Student-Centred Quality Improvement Systems in Manufacturing Engineering Higher Education

A Thesis Submitted for the Degree of Doctor of Philosophy

by

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Abstract

Recent changes within British higher education have led to a refocus as to the purpose of such education. This movement has been particularly noticeable in the engineering disciplines. These changes have involved a move towards a more 'transformational' objective, where the emphasis is on the development of the full range of learning abilities within a student coupled with an external, or 'real world', orientation. To develop such learning abilities requires specific educational approaches that are based on student-centred processes and the preparation for lifelong learning. This new purpose, and its inherent educational methods, has implications for the type of quality improvement systems adopted. Robust approaches developed in manufacturing industries have been identified, and the thesis argues that quality systems based on developments in these industries can be used in higher education to create a culture that engenders this positive learning approach. This involves a move away from passive, quantitative quality monitoring systems that focus on the 'product' of learning, and move towards more qualitative, active and dynamic department-wide quality improvement systems that focus on the developmental 'process'.

Traditional methods of addressing quality in higher education departments can be seen to focus on rudimentary control mechanisms, where action is post-process and reactive, and where the feedback loop often not closed, i.e. preventative and corrective actions, when identified, are not initiated. Such approaches add very little to the purpose of higher education (i.e. developing the range of 'transformational' learning abilities), as there is an overemphasis on evaluation and not enough emphasis on enhancement, development and preparation for continuous learning. The main thesis, therefore, links learning theory to quality theory, via the concepts of development cycles, lifelong learning and continuous improvement.

To ascertain the validity of the theses required a research methodology that was based on an in-depth longitudinal action/applied research case study. The research involved a three and a half year study of the quality improvement systems of a manufacturing engineering department of a British university. The research introduced and investigated a strategy that would result in a move from the 'post-process/passive' student involvement to 'in-process/ active'. The case study found that the thesis was valid, in that particular students and members of staff adopted the quality improvement system (i.e. a change in observable behaviour). The contribution to knowledge involves the examination of the interaction between departmental culture and systems, where a 'cultural shift' is necessary involving (i) a change in the role of the undergraduate student (i.e. from passive members in the process, to central participants in the creation and improvement of quality), and (ii) a change in the focus of quality (i.e. from checking that learning was taken place, to promoting and preparing students for lifelong learning).

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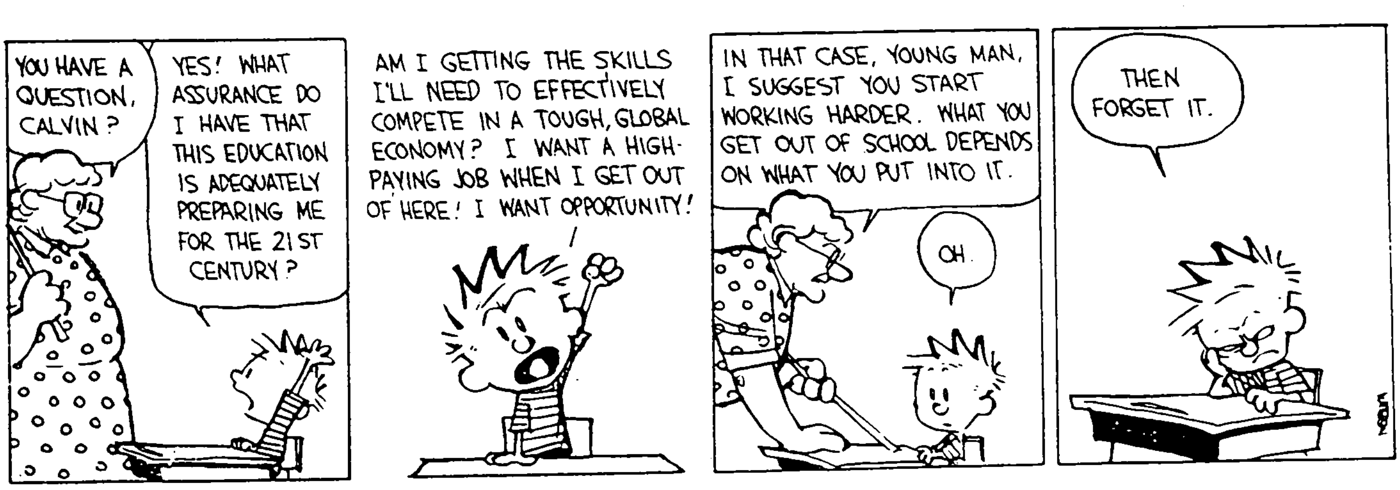
An extra special thank you to Rachel for keeping me going with her determination, confidence and cups of tea.

Finally, this thesis is dedicated to Mum and Dad, without whom it "would not have been possible", and to Joey, Nick, Mamoo and Yelly.



Watterson, 1995, p. 25.

"Give a man a fish and you feed him for one day. Teach a man to fish and you feed him for a lifetime".

Chinese Proverb.

Declaration

I declare that, to the best of my knowledge, no portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

The thesis conforms to British Standard BS 4821: 1990, the 'British Standard Recommendations for the Presentation of Theses and Dissertations', and follows the Harvard referencing system.

Glossary of Definitions

In order that the reader should more easily find the definition of terms used throughout the thesis a list is given.

Affective Domain: Learning related to the emotions, values, and attitudes.

Cognitive Domain: Learning related to mental processes such as knowing and understanding.

Engineering Education: Undergraduate degree programmes in British higher education.

Fitness for Purpose: Systems, methods, approaches, processes, etc. that enable the achievement of educational objectives.

Fitness of Purpose: Objectives that match a transformational orientation.

Higher Education: The range of learning abilities developed in a range of institutions.

Information Age: A society where there a greater uncertainties and faster cahnges, and where communication, flexibility, adaptability and critical thinking are key requirements.

Learning: A relatively permanent change in behaviour or in behavioural potentiality that results from experience and cannot be attributed temporary body states such as those induced by illness, fatigue or drugs.

Learning Abilities: Factors that lie in the full range of the cognitive and affective domains.

Learning to Learn: Educational initiatives aimed at explicitly increasing learners awareness of how they learn and how this can be enhanced and developed.

Liberal Arts Education: The promotion and development of the individual student for the good of society.

Lifelong Learning: Continuous personal and professional development via cycles of personal improvement.

Machine Age: The skills needed for an industrial society, based on hierarchical structure and narrowly defined, isolated jobs.

Organisational Culture: The philosophy and values which create common understanding among organisational members concerning the organisation's mission and how its members should behave.

Process: The transformation of a set of inputs into desired outputs.

