates only to the UK and Ireland, but more documentation has been obtained and is ready for coding.

The Institution of Engineers of Ireland (IEI) is a signatory of the Washington Accord. The Washington Accord is an agreement which provides a mechanism for mutual recognition between signatory bodies of

engineering education accreditation processes. Each member of the group of eight countries involved, has expressed its confidence in the quality assurance processes of the other seven countries. This leads to the effective mutual recognition of accredited engineering degree courses, and, generally, to exemption from the education requirement for practising engineers in each of the signatory countries. The CIT BEng (mechanical engineering) is an accredited course of the IEI and is therefore fully recognised by the eight countries involved. The institutions representing the other seven countries are:

- * The Engineering Council (EC), UK;
- * The Accreditation Board for Engineering & Technology (ABET), United States;
- * The Canadian Council of Professional Engineers (CCPE), Canada;
- * The Engineering Council of South Africa (ECSA), South Africa;
- * The Hong Kong Institution of Engineers (HKIE), China;
- * The Institution of Engineers, Australia (IEAust), Australia;
- * The Institution of Professional Engineers, New Zealand (IPENZ), New Zealand.

Documentation from most of these professional bodies has been obtained and some of the more suitable documentation will be coded in the future as the research proceeds.

From chapter 4, it can be seen how ‘safety, health and welfare of the public’ emerged from the interview data and how this was then linked to documentation from the American Society of Civil Engineers (ASCE). The ASCE documentation regards ‘safety, health and welfare of the public’ as very important in the establishment of a sustainable world, which is our chosen concept of engineering excellence. It may therefore be worth coding this American documentation as the next stage of the research. This will give an added dimension to the wider debate documentation and possibly reveal more essential attributes and other standards of excellence.

For future research, following the completion of N4 project QMt4, the nodes could be readjusted if necessary and another block of interviews, approximately ten in number, could be imported into the software. This will

form the basis of N4 project QMt5. The American documentation can then be coded as an external document in N4 project QMt5. Four blocks of ten interviews, with coding between each of the four, will bring the research up to N4 project QMt9. More documentation, possibly from Australia, could then be coded as an external document in QMt9. This iterative process can be continued indefinitely.

Chapter 6 - Conclusions.

Research questions answered:

The first research question posed in chapter 1 is: *What are the 'essential attributes' that a professional mechanical engineering degree course should provide to graduates, in order to meet international standards of excellence?*

As shown in chapter 4, the essential attributes that have emerged from twenty-four interviews, the course documentation and the wider debate documentation are:

Essential Attributes	Hierarchy position
Teamwork ability	1
Management knowledge	2
Public speaking	3
Personal attributes	4
Self directed learning ability	5
Written communication	6
Safety, health, public welfare	7
Creativity	8
Individual flair	9
Problem solving ability	10
Reasoning	11
Information technology skills	12
Mathematical ability	13
Information research	14
Individual projects	15
Time management	16
Critical evaluation	17

Hence it can be deduced that the evidence so far indicates that these are the essential attributes that a professional mechanical engineering course should provide to graduates in order to meet international standards of excellence. The order given above indicates the emphasis given to the essential attribute by the course stakeholders. The essential attribute of 'safety, health and welfare of the public' has also been reclassified as a standard of excellence,

because of its impact on a sustainable world, which has been chosen as a concept of engineering excellence. For a course to reach this chosen concept of engineering excellence, not only should the essential attributes listed above be provided to graduates, but other standards of excellence emerging from the answer to the third research question, should be addressed.

The second research question (chapter 1) is: *What are the 'essential attributes' that the Cork Institute of Technology (CIT) BEng in mechanical engineering should provide to graduates, in order to meet 'fitness for purpose' standards?*

From table 5.4, it can be seen that there are five essential attributes emerging from the interview data, that are not highlighted sufficiently in the course documentation data and they are:

Essential Attributes	Hierarchy position
Personal attributes	4
Written communication	6
Safety, health, public welfare	7
Reasoning	11
Information research	14

For the course to reach fitness for purpose, then attention would need to be given to these essential attributes. As previously stated, the essential attribute of 'safety, health and welfare of the public' has been reclassified as a standard of excellence, because of its importance in contributing towards a sustainable world. The essential attributes mentioned in the course documentation are:

Essential Attributes	Hierarchy position
Teamwork	1
Management knowledge	2
Public speaking	3
Self directed learning	5
Creativity	8

Individual flair	9
Problem solving	10
Information technology	12
Mathematical ability	13
Individual projects	15

The findings (chapter 4) show that the essential attributes of: - management knowledge, problem solving ability, self directed learning ability and team working ability need more attention to their delivery. With regard to the essential attribute of mathematical ability, there is a syllabus for mathematics included in the course documentation, but mathematical ability is not highlighted or discussed sufficiently in the document. Although a high level of mathematical ability appears to be provided, the evidence indicates that teaching methods could be improved. There is one essential attribute emerging from interview evidence (safety, health and welfare of the public) that is not highlighted in any of the documentation. Hence it can be said that the analysis so far indicates that fitness for purpose is not being achieved. To achieve fitness for purpose, the block of ten essential attributes listed above and the previous block of five should be adequately delivered to students.

The third research question is: *To what extent does the Cork Institute of Technology BEng in mechanical engineering provide the 'essential attributes' in order to meet: (a) international standards of excellence, (b) fitness for purpose standards?*

Part (a) of this question, is answered by comparing the essential attributes that have emerged from course documentation with those that have emerged from the wider debate documentation. Again from table 5.4, the essential attributes that emerge from the wider debate documentation, but missing from the BEng (mechanical engineering) course documentation are:

Essential Attributes	Hierarchy position
Personal attributes	4
Written communication	6
Reasoning	11
Information research	14
Time management	16
Critical evaluation	17

These could now be categorised as standards of excellence.

The research methods have also highlighted features of the course which are important in supporting essential attributes in students and these have also been classified as standards of excellence. These supporting standards of excellence are shown in chapter 4 to be:

Standards of Excellence	Number
Aims and objectives	1
Consultancy activity development	2
Course strategy	3
Employer requirement	4
Extern report response	5
Humboldt principle	6
Local/regional needs	7
Mission statement effect	8
National/international needs	9
Professional body requirement	10
Quality assurance	11
Research activity development	12
CIT research charter	13
Student/staff liaison	14

From chapter 4, it can be seen that the standards of excellence numbered 1, 2, 4, 5, 6, 10, 11, 12, and 13 are referred to in course documentation and are being addressed. However, course strategy, local/regional needs, national/international needs, student staff liaison would need more attention.

For part (b) of this research question, the essential attributes that have emerged from interview data only and not been highlighted in the IEI documentation, should be addressed. As already discussed in answering research question 2, there are five essential attributes emerging from the interview data and not highlighted in the course documentation:

Essential Attributes	Hierarchy position
Personal attributes	4
Written communication	6
Safety, health, public welfare	7
Reasoning	11
Information research	14

Again as discussed in the answer to research question 2, essential attributes mentioned in the course documentation are:

Essential Attributes	Hierarchy position
Teamwork	1
Management knowledge	2
Public speaking	3
Self directed learning	5
Creativity	8
Individual flair	9
Problem solving	10
Information technology	12
Mathematical ability	13
Individual projects	15

As there is this gap between the course documentation and the stakeholder interviews, it can be said that the course is not achieving fitness for purpose.

The fourth research question listed in chapter 1 is: *Should the quality of the BEng course be raised in relation to: (a) international standards of excellence, (b) fitness for purpose standards?*

With regard to part (a) of this question, the findings show that CIT proposes future positive action for most of the fourteen supportive standards of excellence (i.e. aims and objectives, course strategy, development of consultancy activities, requirement of employers, response to reports of external examiners, Humboldt principle, local and regional needs, the effect of a mission statement on excellence, national and international needs, requirement of professional bodies, quality assurance, development of research activities, CIT research charter and 'student - staff liaison committees'). Action on these issues will ensure that the course moves towards international standards of excellence. A more immediate move towards international standards of excellence could be ensured by providing the six essential attributes categorised as standards of excellence and originating from the wider debate documentation (i.e. personal attributes, written communication, reasoning, information research, time management, critical evaluation). Addressing the final standard of excellence of 'safety, health and welfare of the public' should also improve the course dramatically. This standard of excellence was reclassified from being an essential attribute because of its direct impact on the chosen concept of engineering excellence, which is a sustainable world.

The quality of the BEng course should be raised in relation to international standards of excellence, because this is what course stakeholders are demanding. The standards of excellence of 'safety, health and welfare of the public' and 'course strategy' have emerged from the stakeholder interviews. 'Safety, health and welfare of the public' has a direct impact on a sustainable world and 'course strategy' will ensure the sustainability of the course, enabling it to react sufficiently to its environment. Thus we can deduce that stakeholders are demanding both a sustainable world and course sustainability.

With regard to part (b) of this last research question, a problem with fitness for purpose would be indicated by gaps between course documentation and interview data. As stated in answers to research questions two and three, there are five essential attributes emerging from the interview data, that are not highlighted sufficiently in the course documentation data and they are:

Essential Attributes	Hierarchy position
Personal attributes	4
Written communication	6
Safety, health, public welfare	7
Reasoning	11
Information research	12

This indicates problems with fitness for purpose of the course. Addressing the delivery of these essential attributes to students, together with some improvement on teaching methods, would ensure fitness for purpose of the course. However, interview data indicates that the stakeholders are demanding a higher level of excellence than that indicated by the wider debate documentation. This means therefore that, for the BEng course, 'fitness for purpose' and 'excellence' are approaching each other.

The fifth research question listed in chapter 1 is: *To what extent can the 'essential attributes' approach of evaluating course effectiveness, contribute to the higher education sector?*

The CIT case study has shown that the essential attributes approach can have surprising results. Whereas it was originally thought that standards of excellence would emerge from the wider debate documentation, the interview data show that standards of excellence, which have the most impact on the chosen concept of excellence, emerge from the stakeholders. Past graduates and present students, that have industrial experience, are the most informative in this respect. The contribution that the essential attributes approach can make to the higher education sector is that the method may be applied to other disciplines. Thus these phenomena can be investigated in other disciplines apart from engineering.

The sixth research question listed in chapter 1 is: *Is it possible to establish a theory of 'essential attributes', or are there other theories emerging from the data?*

The research extends existing work done by Harvey *et al* (2002) by developing a framework in the form of a conceptual map, which uses the concepts of fitness for purpose (microquality) and standards of excellence (macroquality) as well as essential attributes. This framework provides a structure, which enables data to be controlled and gathered. An overall concept of excellence for the professional discipline is chosen by researching literature, etc. The ultimate aim for the course will be to develop in graduates the essential attributes necessary to move towards this concept of excellence during their working lives. A predicted pattern of events is worked out in the form of a causal flowchart, which will enable students to experience the educational factors necessary to provide them with essential attributes when they graduate. Figure 4.5 in chapter 4 shows how the predicted pattern of events can be amalgamated with the research process to obtain feedback concerning, both the essential attributes and the educational factors necessary for producing essential attributes in students. Hence figure 4.5 is the basis of a theory of essential attributes, which extends existing employability theory. The predicted pattern of events and hence the theory, should be usable for other courses and disciplines. A different concept of excellence from the sustainable world could be chosen (figure 6.1), depending on the professional discipline being taught.

Research questions changed:

The answer to research question 4 has indicated that for the CIT BEng course, stakeholders are demanding excellence. Hence fitness for purpose and excellence are approaching each other. As the case study research proceeds for the CIT BEng case study:

the second research question (chapter 1) could become:

What are the 'essential attributes' that the Cork Institute of Technology (CIT) BEng in mechanical engineering should provide to graduates?

the third research question (chapter 1) could also become:

To what extent does the Cork Institute of Technology BEng in mechanical engineering provide these 'essential attributes'?

and the fourth research question could become

Should the quality of the BEng course be raised?

If the essential attributes approach is used for other disciplines, the research questions relating to fitness for purpose and excellence would probably remain as they were originally in chapter 1. It is only following data gathering and data analysis that research questions can be refined for a particular case.

Figure 6.1: 'Essential attributes' model.

Tangible recommendations:

With regard to the CIT case study of the BEng (mechanical engineering) course, there are five 'essential attributes' that must be developed in order to bring the course up to 'fitness for purpose' standards. These are: personal attributes; written communication; safety, health, public welfare; reasoning and information research. From table 4.4, the empirical 'educational factors', generated from N4 projects QMt, QMt2 and QMt3 for each essential attribute are shown. Thus for the first essential attribute of 'personal attributes', the educational factors that should be considered for implementation at CIT are:

Work placement in industry as part of the course;

Personal development course from the Irish Management Institute;

Confidence through chairing of large meetings;

Confidence building - presentations to the rest of the class.

The work placement could either be in the Summer vacation period (March to September), or could be a year of industrial experience between third and fourth year of the course.

For the second essential attribute of 'written communication', the educational factors that should be considered are:

Use of multi-media/ computers for writing reports;

Laboratory work and laboratory reports - more emphasis.

For 'safety, health and public welfare', which has been reclassified as a 'standard of excellence', the educational factor that should be considered is:

Lectures on safety, health and welfare of the public.

These lectures should cover ethics in the engineering profession.

For the fourth essential attribute of 'reasoning' the educational factor that could be considered for implementation is:

Reduction of intense classes.

The fifth essential attribute of 'information research' generated no educational factors from table 4.4, which is based on N4 projects QMt, QMt2 and QMt3. However, from appendix 9 the latest reports on N4 project QMt4 are shown. These indicate that there are more educational factors emerging for all essential attributes. Thus for the essential attribute of 'information research', the educational factors that could be considered for implementation could be:

How to get information? - detailed instructions from project supervisor.

The essential attributes of management knowledge, problem-solving ability, self-directed learning ability, team working ability and mathematical ability are mentioned in course documentation. However, table 4.4 shows that their delivery can be improved by implementing educational factors. For the essential attribute of 'management knowledge', the educational factors that could be considered are:

Role play (each member of the class playing a different team role)

How to manage getting something done? (progress, costs, etc.)

Project management in first or second year (assisted by former graduates)

Modular approach.

The essential attributes of 'problem solving ability' and 'team working ability' could be improved by considering the educational factors of:

Small group tutorials

Use of teamwork to solve problems

More problem solving.

'Self directed learning ability' is another essential attribute that could be improved by considering, again from table 4.4, the educational factor of:

More self-directed learning guidance from the academic staff.

Also 'mathematical ability' could be improved by the consideration of the educational factors:

Small group tutorials

Practical examples and more examples.

As well as implementing the above recommendations, in order to approach international standards of excellence, the course would need to deliver the essential attributes of critical evaluation and time management. These two essential attributes have emerged from the wider debate documentation. Thus for critical evaluation there are no empirical educational factors shown in table 4.4 and nothing has emerged from N4 project QMt4 (appendix 9). However, table 4.2 shows educational factors derived from the literature and indicates that for 'critical evaluation' consideration should be given to the educational factor:

Assessment practices.

Details of this educational factor and how a deep approach to learning can be developed are given in chapter 3. Internet based assignment delivery and assessment systems with online tutors are one of the assessment practices that could be considered.

With regard to the essential attribute of 'time management', the educational factors derived from N4 project QMt4 (appendix 9) that should be considered are:

How to prioritise work?

Project management software.

To assist the approach towards international standards of excellence, the following supporting standards of excellence would need to be given attention:

Course strategy

Local/regional needs

National/international needs

Student/staff liaison.

The above four supporting standards of excellence could be implemented through a system of regular interviews with former graduates of the course and the subsequent analysis of the interview data.

It is also recommended that frequent interviews be conducted with former graduates of the course, because 'standards of excellence' which could have the greatest impact on the chosen concept of excellence (sustainable world) emanate from interviews with industrially experienced past graduates. This indicates that for the CIT BEng course, 'fitness for purpose' and 'excellence' are approaching each other. Thus, a further recommendation is that an overall concept of excellence should be established for each course and the figure 6.1 'essential attributes' model be followed.

Yorke (2000:72) discusses some USA research, which shows how science, mathematics and engineering teaching can undermine student confidence, thus preventing their progress. Knight and Yorke (2003:14) emphasise the importance of HEIs enhancing the quality of teaching and learning.

However, they take this task one stage further by suggesting that enhancing employability skills in students will also expect more of the students themselves. They suggest that students should represent themselves in the discourses of employability. Designing promising learning environments is one stage. Helping students discover their limitations and learning styles is another stage. The 'essential attributes' approach, with its emphasis on feedback from students, as well as other stakeholders, should contribute to both stages.

Relating findings to literature:

Shearman (2004) in a Royal Academy of Engineering presentation concerning sustainability competences for engineers describes how the new UK standards for professional engineering competence are planning to make promotion of sustainability a mainstream activity. He stresses the importance of sustainability and how it should be reflected in learning outcomes from education. He also states that professional institutions need to reflect this in their requirements. However, he does not give any detail concerning how these learning outcomes can be identified.

Greenish (2004) stresses the importance of understanding the sustainability problem. He also highlighted that future generations are also stakeholders whose needs should be taken into account at this time. Again he emphasises the importance of ensuring engineers develop the skills necessary to take sustainability issues into account. However, he does not give information concerning the nature of the required skills. The presentation by Parkin (2004) also describes integrating sustainability into courses and building the capacity of teachers to do this, but does not indicate how this should be done. Similarly the Harris (2004) presentation is vague on this issue. Both Bartholmew (2004) and Fisk (2004) describe Masters degree courses, which deal with sustainable development. Azapagic (2004) describes a University of Surrey module dealing with the topic, whilst Geddes (2004) suggests graduate training/continuing professional development (CPD) as the way forward. However, it is not clear from the presentations how to integrate the necessary skills into undergraduate courses. Dickens (2004) describes how the Learning and Teacher Support Network (LTSN) is seeking funds from

the Higher Education Academy. This will enable LTSN to provide resources and activities in order to facilitate the integration of sustainability into the engineering curriculum. Again details of the resources and activities are not given.

Howarth and Hadfield (2004) describe teaching sustainable product development at the University of Bournemouth. The use of case studies appears to be quite useful, although very focused on the product. Adeyeri (2004) also describes the use of case studies for teaching sustainable development in an undergraduate chemical engineering programme. The CIT case study has shown that essential attributes, standards of excellence and educational factors, all of which have an impact on a sustainable world, can be identified by use of the essential attributes approach. The opportunity exists for CIT to take a lead in this area and fill the gaps in course effectiveness evaluation that are indicated in chapter 2.

Martin and Schinzinger (1997:35) discuss 'engineering ethics', defining them as an examination of the moral issues and ideals in engineering. Moral issues and ideals concern respect/care for persons including the environment we share. Martin and Schinzinger (1997:391) continue by describing how there is an ongoing need for moral leadership in engineering and other professions. They suggest involvement in professional organisations and community service. This will give engineers and other professionals the opportunity to be morally creative in helping to guide, organize and stimulate groups towards morally desirable goals. However, Martin and Schinzinger (1997:391) are vague on the nature of these morally desirable goals. This issue can therefore be fulfilled by this research. The 'essential attributes' approach gives course leaders the opportunity to show moral leadership by selecting a 'concept of excellence', which in the case of engineering is a 'sustainable world'. This 'concept of excellence', which emerges whilst implementing the 'essential attributes' approach, can also be considered a morally desirable goal. The 'educational factors' employed to promote 'essential attributes' aimed at achieving the 'concept of excellence' are part of the moral creativity described by Martin and Schinzinger (1997:391).

Palihawadana (1992:333) describes a study of postgraduate management students at the University of Strathclyde, concluding that student course outcomes fell short of student expectations. It is interesting that many of the students and graduates interviewed as part of the 'essential attributes' approach, had vague opinions of what to expect when they started the BEng course. For others the course was as expected. As can be seen from appendix 10, it is relatively easy using the N4 software, to compile all the respondent comments for course expectations by generating reports for the node '/Fitness for purpose/Course/Expectations'. This can be done for each of the N4 projects: QMt, QMt2, QMt3 and QMt4. It was only following a period of employment that graduates seem to form opinions concerning course content. Even those that were critical of some aspects of the course, always qualified their opinion with the view that, taken holistically, the course was good. It may be that in the Palihawadana research (1992), postgraduate students being more mature, have greater expectations. Palihawadana (1992:329) also discusses the responsibility that higher educational institutions (HEIs) have in leading the market. He suggests doing this with a systematic procedure focusing on determining student needs. Addressing these needs would enable graduates to be successful in their present and future careers. The 'essential attributes' approach may be such a procedure.

From appendix 4, it can be seen that there are many nodes, which have not been addressed in this research. In the same way as it was possible to produce reports for the node '/Fitness for purpose/Course/Expectations', it is also possible to produce reports concerning every other node, using the N4 software. As well as expectations, Palihawadana (1992:323) looked at student workload, student finance, lecture quality, teaching effectiveness, staff development, staff absenteeism, staff research, staff/student interaction and market orientation. With free tertiary education still operating in Ireland and the BEng course strongly marketed at local schools, student finance and market orientation is not an issue. From appendix 4, it can be seen that the other issues are all covered by the nodes of the 'essential attributes' approach. Hence there is much information contained in the interview transcripts and N4 software, which has not been used. This research focuses

on 'essential attributes' and 'standards of excellence'. Unused information may be utilised in future research.

Data collection review:

Chapter 4 shows that the most productive data, having the most impact on the chosen concept of engineering excellence, are obtained from highly experienced past graduates and present students, who also have some industrial experience. The data from these two groups are most productive in terms of essential attributes, educational factors and standards of excellence. The data from these two groups also display a level of criticality of the BEng course, which the other groups have not displayed. This includes previous IEI panels mentioned in chapter 2 (IEI submission 2000:11). For the highest information return from data, the priority for the future will be to target the more experienced past graduate.

Limitations to research:

The research findings are based on one case study, which are applicable to the CIT BEng course. However, the essential attributes approach provides a structure for existing employability theory, which could be applicable to other courses. The research findings offer the essential attributes approach as a method of course effectiveness evaluation. To ensure that the method works, the essential attributes approach would need to be further validated on higher education courses of different disciplines.

One of the limitations of the research is the time involved in interviews and that these have to be undertaken on a part time basis. It would be advantageous if a full time researcher were employed to undertake these interviews together with the data processing, coding, etc. In the future, therefore, an attempt at obtaining research funding could be tried. If successful a full time researcher could be employed, thus enabling the research to proceed at a faster pace.

Learning:

This research has increased my knowledge of quality management concepts. This new knowledge has enabled me to utilise definitions of quality management concepts, for framing the research and structuring the

collection of data. This made data collection manageable. Following a small amount of data collection and data analysis, it was possible to start theory building. Theory building indicated the variables that should be sought from the next batch of data and the next literature search. Thus a model of a theory could be ultimately built. The techniques learnt can be used for future research or indeed to continue this research.