Purpose of Higher Education: To assist and enable a transformational orientation.

Quality in Higher Education: Enabling students to examine and develop a range of 'transformative learning abilities.

Quality of Higher Education: The attainment of both 'fitness of purpose' and 'fitness for purpose'.

Quality: 'Fitness of purpose' and 'Fitness for purpose'.

Systems: A group or combination of interrelated, interdependent, or interacting elements forming a collective entity.

Total Quality Management: Continuous quality improvement on a personal and an organisation-wide basis.

Transformational Education: The promotion and development of a student's full range of internal learning abilities matched to an external orientation.

Vocational Education: The promotion and development of abilities useful to the economy over those that are useful to an individual.

Glossary of Abbreviations

In order that the reader should more easily find the definition of abbreviations used throughout the thesis a list is given.

BDPD:	Brunel Diploma in Professional Development
BME:	Brunel Manufacturing Engineering
BSI:	British Standards Institution
CEPP:	Centre for the Evaluation of Public Policy and Practice, Brunel University
CNAA:	Council for National Academic Awards
CPD:	Continuing Professional Development
CQI:	Continuous Quality Improvement
CUA:	Conference of University Administrators
CVCP:	Committee of Vice Chancellors and College Principals
DIS:	Diploma in Industrial Studies
DPA:	Departmental Purpose Analysis
EDC:	Engineering Deans Council (USA)
EN:	European Number
EPC:	Engineering Professors' Council (UK)
HEFCs:	Higher Education Funding Councils
HEFCE:	Higher Education Funding Council for England
HEQC:	Higher Education Quality Council
HMI:	Her Majesty's Inspectorate
I:	Inspection
IEE:	Institution of Electrical Engineers
IMechE:	Institution of Mechanical Engineers
ISO:	International Standards Organisation
LEAs:	Local Education Authorities
NAB:	National Advisory Board
NFER:	National Foundation for Educational Research
PCFC:	Polytechnics and Colleges Funding Council
PI:	Performance Indicators
PSHE:	Public Sector Higher Education
PSI:	Personalised System of Instruction
QA:	Quality Assurance
QC:	Quality Control
QFD:	Quality Function Deployment

SEE: Special Environmental Engineering

SEP: Special Engineering Programme

SPC: Statistical Process Control

SRHE: Society for Research into Higher Education

THES: Times Higher Education Supplement

TQM: Total Quality Management

UCoSDA: Universities' and Colleges' Staff Development Agency

UFC: University Funding Council

UGC: University Grants Committee

UNESCO: United Nations Educational, Scientific and Cultural Organisation

USDU: Universities Staff Development Unit

Chapter 1 - Introduction

This dissertation sets out to examine the recent changes in British higher education, and how these have led to a re-focus as to the purpose of higher education, from a vocational orientation towards a 'transformational' one. This new purpose is investigated both in terms of the types of learning abilities required and the types of educational methods available. To achieve the development of these learning abilities requires specific approaches, and it is this area that forms the main thrust of the dissertation. Emphasis is placed on engineering education, as it is within this discipline area that the need for, and attempts to achieve, this new focus have been particularly noticeable. From this it is argued that the achievement and maintenance of the 'transformational' purpose requires an approach based on quality improvement systems (i.e. is the purpose of a higher education institution or course the right one and is this purpose being attained?), and reference is made to the types, and use of, quality systems that have been developed in manufacturing industries. Based on the examination of the 'transformational' purpose, the requisite learning abilities, and the inherent quality systems, the thesis presented in this dissertation postulates a link between the introduction of quality improvement systems that are based on those developed in manufacturing industries, and the move towards a culture that supports the new 'transformational' purpose. To investigate this thesis requires a research methodology that moves beyond quantitative measures towards a more qualitative and in-depth approach, where the relationship between systems and culture can be more meaningfully examined. This approach is based on a longitudinal case study of a particular manufacturing engineering department of a British university. The findings of the case study are related back to the thesis, and it is shown that the thesis is valid. Consideration is then given to both the research case study and the research methodology adopted, and areas of future work are identified.

A brief overview of each of the sections within the dissertation is now given, as well as a summary of the thesis and the findings of the research case study.

1.1 Higher Education

Institutions of higher education have a significant role, both within British society and the British economy. In the past this dual role has resulted in two distinct orientations: societal and economic. The societal orientation has resulted in such institutions of higher education instilling in students a broad cultural awareness and the foundations for continuous and self-directed learning (i.e. the development of the individual), whereas an economic orientation has resulted in the development, within a student, of subject or job specific skills and knowledge. The former orientation is often referred to as 'liberal arts' and the latter as 'vocational', and both emphasise the development of a different range of learning abilities and educational methods. In the past there has been a movement from a liberal arts orientation towards a more vocational orientation. Recent changes within the environment in which the higher education institutions operate, such as an increased and more variable student intake, changes in the fabric of both society and the economy, etc., have led to a re-appraisal of the purposes of these institutions. These changes have led to an orientation that encompasses the strengths of both the vocational and liberal arts orientations, that of 'transformation'.

1.2 Learning

It is argued that such a 'transformational' purpose involves an emphasis on the promotion and development of an individual student's full range of learning abilities together with an external orientation. Under this orientation, higher education should aim to engender students with a rounded ability (i.e. liberal arts elements) matched to an appreciation and understanding of the external environment (i.e. vocational elements). This, therefore, involves developing a student's abilities in both the cognitive (i.e. learning) and affective (i.e. motivation and behavioural) domains. Such an approach has its foundations in concepts such as learning cycles, learning-to-learn, lifelong learning, and continuing professional development, where a student plans, reviews and improves his/her learning strategy and learning ability. From this, it is argued that higher education needs to adopt approaches that explicitly address these learning strategies and the 'transformational' purpose.

1.3 Engineering Education

It has been argued that the British higher education sector has a number of objectives or purposes. It has been found that the emphasis and priority placed on each purpose depends on the particular institution, discipline area, degree course, etc., and is seen to change over time and circumstances. Engineering is seen as an essentially vocational discipline and, based on this premise, the needs of prospective employers and professional institutions have traditionally directed the purpose of engineering education. Such an economic-centred focus has resulted in some engineering departments 'training' students for specific jobs. However, changes in the environment in which engineering education functions, have resulted in a re-appraisal of the purpose of engineering education. These changes have increased pressure for engineering education to move toward more 'transformational' (i.e. student-centred) models. This involves shifting the educational emphasis from the 'product' of learning (i.e. what students learn) to the 'process' of learning (i.e. how students learn). The purpose is, therefore, to prepare students for 'lifelong' learning. Traditional educational methods can act as a barrier to this new purpose, as such methods are often teacher-centred, involve heavily fact-based courses that encourage a passive, surface approach to learning, and are seen to discourage student initiative or adaption. To achieve the 'transformational' purpose requires the introduction and adoption of particular approaches (i.e. 'systems') that ensure that the correct objectives are being achieved (i.e. the required 'quality' is being achieved).

1.4 Quality Systems

From an examination of the traditional (i.e. vocational) purpose of engineering education it can be seen that educational objectives and methods (and their inherent quality systems) are still based in the 'machine age'. Such systems are seen to concentrate on factors that are quantifiable, easily measured and highly visible. It is argued that the issues of purpose and quality are interlinked, as quality cannot be defined without purpose. Defining this purpose is important as it is this that allows us to improve the quality of higher education, i.e. by explicitly defining the objectives of engineering education it is possible to devise strategies and systems for achieving and improving on these objectives. Therefore, there are two stages of this quality process:

- Deciding what the objectives of an engineering degree course are (i.e. fitness of the purpose);
- Instigating ways of meeting these objectives (i.e. fitness for the purpose).

The debate about quality in the British higher education sector has been seen to concentrated on assessment and audit. Both these approaches have been criticised as they are perceived to do little for the attainment of the 'transformational' purpose, the proposed main objective of engineering education (i.e. they do not support and develop the required learning abilities within a student). To develop approaches that will support this 'transformative' orientation, the dissertation examines systems that have been developed in manufacturing industry. The progression of quality improvement systems is discussed, and a robust approach identified, based on individual improvement cycles adopted on an department-wide basis (i.e. continuous organisation-wide improvement).

1.5 The Theoretical Link Between Quality Improvement and Learning

It is argued that engineering education should be trying to develop quality improvement systems that are integrated into, and complement, the objectives of the educational system. This involves enabling and encouraging students and staff to participate in critical reviews of their own performance and the performance of the modules and courses in which they participate. It will be shown that quality theory maps well onto learning theory, in terms of the stages that encourage improvement in both. In encouraging and developing quality improvement systems, by definition, these systems are encouraging and developing quality. The key is to foster a system that provides the information, culture and impetus necessary to promote and encourage reflection and review. By doing this education is not only moving towards an appropriate quality system (i.e. continuous quality improvement), but is also developing the effectiveness of students' ability in learning-to-learn and lifelong learning.

1.6 The Thesis

Based on the discussion presented in this dissertation it can be seen that there are a number of hypotheses to be examined:

- There has been a change in the purpose of higher education;
- The purpose of higher education now involves a movement towards a 'transformational' orientation;
- This orientation involves the development of certain learning abilities;
- This change is particularly noticeable in engineering disciplines;
- To achieve this purpose requires specific approaches to learning and quality improvement.

Based on the above, it can be seen that the main thesis argues that:

> "Quality systems, based on developments in manufacturing industry, can be used in higher education to support a culture that engenders a positive learning approach".

To ascertain the validity of this main thesis requires the adoption of a particular research methodology.

1.7 Research Methodology and Case Study

As the main thesis required an examination of the interaction between culture and systems, i.e. a study of the culture necessary for the adoption of quality improvement and learning initiatives, the research project adopted a longitudinal, in-depth examination of a British higher education engineering department. The approach taken was relatively qualitative (i.e. flexible and iterative) and applied (i.e. a case study examining a particular department), and involved a number of data-gathering techniques so as to ensure triangulation. The case study adopted an interventionist approach, where the research strategy was to move the Department's quality systems from quality monitoring to quality improvement, and to move the students' involvement from 'post-process/passive' to 'in-process/ active' (i.e. in line with robust manufacturing-based quality systems). The research case study was carried out over three and a half years, and a link between quality improvement systems and the required learning approach was identified amongst particular groups of students and staff members. The adoption of the quality improvement system was not Department-wide, owing to a level of dissonance between the existing culture and the introduced system, possibly caused by factors in the affective domain of some participants (i.e. motivational and behavioural). Issues concerning the closing of quality improvement and learning cycles were also identified, as well as the need for the integration of such quality improvement systems at the design stage of courses (i.e. 'pre-process/pro-active').

1.8 Findings and Contribution to Knowledge

Through the research project and an extensive examination of the literature, the theses presented in this dissertation can be shown to be valid. The strong theoretical link between quality improvement systems and learning cycles (as a basis for a 'transformational' orientation) will be shown, and this will be supported by evidence from the success of the change in behaviour by particular participants in the research case study. The impact on departmental culture and systems from the relationship between internal pressure (in the form of group norms and individual behaviours and attitudes) and external pressure (in the form of economic and societal expectations) will be identified and discussed.

1.9 Conclusions

It has been argued that, to examine the theses presented in this dissertation, it is necessary to examine the background to the changes in higher education (see Chapter 2), and to how the different approaches to the required learning are developed (see Chapter 3). An overview of quality definitions and systems used in manufacturing industry and higher education is provided (see Chapter 4), and the underlying theory of quality improvement is related to the theory of learning (see Chapter 5). To ascertain the validity of the theses presented requires a particular research methodology and research strategy (see Chapter 6). The success of the strategy is reviewed (see Chapter 7), and general conclusions and future work are discussed (see Chapter 8).

Chapter 2 - Higher Education

In order to investigate the thesis (i.e. the connection between learning and quality systems), it is necessary to examine the environment and context in which this relationship takes place. The research outlined in this dissertation was carried out in an environment that is known as 'higher education'[1]. Definitions of higher education vary, ranging from institution-based, such as:

> "All types of education (academic, professional, technological, or teacher education) provided in institutions such as universities, liberal arts colleges, technological institutions, and teachers colleges, for which the basic entrance requirement is (a) completion of secondary education.... (b) the entrance age is about 18 years of age; and (c) in which the courses lead to the giving of a named award (degree, diploma, and certificate of higher education)."
>
> (UNESCO, 1962 cited in Encyclopaedia Britannica, 1985, Vol. 18, p. 1)

through to attribute-based, such as:

> "Instruction in knowledge and skills, the promotion of general powers of the mind, the advancement of learning, and the transmission of a common culture and standard of citizenship.... it fully recognises those areas of learning which have an indirect relationship to work, i.e. the arts, humanities, and social sciences."
>
> (Jarvis, 1990, p. 154)

As this dissertation is concerned with learning abilities and quality systems, both institutional and attribute-based definitions are relevant, i.e. a range of attributes developed in a range of institutions. In order to give the reader an understanding of the background to the connection between learning and quality, it is necessary to examine the structure of higher education environment, and how this impinges on the type of attributes required and developed. This will involve an overview of changes in higher education, with an examination of engineering education (as these changes have been particularly noticeable in this discipline area) . The discussion will focus on the gradual erosion of institution

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[1]The discussion is explicitly limited in time and place, as it concerns developments in the British higher education sector in the late 1980s and early 1990s. It will only examine those developments that relate to the teaching function of institutions of higher education.

autonomy, as well as an increase in external pressure on the goals and purposes of such institutions. It will be argued that these factors have resulted in a more open, universal and economic-centred system of higher education. In order to understand this situation, it is necessary to introduce and develop a number of models[2]. These will be used to provide a framework on which to discuss the changes in the British higher education system in general. A more specific discussion will concentrate on some of the changes that encompass engineering education systems. Particular attention will be paid to changes in the purpose of higher education, and how these relate to the educational process and quality systems in the remainder of the dissertation. This will provide an introduction to Chapter 3, where it will be argued that it is in higher education that the full range of such learning (i.e. cognitive and affective) abilities are established and developed.