Future development:

Some aspects of my research were presented at the conference *Globalisation and inclusion: challenges for professional education in the third level sector* held at University College Cork (UCC) on Monday 31st May and Tuesday 1st June 2004. This development education conference was supported by DCI (Department of Foreign Affairs) and organised in conjunction with the Education Department at UCC. The conference focused on the challenges of addressing globalisation and inclusion in the context of higher education. The conference themes/strands were:

- Professional education for globalisation and inclusion
- Human rights, the law and development
- Information and Communication Technologies for development
- Teacher education and the education of teacher educators
- Teaching critical thinking in the context of development at third level
- Inclusion and education for sustainable development
- HIV/AIDS education

Over 60 papers were presented at the conference. My paper was presented in the 'professional education for globalisation and inclusion' strand/theme of the conference. Questions following my paper were mainly concerned with the differences between qualitative and quantitative research methods.

Highlights of the plenary discussion at the end of the conference included the comments of Dr. Colin Brock, Education Department, University of Oxford, who was pleased that the conference papers came from many disciplines. These included education, law, medicine, business, science, engineering, food science, social sciences, arts and humanities. In his

closing remarks, Dr. Peadar Kirby, Centre for International Studies, Dublin City University, expressed disappointment at the dearth of papers concerning local issues of inclusion within Ireland. He urged researchers to confront this issue at future conferences.

I have also submitted an article concerning some aspects of my research, for publication to the international journal *Research in Post-compulsory Education*, which is sponsored by the *Further Education Research Association (FERA)* of the United Kingdom. The article is to be published in the Spring/Summer issue of 2005. Comments from journal readers concerning the research methods could be beneficial for continuing the research.

During June, July and August 2004, more interviews took place with past graduates at their workplace and these were analysed in QMt4. Following this analysis using N4 software, the final iteration QMt4 indicated that there were new essential attributes to be discovered along with the associated educational factors. Continuing with this research beyond this final thesis seems to be worthwhile. If the research continues, there is also the possibility of continuing with theory building, hence modifying the causal flowcharts shown in chapter 4 and the 'essential attributes' model shown in figure 6.1. Discussing causality, Hutchin (2001:71) describes how a single event (the cause) always leads to another event (the effect) leading to the creation of effect-cause-effect relationships. For any given effect there is no single cause, but there has to be a second cause at least, which combines with the first cause in the form of a logical 'and' to lead to the existence of the effect. Without the second cause, the first is insufficient. If **A AND B** then **C** (figure 6.2).

Figure 6.2: the logical 'AND' diagram.

There is also the possibility of the logical 'or' connection. If **A OR B** then **C**. This is shown in figure 6.3 below.

Figure 6.3: the logical 'OR' diagram.

Causality can also be postulated. **C** is a predicted effect caused by **A**, which confirms the existence of **A** and therefore makes the causality of **A** to **B** tenable (figure 6.4).

Figure 6.4: the predicted effect diagram.

According to Hutchin (2001:74), in social science we are always in the position of inferring from observed data, that the hypothesis of X causing Y

is tenable, with some degree of confidence. Therefore, in the early stages as research progresses, we cannot be sure of the logical 'and' (figure 6.2), the logical 'or' (figure 6.3) or the predicted effect (figure 6.4), but we can propose a causal flowchart as a possibility. Therefore, the flowcharts shown in chapter 4 and figure 6.1 have arrows connecting the given phenomena in the logical 'or' format, but they could be in reality, the logical 'and' format. The predicted effect format has not arisen so far in any of the flowcharts completed. Theory building continues as the research proceeds and the contingent effects on the arrows connecting each box in the causal flowcharts will be considered further, as the research continues into the future.

Contribution of my research to wider issues:

Chapter 2 provided a review of the quality management literature concerning the wider debate on engineering higher education. This review concluded that many of the methods used adopted very wide frameworks. The essential attributes approach avoids the wide framework, by allowing the researcher to prioritise data that are analysed by the N4 software. The first stage is to analyse essential attributes categorised under fitness for purpose. The second stage is to analyse essential attributes categorised under standards of excellence. Other supportive standards of excellence can then be examined and, if time permits, data of a lower priority can then be analysed. Appendix 4 shows other nodes, which have not been analysed in the CIT case study. The nodes 'industry links' and 'teaching methods' could be chosen as the next due for analysis. There are much data, which the researcher has to consider and prioritise. Hence, the essential attributes approach of evaluating a course is one of the contributions of this research to the wider issues.

Approach:

Data analysis and the subsequent adjustment of the N4 node structure, takes place following the coding of approximately each ten interviews. This iterative process is repeated several times and a refined node structure should result after the coding of approximately 40 interviews and some external documentation (4 iterations). The refined node structure will help

to identify the standards required for both fitness for purpose and excellence. Identification of standards of excellence is facilitated by a chosen concept of excellence for the course discipline, which graduates from the course aspire to reach.

Outcomes:

The core stakeholder group, which provides the best quality data, can be seen from chapter 5 to be past graduates and present students. Responses from past graduates and present students tended to be more mixed, with some positive responses about the BEng course, but also some criticism. These mixed responses, with many suggestions on improving the BEng course, indicated a reliable source of data. This core stakeholder group tended to be more enthusiastic about responding to interviews and was very keen to give their views about the BEng course. The peripheral stakeholder group, so named because there were fewer respondents from this group, can also be seen from chapter 5, to be non-completing students, employer representatives and lecturers/managerial staff. Responses from this peripheral stakeholder group tended to be more positive about the BEng course, than responses from the core stakeholder group. Hence the peripheral stakeholder group responses were thought to be less reliable. Data collection therefore targets the core stakeholder group as respondents. They were considered a rich and plentiful seam of good quality data.

Chapter 5 discussed the minimalist and maximalist quality concepts. Minimalist quality is achieved when stakeholders, particularly the core stakeholder group, are satisfied with the essential attributes that are being delivered by the course. Hence fitness for purpose is being achieved. Maximalist quality is achieved when, as well as satisfying minimalist quality conditions, the course has a chosen concept of excellence in place. To ensure the course is striving for excellence, the maximalist quality concept requires that the course has attained minimalist quality conditions and has in place a chosen concept of excellence. These must also be supported by standards of excellence obtained from wider debate documentation and obtained from the core stakeholder group. Applying these quality concepts to the CIT case study, it can be seen from chapter 5,

that it is the core stakeholder group that are demanding not just the minimalist quality concept, but the maximalist quality concept. In future research it would be interesting to see if the same result is obtained from other courses or disciplines.

Implications for course evaluation:

In chapter 2, a number of models of course effectiveness evaluation are described and these are shown below. The Higher Educational Institution (HEI), in which they are used, together with the method of data collection predominantly implemented, is also listed.

MODEL	HEI	DATA
Competing values model	Hong Kong HEIs	questionnaires
QMS system	University of Louisville, USA	questionnaires
SET/SEU	Queensland University of Technology	questionnaires
Teaching evaluation index	Hong Kong Polytechnic University	questionnaires
CTR questionnaires	Hofstra University, New York, USA	questionnaires
Focus groups/evaluation forms	Imperial College, London	questionnaires
Process control		interviews
Users/peers		interviews
Class size/learning	USA economics students	questionnaires

From the above list, it can be seen that there are two methods (process control, users/peers) which use qualitative interview methods for collecting data and they are not in use at any HEI. A reason for this could be that interview techniques are considered by most HEIs to be more bureaucratic than questionnaires. The problem with questionnaires, however, is that the response rate is low. From chapter 5, it can be seen that the quality of information that has emerged from interview data, when analysed using the framework of the essential attributes approach, should evaluate a course effectively. The information is in the form that Haworth and Conrad (1996:49) recommend and that is learning centred, with the focus on "realising students dreams". This information, if acted upon, should guide a course towards excellence. This may be a good enough reason to persuade HEIs to use the essential attributes approach.

Another reason for this HEI reluctance to use qualitative interview methods is provided by Hutchin (2001:115), who describes how change can be

prevented by a 'paradigm lock cloud' (plc). The plc affects those responsible for implementing change. An example of a plc in a small consultancy practice, is how one of the original members of the group has difficulty working with some of the other people in the practice. She could not come to terms with non-performance of some of the other members of the team. The plc affected her personally, so that any other option, such as the necessary change, was not allowed. Could this be the reason why the more qualitative approaches to course effectiveness evaluation have not been implemented in HEIs? Certainly in discussions with those involved in the engineering education process, there appears to be a prejudice against the more qualitative approaches to research. These approaches have been the primary methods used in the essential attributes approach, but rarely are they used by HEIs. Hutchin (2001:148) suggests focusing on the big picture as one of the ways to break the plc. To rise above the tactical issues and see the strategic issues is suggested as feature number one of the solution.

Coverage of the minimalist quality concept (fitness for purpose) by the essential attributes approach can be seen from chapter 5 to be more than adequate. This is because the bulk of the interview data derive from the core stakeholder group (past graduates and present students) who, as the case study shows, may demand more than just fitness for purpose. The core stakeholder group may indicate that the course should be striving for excellence and they may set the standards of excellence that the course should follow. This is a very important feature of the essential attributes approach, which was not expected at the start of the research.

The chosen concept of excellence, which for engineering was a sustainable world, is a feature of the essential attributes approach. The chosen concept of excellence, or the maximalist quality concept, emerged as a result of the theory building of chapter 3 and resulted in the causal flowcharts of chapter 4. Those essential attributes, which have a direct bearing on the chosen concept of excellence, are evident when coding takes place using N4 software. They can then be reclassified as standards of excellence. These standards of excellence and the supportive standards of excellence, obtained from wider debate documentation, together with the requirements of the

minimalist quality concept, should be addressed if the course is to move towards the chosen concept of excellence. This makes the essential attributes approach a comprehensive model of course effectiveness evaluation.

Appendices:

		Page
Appendix 1:	Framework of quality dimensions.	179
Appendix 2:	Critical success factors.	180
Appendix 3:	Academic plan.	182
Appendix 4:	Nodes.	190
Appendix 5:	Interview transcript.	197
Appendix 6:	Observation transcript.	203
Appendix 7:	Essential attributes report.	204
Appendix 8:	Standards of excellence report.	222
Appendix 9:	QMt4 reports.	227
Appendix 10:	N4 reports - course expectations.	237

APPENDIX 1: Quality Dimensions.**Table 3: The revised framework of quality dimensions used in the questionnaires**

Dimensions	Items
1. Tangibles	1. Sufficiency of academic equipment, e. g. laboratories, workshops. 2. Ease of access to the equipment. 3. Degree to which the equipment are modern looking. 4. Ease of access to information sources, e.g. books, journals, software, information networks. 5. Degree to which the environment is visually appealing. 6. Adequacy of support services, e. g. common room.
2. Competence	7. Competence of support staff, e.g. technicians, receptionists, secretaries. 8. Sufficiency (number) of academic staff. 9. Theoretical (relevant) knowledge of academic staff. 10. Practical (relevant) knowledge of academic staff. 11. Extent to which academic staff are up to date in their subject. 12. Expertise of academic staff in teaching/communication.
3. Attitude	13. Extent to which academic staff understand student's academic needs. 14. Degree of academic staff's willingness to help. 15. Availability of academic staff's willingness to help. 16. Extent to which academic staff give personal attention.
4. Delivery	17. Extent to which courses material are timely/sequentially presented. 18. Degree to which exams are representative of courses taught.
5. Content	19. Extent to which courses are stimulating. 20. Degree to which the programme contains primary knowledge/skills, e.g. ability to define and analyse engineering problems. 21. Degree to which the programme contains ancillary knowledge/skills, e.g. use of computer technology. 22. Extent to which students learn communication skills. 23. Extent to which students learn teamworking. 24. Relevance of curriculum to future jobs of students. 25. Applicability of knowledge learnt to other fields.
6. Reliability	26. Credibility of degrees awarded to the students. 27. Degree to which school/department handles feedback from students. 28. Extent to which personal (confidential) information is secure.

Owlia and Aspinwall (1998:507)

APPENDIX 2: Critical Success Factors.

Table 2: Rankings of CSFs at planning stage and during implementation

<u>Critical Success Factor</u>	<u>Rank</u>
Leadership	2
Continuous improvement	1
Prevention	9
Measurement of resources	8
Process improvement	6
Internal customer satisfaction	7
External customer satisfaction	3
People management	4
Teamwork	5

Glossary

Leadership (prime):

The development and implementation of quality strategies require fundamental changes in corporate culture and organizational behaviour and can only be achieved through Active leadership provided by top management. The role of leadership is to motivate people and complete all the necessary tasks and is therefore a necessary management component in organisations.

Principles of TQM

Delight the customer:

Delight means being best at what matters most to customers and this changes over time. Being in touch with these changes and delighting the customer now and in the future is an integral part of TQM.

People-based management:

Knowing what to do and how to do it and getting feedback on performance is one way of encouraging people to take responsibility for the quality of their work. Involvement and commitment to customer satisfaction are ways to generate this.

Continuous improvement:

Continuous improvement or incremental change, not major breakthroughs, is the aim of all who wish to move towards total quality.

Management by fact:

Knowing the current performance levels of the products or services in the customers' hands and of all the employees is the first stage of being able to improve. Management must have the facts necessary to manage business at all levels. Giving that information to people so that decisions are based upon facts rather than 'gut feelings' is essential to continuous improvement.

Concepts of TQM

Customer satisfaction:

Some companies go out to their customers to survey what is important to them and to measure their own performance against customers targets. This allows the company to monitor customer satisfaction as measure by the customer.

Internal customers are real:

The definition of quality (i.e. satisfying agreed customer requirements) relates to internal and external customers. Many writers refer to a customer/supplier chain and the need to get the internal relationships working in order to satisfy the external customer. Whether you are supplying information, product or a service, the people you supply internally depend on their internal suppliers for quality work.

All work is process:

A process is a combination of methods, materials, manpower, machinery, etc., which taken together, produce a product or service. All processes contain inherent variability and one approach to quality improvement is progressively to reduce variation: first, by removing variation due to special causes, second, by driving down common cause variation, bringing the process under control and then improving its capability.

Measurement:

Having a measure of how the organisation is doing is the first stage of being able to improve. Measures can focus internally, i. e. on internal customer satisfaction, or externally, i. e. on meeting external customer requirements.

Teamwork:

When people are brought together in terms of a common goal, quality improvement becomes easier to communicate over departmental or functional walls. In this way, the slow breaking down of barriers act as a platform for change.

People make quality:

The role of managers within an organisation is to ensure that everything necessary is in place to allow people to make quality products. This in turn begins to create the environment where people are willing to take responsibility for the quality of their own work.

The continuous improvement cycle:

The continuous cycle of establishing customer requirements, meeting the requirements, measuring success and continuing to improve can be used internally to fuel the engine of external and continuous improvement. By continually checking customers' requirements, a company can find areas in which improvements can be made.

Prevention:

Prevention means causing problems not to happen. The continual process of driving possible failure out of the system can breed a culture of continuous improvement over time.

Business excellence index:

The simultaneous measurement of customers', employers' and shareholders' delights within an organisation to provide overall business success.

Kanji et al (1999:152)

APPENDIX 3: Academic Plan.

Cork Institute of Technology

Academic Plan

October 1997

Ed Riordan

Contents

- A. Mission Statement of the Institute
- B. Ethos
- C. Strategic Goals
- D. Actions
- E. Implementation

A. The Institute's Mission statement

- * To provide quality applied higher education through a balance of disciplines, levels and modes of study.
- * To enable students to achieve their full potential within a supportive environment.
- * To advance and apply learning, research and creativity for the benefit of the economic, industrial, social and cultural development of the region and the community at large.

B. Ethos:

The ethos which will inform the work of the Institute as it carries out this mission will be:

- * A commitment to quality in all activities of the Institution.
- * A humane and caring environment within which students and staff work and learn together.
- * An open and responsive approach to meeting the needs of industry and society.

C. Strategic Goals:

The mission of the Institute is to be met through the implementation of the following six strategic goals.

Goal 1

- to maintain and enhance the education service offered by the

Institute to industry and the community.

Goal 2

- to improve educational provision of the Institute, as regards level, quantity and diversity.

Goal 3

- to increase the research activities of the Institute.

Goal 4

- to ensure the highest possible quality of academic provision at every level.

Goal 5

- to improve the learning environment and to enhance the learning experience of students.

Goal 6

- to place the Institute at the front rank of Higher Education provision in Ireland as a national centre of excellence in applied learning and research.

D. Specific Actions

Each of the six strategic goals requires specific actions for its implementation. These actions will form the agenda for Institute-wide and departmental activities and discussions.

Goal 1:

To maintain and enhance the education service offered by the Institute to industry and the community.

Actions:

- (a) The Institute and its departments will engage in a continuous dialogue with industry and national policy agencies to identify trends and needs.
- (b) The institute will continue to educate and train graduates at a full spectrum of levels, i.e. craft/apprentice, certificate, diploma, degree, professional and postgraduate.
- (c) Procedures for the commencement of new course and the regular revision of existing course will be streamlined and improved.

- (d) The applied nature of education and research in the Institute will be maintained.
- (e) Laboratory, workshop, project and other applied and hands-on activities will be maintained to ensure the immediate employability of graduates.
- (f) Specialist industry support centres, facilities and research units will be expanded.
- (g) Courses in the Institute will be structured and delivered to improve access, with particular reference to social disadvantage and the promotion of lifelong learning.

Goal 2 -

To expand the educational provision of the Institute as regards level, quantity and diversity.

Actions:

- (a) New courses will be developed as required following liaison with industry, development agencies and social partners.
- (b) In particular, the Institute will implement new ab-initio and add-on degree programmes to meet the needs for graduates in applied fields.
- (c) All Certificate programmes will have a Diploma option.
- (d) Within five years, all qualified Diploma graduates will have available to them a Degree option in the Institute.
- (e) Every Degree programme in the Institute will have a postgraduate study element available.
- (f) New technologies and modes of delivery will be harnessed to bring technological higher education to geographically and socially disadvantaged groups.
- (g) Reserved places will be provided to meet the need for life-long learning opportunities among adults. The Institute will exceed the national norms for such places.
- (h) The number of full-time places available in the Institute will be expanded to 6400 by the year 2005 to meet student demand for places and for the economic and social development of the region.

- (i) The necessary Government funding to meet this expansion will be sought.
- (j) The diversity of the institution as regards its range of disciplines will be protected and developed. In particular, the three strands represented by the School of Music, the Crawford College of Art and Design, and the technological and business campus at Bishopstown will be integrated. Cross-disciplinary activity will be encouraged.

Goal 3 -

To increase the research activities of the Institute.

Actions:

- (a) To ensure a positive climate for staff who wish to embark on research and development, through incentives and organisational supports. In particular the research charter of the Institute will be promoted and updated as required.
- (b) To integrate the academic programmes of the Institute with strategically targeted applied research.
- (c) To ensure that each department and centre of the Institute maintains close links with national agencies such as Forbairt, the Environmental Protection Agency, the marine Institute, etc.
- (d) To identify potential industry partners for collaborative applied research and to make available to industry advanced specialist facilities for productive purposes.
- (e) To increase the number of expert groups within the Institute which can function as nuclei for research and development.
- (f) To expand the funding of Institute research and development activity from Government, Industrial and EU/International sources.
- (g) To maintain research collaboration with other Higher Educational Institutions throughout the world.
- (h) To encourage staff publications and involvement in professional bodies.

Goal 4 -

To ensure the highest quality of academic provision at every level.

Actions:

- (a) To update and ensure the implementation of the Institute's academic quality procedures.
- (b) To support and expand the effectiveness of the Institute's Academic Council, in meeting its obligations under the 1992 Act; i.e. to assist the Governing Body in the planning, co-ordination, development and overseeing of the educational work of the college and to protect, maintain and develop the academic standards of the courses and the activities of the college.
- (c) To support and expand the effectiveness of the Registrar's Office, as the key executive agency for the implementation of academic policy.
- (d) To ensure the regular and efficient functioning of Course boards for every course in the Institute and to administratively support these course boards.
- (e) To conduct a thorough annual review of each course, so that course content and delivery are moulded by internal and external academic views as well as inputs from industry and students.
- (f) To ensure that examination and assessment procedures of the Institute are rigorous, fair and appropriate. This to be achieved through a review of the administration of examinations, through the use of a full range of assessment techniques and through adequate training of staff in those techniques.
- (g) To implement appropriate academic staff development programmes for existing and new staff. These staff development programmes to be based on (i) the evaluation by academic members of their own needs as educators and professionals; (ii) staff development policies at Department level; (iii) Institute-wide policies and supports.
- (h) To monitor (i) the level of academic achievement of entrants (ii) student retention rates (iii) graduate achievement, progression and employment rates for each course.
- (i) To secure for the Institute the necessary powers and academic standing to make its own awards.
- (j) To maintain academic links with Universities, Institutes of Technology, RTC's and other higher education institutions.

- (k) To retain the professional recognitions currently held such as IEI/FEANI, Institute of Physics and others; and to achieve additional recognition where appropriate.

Goal 5 -

To improve the learning environment and to enhance the learning experience of students.

Actions:

- (a) The quality and comfort of classrooms, lecturing areas and staff rooms to be improved.
- (b) Common areas such as atria, corridors and the external environs to be upgraded and expanded.
- (c) A comprehensive student services building to be provided.
- (d) The potential of the Library and Information Technology Centre to be fully utilised by all students and staff.
- (e) Use of information technology, distance learning and self-directed study to be expanded to the full.
- (f) An adequate student guidance service meeting the norms of the recent national study completed by Cork RTC for the National Centre for Guidance in education to be introduced.
- (g) Current best practice for interaction of students and lecturing staff to be fostered both through formal mechanisms and informal encouragement.
- (h) Placement of students in industry and other Higher Education Institutions abroad to continue to be a normal aspect of all courses.
- (i) Where appropriate and where compatible with maintaining academic standards, formal class time to be reduced in favour of self-directed applied work such as projects.
- (j) Cultural academic and sports activities based on societies, clubs to be expanded.
- (k) The role of the Institute as a cultural resource of Cork City and region to be supported.

Goal 6 -

To place the Institute at the front rank of Higher Education provision in Ireland, as a national centre of excellence in applied learning and research.

Actions:

- (a) The formal title of the Institution to be Cork Institute of Technology, in order to reflect the quality, level and emphasis of the Institute.
- (b) Power to make awards in its own name to be devolved to the Institute, in recognition of the quality and integrity of the academic procedures of the Institute. The standing of the awards of this Institute to be guaranteed nationally and internationally through an appropriate framework of recognition.
- (c) While supporting the binary system of higher education in Ireland, the policy of the Institute shall be to demand full parity of esteem and resourcing with any other Higher Education Institution in the State.
- (d) The Institute to take a leading role in European Union and other international networks and projects.
- (e) The currently designated national centres of excellence in the Institute to be developed and new centres to be added.
- (f) The Institute to be a leading provider of distance education.
- (g) To be a major centre for applied research in Ireland.
- (h) The Institute to promote access to higher education through the structure of its programmes, through its provision for lifelong learning and through community involvement.

E. IMPLEMENTATION

The academic plan is an ambitious Institute wide set of objectives. Its successful implementation requires considerable resources of capital and personnel, but equally importantly staff and student support.

The basic level at which actions outlined above must be considered and carried out in detail is the departmental level. For this reason, a fully structured process of meetings, evaluation of progress and feedback from staff and students needs to be the norm in the Institute.