2.1 The Structure of Higher Education

In general, the characteristics of a higher education system are seen to vary along two 'dimensions' (Becher and Kogan, 1992): control and access. The position within these two dimensions forms the framework in which higher education has to operate. It is important to examine this framework, as it will form the basis of the arguments relating to nature or 'purpose' of higher education presented later in the dissertation.

2.1.1 Control

An initial model is provided by a triangle of coordinating forces (Barnett, 1992; Becher and Kogan, 1992; CUA, 1989; de Weert, 1990). From Figure 2.1 it can be seen that there are three organising or controlling elements: an academic oligarchy; a state authority, and the market. The influence or importance of each element dictates the form of the higher education system (i.e. its position within the triangle). Using this framework, higher education can be seen to move from an institutionally autonomous system (controlled by the academic oligarchy), to a system of statism (varying degrees of external constraints from a state authority acting as a 'buffer' between the institutions and the market), and

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[2]The term 'model' is used in a non-technical sense (Becher and Kogan, 1992), as a straightforward and simplified means of thinking about the relationship between the components of a higher education system. In this sense it does not set out to quantify the various inputs and outputs and any relationship between them.

finally the market system (in which competition amongst institutions and amongst students determines the structure of such a system).

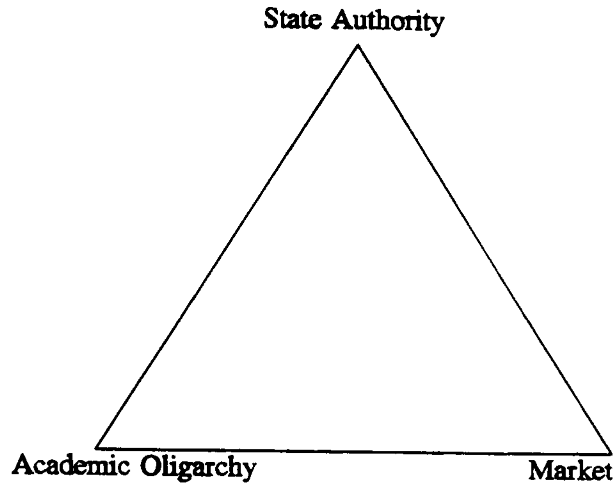

Figure 2.1: The Triangle of Forces in Higher Education (CUA, 1992, p.12).

2.1.2 Access

The second dimension concerns access (Becher and Kogan, 1990; Salter and Tapper, 1994). In this model there is a progression from the traditional position of an elitist system (i.e. a minority participation based on rigorous selection), to a mass system, and finally to a universal system (Figure 2.2). The system of mass access can be divided (Becher and Kogan, 1990) into two distinct sub-categories: a diversified system, where there is a large number of institutions that have distinctive major goals and academic standards; and an integrated system, where institutions provide a 'common experience' for students who have differing prerequisites and abilities. Therefore, under a diversified system, an increase in participation levels provides an opportunity for a greater variety of students and objectives (i.e. 'purposes'), whereas under an integrated system, an increase in participation provides an opportunity for a greater variety of educational (i.e. teaching and learning) methods. Later, it will be argued that increased State influence has directed such methods and purposes to more economic-centred considerations.

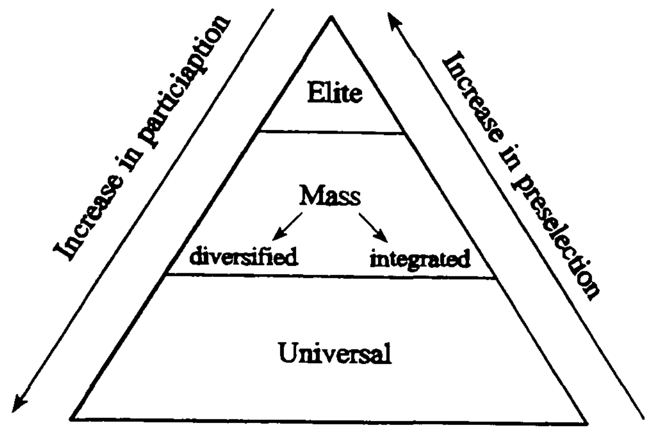

Figure 2.2: Varying Levels of Access to Higher Education

2.1.3 A Structural Model

By combining these two dimensions of control and access, a more complete model can be devised on which to base a discussion of recent developments in a higher education system (Figure 2.3). The triangular forces of control and the varying levels of access are now stretched to give dimensions of 'governance and control' and 'participation'. Using this grid it is possible to map the changes, and subsequent movements, within the British higher education system (henceforth referred to as *the higher education system*).

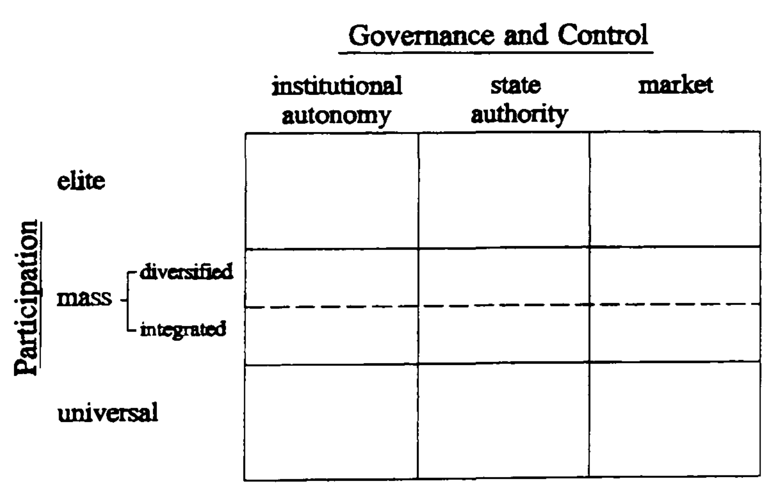

Figure 2.3: A Structural Model of Higher Education

2.1.4 The British Situation

Higher education has been subject to substantial and continuous reform since the 1980s (Green, 1993). As a result of the increasing impact of market forces, the environment that education operates in is becoming more complex and uncertain (Taylor and Hill, 1993).

This has implications for the organizational structures within higher education. Throughout the period under discussion, the Central Government's main policy has been that of reducing public expenditure through the introduction of market forces (Chaston, 1994). This has placed increased pressure on higher education institutions. All major British institutions of higher education receive core funding from the Government, and in this sense are 'public'[3] rather than 'private' (CUA, 1989). The environment in which this relationship exists has experienced significant changes over the past few years. Historically, the higher education system has been largely autonomous, and consisted of two sectors: the university sector, and the non-university sector. Intermediate bodies, such as the Council for National Academic Awards (CNAA) and the University Grants Committee (UGC), acted as a 'buffer' between the state and the institutions (Trow, 1994), i.e. there was an intermediate level between the Government department responsible for education and the individual institutions, these bodies being dominated by academics. The central Government shaped the overall system, but did little to dictate national objectives, relying instead on institutional autonomy and academic freedom. Indeed the UGC was "a body intended to protect universities from the danger of political interference" (Foreword by Maurice Shock, in Allen, 1988, p. xi). By referring to Figure 2.4, we can see that the British system is located roughly in the area indicated in position 1. Here, there is an elite university sector and a more 'open' (in terms of access and prerequisite qualifications) non-university sector. It bridges the elite/mass divide, as these two sectors provide a diversified form of mass education (i.e. the university and non-university sectors have differing goals and standards). The existence of the academically dominated CNAA and UGC meant that there was little direct Government control.

However, recent changes have moved Britain's position within the model. This has led to a shift toward increasing state authority and away from academic oligarchy and institutional autonomy. Evidence of such a shift is provided by the Education Reform Act 1988 and the Further and Higher Education Act 1992. These two Acts resulted in the removal of the binary divide between the university and non-university sectors (i.e a move from diversified to integrated mass education), increased Central Government control of higher education

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[3]Somewhat confusingly, the non-university sector, which consisted of polytechnics and some colleges, was known as 'Public Sector Higher Education' (PSHE). It was a 'Public Sector' in that it did not have the power to award its own degrees and was managed at a Local Government level. To avoid any confusion, this sector will be referred to as 'non-university'.

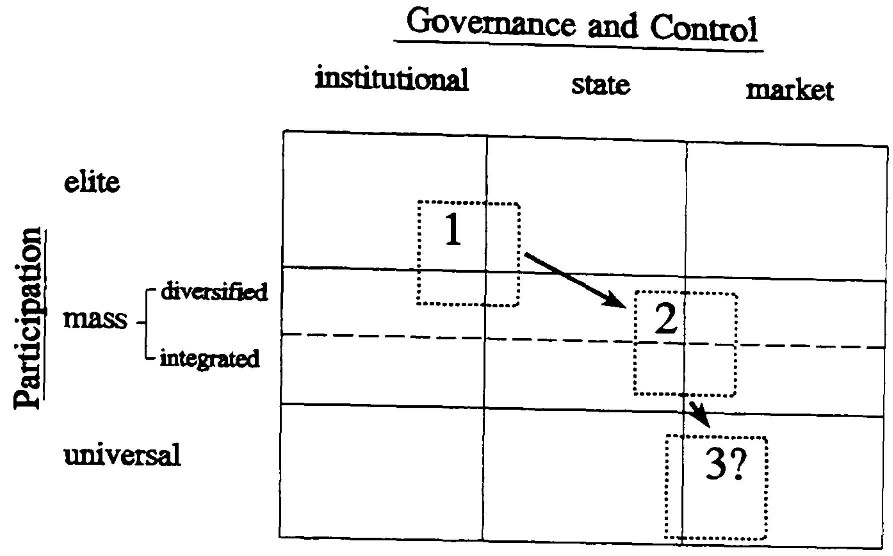

Figure 2.4: 'Mapping' Changes in the British Higher Education System.

funding (i.e. a move from institutional autonomy towards more direct state authority), and increased pressure from Central Government to increase participation rates and increase the economic content of courses and curricula (Beresford-Hill, 1993) in the higher education sector (a move towards a more enterprise based orientation). This movement is indicated by position 2 in Figure 2.4.

2.1.4.a The Education Reform Act 1988

The university sector had traditionally been largely autonomous. This sector received finance from an intermediary, the UGC, and was responsible for its own operations (e.g. it held responsibility for checking and ensuring its own quality). The non-university sector was less autonomous, being under the auspices of the CNAA and National Advisory Board (NAB). The NAB had been established to give advice to Government on funding of this sector (Kaiser et al, 1992), and coordinated funding with Local Education Authorities (LEAs). The CNAA, an independent degree-awarding body, validated proposed courses and reviewed them quinquennially. These validation and review committees consisted of peers (i.e. academics in a similar subject area but at a different institution) and, when applicable, representatives of relevant professions or industries. Broadly speaking, the LEAs were responsible for management and the CNAA was responsible for validation and accreditation. Alongside the CNAA was Her Majesty's Inspectorate (HMI), whose remit was to control quality in this sector of higher education. Therefore, control was still largely independent of Central Government. The Education Reform Act 1988, replaced the UGC with the Universities Funding Council (UFC), and the NAB with the Polytechnics and

Colleges Funding Council (PCFC). At the same time, the CNAA began accrediting non-university institutions so that they were able to validate degrees in their own right, i.e. they became incorporated bodies (Kaiser et al, 1992). This act, by establishing the UFC and PCFC, provided the building blocks for unification of the two sectors. It also marked the move toward increased centralised management by the Government, as the Act established Government control over the UFC by placing their relationship on a statutory basis (Salter and Tapper, 1994). To this end, the Act was seen to embody many of the features of state control that the British system had hitherto avoided (Allen, 1988); there was now an opportunity for the State to use these changes in the structure to direct the purpose of the higher education system.