The Academic Council and the Registrar's Office are the key agents of academic policy development and quality assurance. These bodies in particular need to be fully resourced in terms of personnel, accommodation and budgets.

At management level, senior staff and the Director must develop a framework for reporting and monitoring progress towards the strategic goals outlined, and a time frame for their achievement needs to be set in the light of available resources.

The Governing body of the Institute will need to (i) adopt an academic plan (ii) secure the necessary resources of personnel and funding to ensure its implementation (iii) monitor on a regular basis the progress of the Institute towards its strategic goals.

APPENDIX 4: Nodes

Q.S.R. NUD*IST Power version, revision 4.0.

Licensee: Francis Spenser Murphy.

PROJECT: **QMt Project**, User Francis S. Murphy, 2:42 pm, Jan 27, 2004.

- (1) /Fitness for purpose
- (1 1) /Fitness for purpose/Essential attributes
- (1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability
- (1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability
- (1 1 3) /Fitness for purpose/Essential attributes/Creativity
- (1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability
- (1 1 5) /Fitness for purpose/Essential attributes/Management knowledge
- (1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability
- (1 1 7) /Fitness for purpose/Essential attributes/Public speaking
- (1 1 8) /Fitness for purpose/Essential attributes/Written communication
- (1 1 9) /Fitness for purpose/Essential attributes/Information technology skills.
- (1 1 10) /Fitness for purpose/Essential attributes/Personal attributes
- (1 1 11) /Fitness for purpose/Essential attributes/Time management
- (1 1 12) /Fitness for purpose/Essential attributes/Information research
- (1 1 13) /Fitness for purpose/Essential attributes/Individual projects
- (1 1 30) /Fitness for purpose/Essential attributes/Individual flare
- (1 1 32) /Fitness for purpose/Essential attributes/Reasoning
- (1 2) /Fitness for purpose/Assessment
- (1 2 1) /Fitness for purpose/Assessment/Internal examinations
- (1 2 1 1) /Fitness for purpose/Assessment/Internal examinations/Final year Christmas
- (1 2 1 2) /Fitness for purpose/Assessment/Internal examinations/Computer based exams
- (1 2 2) /Fitness for purpose/Assessment/External examinations
- (1 2 3) /Fitness for purpose/Assessment/Continuous Assessment
- (1 2 3 1) /Fitness for purpose/Assessment/Continuous Assessment/Intellectual challenge
- (1 2 3 2) /Fitness for purpose/Assessment/Continuous Assessment/Feedback
- (1 2 4) /Fitness for purpose/Assessment/Laboratory work
- (1 2 5) /Fitness for purpose/Assessment/Open book examinations
- (1 2 6) /Fitness for purpose/Assessment/Student attendance
- (1 2 6 1) /Fitness for purpose/Assessment/Student attendance/Student lateness
- (1 3) /Fitness for purpose/Industry links
- (1 3 1) /Fitness for purpose/Industry links/Industry cooperative scheme
- (1 3 2) /Fitness for purpose/Industry links/Industry based projects
- (1 3 3) /Fitness for purpose/Industry links/Industry visits
- (1 3 4) /Fitness for purpose/Industry links/Job
- (1 3 5) /Fitness for purpose/Industry links/Industrial Experience
- (1 3 6) /Fitness for purpose/Industry links/Industrial advisory committee
- (1 3 7) /Fitness for purpose/Industry links/Industrialist support
- (1 4) /Fitness for purpose/Teaching
- (1 4 1) /Fitness for purpose/Teaching/Small group tutorials
- (1 4 2) /Fitness for purpose/Teaching/CAL
- (1 4 3) /Fitness for purpose/Teaching/Practical approach
- (1 4 4) /Fitness for purpose/Teaching/Modules
- (1 4 5) /Fitness for purpose/Teaching/Staff experience
- (1 4 6) /Fitness for purpose/Teaching/Learning skills
- (1 4 7) /Fitness for purpose/Teaching/Learning resources
- (1 4 8) /Fitness for purpose/Teaching/Student support and guidance
- (1 4 9) /Fitness for purpose/Teaching/Lectures
- (1 4 10) /Fitness for purpose/Teaching/Class size
- (1 4 18) /Fitness for purpose/Teaching/Discipline
- (1 4 19) /Fitness for purpose/Teaching/Techniques
- (1 4 28) /Fitness for purpose/Teaching/Academic
- (1 5) /Fitness for purpose/Subjects
- (1 5 2) /Fitness for purpose/Subjects/Mechanics of Materials
- (1 5 5) /Fitness for purpose/Subjects/Electro-pneumatics
- (1 5 6) /Fitness for purpose/Subjects/Management
- (1 5 7) /Fitness for purpose/Subjects/Thermodynamics-fluid mechanics
- (1 5 8) /Fitness for purpose/Subjects/Process Subjects
- (1 5 11) /Fitness for purpose/Subjects/Project supervision
- (1 5 12) /Fitness for purpose/Subjects/Computers
- (1 5 13) /Fitness for purpose/Subjects/Electronics
- (1 5 14) /Fitness for purpose/Subjects/Aerospace

(1 5 15) /Fitness for purpose/Subjects/Design
 (1 5 17) /Fitness for purpose/Subjects/Electrical Engineering
 (1 5 22) /Fitness for purpose/Subjects/Mechanics
 (1 5 23) /Fitness for purpose/Subjects/Language
 (1 5 25) /Fitness for purpose/Subjects/Physics
 (1 5 29) /Fitness for purpose/Subjects/Manufacturing
 (1 6) /Fitness for purpose/Course
 (1 6 1) /Fitness for purpose/Course/Up to date
 (1 6 2) /Fitness for purpose/Course/Open days
 (1 6 3) /Fitness for purpose/Course/Completion rates
 (1 6 16) /Fitness for purpose/Course/Expectations
 (1 6 20) /Fitness for purpose/Course/Enjoyable
 (1 6 21) /Fitness for purpose/Course/Course length
 (1 6 24) /Fitness for purpose/Course/Course difficulty
 (1 6 26) /Fitness for purpose/Course/Good course
 (1 6 27) /Fitness for purpose/Course/Excessive material
 (1 6 31) /Fitness for purpose/Course/Alternative course
 (1 7) /Fitness for purpose/Staff training and development
 (1 7 1) /Fitness for purpose/Staff training and development/Conferences
 (1 8) /Fitness for purpose/Accommodation and equipment
 (1 9) /Fitness for purpose/Library
 (2) /Standard of excellence
 (2 1) /Standard of excellence/Humboldt principle
 (2 2) /Standard of excellence/Consultancy
 (2 3) /Standard of excellence/Research
 (2 3 1) /Standard of excellence/Research/CIT Research Charter
 (2 4) /Standard of excellence/Professional bodies
 (2 5) /Standard of excellence/Employers
 (2 6) /Standard of excellence/Mission statement
 (2 7) /Standard of excellence/Aims and objectives
 (2 8) /Standard of excellence/Local and regional needs
 (2 9) /Standard of excellence/National and international needs
 (2 10) /Standard of excellence/Quality assurance
 (2 11) /Standard of excellence/External examiners
 (2 12) /Standard of excellence/Student representation

Q.S.R. NUD*IST Power version, revision 4.0.

Licensee: Francis Spenser Murphy.

PROJECT: **QMt2 Project**, User Francis S. Murphy, 3:03 pm, Jan 27, 2004.

(1) /Fitness for purpose
 (1 1) /Fitness for purpose/Essential attributes
 (1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability
 (1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability
 (1 1 3) /Fitness for purpose/Essential attributes/Creativity
 (1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability
 (1 1 5) /Fitness for purpose/Essential attributes/Management knowledge
 (1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability
 (1 1 7) /Fitness for purpose/Essential attributes/Public speaking
 (1 1 8) /Fitness for purpose/Essential attributes/Written communication
 (1 1 9) /Fitness for purpose/Essential attributes/Information technology skills.
 (1 1 10) /Fitness for purpose/Essential attributes/Personal attributes
 (1 1 11) /Fitness for purpose/Essential attributes/Time management
 (1 1 12) /Fitness for purpose/Essential attributes/Information research
 (1 1 13) /Fitness for purpose/Essential attributes/Individual projects
 (1 1 30) /Fitness for purpose/Essential attributes/Individual flair
 (1 1 32) /Fitness for purpose/Essential attributes/Reasoning
 (1 2) /Fitness for purpose/Assessment
 (1 2 1) /Fitness for purpose/Assessment/Internal examinations
 (1 2 1 1) /Fitness for purpose/Assessment/Internal examinations/Final year Christmas
 (1 2 1 2) /Fitness for purpose/Assessment/Internal examinations/Computer based exams
 (1 2 2) /Fitness for purpose/Assessment/External examinations
 (1 2 3) /Fitness for purpose/Assessment/Continuous Assessment
 (1 2 3 1) /Fitness for purpose/Assessment/Continuous Assessment/Intellectual challenge
 (1 2 3 2) /Fitness for purpose/Assessment/Continuous Assessment/Feedback
 (1 2 4) /Fitness for purpose/Assessment/Laboratory work

(1 2 5)	/Fitness for purpose/Assessment/Open book examinations
(1 2 6)	/Fitness for purpose/Assessment/Student attendance
(1 2 6 1)	/Fitness for purpose/Assessment/Student attendance/Student lateness
(1 3)	/Fitness for purpose/Industry links
(1 3 1)	/Fitness for purpose/Industry links/Industry cooperative scheme
(1 3 2)	/Fitness for purpose/Industry links/Industry based projects
(1 3 3)	/Fitness for purpose/Industry links/Industry visits
(1 3 4)	/Fitness for purpose/Industry links/Job
(1 3 5)	/Fitness for purpose/Industry links/Industrial Experience
(1 3 6)	/Fitness for purpose/Industry links/Industrial advisory committee
(1 3 7)	/Fitness for purpose/Industry links/Industrialist support
(1 4)	/Fitness for purpose/Teaching
(1 4 1)	/Fitness for purpose/Teaching/Small group tutorials
(1 4 2)	/Fitness for purpose/Teaching/CAL
(1 4 3)	/Fitness for purpose/Teaching/Practical approach
(1 4 4)	/Fitness for purpose/Teaching/Modules
(1 4 5)	/Fitness for purpose/Teaching/Staff experience
(1 4 6)	/Fitness for purpose/Teaching/Learning skills
(1 4 7)	/Fitness for purpose/Teaching/Learning resources
(1 4 8)	/Fitness for purpose/Teaching/Student support and guidance
(1 4 9)	/Fitness for purpose/Teaching/Lectures
(1 4 10)	/Fitness for purpose/Teaching/Class size
(1 4 11)	/Fitness for purpose/Teaching/mechanical applications
(1 4 18)	/Fitness for purpose/Teaching/Discipline
(1 4 19)	/Fitness for purpose/Teaching/Techniques
(1 4 28)	/Fitness for purpose/Teaching/Academic
(1 5)	/Fitness for purpose/Subjects
(1 5 1)	/Fitness for purpose/Subjects/control
(1 5 2)	/Fitness for purpose/Subjects/Mechanics of Materials
(1 5 3)	/Fitness for purpose/Subjects/options
(1 5 4)	/Fitness for purpose/Subjects/chemical and process
(1 5 5)	/Fitness for purpose/Subjects/Electro-pneumatics
(1 5 6)	/Fitness for purpose/Subjects/Management
(1 5 7)	/Fitness for purpose/Subjects/Thermodynamics-fluid mechanics
(1 5 8)	/Fitness for purpose/Subjects/Process Subjects
(1 5 9)	/Fitness for purpose/Subjects/statistics
(1 5 10)	/Fitness for purpose/Subjects/welding
(1 5 11)	/Fitness for purpose/Subjects/Project supervision
(1 5 12)	/Fitness for purpose/Subjects/Computers
(1 5 13)	/Fitness for purpose/Subjects/Electronics
(1 5 14)	/Fitness for purpose/Subjects/Aerospace
(1 5 15)	/Fitness for purpose/Subjects/Design
(1 5 16)	/Fitness for purpose/Subjects/safety
(1 5 17)	/Fitness for purpose/Subjects/Electrical Engineering
(1 5 18)	/Fitness for purpose/Subjects/construction
(1 5 19)	/Fitness for purpose/Subjects/CAD
(1 5 20)	/Fitness for purpose/Subjects/project management
(1 5 21)	/Fitness for purpose/Subjects/chemistry
(1 5 22)	/Fitness for purpose/Subjects/Mechanics
(1 5 23)	/Fitness for purpose/Subjects/Language
(1 5 25)	/Fitness for purpose/Subjects/Physics
(1 5 29)	/Fitness for purpose/Subjects/Manufacturing
(1 6)	/Fitness for purpose/Course
(1 6 1)	/Fitness for purpose/Course/Up to date
(1 6 2)	/Fitness for purpose/Course/Open days
(1 6 3)	/Fitness for purpose/Course/Completion rates
(1 6 16)	/Fitness for purpose/Course/Expectations
(1 6 20)	/Fitness for purpose/Course/Enjoyable
(1 6 21)	/Fitness for purpose/Course/Course length
(1 6 24)	/Fitness for purpose/Course/Course difficulty
(1 6 26)	/Fitness for purpose/Course/Good course
(1 6 27)	/Fitness for purpose/Course/Excessive material
(1 6 31)	/Fitness for purpose/Course/Alternative course
(1 7)	/Fitness for purpose/Staff training and development
(1 7 1)	/Fitness for purpose/Staff training and development/Conferences
(1 8)	/Fitness for purpose/Accommodation and equipment
(1 9)	/Fitness for purpose/Library

- (2) /Standard of excellence
- (2 1) /Standard of excellence/Humboldt principle
- (2 2) /Standard of excellence/Consultancy
- (2 3) /Standard of excellence/Research
- (2 3 1) /Standard of excellence/Research/CIT Research Charter
- (2 4) /Standard of excellence/Professional bodies
- (2 5) /Standard of excellence/Employers
- (2 6) /Standard of excellence/Mission statement
- (2 7) /Standard of excellence/Aims and objectives
- (2 8) /Standard of excellence/Local and regional needs
- (2 9) /Standard of excellence/National and international needs
- (2 10) /Standard of excellence/Quality assurance
- (2 11) /Standard of excellence/External examiners
- (2 12) /Standard of excellence/Student representation

Q.S.R. NUD*IST Power version, revision 4.0.

Licensee: Francis Spenser Murphy.

PROJECT: **QMt3 Project**, User Francis Spenser Murphy, 3:22 pm, Jan 27, 2004.

- (1) /Fitness for purpose
- (1 1) /Fitness for purpose/Essential attributes
- (1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability
- (1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability
- (1 1 3) /Fitness for purpose/Essential attributes/Creativity
- (1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability
- (1 1 5) /Fitness for purpose/Essential attributes/Management knowledge
- (1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability
- (1 1 7) /Fitness for purpose/Essential attributes/Public speaking
- (1 1 8) /Fitness for purpose/Essential attributes/Written communication
- (1 1 9) /Fitness for purpose/Essential attributes/Information technology skills
- (1 1 10) /Fitness for purpose/Essential attributes/Personal attributes
- (1 1 11) /Fitness for purpose/Essential attributes/Time management
- (1 1 12) /Fitness for purpose/Essential attributes/Information research
- (1 1 13) /Fitness for purpose/Essential attributes/Individual projects
- (1 1 30) /Fitness for purpose/Essential attributes/Individual flair
- (1 1 32) /Fitness for purpose/Essential attributes/Reasoning
- (1 2) /Fitness for purpose/Assessment
- (1 2 1) /Fitness for purpose/Assessment/Internal examinations
- (1 2 1 1) /Fitness for purpose/Assessment/Internal examinations/Final year Christmas
- (1 2 1 2) /Fitness for purpose/Assessment/Internal examinations/Computer based exams
- (1 2 2) /Fitness for purpose/Assessment/External examinations
- (1 2 3) /Fitness for purpose/Assessment/Continuous Assessment
- (1 2 3 1) /Fitness for purpose/Assessment/Continuous Assessment/Intellectual challenge
- (1 2 3 2) /Fitness for purpose/Assessment/Continuous Assessment/Feedback
- (1 2 4) /Fitness for purpose/Assessment/Laboratory work
- (1 2 5) /Fitness for purpose/Assessment/Open book examinations
- (1 2 6) /Fitness for purpose/Assessment/Student attendance
- (1 2 6 1) /Fitness for purpose/Assessment/Student attendance/Student lateness
- (1 2 7) /Fitness for purpose/Assessment/Semesterisation
- (1 3) /Fitness for purpose/Industry links
- (1 3 1) /Fitness for purpose/Industry links/Industry cooperative scheme
- (1 3 2) /Fitness for purpose/Industry links/Industry based projects
- (1 3 3) /Fitness for purpose/Industry links/Industry visits
- (1 3 4) /Fitness for purpose/Industry links/Job
- (1 3 5) /Fitness for purpose/Industry links/Industrial Experience
- (1 3 6) /Fitness for purpose/Industry links/Industrial advisory committee
- (1 3 7) /Fitness for purpose/Industry links/Industrialist support
- (1 3 8) /Fitness for purpose/Industry links/experience abroad
- (1 3 9) /Fitness for purpose/Industry links/Industrial relevance
- (1 4) /Fitness for purpose/Teaching
- (1 4 1) /Fitness for purpose/Teaching/Small group tutorials
- (1 4 2) /Fitness for purpose/Teaching/CAL
- (1 4 3) /Fitness for purpose/Teaching/Practical approach
- (1 4 4) /Fitness for purpose/Teaching/Modules
- (1 4 5) /Fitness for purpose/Teaching/Staff experience
- (1 4 6) /Fitness for purpose/Teaching/Learning skills

(1 4 7) /Fitness for purpose/Teaching/Learning resources
 (1 4 8) /Fitness for purpose/Teaching/Student support and guidance
 (1 4 9) /Fitness for purpose/Teaching/Lectures
 (1 4 10) /Fitness for purpose/Teaching/Class size
 (1 4 11) /Fitness for purpose/Teaching/mechanical applications
 (1 4 18) /Fitness for purpose/Teaching/Discipline
 (1 4 19) /Fitness for purpose/Teaching/Techniques
 (1 4 28) /Fitness for purpose/Teaching/Academic
 (1 5) /Fitness for purpose/Subjects
 (1 5 1) /Fitness for purpose/Subjects/Control
 (1 5 2) /Fitness for purpose/Subjects/Mechanics of Materials
 (1 5 3) /Fitness for purpose/Subjects/Options
 (1 5 4) /Fitness for purpose/Subjects/Chemical and process
 (1 5 5) /Fitness for purpose/Subjects/Electro-pneumatics
 (1 5 6) /Fitness for purpose/Subjects/Management
 (1 5 7) /Fitness for purpose/Subjects/Thermodynamics-fluid mechanics
 (1 5 8) /Fitness for purpose/Subjects/Process Subjects
 (1 5 9) /Fitness for purpose/Subjects/Statistics
 (1 5 10) /Fitness for purpose/Subjects/Welding
 (1 5 11) /Fitness for purpose/Subjects/Project supervision
 (1 5 12) /Fitness for purpose/Subjects/Computers
 (1 5 13) /Fitness for purpose/Subjects/Electronics
 (1 5 14) /Fitness for purpose/Subjects/Aerospace
 (1 5 15) /Fitness for purpose/Subjects/Design
 (1 5 16) /Fitness for purpose/Subjects/Safety
 (1 5 17) /Fitness for purpose/Subjects/Electrical Engineering
 (1 5 18) /Fitness for purpose/Subjects/Construction
 (1 5 19) /Fitness for purpose/Subjects/CAD
 (1 5 20) /Fitness for purpose/Subjects/Project management
 (1 5 21) /Fitness for purpose/Subjects/Chemistry
 (1 5 22) /Fitness for purpose/Subjects/Mechanics
 (1 5 23) /Fitness for purpose/Subjects/Language
 (1 5 24) /Fitness for purpose/Subjects/Properties of materials
 (1 5 25) /Fitness for purpose/Subjects/Physics
 (1 5 26) /Fitness for purpose/Subjects/Operational research
 (1 5 27) /Fitness for purpose/Subjects/Mechanics of Machines
 (1 5 28) /Fitness for purpose/Subjects/Bio technology
 (1 5 29) /Fitness for purpose/Subjects/Manufacturing
 (1 5 30) /Fitness for purpose/Subjects/HVAC
 (1 5 31) /Fitness for purpose/Subjects/Validation
 (1 5 32) /Fitness for purpose/Subjects/Project Engineering
 (1 6) /Fitness for purpose/Course
 (1 6 1) /Fitness for purpose/Course/Up to date
 (1 6 2) /Fitness for purpose/Course/Open days
 (1 6 3) /Fitness for purpose/Course/Completion rates
 (1 6 16) /Fitness for purpose/Course/Expectations
 (1 6 20) /Fitness for purpose/Course/Enjoyable
 (1 6 21) /Fitness for purpose/Course/Course length
 (1 6 24) /Fitness for purpose/Course/Course difficulty
 (1 6 26) /Fitness for purpose/Course/Good course
 (1 6 27) /Fitness for purpose/Course/Excessive material
 (1 6 31) /Fitness for purpose/Course/Alternative course
 (1 7) /Fitness for purpose/Staff training and development
 (1 7 1) /Fitness for purpose/Staff training and development/Conferences
 (1 8) /Fitness for purpose/Accommodation and equipment
 (1 9) /Fitness for purpose/Library
 (2) /Standard of excellence
 (2 1) /Standard of excellence/Humboldt principle
 (2 2) /Standard of excellence/Consultancy
 (2 3) /Standard of excellence/Research
 (2 3 1) /Standard of excellence/Research/CIT Research Charter
 (2 4) /Standard of excellence/Professional bodies
 (2 5) /Standard of excellence/Employers
 (2 6) /Standard of excellence/Mission statement
 (2 7) /Standard of excellence/Aims and objectives
 (2 8) /Standard of excellence/Local and regional needs
 (2 9) /Standard of excellence/National and international needs

- (2 10) /Standard of excellence/Quality assurance
- (2 11) /Standard of excellence/External examiners
- (2 12) /Standard of excellence/Student representation
- (2 13) /Standard of excellence/Course strategy

Q.S.R. NUD*IST Power version, revision 4.0.

Licensee: Francis Spenser Murphy.

PROJECT: **QM4 Project** , User Francis Spenser Murphy, 1:15 pm, July 17, 2004.