2.1.4.b The Further and Higher Education Act 1992

It has been argued that the non-university sector had still not found a fully satisfactory way to provide mass higher education alongside the highly selective universities (Trow, 1994). To facilitate its commitment to increased 'competition' and participation, the Central Government .removed the binary divide between the polytechnic and universities, by merging the two sectors (Chaston, 1994; HEFCE, 1994) under the Further and Higher Education Act 1992. The UFC and PCFC were amalgamated into the Higher Education Funding Councils (HEFCs), with a separate council for England, Wales and Scotland (Kaiser et al, 1992). Whereas the UGC had been a buffer to protect the institutions of higher education from political pressure and ensure their autonomy, the HEFCs were an explicit instrument for the implementation of the Government's higher education policy (Trow, 1994). The Act, in effect, raised the number of university establishments from 46 to 74 (Neave, 1994). The Act increased the Government's control over the 'command structure' (Tasker and Packham, 1994) and gave it a direct means, via the HEFCs, to exert control over university teaching. The funding councils managed the universities from within a framework of ministerial directives, leading to a focus on inputs and outputs, and the concept of accountability and 'value-for-money' (Salter and Tapper, 1994). In respect to this, the state influenced university academic development, both politically and academically, by dictating the general direction of academic policy. A summary of some of the issues raised, and changes brought about, by this amalgamation and increased centralised control is provided in Table 2.1. The readers attention is drawn to column four of the table ('New University Model of HE'), where the shift towards integrated mass education and economic-centred purposes is shown.

This more active role of the state authority was inspired, in part, by the policy of 'mass' higher education. This emphasis on increased access led to a rise in student numbers. Target figures often quoted (CUA, 1989) involved a doubling in participation rates in higher education, over a period of the next 25 years, from 15% to 30%, and showed the first steps towards a possible 'universal' higher education system (point 3 in Figure 2.4). However, as participation targets were increased, the number of eighteen year olds was decreasing, due to lower birth rates in the 1960s and 1970s (Johnes, 1992; PCFC, 1989). This 'demographic dip' caused problems, as it was this group that traditionally formed the population that entered higher education. This had implications for the supply of students available to the higher education sector. In order to realise the target increase, action needed to be taken to reverse the effects of this demographic downturn. This resulted in higher education institutions encouraging entrants from increasingly diverse backgrounds (Bassis, 1986; Harvey and Green, 1993; Johnes, 1992), e.g. mature students, non-traditional qualifications, lower entry requirements, more female students in technical and scientific areas, more overseas students, etc. The traditional autonomy of the universities now had to operate in an increasingly regulatory framework of legislation and control. This can be seen in the move from state supervision to state control, which in turn mirrored the move from institutional autonomy to increased state authority, and it can be argued that there had been an erosion in the trust between Government and universities for the institutions of higher education broadly to govern themselves (Elton, 1991; Trow, 1994). This manifested itself in the linking of funding to quality assessments carried out by the funding agencies. Therefore, reform in the higher education sector was taking place (Barnett, 1993), under the direction, coordination and active influence of the state. The higher education sector was now subject to increased pressures from wider access, the 'demographic dip', increased accountability and justification for public funds, an increased linking of courses and curricula to economic needs, and a Government policy committed to increased efficiency and value for money. This situation had implications for the quality mechanisms that existed in higher education (see Chapter 4).

Category:	**University Model**	**Public Sector Higher Education (PSHE)**	**New University Model of HE (1992 to date)**
A) Entry:	Preselected and controlled ('elitist')	Preselected ('public')	Less restrictive preselection ('mass')
B) Formal experience of higher education:	1) Degree programmes 2) Full-time study 3) Liberal Education bias 4) A socio-cultural socialisation process	1) Varying qualifications 2) Full and part-time and sandwich 3) Vocational bias 4) Little socio-cultural socialisation	1) Varying qualifications 2) Full and part-time and sandwich 3) Vocational bias 4) Little socio-cultural socialisation
C) Teaching and Research:	1) To transmit and expand knowledge 2) A dual role for each academic 3) Basic research	1) Teaching institution 2) Academic as teacher 3) Some applied research	1) Increasingly clear-cut separation of these two functions at an institutional, departmental and individual level 2) Increased awareness of the need to support applied research
D) Relations to state/society and tradition of internal government:	1) Institutional autonomy 2) Negotiated response to societal demands 3) Domination by academics	1) Controlled by local state and voluntary organisations, with increasing central state input 2) Ready incorporation of societal demands 3) External political and bureaucratic influence replaced by internal managerial control	1) Increasingly responsive to societal demands 2) State funding through intermediate institutions (HEFCs and Research Councils)

Table 2.1: Impact of Increased Government Control (based on Salter and Tapper, 1994)

2.2 The Purpose of Higher Education

"What is higher education for?" is a question often posed (Allen, 1988; Atkins et al, 1993). Is it for the development of 'well-rounded' and culturally aware individuals, for the 'production' of individuals that are of use to the economy, or for some other purpose? This confusion has resulted in there being no universally accepted view as to the purpose of higher education (Allen, 1988). Indeed, it has been argued that in British higher education there are a number of multiple and often conflicting purposes (Mulgan, 1993; Sparkes, 1993). The emphasis and priority placed on each purpose seems to depend on the particular institution, discipline area, and degree course, and is seen to change over time and circumstances (Chalkley et al, 1995b). To this end, a taxonomy of some potential goals is given in Table 2.2. To assist in the discussion as to these purposes of education, it is necessary to introduce a general framework. This will allow the examination of the principles of higher education that help direct and decide on these purposes.

2.2.1 Principles of Higher Education

It has been suggested (Barnett, 1990) that there are two axioms or principles of higher education: the epistemological axiom, which covers the realm of objective knowledge and recognised truth; and the sociological axiom, which states that this objective knowledge is more effectively maintained and disseminated in institutions which are relatively autonomous and in which there is comparative academic freedom. Barnett argues that Central Government policy is eroding these two axioms (see 2.1.4), whereby the securing of objective knowledge in a neutral way can no longer be assumed (the epistemological undermining), and the social independence and autonomy of institutions has evaporated (the sociological undermining). Therefore, the purpose of higher education is being steered towards programmes of study required to fulfil a particular objective, i.e. a move toward 'operationalism' (Barnett, 1993) or vocational education. The epistemological distinction (i.e. what knowledge and learning is being fostered) allows the definition of three broad categories of educational purpose: liberal arts; vocational; and what will be referred to as 'transformational'. The sociological distinction (i.e. what knowledge does society require) allows the linking of knowledge, higher education and society.