- (1) /Fitness for purpose
- (1 1) /Fitness for purpose/Essential attributes
- (1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability
- (1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability
- (1 1 3) /Fitness for purpose/Essential attributes/Creativity
- (1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability
- (1 1 5) /Fitness for purpose/Essential attributes/Management knowledge
- (1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability
- (1 1 7) /Fitness for purpose/Essential attributes/Public speaking
- (1 1 8) /Fitness for purpose/Essential attributes/Written communication
- (1 1 9) /Fitness for purpose/Essential attributes/Information technology skills.
- (1 1 10) /Fitness for purpose/Essential attributes/Personal attributes
- (1 1 11) /Fitness for purpose/Essential attributes/Time management
- (1 1 12) /Fitness for purpose/Essential attributes/Information research
- (1 1 13) /Fitness for purpose/Essential attributes/Individual projects
- (1 1 14) /Fitness for purpose/Essential attributes/Critical evaluation
- (1 1 30) /Fitness for purpose/Essential attributes/Individual flair
- (1 1 32) /Fitness for purpose/Essential attributes/Reasoning
- (1 2) /Fitness for purpose/Assessment
- (1 2 1) /Fitness for purpose/Assessment/Internal examinations
- (1 2 1 1) /Fitness for purpose/Assessment/Internal examinations/Final year Christmas
- (1 2 1 2) /Fitness for purpose/Assessment/Internal examinations/Computer based exams
- (1 2 2) /Fitness for purpose/Assessment/External examinations
- (1 2 3) /Fitness for purpose/Assessment/Continuous Assessment
- (1 2 3 1) /Fitness for purpose/Assessment/Continuous Assessment/Intellectual challenge
- (1 2 3 2) /Fitness for purpose/Assessment/Continuous Assessment/Feedback
- (1 2 4) /Fitness for purpose/Assessment/Laboratory work
- (1 2 5) /Fitness for purpose/Assessment/Open book examinations
- (1 2 6) /Fitness for purpose/Assessment/Student attendance
- (1 2 6 1) /Fitness for purpose/Assessment/Student attendance/Student lateness
- (1 2 7) /Fitness for purpose/Assessment/Semesterisation
- (1 3) /Fitness for purpose/Industry links
- (1 3 1) /Fitness for purpose/Industry links/Industry cooperative scheme
- (1 3 2) /Fitness for purpose/Industry links/Industry based projects
- (1 3 3) /Fitness for purpose/Industry links/Industry visits
- (1 3 4) /Fitness for purpose/Industry links/Job
- (1 3 5) /Fitness for purpose/Industry links/Industrial Experience
- (1 3 6) /Fitness for purpose/Industry links/Industrial advisory committee
- (1 3 7) /Fitness for purpose/Industry links/Industrialist support
- (1 3 8) /Fitness for purpose/Industry links/experience abroad
- (1 3 9) /Fitness for purpose/Industry links/Industrial relevance
- (1 4) /Fitness for purpose/Teaching
- (1 4 1) /Fitness for purpose/Teaching/Small group tutorials
- (1 4 2) /Fitness for purpose/Teaching/CAL
- (1 4 3) /Fitness for purpose/Teaching/Practical approach
- (1 4 4) /Fitness for purpose/Teaching/Modules
- (1 4 5) /Fitness for purpose/Teaching/Staff experience
- (1 4 6) /Fitness for purpose/Teaching/Learning skills
- (1 4 7) /Fitness for purpose/Teaching/Learning resources
- (1 4 8) /Fitness for purpose/Teaching/Student support and guidance
- (1 4 9) /Fitness for purpose/Teaching/Lectures
- (1 4 10) /Fitness for purpose/Teaching/Class size
- (1 4 11) /Fitness for purpose/Teaching/mechanical applications
- (1 4 18) /Fitness for purpose/Teaching/Discipline
- (1 4 19) /Fitness for purpose/Teaching/Techniques
- (1 4 28) /Fitness for purpose/Teaching/Academic

(1 5) /Fitness for purpose/Subjects
 (1 5 1) /Fitness for purpose/Subjects/Control
 (1 5 2) /Fitness for purpose/Subjects/Mechanics of Materials
 (1 5 3) /Fitness for purpose/Subjects/Options
 (1 5 4) /Fitness for purpose/Subjects/Chemical and process
 (1 5 5) /Fitness for purpose/Subjects/Electro-pneumatics
 (1 5 6) /Fitness for purpose/Subjects/Management
 (1 5 7) /Fitness for purpose/Subjects/Thermodynamics-fluid mechanics
 (1 5 8) /Fitness for purpose/Subjects/Process Subjects
 (1 5 9) /Fitness for purpose/Subjects/Statistics
 (1 5 10) /Fitness for purpose/Subjects/Welding
 (1 5 11) /Fitness for purpose/Subjects/Project supervision
 (1 5 12) /Fitness for purpose/Subjects/Computers
 (1 5 13) /Fitness for purpose/Subjects/Electronics
 (1 5 14) /Fitness for purpose/Subjects/Aerospace
 (1 5 15) /Fitness for purpose/Subjects/Design
 (1 5 16) /Fitness for purpose/Subjects/surveying
 (1 5 17) /Fitness for purpose/Subjects/Electrical Engineering
 (1 5 18) /Fitness for purpose/Subjects/construction
 (1 5 19) /Fitness for purpose/Subjects/CAD
 (1 5 20) /Fitness for purpose/Subjects/Project management
 (1 5 21) /Fitness for purpose/Subjects/Chemistry
 (1 5 22) /Fitness for purpose/Subjects/Mechanics
 (1 5 23) /Fitness for purpose/Subjects/Language
 (1 5 24) /Fitness for purpose/Subjects/Properties of materials
 (1 5 25) /Fitness for purpose/Subjects/Physics
 (1 5 26) /Fitness for purpose/Subjects/Operational research
 (1 5 27) /Fitness for purpose/Subjects/Mechanics of Machines
 (1 5 28) /Fitness for purpose/Subjects/Bio technology
 (1 5 29) /Fitness for purpose/Subjects/Manufacturing
 (1 5 30) /Fitness for purpose/Subjects/HVAC
 (1 5 31) /Fitness for purpose/Subjects/Validation
 (1 5 32) /Fitness for purpose/Subjects/Project Engineering
 (1 5 33) /Fitness for purpose/Subjects/building services engineering
 (1 6) /Fitness for purpose/Course
 (1 6 1) /Fitness for purpose/Course/Up to date
 (1 6 2) /Fitness for purpose/Course/Open days
 (1 6 3) /Fitness for purpose/Course/Completion rates
 (1 6 4) /Fitness for purpose/Course/Course promotion
 (1 6 16) /Fitness for purpose/Course/Expectations
 (1 6 20) /Fitness for purpose/Course/Enjoyable
 (1 6 21) /Fitness for purpose/Course/Course length
 (1 6 24) /Fitness for purpose/Course/Course difficulty
 (1 6 26) /Fitness for purpose/Course/Good course
 (1 6 27) /Fitness for purpose/Course/Excessive material
 (1 6 31) /Fitness for purpose/Course/Alternative course
 (1 7) /Fitness for purpose/Staff training and development
 (1 7 1) /Fitness for purpose/Staff training and development/Conferences
 (1 8) /Fitness for purpose/Accommodation and equipment
 (1 9) /Fitness for purpose/Library
 (2) /Standard of excellence
 (2 1) /Standard of excellence/Humboldt principle
 (2 2) /Standard of excellence/Consultancy
 (2 3) /Standard of excellence/Research
 (2 3 1) /Standard of excellence/Research/CIT Research Charter
 (2 4) /Standard of excellence/Professional bodies
 (2 5) /Standard of excellence/Employers
 (2 6) /Standard of excellence/Mission statement
 (2 7) /Standard of excellence/Aims and objectives
 (2 8) /Standard of excellence/Local and regional needs
 (2 9) /Standard of excellence/National and international needs
 (2 10) /Standard of excellence/Quality assurance
 (2 11) /Standard of excellence/External examiners
 (2 12) /Standard of excellence/Student representation
 (2 13) /Standard of excellence/Course strategy
 (2 16) /Standard of excellence/Safety

APPENDIX 5: Interview transcript

Past graduate student: interview number 5.

Current Occupation: Associate Director - Senior Project Manager

Year Graduated: 1989.

An interview took place with a past graduate student on 11th August 2003, at Project Management (PM), LoughMahan Technology Park, Blackrock, Cork. The interview was open, loosely based on the following questions.

1. How did you find the BEng/BTech course in mechanical engineering?

The course was technically oriented. It was light on the management side. Scheduling and Progress Monitoring is important for me these days.

The course in terms of deadlines was good, but the content was not really relevant to the job, which I am doing today. Very little was done on Bar charts and Scheduling. Critical Path Analysis (CPA) was done at a very high level. A lot of organisations have an experienced planner do CPA. It would have been better if CPA had been done more simply.

Of the technical content of the course, I would have used about 5% during my working life. However, at the same time, the course did give a very strong grounding in the fundamentals of mechanical engineering. The subject 'Mechanics of Materials' was relevant, particularly the work we did on beams. Also relevant was the work we did on pumps in the subject 'Mechanics of Fluids'. Subjects like 'Control' was of little relevance. The basics of the subject 'Mechanics of Machines' was useful, but not the heavier content of the subject.

People skills, such as approaching people, dealing with people, communication, body language, etc., all comes with practice.

The course could do more on problem solving. The methodology for solving problems in different projects is similar. The use of teamwork to solve problems could be shown.

In this current day and age, the course could do more to show the very basics on environmental health and safety. Two to three hours of lectures during the course could be done on 'environmental impact statements', 'integrated pollution control' (IPC), 'Safe pass card' and the need for a formal course from the industrial training authority (FAS), before working on a construction site.

The course could do more on: - 'Where to find information?' 'Design Standards', 'What standards to use?' 'How to go about finding and compiling these standards?' 'The use of Compass Directories to find out things like "Who makes bearings?" etc.'

The course could also do more on: - 'Budgets, money, costs,' 'How to do a budget for an upgrade of a plant, etc.?' 'Order of magnitude estimate', 'Contingency estimate' and 'Risk analysis'.

Engineers have to span all of this and it takes a certain amount of individual flair. I like it.

2. Was the course what you expected?

It was.

I was expecting the technical content.

3. Which subjects gave you the most problems? and 4. Any reasons for the difficulties?

I had to work hard at all of them. I had difficulties with the subjects 'control' and some of the 'Thermodynamics'. There was a high level of the analytical and the theoretical side of the topics, but I could see the practical side also.

The subject 'Statistics' I found hard, as it was too heavy.

The course was like being put into a pressure cooker. If you come out of the other side then you are prepared for the workplace. If you can handle this college course, then you can handle most things in life. It was a very good course. I found that I was way ahead of graduates from other colleges, when I went into the workplace.

5. Any educational factors or techniques that you consider could improve the course?

Tailoring the subject matter of the course to what is relevant to industry would be one factor.

Another important topic is 'Validation'. Students should know the basics of 'Validation' and what it is.

More analysis of case studies is another educational technique that could be used.

It may also be possible to bring in someone from industry who could talk to the students for an hour. This could be done for about 5 hours during each year of the course.

Site visits to industry or a factory could also be useful in showing the students working plant. This could be done frequently throughout the course.

Personal development is important, so frequent presentations and meetings should be the norm. It is very important for students to know how to prepare for presentations and meetings. Students should know that presentations should have, say, five important points. This will ensure that they come across well and that they get their point across. Communication is very important.

If I was able to understand the material as I was receiving the lecture, then I was OK after that. So that is what I did and it worked. I took the notes and went through them, breaking them down, about 6 weeks before the exam.

6. Any subjects that you think should be excluded from the course? and 7. Any subjects that you think should be included in the course?

The computer language FORTRAN is of no relevance. EXCEL and POWERPOINT are more useful. Students should know how to do 'macro programming' in EXCEL. 'Microsoft Scheduling' and how to do a simple bar chart is also very useful.

We just did a CAD introduction on the course. P&I.D. (process and instrumentation diagrams) should be covered. Also HVAC (heating, ventilating, air conditioning) should also be covered. Both of these topics are very important for the pharmaceutical industry, which is prominent in the Cork area.

8. Any other ways in which the course could be improved?

I think I have covered this already. The course needs to go lesser into some areas, so adjustments can be made.

9. Is there any attribute that you use in your work today, that may have been better developed by the course? Examples are 'teamwork', 'public speaking', 'personal attributes', 'self directed learning', 'management', etc.

I have mentioned some of these attributes already.

The use of IT and the skills necessary for these could be developed by the course. The use of common packages and the use of the Internet are very important.

A 'Project Engineering Course' could be added.

Developing in students the skills in the chairing of large meetings, such as progress review meetings, progress report meetings, where, by doing most of the talking, it is important to sell where you are at.

Passing on information through presentations, develops confidence in students. So the latest advances in a particular area could be presented to the rest of the class by one student. By answering questions this gives a forum to everyone for building confidence.

A student could also prepare and organise a presentation on how to do a particular job and could present different ways of doing the job. If one does not have the equipment what is the next best way to solve the problem? Should money be thrown at the problem or is some equivalent equipment on a shelf somewhere? These are examples of the way a student should be thinking. The student could suggest brainstorming with his colleagues.

Another type of problem is how to give a client what he wants for a lower price, without compromising on quality. 'Value Engineering' should be included on the course. If a student can rank the easy things to do, rate them, cost them and give the savings for each solution, then 50% of the project is done.

On the positive side, I found the course to be very strong. The good appreciation of the technical side of things, which I gained from the course, I have found to have been an asset in my working life.

RESPONDENT VALIDATION

Francis,
 Sorry for the delay in responding to you. The notes are basically fine. A few small comments Question 1 end 3rd Paragraph. What I wanted to say instead of safe pass was to be given an overview of Building Regulations Fire Certificates, Commencement notices etc. Again this is leaning towards the Construction industry. In the current climate we are seeing emergence of cleaner, secondary type pharmaceutical plants coming into Ireland instead of the pure bulk chemicals. We now have Weyth, Genzyme in Waterford, Amersham, Stryker. These facilities are what's called FIII Finish where the drug is mixed in its final dosage format either in vials or ampoules for injections. The machines that do this are quite complex. This is an area that will see a lot of growth in the years to come. Bio Technology is similar technology and processing is done aseptically or in a sterile atmosphere. These

facilities require a very high level of utilities Water For Injection, Clean Steam, Steam in Place and their HVAC requirements are very complex requiring Class 100 atmospheres which is no more than 100 particles more than 1 micron per m3 of air. This whole area could be looked at by the mech course for the future.

Regards, JJ

-----Original Message----->From: Francis Spenser Murphy

Sent: 14 August 2003 22:18

To: jj.ie Subject: CIT degree course - mechanical

JJ,

Attached is a copy of the transcript of our recent discussions concerning the Mech. Eng. degree course. It is written in word 6. If you wish to add or change anything, you might return the updated document to me. Many thanks for your help in this matter. I hope to do a lot more work on this, over the next 12 months and I am hoping that improvements to engineering education will result.

Regards,

Francis.

APPENDIX 6: Workplace observation transcript**Project Management Group**

Project Management is an international provider of professional services in project management, construction management, engineering design and consultancy. They have a large new modern office block on the eastern edge of Cork City. They undertake a lot of work for the Pharmaceutical industry, which is very prevalent in the Cork area. The working environment at the office is very clean and pleasant. Library facilities are available in the building.

APPENDIX 7:

ESSENTIAL ATTRIBUTES - report from QMt, QMt2 and QMt3.

Key to Workplace Observations

ON-LINE DOCUMENT: past grad. 2-2

Interview past grad. 2-2 was conducted at Bourns Electronics, Mahon Industrial Estate, Cork City, Ireland.

A quiet, red brick, manufacturing facility in a clean modern environment, Bourns Electronics produce components for: automotive, industrial, medical, computer and peripherals, audio visual, telecommunications, aerospace.

ON-LINE DOCUMENT: employer 2-1

Interview employer 2-1 was conducted at Fujisawa (Ireland) Ltd., Killorglin, County Kerry, Ireland.

Fujisawa is a very clean looking plant/working environment, just outside the town of Killorglin, Co. Kerry, Ireland. The Fujisawa plant stands next to Klinge, which is another plant manufacturing pharmaceuticals. In the Fujisawa plant, the manufacture and distribution worldwide of the immune suppressant drug 'Prograf' takes place. 'Prograf' is used in transplant operations.

ON-LINE DOCUMENT: past grad. 3-1

ON-LINE DOCUMENT: past grad. 3-2

Interviews past grad. 3-1 and past grad. 3-2 were conducted at Freefoam Plastics, Centre Park Road, Cork, Ireland.

Freefoam Plastics is a small manufacturing facility near the centre of Cork City. They produce fascia, soffit boards and the necessary fittings for roofing/rain water management. It appears to be a clean pleasant working environment.

ON-LINE DOCUMENT: past grad. 3-3

Interview past grad. 3-3 was conducted at Pfizer, Ringaskiddy, County Cork, Ireland.

Pfizer is a large modern pharmaceutical plant near the village of Ringaskiddy about 7 miles east from Cork City. They manufacture the drug 'Viagra'. A very clean modern working environment.

ON-LINE DOCUMENT: past grad. 3-4

Interview past grad. 3-4 was conducted at EMC, Ovens, County Cork, Ireland.

EMC is a modern medium sized manufacturing plant located 7 miles west of Cork City in the village of Ovens. They manufacture computer casings (information storage systems) for medium to large size organisations, such as banks, solicitors, etc. The working environment is very clean and pleasant.

ON-LINE DOCUMENT: past grad. 3-5

Interview past grad. 3-5 was conducted at Project Management (PM), Lough Mahon Technology Park, Blackrock, Cork, Ireland.

Project Management is an international provider of professional services in project management, construction management, engineering design and consultancy. They have a large modern office block on the eastern edge of Cork City. They undertake much work for the Pharmaceutical industry, which is very prevalent in the Cork area. The working environment at the office is very clean and pleasant. Library facilities are available in the building.

ON-LINE DOCUMENT: past grad. 3-6

Interview past grad. 3-6 was conducted at RPS-MCOS, Consulting Engineers, Innishmore, Ballincollig, County Cork, Ireland.

RPS-MCOS, Consulting Engineers, were formerly known as M. C. O'Sullivan, Consulting Engineers. They undertake strategic studies on national and regional infrastructure in the fields of water services, natural gas, transportation and waste management. The Cork offices indicate a clean, comfortable working environment for employees.

Q.S.R. NUD*IST Power version, revision 4.0. Licensee: Francis Spenser Murphy.

1. CREATIVITY - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 11:02 pm, Oct 16, 03.

(1 1 3) /Fitness for purpose/Essential attributes/Creativity

*** Definition: imagination and originality.

+++++

+++ ON-LINE DOCUMENT: 2. past graduate (male CIT postgraduate)

++ Text units 2-2:

Good course. Design in second and third year is improving with the introduction of topics, such as the "pro engineer" package. 2

+++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 14-14:

(d) Creativity and innovation: Yes. 14

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 13-13:

(d) Creativity and innovation: Yes:- in third year projects and some fourth year projects, this is included. 13

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 1

++ Units:3-3

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 3

++ Units:7-7

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:1-1 26-26

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:7-7

PROJECT: QMt2 Project,

(1 1 3) /Fitness for purpose/Essential attributes/Creativity

*** Definition: imagination and originality.

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 6-6:

Most of the time, I am looking for someone with initiative, who wants to try things, is willing and shows interest. 6

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 23-23:

No. I don't know of any degree course that could do that. I don't think any course sets out to do that. 23

PROJECT: QMt3 Project,

(1 1 3) /Fitness for purpose/Essential attributes/Creativityⁱ

*** Definition: imagination and originality.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 35-35:

There should also be more emphasis on coming up with ideas. 35*

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 20-20:

Design in third year was good and helped in this regard. So did the bridge design that we did in second year. First year workshop also helped with creativity. 20

+++++

2. INDIVIDUAL FLAIR - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 8:06 pm, Oct 19, 2003.

(1 1 30) /Fitness for purpose/Essential attributes/Individual flair

*** Definition: natural ability

+++++

+++ ON-LINE DOCUMENT: 9. employer (male telephone)

++ Text units 17-17:

There is an open plan system and there are weekly or bi-weekly engineering meetings. There is the danger that an over emphasis on teamwork can smother individual flair. Our main requirement is that graduates get on with people. 17

PROJECT: QMt3 Project,

(1 1 30) /Fitness for purpose/Essential attributes/Individual flair

*** Definition: natural ability.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 44-44:

There is for and against teamwork. I would rather do the project on my own.

44

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 12-12:

Engineers have to span all of this and it takes a certain amount of individual flair. I like it. 12

+++++

3. INDIVIDUAL PROJECTS - report QMt, QMt2 and QMt3**PROJECT: QMt Project,** User Francis S. Murphy, 7:59 pm, Oct 19, 2003.

(1 1 13) /Fitness for purpose/Essential attributes/Individual projects

*** Definition: independent of others

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:6-6

+++++4.

INFORMATION RESEARCH - report QMt, QMt2 and QMt3**PROJECT: QMt Project,** User Francis S. Murphy, 7:49 pm, Oct 19, 2003.

(1 1 12) /Fitness for purpose/Essential attributes/Information research

*** Definition: Generic investigative skills.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:6-6

PROJECT: QMt2 Project,

(1 1 12) /Fitness for purpose/Essential attributes/Information research

*** Definition: Generic investigative skills.

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 15-15:

It is important therefore to teach the basic skills on FAT (factory acceptance test). Adequate research needs to be done - look for a manual. Approach the problem with a proper check list. 15

+++++

5. INFORMATION TECHNOLOGY- report QMt, QMt2 and QMt3**PROJECT: QMt Project,** User Francis S. Murphy, 5:26 pm, Oct 19, 2003.

(1 1 9) /Fitness for purpose/Essential attributes/Information technology skills.

*** Definition: Computing and associated skills.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-6 9-9

PROJECT: QMt2 Project,

(1 1 9) /Fitness for purpose/Essential attributes/Information technology skills.

*** Definition: Computing and associated skills.

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 4-4:

There is a lot of work on the documentation side. I would be looking to see how good the graduate is at writing reports. Report writing must be good. We do a lot of documentation work, sometimes using software, on project management, operation qualification (OQ), installation qualification (IQ) and process validation. 4

PROJECT: QMt3 Project,(1 1 9) /Fitness for purpose/Essential attributes/Information technology skillsⁱⁱ.

*** Definition: Computing and associated skills.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-2 (male Freefoam)

++ Text units 33-33:

Information Technology (IT) skills are very important.

33

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 17-17:

The laboratory work and practical work was good. Report writing was a chore. **Nowadays it should be more multi-media. Students should E-mail the material to prepare them for the work scene. They could put results on EXCEL work sheets.** Only one or two students were well up on computing at that time.

+++++
+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 41-41:

The use of IT and the skills necessary for these could be developed by the course. **The use of common packages and the use of the internet are very important.** 41*

+++++

6. MANAGEMENT KNOWLEDGE - report QMt, QMt2 and QMt3

PROJECT: **QMt Project**, User Francis S. Murphy, 7:13 pm, Oct 18, 2003.