Table 2.2: A Taxonomy of British University Aims (based on Allen, 1988 and Collier, 1983)

A) <u>Abilities and Attitudes of Individual Students:</u>	1) Cognitive Learning	a) verbal skills (*eg. comprehension and discussion*) b) quantitative skills (*eg. mathematics and computing*) c) substantive knowledge (*eg. on general and specific subjects*) d) rationality (*eg. think logically, analyze and synthesise)* e) intellectual perspective (*eg. question orthodoxy*) f) aesthetic sensibility (*eg. appreciation of literature and art)* g) creativity (*eg. formulate new hypotheses and ideas*) h) intellectual integrity (*eg. conscientiousness and accuracy*) i) lifelong learning (*eg. self-directed learning and continuing education*)
	2) Emotional Development	a) self-awareness (*eg. self-analysis and reflection*) b) psychological well being (*eg. confidence and self-expression*) c) human understanding (*eg. cooperation, empathy, compassion and respect*) d) values and morals (*eg. social responsibility*) e) world-view (*eg. appreciation and respect for the varieties of religion*)
	3) Practical Competence	a) traits useful in practical affairs (*eg. apply knowledge, cope with change*) b) leadership (*eg. willingness to assume responsibility and seek advice)* c) citizenship (*eg. democracy, awareness of social issues*) d) work and careers (*eg. awareness of needs of industry and commerce*) e) family life (*eg. personal qualities required*) f) leisure (*eg. balance between work, leisure and other pursuits*) g) health (*eg. awareness of physical and mental health*)
B) <u>The Needs of Society</u>:	1) Knowledge	a) preserve knowledge (*i.e. through scholarship, publications and libraries*) b) disseminate knowledge (*i.e. so as to foster abilities of students in (A)*) c) discover new knowledge (*i.e. through pure and applied research*) d) apply knowledge to practical problems (*i.e. both in industry and society*)
	2) The Arts	a) act as a centre of the arts to benefit the local community
	3) Development of Talent	a) identify, develop and certify skills in individuals b) provide skilled manpower for the growth of national productivity c) offer opportunities to all those seeking a university education d) provide continuing education courses (*i.e. both vocational and academic*)
	4) University Experience	a) provide satisfaction and enjoyment to all university participants

2.2.2 Liberal Arts

In this category, the role of higher education is to make students part of a wider community of "wise and tolerant individuals" (Allen, 1990, p.106). By referring to Table 2.2, categories relevant to this orientation can be identified, i.e. higher education should seek to provide the student with a broad cultural awareness, the ability to think and argue rationally and logically, a willingness to question orthodoxy and consider new ideas, and the ability to become a self-directed and continuous learner. The goals of such a course are therefore broad and multiple, and can be described as a 'shotgun' approach. The purpose of such an education can be seen, on one hand as serving the needs of the individual (as it aims to enhance the individuals capacity to lead a full life), and on the other hand as serving the needs of society (as it produces rounded citizens). In general, this view argues that:

> "Universities are not intended to teach knowledge required to fit men for some special mode of making their livelihood. Their object is not to make skilful lawyers, or physicians, or engineers, but capable and cultivated human beings".
>
> (John Stuart Mill, quoted in Allen, 1988, p. 30)

This orientation is seen to provide a general education base for life rather than specific preparation for potential jobs (Neave, 1991). Such courses are traditionally reliant on institutional autonomy, and the driving force is the academic staff, as it is they who largely decide what is to be taught and how it is to be taught.

2.2.3 Vocational Studies

In this category, higher education serves the needs of the economy rather than the needs of the individual, and endeavours to improve economic performance (Allen, 1988). A vocational course often requires a student to absorb a large amount of factual information and develop certain behavioural traits (i.e. transferable skills) that are demanded by potential employers. The emphasis is therefore on practical rather than theoretical studies. By referring to Table 2.2, aims of such courses will usually involve deep and detailed knowledge of a specific subject, the ability to apply this knowledge to solve problems, the capacity to lead others, and an awareness of the needs of industry. This orientation towards education requires an acknowledgement of the right of industry to have a measure of input and control over courses in higher education institutions. Professional institutions also have a significant influence over the curriculum of many degree courses (Allen, 1988). Therefore, education displaying a vocational bias aims to train people for the labour market (i.e. a planned flow of qualified manpower) such that 'waste' represented by graduates emerging from the 'wrong' discipline is limited (Neave, 1991). In the vocational orientation, education is directed toward promoting a student's operational characteristics (Barnett, 1993), either in relation to industry (e.g. as in professional education) or in relation to the wider society (e.g. as in humanities students learning computing and management). This view can be summarised by:

> "What is a university for?.... The production of a high quality, skilled and motivated work force".
>
> (THES, 9 December, 1994, p.11)

2.2.4 Transformational

Courses aimed purely at either a vocational or a liberal arts orientation have a number of disadvantages. A vocational course may be too narrowly defined, whereas a liberal arts course may be too broad and detached from the 'real world', i.e. rigorous adherence to either one of these orientations can lead to the 'overdevelopment' of certain abilities and the neglect of others. To overcome these potential problems, this dissertation proposes a third orientation of courses: *transformational*. Such courses are 'in-between' the liberal arts and vocational orientations and extend into both areas (Allen, 1988). It can be argued that such an orientation takes the strengths of both approaches, and uses them to produce a rounded individual with an appreciation and understanding of 'real world' (e.g. economic, environmental, and industrial) issues (Sparkes, 1993). This is the 'transformational' orientation referred to earlier, and will be developed in subsequent chapters. In Figure 2.5, it can be seen that this 'transformation' requires an approach that promotes and develops a student's 'internal' or personal abilities (through self-reflection and analysis), whilst being conscious of 'real world' issues. It, therefore, requires a continuous cycle of an internal focus and an external orientation.

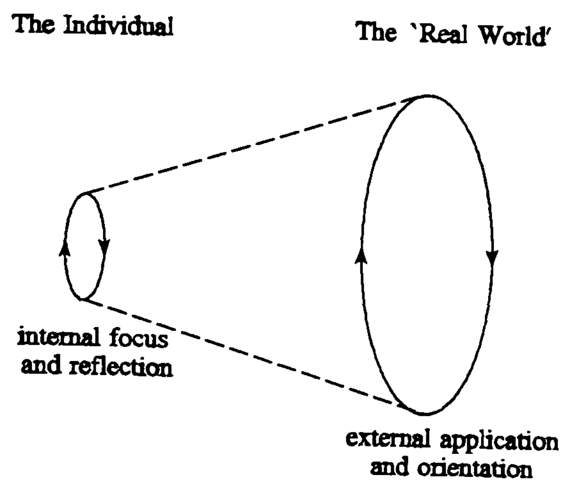

Figure 2.5: Elements of the 'Transformational' Approach

Referring to Table 2.2, such a 'transformational' orientation would focus on lifelong learning, self-awareness, human understanding, rationality, creativity and substantive knowledge. The purpose of such an orientation can be summarised by:

> "University education is not about fitting people for jobs.... the point of university education is to increase the capacity to learn rapidly and strategically in periods of great change"
>
> (Ledgerwood, 14 March, 1995, p. 8)

and

> "One of the major concerns of all staff is with preparing students for their changing and challenging futures. The ability to learn, and to continue to learn and be amenable to change are key to that preparation"
>
> (Partington, 20 January, 1995, p. 12)

2.2.5 Linking Knowledge, Higher Education and Society

The emphasis placed on each epistemological orientation can be viewed as a result of the interaction between a desired 'type' of knowledge, higher education institutions and the wider society. According to Barnett (1993, p. 33):

> "Knowledge is an essential feature of modern society.... Higher education, too, has irredeemable association with knowledge, both in its uncovering and its transmission. Higher education has ....become a pivotal institution in modern society."