(1 1 5) /Fitness for purpose/Essential attributes/Management knowledge

*** Definition: organisation, managing, legislation, finance, information, quantitative methods.

+++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 16-16:

(f) Management/finance/legislation: Not sure. 16

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 4-4:

Very good as a broad manufacturing engineering degree. It is not a mechanical engineering degree, which should include more management studies and more theoretical work. Our BEng course is lacking in some of the non-technical subjects, i.e. Engineer in Society, History of Technology, Legal Aspects. As a broad degree, our course is very good. 4

++ Text units 14-15:

(e) Teamwork: Yes:- again in third year mini-projects and in laboratory work to some extent. 14

(f) Management/finance/legislation: Not sure. 15

+++++

+++ ON-LINE DOCUMENT: 9. employer (male telephone)

++ Text units 13-15:

With all the engineering degrees, management is poor. Many graduates have difficulty relating to operators on the factory floor. Human interaction can be a problem for some graduates. If possible, it would be useful if undergraduates could be enlightened as to how engineering fits in to the overall matrix of industry. The effect of unions on industry, for example, would be useful for undergraduates to study and appreciate. 13

Once graduates have been in the industry for a while, some enrol for an MBA. 14

Undergraduates should be sensitised to the manufacturing environment and realise that 60 to 70% of managing directors are engineers. Graduates from the business faculties, work for them. If this could be explained to engineering undergraduates at the start of their management course, it might make the subject more relevant to them. 15

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:10-11

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-5

PROJECT: **QMt2 Project**,

(1 1 5) /Fitness for purpose/Essential attributes/Management knowledgeⁱⁱⁱ

*** Definition: organisation, managing, legislation, finance, information, quantitative methods.

+++++

+++ ON-LINE DOCUMENT: 1. past grad. 2-1 (male lecturer CIT)

++ Text units 4-4:

My second job was in the area of process equipment. It involved Project Management. It concerned the start up of a pharmaceutical plant. We did not do any Project management at CIT. We did Business Management as opposed to Engineering Management. Being a junior engineer at the time of my second job, I sat in on project meetings and picked up the Project Management knowledge. Cost Management and Cost Control is equally as important. 4

++ Text units 26-26:

Project Management. 26

++ Text units 27-30:

A lot of people from different disciplines, such as chemical engineering, civil engineering, electrical engineering, mechanical engineering, etc., all trying to obtain the same goal and each putting forward their views, should be shown, if possible. **This could be done by splitting the class and each part of the class playing a different part in the team.** 27*

In industry, the deadline changes. For example, one company can make a half a million contact lenses per day, which could be worth £50,000. Hence, everyday cut from the schedule is worth £50,000 for the company. 28

A teaching methodology for showing this might be included in the course and would show that the biggest frustration in industry is the interaction with other groups. 29 30*

+++++

+++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 94-94:

A. Procedures for assembling scaffolding would be very useful. Also information and techniques concerning pricing is important. It would be useful if the course could cover things like:- 'How to deal with people in industry?', telephone talking techniques, etc. 94

++ Text units 119-119:

B. Learn about general financial controlling, for example with a view to employee/employer rights. 119

++ Text units 121-121:

A. Another topic would be financial quotes - 'How to deal with them?' This should be included in the course. 121

++ Text units 125-125:

A. Industrial politics:- fitters, electricians - 'Are they happy or unhappy?' 'How to deal with this?' This should be included in the course. 125

+++++

+++ ON-LINE DOCUMENT: 3. past grad. 2-2 (male Bourns)

++ Text units 25-26:

The subject 'Management' should be left out of the course. Management is just 'skimmed' on the course. It was taught in a very superficial way at that time. The course should cluster around a few core disciplines. 25

I learnt Management from external courses, subsequent to leaving CIT. 26

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 14-15:

They should become more and more involved in documentation concerning: Installation Qualification, Operation Qualification, Process Validation, User Requirement Specification (URS) and Factory Acceptance Test (FAT). There is a right and a wrong way - detailed check lists are necessary. 14

It is important therefore to teach the basic skills on FAT (factory acceptance test). Adequate research needs to be done - look for a manual. Approach the problem with a proper check list. 15

++ Text units 18-19:

They should know more about dealing with Trade Unions. The correct way of talking to Unions and negotiating with Unions. For example, it may be necessary to have someone alongside who can act as a witness. 18

Usually graduates are fairly good at finance. They need to be good with budgets, looking for hidden costs and tracking variations. 19

++ Text units 21-23:

With regard to legislation, the environmental side is important. It is important that graduates know when products have to be properly marked to comply with the law. On the building side the Planning and Development Act is important. Legislation regarding recycling is also important. 21

Again, on the finance side, it is important to be able to carry out analysis of tenders, together with the process of checking of prices, history, availability of spare parts and make the recommendations to senior management. 22

Health and safety legislation is very important including manual handling training, safety files and to know the person who has responsibility for safety. 23

++ Text units 26-26:

Younger people are usually better at this. Older people are usually fixed in their ways. We like new ideas and want people that are flexible. We try to avoid "We want to do it this way" approach. We try to 'marry' European Project Management skills into the Japanese way, so flexibility is very important. 26

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 27-27:

The course has enough there to do it. It is difficult to develop these attributes in young students, owing to their lack of experience. They sometimes cannot grasp the necessary concepts. 27

PROJECT: QM3 Project,

(1 1 5) /Fitness for purpose/Essential attributes/Management knowledge^{iv}

*** Definition: organisation, managing, legislation, finance, information, quantitative methods.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 27-27:

The safety regulations that we did as part of management was good. Also very useful were the management topics concerning the EMU and the single currency. 27

++ Text units 46-46:

Another attribute would relate to the real world, i.e. how to manage getting something done? More emphasis could be put on progress, costs, getting the project done. 46*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-2 (male Freefoam)

++ Text units 34-34:

The application of 'Project Management' to practical situations should also be given more attention, possibly with the use of 'Microsoft Project' software. I did a two year Diploma in this topic at the University of Limerick after the CIT degree course. The 'Project Management' at CIT was limited. We should have done more on the process for arriving at the 'critical path'. This is a very important topic, because most engineers are involved in projects and there are implications for people, information, hardware, etc. **'Project Management' was done at the end of third year. It should be done in first year.**

34*

++ Text units 41-42:

Management skills are important. Project management, supervisory skills, chairing a meeting, report writing, etc. are all important. Not enough guidance was given on report writing. The ability to communicate professionally is very important. 41

More attention should be given to 'How to work as a professional?' Subjects such as 'Business Organisation' are very important in the real world, as one is not 'cocooned' in the real world. So topics concerning cheques, purchase orders, invoices, filing, etc. should all be given sufficient attention during the course. 42

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 11-11:

I found the mathematical based subjects less hard than the others. The Business type subjects were harder. Properties of Materials was also harder, because it relies on pure memory. 11

++ Text units 27-27:

An introduction to this industry and also other large employment areas like **project management should be included in the first or second year. This could be assisted by graduates.**

+++++

+++ ON-LINE DOCUMENT: past grad. 3-4 (male EMC)

++ Text units 36-36:

It might be possible to 'roll in' the softer stuff, like presentation skills, with the management subjects. 36

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

The course was technically oriented. It was light on the management side. Scheduling and Progress Monitoring is important for me these days. 3

The course in terms of deadlines was good, but the content was not really relevant to the job which I am doing today. Very little was done on Bar charts and Scheduling. Critical Path Analysis (CPA) was done at a very high level. A lot of organisations have an experienced planner do CPA. It would have been better if CPA had been done more simply. 4

++ Text units 11-11:

The course could also do more on:- 'Budgets, money, costs,' 'How to do a budget for an upgrade of a plant, etc.?', 'Order of magnitude estimate', 'Contingency estimate' and 'Risk analysis'. 11

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 27-27:

Engineering management accountancy - introduction to accounts (profit and loss), invoices, preparation of bills, orders, etc. 27

++ Text units 29-29:

Module on evaluation of whole life cost analysis; including: - maintenance costs, power consumption costs, labour costs, material costs, etc. 29*

++ Text units 31-31:

Modules on Project Management, people management (Dealing with people and getting work done by them, etc.), practical tips on how to get on in the workplace (such as 'look for the experienced person and get to know them', etc.) would also be useful. 31*

++ Text units 38-38:

The course is comprehensive, but the addition of basic engineering management accountancy would add excellent value. 38

++ Text units 55-55:

I mentioned teamwork previously in the form of how to manage the workload of three people. The course should try and provide more practical management. The University of Limerick offer a degree in project management. I would like to see more of the 'management of people and getting the best out of them', included in the course. So what I am talking about is managing a job and getting people to do different elements of the job, programming the job, linking the job together and reviewing the job. 55

++ Text units 57-57:

An introduction to Contract law and procurement could also be an additional subject. These could give an introduction into IEl, IMechE and FIDIC (International Federation of Consulting Engineers) type procurement contracts. 57

++ Text units 59-59:

The Safety, Health and Welfare at Work Act, including the role of the engineer in the design of mechanical elements of a project, should be covered by the course. This should be done both from the construction point of view (HAZCON - hazards in construction) and the operation point of view (HAZOP - hazards and operability), with the relevant risk analysis. 59

++ Text units 63-63:

Again the practical management side would be useful - deliverables, time frames, breach of contract, contractor responsibilities, etc. 63

+++++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 24-24:

We do not really need that. 24

+++++ ON-LINE DOCUMENT: 4. present student (male CIT)

7. MATHEMATICAL ABILITY- report QMt, QMt2 and QMt3

PROJECT: **QMt Project**, User Francis S. Murphy, 7:48 pm, Oct 16, 2003.

(1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability

*** Definition: mathematical skills.

+++++ ON-LINE DOCUMENT: 4. present student (male CIT)

++ Text units 5-5:

Some subjects of limited relevance, i.e. Computers, Mathematics, Electronics. There should be more information given on such items as programmable logic controllers (PLCs), which are used in industry. 5

++ Text units 11-11:

Mathematics. 11

++ Text units 17-17:

Mathematics all the way from first to third year is too much. 17

+++++ ON-LINE DOCUMENT: 5. non-completing (male telephone)

++ Text units 13-13:

I am more mathematically minded. 13

+++++ ON-LINE DOCUMENT: 6. non-completing (male telephone)

++ Text units 11-11:

Physics and mathematics were not too bad. 11

++ Text units 13-13:

I don't know. I just did not like them. 13

+++++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 13-13:

(c) Mathematics to a sufficiently high level: Yes. 13

+++++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 12-12:

(c) Mathematics to a sufficiently high level: Yes. 12

+++++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:4-5

PROJECT: **QMt2 Project**,

(1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability^v

*** Definition: mathematical skills.

+++++ ON-LINE DOCUMENT: 1. past grad. 2-1 (male lecturer CIT)

++ Text units 11-11:

Mathematics and Statistics. There was no practical application of Mathematics given to us. The calculus part of Mathematics was difficult. 11

+++++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 12-12:

A. I expected the subjects:- mechanics, thermodynamics, mathematics. I did not expect manufacturing. The course was much more general than I thought it would be. 12

++ Text units 35-35:

A. Statistics in third year is also difficult. **We should do more examples in statistics.** We have to research statistics on our own. 35*

++ Text units 116-116:

A. **Tutorials would be a good idea.** If we got stuck for example in mathematics, we could get help. I think there would be good numbers of students attending tutorials. 116*

+++++ ON-LINE DOCUMENT: 3. past grad. 2-2 (male Bourns)

++ Text units 8-9:

I expected a more practical slant - 'worked examples' from industry. 8*

This was particularly the case with maths. We did 'Pure Mathematics'. There was not enough practical integration into engineering. Maths was very tough. Things like 'Bessel functions' and Chebychev functions were applicable to 'filter circuits' in electronic Engineering and not to Mechanical Engineering. They were too abstract. 9

++ Text units 14-14:

Mathematics and Control. They were so abstract. 14

++ Text units 34-35:

Practical examples from industry.

34*

Integration of maths into actual Mechanical Engineering subjects, e.g. vibrations, etc.

35

++ Text units 38-38:

Yes, those first two examples that you give are good ones. This is a leading question, I couldn't argue with the first two suggestions. I don't see the need for more maths, just the right maths. 38

+++++

+++ ON-LINE DOCUMENT: 5. non-comp. 2-1 (male telephone)

++ Text units 4-7:

I was working for a year and a half prior to the course. 4

The course did not suit me. It was a tough course. 5

I had not done enough maths. 6

I had previously done architecture. 7

++ Text units 10-14:

Yes. 10

There was a high proportion of maths. 11

The practical side was interesting.

12*

It was very theory based. 13 14

++ Text units 16-19:

Chemistry. 16

Maths was not too bad. 17

Physics was O.K. 18

I got used to the thermodynamics. It took me the year to get the hang of it. 19

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 21-21:

Yes. 21

PROJECT: QMt3 Project,

(1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability

*** Definition: mathematical skills.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 11-11:

I found the mathematical based subjects less hard than the others. The Business type subjects were harder.

Properties of Materials was also harder, because it relies on pure memory. 11

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 18-18:

Yes. 18

+++++

8. PERSONAL ATTRIBUTES - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 5:40 pm, Oct 19, 2003.

(1 1 10) /Fitness for purpose/Essential attributes/Personal attributes

*** Definition: Confidence, responsibility.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-5

PROJECT: QMt2 Project,

(1 1 10) /Fitness for purpose/Essential attributes/Personal attributes^{vi}

*** Definition: Confidence, responsibility.

+++++

+++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 94-94:

A. Procedures for assembling scaffolding would be very useful. Also information and techniques concerning pricing is important. It would be useful if the course could cover things like:- 'How to deal with people in industry?', telephone talking techniques, etc. 94

++ Text units 96-96:

B. Yes. 'How to deal with people in industry?' like fitters, electricians, etc., - **this can be achieved through work placement** and workshop theory. An awareness of safety issues, which were previously discussed, such as:- fire drills, awareness of the nearest fire extinguisher, etc. There is a need for basic communication skills.

++ Text units 117-117:

Another subject for inclusion in the course would be 'How to deal with people?'. 117

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 10-11:

Some graduates are nervous when dealing with companies over the telephone. 10

Chairing of meetings is also important. Some graduates will make the mistake of going into a meeting without an agenda. 11

++ Text units 18-18:

They should know more about dealing with Trade Unions. The correct way of talking to Unions and negotiating with Unions. For example, it may be necessary to have someone alongside who can act as a witness. 18

++ Text units 20-20:

Sometimes graduates have to carry out technician appraisal and discuss with them how well they are doing at their work. It is important that they do this without demotivating the technician. 20

PROJECT: QMt3 Project,

(1 1 10) /Fitness for purpose/Essential attributes/Personal attributes^{vii}

*** Definition: Confidence, responsibility.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-2 (male Freefoam)

++ Text units 41-41:

Management skills are important. Project management, supervisory skills, chairing a meeting, report writing, etc. are all important. Not enough guidance was given on report writing. **The ability to communicate professionally is very important.** 41*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 34-34:

We do a personal development course at Pfizer. A one or two day course, if given by the right people, can be good, particularly if delivered in the right way. **Someone from the Irish Management Institute (IMI) might be suitable to do this.** 34*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-4 (male EMC)

++ Text units 24-24:

Both the industrial experience and presentation/exhibition skills, gives them a subtle difference when they go for a job interview. This subtle difference is the gap between the confident, prepared graduate and the standard graduate. **Interviewing over the years, shows me that as early as possible, students need to get their 'foot in the door' when it comes to obtaining industrial experience.** 24*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 6-6:

People skills, such as approaching people, dealing with people, communication, body language, etc., all comes with practice. 6

++ Text units 29-29:

Personal development is important, so frequent presentations and meetings should be the norm. It is very important for students to know how to prepare for presentations and meetings. Students should know that presentations should have, say, five important points. This will ensure that they come across well and that they get their point across. Communication is very important. 29

++ Text units 43-44:

Developing in students the skills in the chairing of large meetings, such as progress review meetings, progress report meetings, where, by doing most of the talking, it is important to sell where you are at.

Passing on information through presentations, develops confidence in students. **So the latest advances in a particular area could be presented to the rest of the class by one student. By answering questions this gives a forum to everyone for building confidence.** 44*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 53-53:

At RPS-MCOS, CPD (Continuing Professional Development) is encouraged and all staff can avail of the opportunities to develop personally. There are many courses available at CIT, but few are accredited. This should be rectified. 53

+++++

9. PROBLEM SOLVING - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 10:14 pm, Oct 15, 03.

(1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability

*** Definition: resolution skills.

+++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 11-11:

(a) Problem Solving: Yes. 11

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 10-10:

(a) Problem Solving: I would give the course 6 out of 10 for this. The third year mini-projects are addressing the problem. This should be carried on from first year. Conceptual design is problem solving; specifying a gearbox is not. Also, conceptual design is done in third year design. 10

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 3

++ Units:7-7

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:11-11 26-26

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:6-7

PROJECT: QMt2 Project,

(1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability^{viii}

*** Definition: resolution skills.

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 17-17:

Just about 17

++ Text units 42-45:

Reduce lecturing. 42

Introduce more self directed learning. 43

Hand students a lot more problems to solve themselves. **However, this would cost more, as it would require smaller tutorial groups.** Thus it would take more resources. 44 45*

PROJECT: QMt3 Project,

(1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability^{ix}

*** Definition: resolution skills.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 10-10:

Mechanics of materials. The theory and derivations were heavy. They were not really problem solving. 10

++ Text units 34-34:

There is not enough problem solving in the DME course. 34*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 7-7:

The course could do more on problem solving. The methodology for solving problems in different projects is similar. **The use of teamwork to solve problems could be shown.** 7*

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 12-12:

We mostly just do problems in exams. If we did a similar question in industry, we would probably have to go and look for the data. 12

+++++

10. PUBLIC SPEAKING - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 10:52 pm, Oct 18, 03.

(1 1 7) /Fitness for purpose/Essential attributes/Public speaking

*** Definition: presentation skills, etc.

+++++

+++ ON-LINE DOCUMENT: 2. past graduate (male CIT postgraduate)

++ Text units 22-22:

Presentations should be introduced starting in the first year. 22

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 19-19:

Communications skills is important. The course is starting to do this topic well. 19

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:23-23 26-26

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-6

PROJECT: QMt2 Project,

(1 1 7) /Fitness for purpose/Essential attributes/Public speaking^x

*** Definition: presentation skills, etc.

+++++

+++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 96-96:

B. Yes. 'How to deal with people in industry?' like fitters, electricians, etc., - this can be achieved through work placement and workshop theory. An awareness of safety issues, which were previously discussed, such as:- fire drills, awareness of the nearest fire extinguisher, etc. There is a need for basic communication skills.

96

++ Text units 98-98:

A. Yes, I think the course should allocate half an hour per week to these issues. 98

++ Text units 110-110:

B. More presentation skills. 110

++ Text units 112-112:

A. There should be more presentations in second and third year. 112

++ Text units 114-114:

B. We would learn more about different subjects if we had to give a presentation on topics that are relating to Engineering. **Perhaps letting senior students to present labs. to junior students and lecturers, holding questions from lecturers after presentation.** 114*

++ Text units 123-123:

B. Communication is very important. 123

+++++

+++ ON-LINE DOCUMENT: 3. past grad. 2-2 (male Bourns)

++ Text units 38-38:

Yes, those first two examples that you give are good ones. This is a leading question, I couldn't argue with the first two suggestions. I don't see the need for more maths, just the right maths. 38

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 9-9:

Yes, in presentation skills:- It is sometimes necessary to sell an idea to senior management using these skills.

9

PROJECT: QMt3 Project,

(1 1 7) /Fitness for purpose/Essential attributes/Public speaking^{xi}

*** Definition: presentation skills, etc.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 43-43:

The course tried to address these areas. Two presentations during DME4 were good for the project. 43

++ Text units 45-45:

If more presentations were done during the year, it would do no harm. 45

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 33-33:

Presentation skills were well done on the course. Teamwork was not done enough, although this would be difficult to assess. There were no other difficulties - not in the main part of the course. 33

+++++

+++ ON-LINE DOCUMENT: past grad. 3-4 (male EMC)

++ Text units 22-24:

Presentation skills are important, because they build confidence. It is one of the soft skills. When I did the course, the final year project presentation was the only soft skill we encountered. 22

Students should be encouraged to better prepare for the final year project exhibition, with more marks being allocated to the exhibition. This is very important for engineers. **A lecture should be given to the final year students on how they should prepare for the exhibition and the presentation.** This type of training may not make much difference in the short term, but could in the long term.

Both the industrial experience and presentation/exhibition skills, gives them a subtle difference when they go for a job interview. This subtle difference is the gap between the confident, prepared graduate and the standard graduate. Interviewing over the years, shows me that as early as possible, students need to get their 'foot in the door' when it comes to obtaining industrial experience. 24

++ Text units 31-31:

The softer stuff: -presentation skills, etc. 31

++ Text units 36-36:

It might be possible to 'roll in' the softer stuff, like presentation skills, with the management subjects.

36

++ Text units 40-40:

Again the soft side of engineering could be given more emphasis. 40

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 29-29:

Personal development is important, so frequent presentations and meetings should be the norm. It is very important for students to know how to prepare for presentations and meetings. Students should know that presentations should have, say, five important points. This will ensure that they come across well and that they get their point across. Communication is very important. 29

++ Text units 44-44:

Passing on information through presentations, develops confidence in students. **So the latest advances in a particular area could be presented to the rest of the class by one student.** By answering questions this gives a forum to everyone for building confidence. 44*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 25-25:

Increased emphasis on communications and presentations skills. 25

11. REASONING - report QMt, QMt2 and QMt3

PROJECT: QMt Project,

(1 1 32) /Fitness for purpose/Essential attributes/Reasoning

*** Definition: ability to think, understand, conclude.

+++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 12-12:

(b) Reasoning: Yes. 12

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 11-11:

(b) Reasoning: I would give the course 4 out of 10 for this. Too much memory retention is still required from the students. However, reasoning is difficult to teach. 11

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 3

++ Units:7-7

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:6-6

PROJECT: QMt2 Project,

(1 1 32) /Fitness for purpose/Essential attributes/Reasoning

*** Definition: ability to think, understand, conclude.

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 19-19:

It used to do. I am not sure now. When the classes were smaller it did. 19

PROJECT: QMt3 Project,

(1 1 32) /Fitness for purpose/Essential attributes/Reasoning^{xii}

*** Definition: ability to think, understand, conclude.

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 16-16:

The course is an upgrade from secondary school only with more intense classes. This does not really help in promoting reasoning or thinking logically. 16*

+++++

12. SELF DIRECTED LEARNING - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 7:58 pm, Oct 18, 2003.

(1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability

*** Definition: learning continually without the need for help.

+++++

+++ ON-LINE DOCUMENT: 1. past graduate (male CIT postgraduate)

++ Text units 19-19:

More self directed learning would suit some people, but not others. 19

+++++

+++ ON-LINE DOCUMENT: 3. present student (male CIT)

++ Text units 27-27:

Students are not properly prepared in keeping up to date subsequent to graduating. Some form of guidance should be provided for this. 27

+++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)

++ Text units 18-18:

Depends on the industry- there are advanced technologies to which we do not have access, because they are too esoteric, i.e. space shuttle blue prints, warfare technologies, high level electronics. It is important for the future for graduates to have a very good practical understanding of electronics for future jobs. 18

++ Text units 37-37:

(g) More self directed learning: Yes. 37

+++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)

++ Text units 14-14:

(e) Teamwork: Yes:- again in third year mini-projects and in laboratory work to some extent. 14

++ Text units 17-17:

No:- we tend to 'spoon feed' the students too much. 17

++ Text units 31-31:

(g) More self directed learning or open learning: Yes. 31

+++++

+++ ON-LINE DOCUMENT: 9. employer (male telephone)

++ Text units 19-21:

Full time graduates get in-house training. 19

The process we use does not change that much, unlike the electronics industry, even though there are some modifications to the method of applying the coating. 20

We do not find updating a problem. 21

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:4-4

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-7

PROJECT: QMt2 Project,

(1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability

*** Definition: learning continually without the need for help.

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 15-15:

It is important therefore to teach the basic skills on FAT (factory acceptance test). Adequate research needs to be done - look for a manual. Approach the problem with a proper check list. 15

++ Text units 29-29:

Yes. We encourage people to join the IEI and become involved in their CPD programme. We encourage people to become Chartered Engineers. If someone wishes to do course, we would support them on that. An Engineering manager would see deficiencies in someone and would suggest a possible course for the graduate. Most of our graduates do push themselves and obtain more qualifications. 29

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 31-31:

Yes 31

++ Text units 42-45:

Reduce lecturing. 42

Introduce more self directed learning. 43

Hand students a lot more problems to solve themselves. However, this would cost more, as it would require smaller tutorial groups. Thus it would take more resources. 44 45

++ Text units 59-62:

(g) More self directed learning: 59 Yes. 60

(h) Change to teaching methods: 61 Yes: - self directed learning and more tutorials will require a change in teaching methods. 62

PROJECT: QMt3 Project,

(1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability^{xiii}

*** Definition: learning continually without the need for help.

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 26-26:

No. There is a lack of inspiration coming from academic staff. They need to be more positive.

+++++

13. TEAMWORK - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 6:57 pm, Oct 12, 2003.

(1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability

*** Definition: willingness to act for the good of the group.

+++++

+++ ON-LINE DOCUMENT: 1. past graduate (male CIT postgraduate)
 ++ Text units 14-14:
 More teamwork, co-operation among students, i.e. group projects. 14
 ++++++

+++ ON-LINE DOCUMENT: 2. past graduate (male CIT postgraduate)
 ++ Text units 3-3:
 Also the mini-projects in third year improve the course. Prior to this the intake of the Diploma students into third year had an advantage, with their experience of project. There is a lot at stake in fourth year particularly with the final year projects. 3
 ++ Text units 21-21:
 Group working is a good idea and this is being introduced in third year mini projects. 21
 ++++++

+++ ON-LINE DOCUMENT: 3. present student (male CIT)
 ++ Text units 23-24:
 Have doubts about group work, because each person in the class is an aspiring engineer, which is an independent role. In a teamwork situation, with everyone being equal, there tends to be someone who ends up doing all the work. 23
 Being a student who repeated a year, it is possible to see the differences with the present class and the previous class. With the present class, it is a rat race or dog eat dog situation. With the previous class they were more easy to approach in helping each other. 24
 ++++++

+++ ON-LINE DOCUMENT: 4. present student (male CIT)
 ++ Text units 25-25:
 Working in pairs is a better idea than working in groups. I think that most engineers will be working individually in industry. 25
 ++++++

+++ ON-LINE DOCUMENT: 5. non-completing (male telephone)
 ++ Text units 25-25:
 With regard to working in groups, we formed groups once or twice, but I did not like it. 25
 ++++++

+++ ON-LINE DOCUMENT: 6. non-completing (male telephone)
 ++ Text units 21-21:
 I don't know if working in groups would improve the situation. 21
 ++++++

+++ ON-LINE DOCUMENT: 7. lecturer (male CIT)
 ++ Text units 15-15:
 (e) Teamwork: Yes. 15
 ++ Text units 33-33:
 (c) More group work: Balance about right- not sure. 33
 ++++++

+++ ON-LINE DOCUMENT: 8. lecturer (male CIT)
 ++ Text units 14-14:
 (e) Teamwork: Yes:- again in third year mini-projects and in laboratory work to some extent. 14
 ++ Text units 27-28:
 (c) More group work: Yes. 27
 (d) Better project supervision: We do as much as we can. Projects in groups might be an advantage. 28
 ++++++

+++ ON-LINE DOCUMENT: 9. employer (male telephone)
 ++ Text units 17-17:
 There is an open plan system and there are weekly or bi-weekly engineering meetings. There is the danger that an over emphasis on teamwork can smother individual flair. Our main requirement is that graduates get on with people. 17
 ++++++

+++ EXTERNAL DOCUMENT: IEI Submission
 ++ Units:11-11 47-47
 ++++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report
 ++ Units:5-7

PROJECT: QMt2 Project,
 (1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability^{xiv}
 *** Definition: willingness to act for the good of the group.
 ++++++

+++ ON-LINE DOCUMENT: 1. past grad. 2-1 (male lecturer CIT)
 ++ Text units 27-30:
 A lot of people from different disciplines, such as chemical engineering, civil engineering, electrical engineering, mechanical engineering, etc., all trying to obtain the same goal and each putting forward their views, should be

shown, if possible. **This could be done by splitting the class and each part of the class playing a different part in the team.** 27*

In industry, the deadline changes. For example, one company can make a half a million contact lenses per day, which could be worth £50,000. Hence, everyday cut from the schedule is worth £50,000 for the company. 28

A teaching methodology for showing this might be included in the course and would show that the biggest frustration in industry is the interaction with other groups. 29 30*

+++++

+++ ON-LINE DOCUMENT: 3. past grad. 2-2 (male Bourns)

++ Text units 38-38:

Yes, those first two examples that you give are good ones. This is a leading question, I couldn't argue with the first two suggestions. I don't see the need for more maths, just the right maths. 38

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 26-26:

Younger people are usually better at this. Older people are usually fixed in their ways. We like new ideas and want people that are flexible. We try to avoid "We want to do it this way" approach. We try to 'marry' European Project Management skills into the Japanese way, so flexibility is very important. 26

+++++

+++ ON-LINE DOCUMENT: 7. lecturer 2-1 (male CIT)

++ Text units 25-25:

Yes:- but with the odd student- no. The course is capable of developing teamwork attributes, where it is there to be developed. 25

++ Text units 51-52:

(c) More group work: 51 Yes. 52

PROJECT: QMt3 Project,

(1 1 4) /Fitness for purpose/Essential attributes/Teamworking ability^{xv}

*** Definition: willingness to act for the good of the group.

+++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 44-44:

There is for and against teamwork. I would rather do the project on my own. 44

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 33-33:

Presentation skills were well done on the course. Teamwork was not done enough, although this would be difficult to assess. There were no other difficulties - not in the main part of the course. 33

+++++

+++ ON-LINE DOCUMENT: past grad. 3-4 (male EMC)

++ Text units 39-39:

Teamwork was good in our year. There was good 'camaraderie' in our class. 39

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 7-7:

The course could do more on problem solving. The methodology for solving problems in different projects is similar. **The use of teamwork to solve problems could be shown.** 7*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 55-55:

I mentioned teamwork previously in the form of how to manage the workload of three people. The course should try and provide more practical management. The University of Limerick offer a degree in project management. I would like to see more of the 'management of people and getting the best out of them', included in the course. So what I am talking about is managing a job and getting people to do different elements of the job, programming the job, linking the job together and reviewing the job. 55

+++++

+++ ON-LINE DOCUMENT: pres. stud. 3-1 (male CIT)

++ Text units 22-22:

Again third year project was good for teamwork. We held team meetings each week to discuss the project. 22

+++++

14. TIME MANAGEMENT - report from QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 7:42 pm, Oct 19, 2003.

(1 1 11) /Fitness for purpose/Essential attributes/Time management

*** Definition: ability to use time efficiently.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:6-6

+++++

15. WRITTEN - report from QMt, QMt2 and QMt3

PROJECT: **QMt Project**, User Francis S. Murphy, 11:20 pm, Oct 18, 03.

(1 1 8) /Fitness for purpose/Essential attributes/Written communication

*** Definition: report writing skills, etc.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-6

PROJECT: **QMt2 Project**,

(1 1 8) /Fitness for purpose/Essential attributes/Written communication^{xvi}

*** Definition: report writing skills, etc.

+++++

+++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 96-96:

B. Yes. 'How to deal with people in industry?' like fitters, electricians, etc., - this can be achieved through work placement and workshop theory. An awareness of safety issues, which were previously discussed, such as:- fire drills, awareness of the nearest fire extinguisher, etc. There is a need for basic communication skills.

96

++ Text units 98-98:

A. Yes, I think the course should allocate half an hour per week to these issues. 98

++ Text units 123-123:

B. Communication is very important. 123

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 4-4:

There is a lot of work on the documentation side. **I would be looking to see how good the graduate is at writing reports. Report writing must be good.** We do a lot of documentation work, sometimes using software, on project management, operation qualification (OQ), installation qualification (IQ) and process validation.

++ Text units 14-14:

They should become more and more involved in documentation concerning: Installation Qualification, Operation Qualification, Process Validation, User Requirement Specification (URS) and Factory Acceptance Test (FAT). There is a right and a wrong way - detailed check lists are necessary. 14

PROJECT: **QMt3 Project**,

(1 1 8) /Fitness for purpose/Essential attributes/Written communication^{xvii}

*** Definition: report writing skills, etc.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-2 (male Freefoam)

++ Text units 41-41:

Management skills are important. Project management, supervisory skills, chairing a meeting, report writing, etc. are all important. **Not enough guidance was given on report writing.** The ability to communicate professionally is very important. 41*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 17-17:

The laboratory work and practical work was good. Report writing was a chore. **Nowadays it should be more multi-media. Students should E-mail the material to prepare them for the work scene. They could put results on EXCEL work sheets.** Only one or two students were well up on computing at that time.

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 25-25:

Increased emphasis on communications and presentations skills. 25

+++++

i there should be more emphasis on coming up with ideas.

ii more use of common computer packages/internet and the development of IT skills;

-
- more use of multi-media/computers for writing reports.
 - iii role play (each part of the class playing a different role in the team to show the frustration of group interaction and the need for flexibility).
 - iv how to manage getting something done? (progress, costs, etc.);
introduction to project management in first or second year (assisted by former graduates);
modular approach.
 - v small tutorial groups;
practical examples;
more examples.
 - vi work placement in industry as part of the course.
 - vii the ability to communicate professionally;
personal development course (Irish Management Institute);
confidence through industrial experience; confidence through chairing of large meetings; confidence building by latest advances in a particular area presented to the rest of the class by one student (question and answer session to follow).
 - viii small tutorial groups.
 - ix use of teamwork to solve problems;
more problem solving.
 - x mentoring by senior students: e.g. laboratory work presentations.
 - xi lecture in final year concerning preparation for the exhibition and project presentation; latest advances in a particular area presented to the rest of the class by one student (followed by a question and answer session).
 - xii reduction of intense classes.

-
- xiii more self directed learning guidance from academic staff.
 - xiv role play (each part of the class playing a different role in the team to show the frustration of group interaction and the need for flexibility)
 - xv the use of teamwork to solve problems could be shown.
 - xvi laboratory work and laboratory reports.
 - xvii more guidance on report writing;
more use of multi-media/computers for writing reports.

APPENDIX 8:

STANDARDS OF EXCELLENCE - report QMt, QMt2 and QMt3.

Key to Workplace Observations

ON-LINE DOCUMENT: past grad. 2-2

Interview past grad. 2-2 was conducted at Bourns Electronics, Mahon Industrial Estate, Cork City, Ireland.

A quiet, red brick, manufacturing facility in a clean modern environment, Bourns Electronics produce components for: automotive, industrial, medical, computer and peripherals, audio visual, telecommunications, aerospace.

ON-LINE DOCUMENT: employer 2-1

Interview employer 2-1 was conducted at Fujisawa (Ireland) Ltd., Killorglin, County Kerry, Ireland.

Fujisawa is a very clean looking plant/working environment, just outside the town of Killorglin, Co. Kerry, Ireland. The Fujisawa plant stands next to Klinge, which is another plant manufacturing pharmaceuticals. In the Fujisawa plant, the manufacture and distribution worldwide of the immune suppressant drug 'Prograf' takes place. 'Prograf' is used in transplant operations.

ON-LINE DOCUMENT: past grad. 3-1

ON-LINE DOCUMENT: past grad. 3-2

Interviews past grad. 3-1 and past grad. 3-2 were conducted at Freefoam Plastics, Centre Park Road, Cork, Ireland.

Freefoam Plastics is a small manufacturing facility near the centre of Cork City. They produce fascia, soffit boards and the necessary fittings for roofing/rain water management. It appears to be a clean pleasant working environment.

ON-LINE DOCUMENT: past grad. 3-3

Interview past grad. 3-3 was conducted at Pfizer, Ringaskiddy, County Cork, Ireland.

Pfizer is a large modern pharmaceutical plant near the village of Ringaskiddy about 7 miles east from Cork City. They manufacture the drug 'Viagra'. A very clean modern working environment.

ON-LINE DOCUMENT: past grad. 3-4

Interview past grad. 3-4 was conducted at EMC, Ovens, County Cork, Ireland.

EMC is a modern medium sized manufacturing plant located 7 miles west of Cork City in the village of Ovens. They manufacture computer casings (information storage systems) for medium to large size organisations, such as banks, solicitors, etc. The working environment is very clean and pleasant.

ON-LINE DOCUMENT: past grad. 3-5

Interview past grad. 3-5 was conducted at Project Management (PM), Lough Mahon Technology Park, Blackrock, Cork, Ireland.

Project Management is an international provider of professional services in project management, construction management, engineering design and consultancy. They have a large modern office block on the eastern edge of Cork City. They undertake much work for the Pharmaceutical industry, which is very prevalent in the Cork area. The working environment at the office is very clean and pleasant. Library facilities are available in the building.

ON-LINE DOCUMENT: past grad. 3-6

Interview past grad. 3-6 was conducted at RPS-MCOS, Consulting Engineers, Innishmore, Ballincollig, County Cork, Ireland.

RPS-MCOS, Consulting Engineers, were formerly known as M. C. O'Sullivan, Consulting Engineers. They undertake strategic studies on national and regional infrastructure in the fields of water services, natural gas, transportation and waste management. The Cork offices indicate a clean, comfortable working environment for employees.

Q.S.R. NUD*IST Power version, revision 4.0. Licensee: Francis Spenser Murphy.

16. AIMS AND OBJECTIVES - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 3:52 pm, Nov 15, 03.

(2 7) /Standard of excellence/Aims and objectives.

*** Definition: The broad educational purposes of the provision set out in the course self assessment document (aims). Learning outcomes of each course programme (objectives).

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:4-4

+++++

17. CONSULTANCY - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 10:20 pm, Nov 13, 03.

(2 2) /Standard of excellence/Consultancy

*** Definition: Development of staff consultancy activities.

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 2

++ Units:15-15 17-17

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:4-4 12-12

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-7

+++++

18. EMPLOYERS - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 3:31 pm, Nov 15, 03.

(2 5) /Standard of excellence/Employers

*** Definition: Requirement of employers

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 2

++ Units:19-20

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:10-10 23-23 29-29

PROJECT: QMt3 Project, User Francis S. Murphy, 3:34 pm, Nov 15, 03.

(2 5) /Standard of excellence/Employers

*** Definition: Requirement of employers

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 9-9:

Within my company the Mechanical Engineering degree is regarded very highly and the company pays a premium of approximately 10% more than other Engineering disciplines. 9

+++++

19. EXTERNS - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 4:06 pm, Nov 15, 03.

(2 11) /Standard of excellence/External examiners

*** Definition: Course response to external examiner reports.

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:9-9

+++++20.

HUMBOLDT PRINCIPLE - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 10:15 pm, Nov 13, 03.

(2 1) /Standard of excellence/Humboldt principle

*** Definition: Relationship between research, teaching and study

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 3

++ Units:7-7

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:26-26

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-5

21. LOCAL AND REGIONAL NEEDS - report QMt, QMt2 and QMt3

PROJECT: QMt Project,

(2 8) /Standard of excellence/Local and regional needs

*** Definition: Education and employment needs at regional level.

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-5

22. MISSION STATEMENT - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 3:47 pm, Nov 15, 03.

(2 6) /Standard of excellence/Mission statement

*** Definition: Effect of mission statement on excellence

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:4-4

23. NATIONAL AND INTERNATIONAL QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 4:00 pm, Nov 15, 03.

(2 9) /Standard of excellence/National and international needs

*** Definition: Education and employment needs at national or international level.

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-5

24. PROFESSIONAL BODIES - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 3:23 pm, Nov 15, 03.

(2 4) /Standard of excellence/Professional bodies

*** Definition: Requirement of the professional bodies

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 2

++ Units:19-19

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:3-3 5-5 10-10

PROJECT: QMt2 Project, User Francis S. Murphy, 3:25 pm, Nov 15, 03.

(2 4) /Standard of excellence/Professional bodies

*** Definition: Requirement of the professional bodies

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 29-29:

Yes. We encourage people to join the IEI (Institution of Engineers of Ireland) and become involved in their CPD (continual professional development) programme. We encourage people to become Chartered Engineers. If someone wishes to do a course, we would support them on that. An Engineering manager would see deficiencies in someone and would suggest a possible course for the graduate. Most of our graduates do push themselves and obtain more qualifications.

29

PROJECT: QMt3 Project, User Francis S. Murphy, 3:28 pm, Nov 15, 03.

(2 4) /Standard of excellence/Professional bodies

*** Definition: Requirement of the professional bodies

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 46-46:

The course tends to be primarily affiliated with the Society of Manufacturing Engineers (SME). The course coordinators should try to create a balance between mechanical engineering and manufacturing engineering i.e. equal affiliation with SME and IMechE (Institution of Mechanical Engineers) and IEI (Institution of Engineers of Ireland). 46

25. QUALITY ASSURANCE - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 4:02 pm, Nov 15, 2003.

(2 10) /Standard of excellence/Quality assurance

*** Definition: Institutional review of programmes

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:9-10

+++++26.

RESEARCH - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 10:25 pm, Nov 13, 03.

(2 3) /Standard of excellence/Research

*** Definition: Development of research activities

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 1

++ Units:3-3 13-13

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 2

++ Units:19-20 22-22

+++++

+++ EXTERNAL DOCUMENT: CIT Academic Quality Book 3

++ Units:1-1 7-7

+++++

+++ EXTERNAL DOCUMENT: IEI Submission

++ Units:1-1 3-5 10-10 13-13 26-26 29-29

+++++

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:5-6

+++++

27. RESEARCH CHARTER - report QMt, QMt2 and QMt3.

(2 3 1) /Standard of excellence/Research/CIT Research Charter

*** Definition: CIT Academic Quality Book 3 page 7

+++++28.

SAFETY - report QMt, QMt2 and QMt3

PROJECT: QMt2 Project, User Francis S. Murphy, 9:42 pm, Nov 13, 03.

(1 5 16) /Fitness for purpose/Subjects/safety^{xviii}

*** Definition: Safety, health and welfare of the public with its implications for the achievement of a 'sustainable world'.

+++++

+++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A&B) CIT)

++ Text units 91-92:

M. It is also important to have information concerning industrial practice on safety issues such as:- manual handling of heavy loads, wearing of safety clothing, scaffolding, etc. 91

First Aid, Emergency procedure training, emergency response management, handling of dangerous substance, general site safety practices, fire extinguishers, etc. 92

++ Text units 96-96:

M. Yes. 'How to deal with people in industry?' like fitters, electricians, etc., - this can be achieved through work placement and workshop theory. An awareness of safety issues, which were previously discussed, such as:- fire drills, awareness of the nearest fire extinguisher, etc. There is a need for basic communication skills, 96

++ Text units 98-98:

A. Yes, I think the course should allocate half an hour per week to these issues. 98*

+++++

+++ ON-LINE DOCUMENT: 4. employer 2-1 (male Fujisawa)

++ Text units 23-23:

Health and safety legislation is very important including manual handling training, safety files and to know the person who has responsibility for safety. 23

PROJECT: QMt3 Project, User Francis S. Murphy, 9:44 pm, Nov 13, 03.

(1 5 16) /Fitness for purpose/Subjects/safety

*** Definition: Industrial practice on safety issues

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 8-8:

In this current day and age, the course could do more to show the very basics on environmental health and safety. **Two to three hours of lectures during the course could be done on 'environmental impact statements', 'integrated pollution control' (IPC), 'an overview of building regulations, fire certificates, commencement notices, etc. and the need for a formal course from the industrial training authority (FAS), before working on a construction site.** Again this is leaning towards the construction industry. 8*

+++++

+++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)

++ Text units 59-59:

The Safety, Health and Welfare at Work Act, including the role of the engineer in the design of mechanical elements of a project, should be covered by the course. This should be done both from the construction point of view (HAZCON - hazards in construction) and the operation point of view (HAZOP - hazards and operability), with the relevant risk analysis.

+++++

29. STUDENT REPRESENTATION - report QMt, QMt2 and QMt3

PROJECT: QMt Project, User Francis S. Murphy, 4:10 pm, Nov 15, 03.

(2 12) /Standard of excellence/Student representation

*** Definition: Student-staff liaison committees, etc.

+++ EXTERNAL DOCUMENT: QAA Subject Overview Report

++ Units:10-10

+++++

30. COURSE STRATEGY - report QMt, QMt2 and QMt3

PROJECT: QMt3 Project, User Francis S. Murphy, 1:10 am, Mar 17, 04.

(2 13) /Standard of excellence/Course strategy

*** Definition: New industries/likely employers entering the region

+++++

+++ ON-LINE DOCUMENT: past grad. 3-5

++ Text units 9-9:

In the current climate we are seeing the emergence of a cleaner, secondary type pharmaceutical plant coming into Ireland. instead of the pure bulk chemicals. We now have Weyth, Genzyme in Waterford, Amersham, Stryker. These facilities are whats called FI11 finish, where the drug is mixed in its final dosage format, either in vials or ampoules for injections. The machines that do this are quite complex. This is an area that will see a lot of growth in the years to come. Bio technology is similar technology and processing is done aseptically or in a sterile atmosphere. These facilities require a very high level of utilities water for injection, clean steam, steam in place and their HVAC (heating, ventilating and air conditioning) requirements are very complex, requiring class 100 atmospheres, which is no more than 100 particles more than 1 micron per cubic metre of air. This whole area could be looked at by the mechanical engineering course for the future.

9

+++++

xviii^{xviii} Lecture time allocated to safety, health and welfare of the public.

APPENDIX 9:

ESSENTIAL ATTRIBUTES - report from QMt4 and STANDARDS OF EXCELLENCE - report from QMt4.

Key to Workplace Observations

ON-LINE DOCUMENT: past grad. 4-1

Interview past grad. 4-1 was conducted at Sifco (Ireland), Blackrock, Cork, Ireland.

SIFCO Ireland is repair facility for aircraft jet engine turbine blades. The Blackrock plant is also starting to manufacture turbine blades for the engines. Pratt and Whitney, CFMI, General Electric and Rolls Royce engines are the product capability of SIFCO Ireland. The Blackrock plant is a clean modern plant providing a pleasant working environment in which employees appear to be able to use their initiative

ON-LINE DOCUMENT: past grad. 4-2

Interview past grad. 4-2 was conducted at Flow Technology, Charleville, Co. Cork, Ireland.

Flow Technology is an organisation offering consultancy engineering services, mainly to the pharmaceutical industry in the Cork region. The plant is located on the southern side of Charleville, County Cork. It appears to be a very modern pleasant working environment.

ON-LINE DOCUMENT: past grad. 4-3

Interview past grad. 4-3 was conducted at Arup Consulting Engineers, 15 Oliver Plunkett Street, Cork, Ireland.

Arup Consulting Engineers offer engineering consultancy services in all aspects of the built environment. Design solutions are developed which integrate civil, structural and building services. The Cork office is clean modern facility providing a pleasant working environment in which employees appear to be able to use their initiative.

ON-LINE DOCUMENT: past grad. 4-5

Interview past grad. 4-5 was conducted at O'Donovan Engineering co. Ltd., Coachford Co. Cork, Ireland.

O'Donovan Engineering is a family owned and run business located due west of Cork city, on the eastern edge of the town of Coachford, Co Cork. The company serves the agricultural, food processing, construction and manufacturing industries, offering a diversity of goods. These include facilities for horse, cattle, pig and sheep management, as well as weighing equipment, gun cabinets and modular buildings. The factory has been in existence for some time and although the open plan office accommodation and staff facilities reflect this, employees can use their initiative, thus gaining much experience.

ON-LINE DOCUMENT: past grad. 4-6

Interview past grad. 4-6 was conducted at Dornan Engineering Ltd., Cork University Hospital (CUH) Site Office, Bishopstown, Cork, Ireland.

Dornan Engineering Ltd. is the Irish operation of a privately owned multinational, Kentech Engineering Ltd. They provide engineering, procurement, construction, and maintenance of mechanical, electrical, instrumentation and telecommunications services. Kentech is one of the largest engineering contractors in the world. Dornan Engineering was founded in 1966 and is one of the oldest engineering contractors in Ireland. The working environment was pleasant, consisting of a temporary portable cabin with the latest office equipment at the CUH new maternity extension.

ESSENTIAL ATTRIBUTES - report from QMt4

Q.S.R. NUD*IST Power version, revision 4.0. Licensee: Francis Spenser Murphy.

2. INDIVIDUAL FLAIR - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 1:15 am, Jul 16, 2004.

(1 1 30) /Fitness for purpose/Essential attributes/Individual flair^{xix}

*** Definition: Opposite to teamwork

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 9-10:

One item the course could improve on is 'presentation skills' or general public speaking. We have a lot of meetings. It is important to get your point across. There are arguments and you must stand your ground and find your way out. Ways of speaking on the phone, being able to fight your corner, etc. are important. It is important to speak your case, as there is always someone who wants to pin something on the other guy. These are points that the course could look at - **the ability to field and answer difficult questions under pressure**. There should be more on this, such as **a class on 'the methods on how to answer questions?'; 'How to avoid questions?'; 'How to explain things to craftsmen /other engineers ' and Generally how to get your point across clearly**. All this comes with experience when you get working anyway but some initial theory and guidance on the issue would help prepare engineers for the workplace.

Another general point is **the ability to get things right first time**. There are repercussions if things aren't right. One should concentrate a bit more to make sure its right. It won't work in industry if things aren't right. On the course, any attempt at an assignment gets the pass mark (40%). Maybe this should be tightened up. **It is important that in anything one does:- to do it, check it, make sure its completely correct.**

++ Text units 33-33:

How to deal with people?

33

+++++

3. INDIVIDUAL PROJECTS - report QMt4

PROJECT: QMt4 , User Francis S. Murphy, 1:17 am, Jul 16, 2004.

(1 1 13) /Fitness for purpose/Essential attributes/Individual projects^{xx}

*** Definition: Individual projects or dissertations

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 31-31:

I think we do enough concerning 'individual projects' on the course.

31

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 35-35:

Building towards a project could be one technique that is used. Instead of individual drawings, there could be more CAD, building towards an overall project. 35*

++ Text units 37-37:

With regard to the subject 'Project', mine was a poor project. Half the problem was that the objective of the project changed. At the time we did not know that this was going to happen. What started as a design project, ended up as a management project. I suggest that 'individual projects' should be a bigger part of the BEng course.

++ Text units 42-42:

Dealing with people; dealing with people over the phone; ringing up and making phone calls; arranging meetings; - these are all very important and should be covered by the BEng course. It is important in the subject 'Project' to make sure that students have to deal with external people from industry. They must express themselves clearly over the phone.

42

++ Text units 47-47:

As I said previously, building towards an overall project is a good educational technique and what is now big and is not going to go away, is the whole environmental issue. It will be important for students to know: **'How to refer to information, legislation and regulations in general on this issue?'**

+++++

4. INFORMATION RESEARCH - report QMt4

PROJECT: QMt4 , User Francis S. Murphy, 0:32 am, Jun 25, 2004.

(1 1 12) /Fitness for purpose/Essential attributes/Information research^{xxi}

*** Definition: Generic skills

+++++

+++ ON-LINE DOCUMENT: past grad. 4-3 (male Arup)

++ Text units 32-32:

The internet was something we used for researching a topic. I researched turbochargers and subsequently gave a presentation on the topic.

32*

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 28-28:

10*

There should be less classroom time where we could research a bit more ourselves (information research).

28

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 47-50:

As I said previously, building towards an overall project is a good educational technique and what is now big and is not going to go away, is the whole environmental issue. It will be important for students to know: **'How to refer to information, legislation and regulations in general on this issue?'**

Students should know: 'What do the public bodies refer to, on this issue?' 48

At the moment the project is geared towards writing up the final report. This should be reduced. More important is **'How to get information?'** The project supervisor should point the student in the right direction.

When I did my final year project, I visited many 'waste water' treatment plants, dealt with people, external bodies, etc. Sometimes, I was pointed in the right direction. Other times, I set myself up, or my supervisor said 'Give the environmental office a call'. 50

+++++6.

MANAGEMENT KNOWLEDGE - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 10:55 am, Jun 24, 2004.

(1 1 5) /Fitness for purpose/Essential attributes/Management knowledge^{xxii}

*** Definition:

organisation, managing people, legislation, finance, information systems, quantitative methods.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 23-23:

The subject 'Project Management' should be included. There was no emphasis on the subject 'Computer Aided Design' (CAD) when I did the course. There should be. 23

++ Text units 36-36:

There is no harm in doing most of these on the course. 36

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 49-50:

'Team management' might be a good idea. If one is in charge of a team - the responsibility of a team leader.

Methods of personnel management is another attribute that could be done by the course - 'How to deal with a guy who is not pulling his weight?' 50*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 44-44:

I like the management side of engineering a lot. **General Electric management philosophies** and **Japanese management skills** should be done. 44*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 3-3:

I am not utilising much of it. This is because of the job I have, which is to do with: pricing work, estimating, drafting, quality control, MRP (materials requisition planning), etc. 3

++ Text units 20-20:

Maybe more should be done on the 'estimating' side of things. 'People management' also. 20

++ Text units 30-30:

We should do something on ISO standards. I was totally unfamiliar with them when first joining this company. ISO 9001 is fairly rigorously applied here. I did not know the first thing about it- there was not enough depth covered concerning ISO standards on the course. 30

++ Text units 35-35:

'People management' and 'Money Management' are other things that could be covered more by the course.

+++++7.

MATHEMATICAL ABILITY- report QMt4

PROJECT: QMt4, User Francis S. Murphy, 10:51 am, Jun 24, 2004.

(1 1 2) /Fitness for purpose/Essential attributes/Mathematical ability^{xxiii}

*** Definition: mathematical skills.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 15-15:

A lot more 'maths' than originally envisaged - in 'fluids', 'control', even 'manufacturing'. But one has to be able to do it. The level of 'maths' I am using now is not as high, but sometimes one needs an understanding of the high level 'maths'. One has to do it. 15

++ Text units 45-45:

'Mathematics' is well covered by the course. ' 45

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 42-42:

There is enough 'mathematics', but there should be more 'statistics'. Applying 'statistics' to industry is important.
More industry based examples should be shown. 42*

+++++8.

PERSONAL ATTRIBUTES - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 11:10 am, Jun 24, 2004.

(1 1 10) /Fitness for purpose/Essential attributes/Personal attributes^{xxiv}

*** Definition: Confidence, responsibility.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 36-36:

There is no harm in doing most of these on the course. 36

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 9-10:

One item the course could improve on is 'presentation skills' or general public speaking. We have a lot of meetings. It is important to get your point across. There are arguments and you must stand your ground and find your way out. Ways of speaking on the phone, being able to fight your corner, etc. are important. It is important to speak your case, as there is always someone who wants to pin something on the other guy. These are points that the course could look at - **the ability to field and answer difficult questions under pressure**. There should be more on this, such as **a class on 'the methods on how to answer questions?'; 'How to avoid questions?'; 'How to explain things to craftsmen /other engineers' and generally how to get your point across clearly**. All this comes with experience when you get working anyway but some initial theory and guidance on the issue would help prepare engineers for the workplace.

Another general point is **the ability to get things right first time**. There are repercussions if things aren't right. One should concentrate a bit more to make sure its right. It won't work in industry if things aren't right. On the course, any attempt at an assignment gets the pass mark (40%). Maybe this should be tightened up. **It is important that in anything one does:- to do it, check it, make sure its completely correct.**

++ Text units 32-33:

Confidence - public speaking. 32

How to deal with people? 33

++ Text units 47-47:

'Personal attributes' we have already discussed and more could be done. 47

++ Text units 49-50:

'Team management' might be a good idea. If one is in charge of a team - the responsibility of a team leader. 49*

Methods of personnel management is another attribute that could be done by the course - 'How to deal with a guy who is not pulling his weight?' 50*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 34-34:

There should be more focus on project work from the start. Projects should be industry based. Some students are exceptionally good academically, but cannot apply this. With more emphasis on third year projects, this will develop these practical skills more. All projects should be industry based. The internal 'made up' projects tend to be difficult. 34

++ Text units 38-38:

Personality development for engineers. 38*

++ Text units 45-45:

The whole concept of teaching and learning is another area we should study. **We should be given the foundations of 'self directed learning'**. This would be difficult to do, but maybe possible through project work. The project side of things should be encouraged. **The development of public speaking and project skills develops confidence**. Students feel more confident about themselves. **All of these things tie in together.**

+++++9.

PROBLEM SOLVING - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 10:50 am, Jun 24, 2004.

(1 1 1) /Fitness for purpose/Essential attributes/Problem solving ability^{xxv}

*** Definition: resolution skills.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 38-38:

Another method is for six to eight people to discuss a problem around a table. This could be recorded on video. The various roles within the group would then be highlighted. These are very important skills, which could be developed by the course. 38*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 4-4:

However, when working in the aviation industry, between third and fourth year, I found that I could not apply the academic experience to industry. On the other hand, the way we were taught to approach problems was very helpful.

4

++ Text units 39-39:

How to find solutions to problems? With problem solving skills, we are left to develop them ourselves. **There are new problem solving skills out there. Ford, General Electric, Toyota have developed these.** We develop these ourselves, but **there should be more structured learning on these.**

+++++10.

PUBLIC SPEAKING - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 11:08 am, Jun 24, 2004.

(1 1 7) /Fitness for purpose/Essential attributes/Public speaking^{xxvi}

*** Definition: Public speaking, presentations, etc.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 36-37:

There is no harm in doing most of these on the course.

36

When we did our final year project presentation, everyone was terrified. A course on presentation skills, during which **presentations are recorded on video and subsequently played back**, is very useful. There could be 20 minutes preparation time allowed for a two minute presentation.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 9-9:

One item the course could improve on is 'presentation skills' or general public speaking. We have a lot of meetings. It is important to get your point across. There are arguments and you must stand your ground and find your way out. Ways of speaking on the phone, being able to fight your corner, etc. are important. It is important to speak your case, as there is always someone who wants to pin something on the other guy. These are points that the course could look at - **the ability to field and answer difficult questions under pressure**. There should be more on this, such as **a class on 'the methods on how to answer questions?'; 'How to avoid questions?'; 'How to explain things to craftsmen /other engineers '** and generally **how to get your point across clearly**. All this comes with experience when you get working anyway but some initial theory and guidance on the issue would help prepare engineers for the workplace.

9*

++ Text units 32-32:

Confidence - public speaking.

32

++ Text units 46-46:

'Public speaking' we have already discussed and more should be done in that area.

46

+++++

+++ ON-LINE DOCUMENT: past grad. 4-3 (male Arup)

++ Text units 32-32:

The internet was something we used for researching a topic. I researched turbochargers and subsequently gave a presentation on the topic.

32

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 35-35:

Communication skills are important. Students should increase the development of their report writing skills. There should be **more emphasis on presentations** and **more emphasis on project work**.

++ Text units 45-45:

The whole concept of teaching and learning is another area we should study. We should be given the foundations of 'self directed learning'. This would be difficult to do, but maybe possible through project work. The project side of things should be encouraged. **The development of public speaking and project skills develops confidence.** Students feel

more confident about themselves. All of these things tie in together.

45*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 34-34:

'Public speaking' maybe. One is either good at it or one is not.

34

+++++12.

SELF DIRECTED LEARNING - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 11:07 am, Jun 24, 2004.

(1 1 6) /Fitness for purpose/Essential attributes/Self directed learning ability^{xxvii}

*** Definition: lifelong learning desire

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 36-36:

There is no harm in doing most of these on the course.

36

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

+++ Retrieval for this document: 1 unit out of 50, = 2.0%

++ Text units 45-45:

The whole concept of teaching and learning is another area we should study. We should be given the foundations of 'self directed learning'. This would be difficult to do, but maybe possible through project work. The project side of things should be encouraged. **The development of public speaking and project skills develops confidence.** Students feel more confident about themselves. All of these things tie in together. **45***

+++++13.

TEAMWORK - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 10:53 am, Jun 24, 2004.

***** (1 1 4)

/Fitness for purpose/Essential attributes/Teamworking ability^{xxviii}

*** Definition: willingness to act for the good of the group.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 33-33:

With our class there was some competition, but because it was a small group of people, they would help each other when in trouble. This could be lost if the class becomes too big.

33

++ Text units 36-36:

There is no harm in doing most of these on the course.

36

++ Text units 38-38:

Another method is for **six to eight people to discuss a problem around a table. This could be recorded on video. The various roles within the group would then be highlighted.** These are very important skills, which could be developed by the course. **38***

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 48-49:

This ties up with 'teamwork'. In bigger companies one tends to get project teams. Teamwork is generally not a problem. In engineering, teams do not have to train together. **48**

'Team management' might be a good idea. If one is in charge of a team - the responsibility of a team leader. **49***

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 43-43:

The course does not encourage teamwork. It is all about individualism. We have never been taught about teams. Individualism is not good. **There are not enough 'teamworking development skills' on the course.**

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 41-41:

The teamwork projects in third year were OK. A lot of the guys let everyone else do the work, but the team knows who is doing the work. **41**

+++++

14. TIME MANAGEMENT - report from QMt4

PROJECT: QMt4, User Francis S Murphy, 1:31 am, Jul 16, 2004.

(1 1 11) /Fitness for purpose/Essential attributes/Time management^{xxix}

*** Definition: generic skills

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 29-29:

In this place we are always rushing, so maybe we could have done something on how to prioritise work (time management). **29**

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 38-38:

With regard to 'time management', **the project management software MICROSOFT PROJECT is a simple and important software package to be using, which will deal with this.** We can compare this with 'How many men are needed on site?', and 'How to allocate resources?' **38***

+++++

15. WRITTEN - report from QMt4

PROJECT: QMt4, User Francis S. Murphy, 11:09 am, Jun 24, 2004.

(1 1 8) /Fitness for purpose/Essential attributes/Written communication^{xxx}

*** Definition: Report writing skills, etc.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-3 (male Arup)

++ Text units 36-37:

Report writing is very important. Engineers are quite poor at writing. It should be developed. One way of doing this would be to **give students a four page document on heat exchangers for example. They should then produce a synopsis of this document reducing it into ten lines.**

The more practice before the final year report the better. For some students, the first report that they write in the four years of the course is the final year project. 37

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 3-3:

Very helpful with regard to report writing. 3

++ Text units 35-35:

Communication skills are important. Students should **increase the development of their report writing skills.** There should be **more emphasis on presentations** and **more emphasis on project work.**

+++++

STANDARDS OF EXCELLENCE - report from QMt4

Q.S.R. NUD*IST Power version, revision 4.0. Licensee: Francis Spenser Murphy.

28. SAFETY - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 1:26 am, Jul 16, 2004.

(2 16) /Standard of excellence/safety

*** Definition: industrial practice on safety issues

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 26-26:

There should be something done on the course concerning 'safety' The first thing I had to do when employed here, was the 'Safe Pass' course. 26

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 36-36:

Since starting this job, I completed a safety course. I think there should be more done on the BEng course concerning 'safety'. Students should be more familiar with the 'safety statement' and the 'method statement'. None of us on the course were shown how to do the 'safety statement'.

+++++

30. COURSE STRATEGY - report QMt4

PROJECT: QMt4, User Francis S. Murphy, 1:27 pm, Jun 26, 2004.

(2 13) /Standard of excellence/Course strategy^{xxxi}

*** Definition: New industries/likely employers entering the region

+++++

+++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)

++ Text units 41-43:

Automation will be very important for industry, within the next few years. In Ireland the cost base is too high and unless the manpower costs are reduced, Ireland will lose significant amounts of its' manufacturing companies. Non-conventional machining is increasing in use these days. Laser cutting and water cutting and Wire EDM (electro discharge machining) are becoming widely utilised. Conventional machining methods are tending to move from 3 axis to multi-axis machining, this reduces the amount of part handling that occurs during the manufacturing process. 42

I think **automation is going to be very big**, with an increased use of robots interacting with machinery.

+++++

+++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)

++ Text units 53-58:

New technologies are so far ahead that one can only briefly touch on them during the course. As the bio-medical industry has done recently, I don't think any industry like this is about to enter Ireland in the near future.

Environment engineering and renewable energy might be an important one in the not too distant future.

I think process control, such as SCADA (supervisory control and data acquisition) and different versions of it will be important in the future. 54

Just to recap, the 'electrical/ electronic engineering' that we did on the course is not specific to what I am using in industry. The 'LABVIEW' software that we did in that area is handy. The 'electrical' side is fine - theory of motors, etc. However, we subcontract for site work. The 'electrical' that we deal with in industry does not resemble the stuff that we did on the course.

There are new systems coming in now such as 'profibus' and 'fieldbus'- **to do with 'control', to do with 'automation'**, it is a relatively new technology and will become more popular over time as its cost relative to present control/wiring systems reduces. 56, 57, 58

+++++

+++ ON-LINE DOCUMENT: past grad. 4-3 (male Arup)

++ Text units 40-42:

Pharmaceuticals.

40

One area the course could address is '**starting your own business**'.

Someone who has done it previously could talk to students.

41, 42*

+++++

+++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)

++ Text units 48-48:

My experience is with SIFCO and the aviation industry where the move has been from aviation to more land based turbines. There are constraints on aviation products, which make them more costly to produce. Land based products are not so tightly constrained. 48

+++++

+++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)

++ Text units 38-38:

In 5 to 6 years we will see a lot more 'modular buildings' produced, with a lot more technology going into them.

The mass production of 'pods' (modular bathroom, modular kitchens, etc.) that can be just dropped into a building using a crane, is going to increase. These are being exported from this country by companies, such as Fusion Buildings (Ringaskiddy) and Delta Homes, which operates on similar lines. We are also working on this system here. 38

+++++

+++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 47-47:

As I said previously, building towards an overall project is a good educational technique and **what is now big and is not going to go away, is the whole environmental issue.** It will be important for students to know: 'How to refer to information, legislation and regulations in general on this issue?'

+++++

xix a class on 'the methods on how to answer questions?'

'how to avoid questions?' 'how to explain things to craftsmen/other engineers?' and generally 'how to get your point across clearly?';

it is important that in anything one does: - to do it, check it, make sure it's completely correct.

xx building towards a project;

how to refer to information, legislation and regulations.

xxi the internet was something we used for researching a topic;

how to refer to information, legislation and regulations;

how to get information.

xxii 'team management' might be a good idea;

methods of personnel management;

General Electric management philosophies;

Japanese management skills;

'people management' and 'money management'.

xxiii more industry-based examples should be shown.

-
- xxiv a class on 'the methods on how to answer questions?'
 'how to avoid questions?' 'how to explain things to
 craftsmen /other engineers?' and generally 'how to get
 your point across clearly?';
 it is important that in anything one does: - to do it, check
 it, make sure its completely correct;
 'team management' might be a good idea;
 methods of personnel management;
 personality development for engineers;
 the foundations of 'self directed learning'- the
 development of public speaking and project skills
 develops confidence.
- xxv six to eight people to discuss a problem around a table -
 this could be recorded on video - the various roles within
 the group would then be highlighted;
 structured learning on Ford, General Electric, Toyota
 problem solving skills.
- xxvi presentations are recorded on video and
 subsequently played back;
 a class on 'the methods on how to answer questions?'
 'how to avoid questions?' 'how to explain things to
 craftsmen /other engineers' and generally 'how to get
 your point across clearly?';
 more emphasis on presentations;
 more emphasis on project work;
 the development of public speaking and project
 skills develops confidence.
- xxvii the development of public speaking and project
 skills develops confidence.
- xxviii six to eight people to discuss a problem around a table -
 this could be recorded on video - the various roles within
 the group would then be highlighted;
 'team management' might be a good idea;

there are not enough 'team working development skills'
on the course.

xxix the project management software MICROSOFT
PROJECT.

xxx give students a four page document on heat exchangers
for example - they should then produce a synopsis of this
document reducing it into ten lines; increase the
development of their report writing skills;
more emphasis on presentations;
more emphasis on project work.

xxxi someone who has done it previously could talk to
students.

APPENDIX 10: N4 reports-course expectations.

Q.S.R. NUD*IST Power version, revision 4.0.

Licensee: Francis Spenser Murphy.

PROJECT: QMt Project, User Francis S. Murphy, 3:53 pm, Apr 9, 2004.

***** (1 6 16) /Fitness for purpose/Course/Expectations

*** Definition: Previous expectations of the course

+++++ ON-LINE DOCUMENT: 1. Past graduate (male CIT)

++ Text units 4-4:

No preconceived ideas of the course. Was happy enough with the course. 4

+++++ ON-LINE DOCUMENT: 4. Present student (male CIT)

++ Text units 9-9:

The first year in industry, subsequent to the degree course, will be another year of learning. Not disappointed with the course from the point of view of previous expectation. 9

+++++ ON-LINE DOCUMENT: 5. Non-completing (male telephone)

++ Text units 9-10:

Yes. 9
I looked at every engineering course and my points influenced the decision in favour of mechanical engineering. 10

+++++ ON-LINE DOCUMENT: 6. Non-completing (male telephone)

++ Text units 7-7:

Not really. 7

+++++ **PROJEC**

T: QMt2 Project, User Francis S. Murphy, 3:55 pm, Apr 9, 2004.

***** (1 6 16) /Fitness for purpose/Course/Expectations

*** Definition: Previous expectations of the course

+++++ ON-LINE DOCUMENT: 2. present studs. 2-1 (2 female (A & B) CIT)

++ Text units 10-10:

A. I didn't know what to expect. 10

++ Text units 12-12:

B. I expected the subjects: - mechanics, thermodynamics, mathematics. I did not expect manufacturing. The course was much more general than I thought it would be. 12

++ Text units 14-14:

A. Yes, we get a taste of everything. We don't really specialise. 14

+++++ ON-LINE DOCUMENT: 6. non-comp. 2-2 (male telephone)

++ Text units 9-9:

Did not know what to expect. It wasn't interesting. 9

+++++ **PROJEC**

T: QMt3 Project, User Francis S. Murphy, 3:57 pm, Apr 9, 2004.

***** (1 6 16) /Fitness for purpose/Course/Expectations

*** Definition: Previous expectations of the course

+++++ ON-LINE DOCUMENT: past grad. 3-1 (male Freefoam)

++ Text units 8-8:

Yes. It was. 8

+++++ ON-LINE DOCUMENT: past grad. 3-2 (male Freefoam)

++ Text units 7-7:

Yes, for the most part. 7

+++++ ON-LINE DOCUMENT: past grad. 3-3 (male Pfizer)

++ Text units 7-8:

At the METS interviews, I had an idea of mechanical engineering, but it was no way near. It was actually a surprise. 7

We had no school visits to CIT prior to becoming a student, so it was very hard at the start. 8

+++++ ON-LINE DOCUMENT: past grad. 3-4 (male EMC)

++ Text units 11-13:

It was. 11

The course was recommended to me by one of my school classmates, whose brother had done the course. 12

+++++ ON-LINE DOCUMENT: past grad. 3-5 (male PM)

++ Text units 15-16:
It was. 15

I was expecting the technical content. 16

+++++ ON-LINE DOCUMENT: past grad. 3-6 (male MCOS)
++ Text units 12-12:

Leaving secondary school I did not know what to expect from the course. It is very difficult to have expectations at that age. However, in retrospect I am very pleased that my choice was the Mechanical course. My first choice in my CAO was Food Processing Engineering, but I am now very pleased that this did not come to fruition. 12

+++++ **PROJEC**
T: QMt4 Project, User Francis Spenser Murphy, 3:54 pm, Jul 16, 2004.

***** (1 6 16) /Fitness for
purpose/Course/Expectations

*** Definition: Previous expectations of the course

+++++ ON-LINE DOCUMENT: past grad. 4-1 (male Sifco)
++ Text units 10-10:

Hard to know, I do not know what I was expecting. I wanted to go into engineering. I am from a family of engineers - the seventh generation of engineers. 10

+++++ ON-LINE DOCUMENT: past grad. 4-2 (male Flow Technology)
++ Text units 14-15:

Yes - more or less. 14

A lot more 'maths' than originally envisaged - in 'fluids', 'control', even 'manufacturing'. But one has to be able to do it. The level of 'maths' I am using now is not as high, but sometimes one needs an understanding of the high level 'maths'. One has to do it. 15

+++++ ON-LINE DOCUMENT: past grad. 4-3 (male Arup)
++ Text units 10-12:

I did not know what to expect. I was only 17 at the time. 10

I based my choice of courses on the brochure. There was a big picture of a turbine from SIFCO.

I am also from a farming background. I loved machinery, so mechanical engineering was an obvious choice.

+++++ ON-LINE DOCUMENT: past grad. 4-4 (male CIT postgraduate)
++ Text units 9-9:

I suppose I did not know what to expect. I had a few tours of the college facilities beforehand and toured a chemical plant. I wasn't too sure of what to expect. These are difficult decisions to make at seventeen or eighteen. 9

+++++ ON-LINE DOCUMENT: past grad. 4-5 (male O'Donovan)
++ Text units 6-6:

It was. I transferred from the National Diploma in Manufacturing Engineering, so I knew what to expect.
+++++ ON-LINE DOCUMENT: past grad. 4-6 (male Dornan)

++ Text units 6-6:

I would not say so. I did not put a whole lot of thought into it. Actually I am quite easy to please.
+++++

References:

- Adeyeri, E. (2004) "Sustainable development: from education to industrial application", *Sustainability competences for engineers workshop*, 17th February 2004 [online],
http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).
- Albrighton, F. and Thomas, J. (2000) "External relations" in Warner, D. and Palfreyman, D. (eds) *Higher education management: the key elements*, Buckingham: SRHE and Open University Press.
- Anderson, G. L. and Jones, F. (2000) "Knowledge generation in educational administration from the inside out: the promise and perils of site based administrator research", *Educational Administration Quarterly*, 36 (3): pp428-464.
- Arcidiacono, C., Sommantico, M. and Procentese, F. (2001) "Neapolitan youth's sense of community and the problem of unemployment", *Journal of Community and Applied Social Psychology*, 11: pp465-473.
- Atkinson, P., Shone, D. and Rees, T. (1993) "Labouring to learn? Industrial training for slow learners" in Gomm R. and Woods, P. (eds) *Educational Research in Action*, London: Chapman.
- Azapagic, A. (2004) "Educating the 'honest broker' engineer", *Sustainability competences for engineers workshop*, 17th February 2004 [online],
http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).
- Bachelor of Engineering in Mechanical Engineering - Submission to the Institution of Engineers of Ireland for Re-accreditation of the Degree Course in Mechanical Engineering at Cork Institute of Technology, April 2000.
- Baba, M., Kamibeppu, T. and Shimada, K. (2001) "What Universities can learn from corporations about quality control of students. A proposal from a Japanese perspective", *Total Quality Management* 12 (2): pp159-166.

Baker, R. L. (2002) "Evaluating quality and effectiveness: regional accreditation principles and practices", *The Journal of Academic Librarianship* 28 (1-2): pp3-7

Ball, L. (2000) "A framework for personal and professional development" in Bourner, T., Katz, T. and Watson, D. (eds) *New directions in professional higher education*, Buckingham: SRHE and Open University Press.

Ball, S. J. (1993) 'Self-doubt and soft data: social and technical trajectories in ethnographic fieldwork' in Hammersley, M. (ed) *Educational Research: Current Issues*, London: Chapman.

Ballantyne, R., Borthwick, J. and Packer, J. (2000) "Beyond student evaluation of teaching and addressing academic staff development needs", *Assessment and Evaluation in Higher Education*, 25 (3): pp221-236.

Barnett, R. (2000) *Realizing the university in an age of supercomplexity*, Buckingham: SRHE and Open University Press.

Bartholomew, D. (2004) "Sustainability in the built environment", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Becker, W. E. and Powers, J. R. (2001) "Student performance, attrition, and class size given missing student data", *Economics of Education Review*, 20: pp377-388.

Belfield, C. R. and Fielding, A. (2001) "Measuring the relationship between resources and outcomes in higher education in the UK", *Economics of Education Review*, 20: pp589-602.

Bennett, N., Dunne, E. and Carré C. (2000) *Skills development in higher education and employment*, Buckingham: SRHE and Open University Press.

Bolton, A. (1995) "A rose by any other name: TQM in higher education", *Quality Assurance in Education*, 3 (2): pp13-18.

- Bolton, A. (2000) *Managing the academic unit*, Buckingham: Open University Press.
- Bourner, T., O'Hara, S. and France, L. (2000) "Practitioner-centred research" in Bourner, T., Katz, T. and Watson, D. (eds) *New directions in professional higher education*, Buckingham: SRHE and Open University Press.
- Brockbank, A. and McGill, I. (1999) *Facilitating reflective learning in higher education*, Buckingham; SRHE and Open University Press.
- Brown, P. and Scase, R. (1997) "Universities and employers: rhetoric and reality" in Smith, A. and Webster, F. (eds) *The postmodern university?: contested visions of higher education in society*, Buckingham: SRHE and Open University Press.
- Carr, W. (1993) 'What is an educational practice' in Hammersley, M. (ed) *Educational Research: Current Issues*, London: Chapman.
- Cassella, R. (1999) "What are we doing when we are 'doing' cultural studies in education - and why?", *Educational Theory*, 49 (1): pp107-124.
- Clark, B. R. (1993) *The Research Foundations of Graduate Education*, Oxford: University of California Press.
- CLMS (1993), videotape, *MSc in Training, Module 1: Learning development and training*, Centre for Labour Market Studies (CLMS), Audio visual services, Leicester University.
- Coffey, M. and Gibbs, G. (2002) "Measuring teachers' repertoire of teaching methods" *Assessment and Evaluation in Higher Education*, 27 (4): pp383-387.
- Cork Institute of Technology (2000) - Academic Quality System - Book 1 - Introduction and Overview.
- Cork Institute of Technology (2000) - Academic Quality System - Book 2 - Procedures.

Cork Institute of Technology (2000) - Academic Quality System - Book 3 - Post-graduate study by Research - The CIT Research Charter.

Creemers, B. P. (1998) 'Towards a theory of educational effectiveness' in Harris, A., Bennett, N. and Preedy, M. (eds) *Organizational effectiveness and improvement in education*, Buckingham: Open University Press.

Crossley, M. and Vulliamy, G. (eds) (1997) *Qualitative educational research in developing countries: current perspectives*, New York; London: Garland.

Denning, P. (1992) "Educating a new engineer", *Communications of the ACM*, 35(12), p 83-97.

Department of Education and Science (2001) *Strategy Statement 2001-2004*, Dublin: DES.

Dickens, J. (2004) "LTSN Engineering", *Sustainability competences for engineers workshop*, 17th February 2004 [online],
http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Drudy, S. and Úi Chatháin, M. (2002) "Gender effects in classroom interaction: data collection, self-analysis and reflection", *Evaluation and Research in Education*, 16 (1): pp34-50.

Durkin, K. and Main, A. (2002) "Discipline-based skills support for first-year undergraduate students", *Active Learning in Higher Education*, 31 (1): pp24-39.

Eastcott, D. and Farmer, B. (2000) "Managing student learning" in Warner, D. and Palfreyman, D. (eds) *Higher education management: the key elements*, Buckingham: SRHE and Open University Press.

Easton, G. (1992) *Learning from case studies*, Hemel Hempstead: Prentice Hall.

Evers, C. W. (1987) "Epistemology and the structure of educational theory: some reflections on the O'Connor-Hirst debate" *Journal of Philosophy of Education*, 21(1): pp3-13.

E835 (1997) *Educational research in action*, The Open University, Totton: Hobbs.

E838 (1996) *Effective leadership and management in education*, The Open University, Trowbridge: Redwood.

Fidler, B. (1998) 'Organizational structure and organizational effectiveness' in Harris, A., Bennett, N. and Preedy, M. (eds) *Organizational effectiveness and improvement in education*, Buckingham: Open University press.

Finegold, D., Benson, G. S. and Mohrman, S. A. (2002) "Harvesting what they grow: Can firms get a return on investments in general skills?", *Organisational Dynamics*, 31 (2): pp151-164.

Fisk, D. (2004) "MSc: civil eng with sustainable development", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Freire, P. (1972) *Pedagogy of the oppressed*, Harmondsworth: Penguin.

Gahan, C. and Hannibal, M. (1999) *Doing qualitative research using QSR NUD*IST*, London: Sage.

Gans, A. M., Kenny M. C. and Ghany, D. L. (2003) "Comparing the self-concept of students with and without learning disabilities", *Journal of Learning Disabilities* 36(3): pp287-295.

Gardner, H. (1993) *Creating minds*, New York: Basic Books.

Geddes, F. (2004) "Mainstreaming sustainable development into engineering education", *Sustainability competences for engineers workshop*, 17th February 2004 [online],

http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Greenish, P. (2004) "Sustainable development is an all engineering affair. The role of the Royal Academy of Engineering", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Hargreaves (1993) "Time and teachers' work: an analysis of the intensification thesis" in Gomm, R. and Woods, P. (eds) *Educational Research in Action*, London: Chapman.

Harris (2004) "Quality assurance and good teaching", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Harrison, C. (2000) "Academic support services" in Warner, D. and Palfreyman, D. (eds) *Higher education management: the key elements*, Buckingham: SRHE and Open University Press.

Harvey L., Locke, W. and Morey, A. (2002) *Enhancing employability, recognising diversity: making links between higher education and the world of work*, London: Universities UK; Manchester: CSU.

Haworth, J. G. and Conrad, C. F. (1996) "Refocusing quality assessment on student learning", *New Directions for Institutional Research*, 92: pp45-60.

Hernon, P. (2002) "Quality: new directions in the research", *The Journal of Academic Librarianship*, 28 (4): pp224-231.

Hicks, D. (1999) "The particular and the feminine: gendered accounts in educational theorizing", *Educational Theory*, 49 (2): pp251-265.

Hirst, P. H. (1993) "Educational Theory" chapter 10 in Hammersley, M. (ed) *Educational research: current issues*, London: PCP; first published in *Educational theory and its foundation disciplines* (1983) London: Routledge & Kegan Paul.

Howarth, G. and Hadfield, M. (2004) "Sustainable product development teaching at Bournemouth University", *Sustainability competences for engineers workshop*, 17th February 2004 [online],
http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Huitema, D., Jeliaskova, M. and Westerheijden, D. F. (2002) "Phases, levels and circles in policy development: the cases of higher education and environmental quality assurance, *Higher Education Policy*, 15: pp197-215.

Hutchin, T. (2001) *Unconstrained organisations - managing sustainable change*, London: Telford.

Hyland, A. (1999) "Inclusiveness in Education" in Ward, N. and Dooney, T. (eds) *Irish Education for the 21st Century*, Dublin: Oak Tree Press.

Jackson, N. and Lund, H. (2000) "Benchmarking for higher education: taking stock" in Jackson, N. and Lund, H. (eds) *Benchmarking for higher education*, Buckingham: SRHE and Open University Press.

Jarvis, P. (1987) "The social construction of the person" in Jarvis, P. (ed) *Adult Learning in the Social Context*, London: Croom Helm.

Johnston, C. and Olekahns, N. (2002) "Enriching the learning experience: a CALM approach", *Studies in Higher Education*, 27 (1): pp103-119.

Kanji, G. K. and Tambi, A. M. B. A. (1999) "Total quality management in UK higher education institutions" *Total Quality Management*, 10(1): pp129-153.

Katz, T. (2000) "University education for developing professional practice" in Bourner, T., Katz, T. and Watson, D. (eds) *New directions in professional higher education*, Buckingham: SRHE and Open University Press.

Kirpotin, S. N. (1999) "The challenge of developing innovative teaching methods in a Russian university", *Teaching in Higher Education*, 4 (3): pp415-417.

Knight, P. T. and Yorke, M. (2003) "Employability and good learning in higher education", *Teaching in Higher Education*, 8 (1): pp4-16.

Koch, J. V. and Fisher, J. L. (1998) "Higher education and total quality management" *Total Quality Management*, 9(8): pp659-668.

Kolb, D. A. (1988) "The process of experiential learning" in Kolb, D. A. (ed) *Experience as the source of learning and development*, London: Prentice Hall.

Kramarski, B., Mevarech, Z. R. and Lieberman, A. (2001) "Effects of multilevel versus unilevel metacognitive training on mathematical reasoning", *The Journal of Educational Research*, 94 (5): pp292-300.

Lawless, C. (2000) "Using learning activities in mathematics: workload and study time", *Studies in Higher Education*, 25 (1): pp97-111.

Lewins, A. and Silver, C. (2004) *Choosing a CAQDAS package* [online], <http://caqdas.soc.surrey.ac.uk/> (accessed 2nd January 2005).

Long, P.; Tricker, T.; Rangecroft, M. and Gilroy, P. (1999) "Measuring the satisfaction gap: education in the marketplace", *Total Quality Management*, 10(4/5): ppS772-S778.

Louisy, P. (1997) "Dilemmas of insider research in a small-country setting: tertiary education in St. Lucia" in Crossley, M. and Vulliamy, G. (eds) *Qualitative educational research in developing countries: current perspectives*, New York; London: Garland.

MacAlpine, M. (2001) "An attempt to evaluate teaching quality; one department's story", *Assessment and Evaluation in Higher Education*, 26 (6): pp563-578.

Mann, S. J. (2001) "Alternative perspectives on the student experience: alienation and engagement", *Studies in Higher Education*, 26 (1): pp7-19.

Martin, M. and Schinzinger, R. (1997) *Ethics in engineering*, Singapore: McGraw-Hill.

Mergen, E.; Grant, D. and Widrick, S. M. (2000) "Quality management applied to higher education", *Total Quality Management*, 11(3): pp345 -348.

Miles, M. B. and Huberman, A. M. (1994) *Qualitative data analysis: an expanded sourcebook*, Thousand Oaks: Sage Publications Inc.

Mintzberg, H. (1983) *Structure in fives: designing effective organizations*, Engelwood Cliffs, NJ: Prentice Hall.

Nestel, D. (2002) "Development of an evaluation model for an introductory module on social medicine", *Assessment and Evaluation in Higher Education*, 27 (4): pp301-308.

Newton, J. (2002) "Barriers to effective quality management and leadership: case study of two academic departments", *Higher Education*, 44: pp185-212.

NQAI framework report 3 (2001) *Towards a national framework of qualifications: a discussion document 2001(1)*, Dublin: National Qualifications Authority of Ireland.

Ogawa, R. and Bossert, S. (1998) "Leadership as an organizational quality" in Crawford, M., Kydd, L. and Riches, R. (eds) *Leadership and teams in educational management*, Buckingham: Open University Press.

Okamoto, S. K. (2003) "The function of professional boundaries in the therapeutic relationship between male practitioners and female youth clients", *Child and Adolescent Social Work Journal*, 20(4): pp303-313.

Owlia, S. M. and Aspinall, E. M. (1998) "A framework for measuring quality in engineering education", *Total Quality Management*, 9(2): pp501-508.

Parkin, S. (2004) "Forum for the future", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Palihawadana, D. (1992) *Marketing of management education: a case study related to the Strathclyde Business School*, thesis [PhD] University of Strathclyde.

Philips, D. C. (1993) "Subjectivity and objectivity: an objective inquiry" in Hammersley, M. (ed) *Educational Research: Current Issues*, London: Chapman.

Pounder, J. (2000) "Towards a model of institutional effectiveness in higher education: implications of a Hong Kong study", *Higher Education Management* 12 (2): pp81-96.

Quality Assurance Agency for Higher Education - Subject Overview Report QO 11/98 - Quality Assessment of Mechanical, Aeronautical & Manufacturing Engineering-1996 to 1998 [online] <http://www.qaa.ac.uk/revreps/subjrev/overviews.asp> (accessed March 2001).

Reid, Y., Johnston, S., Morant, N., Kuipers, E., Szmukler, G., Thornicroft, G., Bebbington, P. and Prosser, D. (1999) "Explanations for stress and satisfaction in mental health professionals: a qualitative study", *Soc Psychiatry Psychiatr Epidemiol*, 34: pp301-308.

Reynolds, M. and Trehan, K. (2000) "Assessment: a critical perspective", *Studies in Higher Education*, 25 (3): pp267-278.

Savin-Baden, M. (2000) *Problem-based learning in higher education: untold stories*, Buckingham: SRHE and Open University Press.

Scott, P. (1997) "The postmodern university" in Smith, A. and Webster, F. (eds) *The postmodern university?: contested visions of higher education in society*, Buckingham: SRHE and Open University Press.

Scott, W. R. (1998) "Organizational effectiveness" in Harris, A., Bennett, N. and Preedy, M. (eds) *Organizational effectiveness and improvement in education*, Buckingham: Open University Press.

Shearman, R. (2004) "[Engineering Council (UK)] United Kingdom standards for professional engineering competence", *Sustainability competences for engineers workshop*, 17th February 2004 [online], http://www.raeng.org.uk/education/vps/events_1.htm (accessed 9th March 2004).

Spencer, K. J. and Schmelkin, L. P. (2002) "Student perspectives on teaching and its evaluation", *Assessment and Evaluation in Higher education*, 27 (5): pp397-409.

Staropoli, A. (1991a) "Institutional evaluation: the role of the main actors in higher education" in Dahllöf, U., Harris, J., Shattock, M., Staropoli, A. and in't Veld, R. *Dimensions of evaluation in higher education*, London: Jessica Kingsley Publishers.

Staropoli, A. (1991b) "The evaluation of research" in Dahllöf, U., Harris, J., Shattock, M., Staropoli, A. and in't Veld, R. *Dimensions of evaluation in higher education*, London: Jessica Kingsley Publishers.

Staufanbiel, R. W. (1993) "German Education in Mechanical Engineering from the perspective of the RWTH Aachen", *International Journal of Engineering Education*, 9(1): pp29-42.

Taylor, S. and Henry, M. (2000) "Globalization and educational policymaking: a case study", *Educational Theory*, 50 (4): pp487-504.

THES (1987) *Response to help*, a review of "Thought and Language" by Lev Vygotsky, *Times Higher Educational Supplement*, 19/6/87.

Thomas, H. (2000) "Strategic planning" in Warner, D. and Palfreyman, D. (eds) *Higher education management: the key elements*, Buckingham: SRHE and Open University Press.

Thomas, H. G. (2001) "Towards a new higher education law in Lithuania: reflections on the process of policy formulation" *Higher Education Policy*, 14: pp213-223.

Toohey, S. (2000) *Designing courses for higher education*, Buckingham: SRHE and Open University Press.

Torrance, H. and Pryor, J. (2001) "Developing formative assessment in the classroom: using action research to explore and modify theory" *British Educational Research Journal*, 27 (5): pp615-631.

Trifonnas, P. (1998) "Reason unbound: toward a re-grounding the metaphysical foundations of the university", *Educational Theory*, 48 (3): pp395-410.

Vesilind, P. A. and Gunn, A. S. (1998) *Engineering, ethics, and the environment*, Cambridge: Cambridge University Press.

Walker, J. C. and Evers, C. W. (1986) "Theory, politics and experiment in educational research methodology", *International Review of Education*, 32(4: 86) pp373-397.

Waghid, Y. (2000) "Reconceptualising engineering education: creating spaces for outcomes and dialogical *agape*", *Higher Education* 40: pp259-276.

Wals, A. E. J. and Jickling, B. (2002) "Sustainability in higher education: from doublethink and newspeak to critical thinking and meaningful learning", *International Journal of Sustainability in Higher Education*, 3 (3): pp221-232.

Watson, D. (2000a) "Lifelong learning and professional higher education" in Bourner, T., Katz, T. and Watson, D. (eds) *New directions in professional higher education*, Buckingham: SRHE and Open University Press.

Watson, D. (2000b) *Managing strategy*, Buckingham: Open University Press.

Webb, B. (2002) "Using focus groups as a research method: a personal experience", *Journal of Nursing Management*, 10: pp27-25.

Welsh, J. F., Alexander, S. and Dey, S. (2001) "Continuous quality measurement: restructuring assessment for a new technological and organisational environment", *Assessment and Evaluation in Higher Education* 26 (5): pp391-401.

Yin, R. K. (1994) *Case study research: design and methods*, Thousand Oaks: Sage Publications Inc.

Yorke, M. (2000) The quality of the student experience: what can institutions learn from data relating to non-completion? *Quality in Higher Education*, 6 (1): pp61-75.