To this end, a triangular relationship exists (see Figure 2.6), with each element involved in a two-way interaction. 'Higher Education' takes account of the signals it receives from society as to the knowledge capacities it seeks, 'Society' favours knowledge that help realise certain 'objectives' (in the case of modern society this knowledge is largely of an operational and strategic character, and Government policy can be seen to have a large impact on, and influence, over the type of knowledge required), and the production of 'Knowledge' within an institution of higher education has an impact on the character of the curriculum and the teaching methods used.

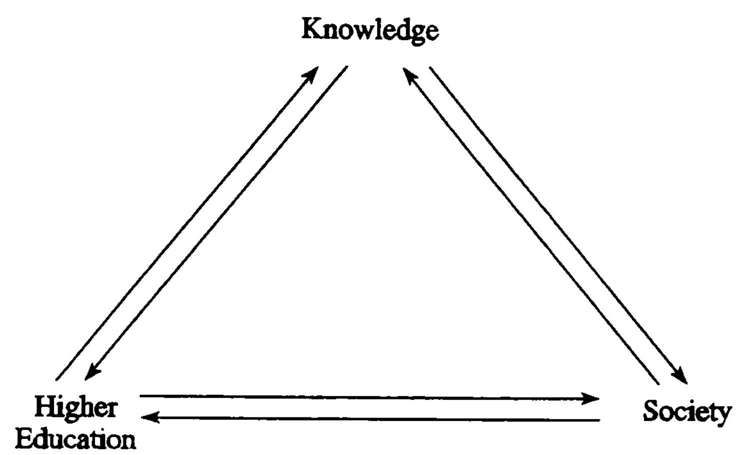

Figure 2.6: The Relationship Between Knowledge, Higher Education and Society.

From the above discussion, and the examination of the British situation in 2.1.4, it can be seen that higher education is being increasingly assimilated into society, where society is demanding that the higher education institutions supply graduates with certain kinds of skills and technical capacities (i.e. students that match or 'fit' specific objectives or 'purposes'). As the higher education sector in the UK is extremely broad, covering a large range of disciplines and courses, it will be necessary to limit the discussion by concentrating on one particular area. One specific area that has attracted much interest and activity is that of engineering education. This dissertation will, therefore, use engineering education as a particular case study of learning and quality systems. The rest of the chapter examines the background to these changes.

2.3 Engineering Higher Education

Engineering is seen as an essentially vocational discipline (Life and Wild, 1981; Nkasu, 1993; Parnaby and Donovan, 1987; Sobol, 1990; West, 1992), and, based on this premise, the needs of prospective employers (Bryce, 1993) and professional institutions (Kelly,

1988) have traditionally directed the purpose of engineering education[4]. Concentrating on such wealth creating attributes has resulted in an economic-centred focus, where higher education institutions 'train' graduates for specific jobs. In effect, precedence has been given to the needs of industry and the state authority, rather than society and the individual. Therefore, the system is being manipulated to achieve a defined purpose. However, changes in the environment in which engineering education functions, have resulted in a reappraisal of this purpose of engineering education. Such changes include:

- the structure of employment and the broadening of job descriptions (Goodman, 1993; Leake, 1993; Parnaby and Donovan, 1987; THES, 1995);
- the nature of society, where there is a move from the 'machine age[5]' towards the 'information age'[6] (Daily et al, 1992; McMaster, 1992; Sobol, 1990; Vasilca, 1994; Zell and Malacinski, 1994);
- the engineering profession itself, where there is a move away from the significance of factual knowledge (Chisholm, 1990; Sparkes, 1992; Vandelinde, 1993) and an increased emphasis on Continuous Professional Development (The Engineering Council, 1995; Farmer, 1994; Manley, 1992);
- the policy of the Government, where there is an increased emphasis on science, technology, transferable skills, and entrepreneurial skills (Barnett, 1990, 1993), as well as a move towards the concept of 'lifelong learning' (Karbhari, 1989; Sibley, 1994). These can be referred to as *inter* (between individuals) and *intra* (within an individual) personal abilities (Chalkley et al, 1995a; Kuo, 1992, McMaster, 1992; Sparkes, 1989).

These changes in purpose have increased pressure on higher education institutions to rethink their approach to engineering education, i.e. how can they achieve these new purposes (Chisholm, 1990; Sparkes, 1989, 1992, 1993). This has led to a move from a narrow, short-term approach based on vocational considerations, towards a broader

[4]'Engineering education' refers to undergraduate engineering degree programmes in higher education

[5] The term 'machine age' is used to describe the skills needed for an industrial society. It is based on a system of hierarchical structures and narrowly defined, isolated jobs.

[6]The term 'information age' is used to describe a society where there are greater uncertainties and faster changes, and where communication, flexibility, adaptability and critical thinking are key requirements.

longer-term approach based on the development of the individual learner matched to an external orientation (i.e. 'transformation').

2.4 Models of Higher Education

From the above discussions on 'structure' (2.1), 'purpose' (2.2) and 'engineering education' (2.3), two further models relating to engineering higher education can be introduced. The first deals with the changing purpose of higher education, and the second deals the operational elements of a simple higher education system.

2.4.1 The Dynamic Focus of Higher Education

The discussion so far has demonstrated that, through changes in the structure of higher education, there has been a move from a university-centred focus (related to a liberal arts orientation, academic autonomy, and an 'age of scholarship'), to an economic-centred focus (through a vocational orientation, industrial 'control', and an 'age of machines'). It has been shown, with particular reference to engineering education, that this shift towards a vocational orientation has perhaps gone too far, with students being 'trained' for too narrow a job specification and being unable to transfer their learning ability from one situation to another. The changes highlighted in 2.2 have led to the rise of the concept of 'lifelong learning' (Chalkley et al, 1995b), where engineering higher education provides and develops a base of knowledge and abilities that facilitate this.

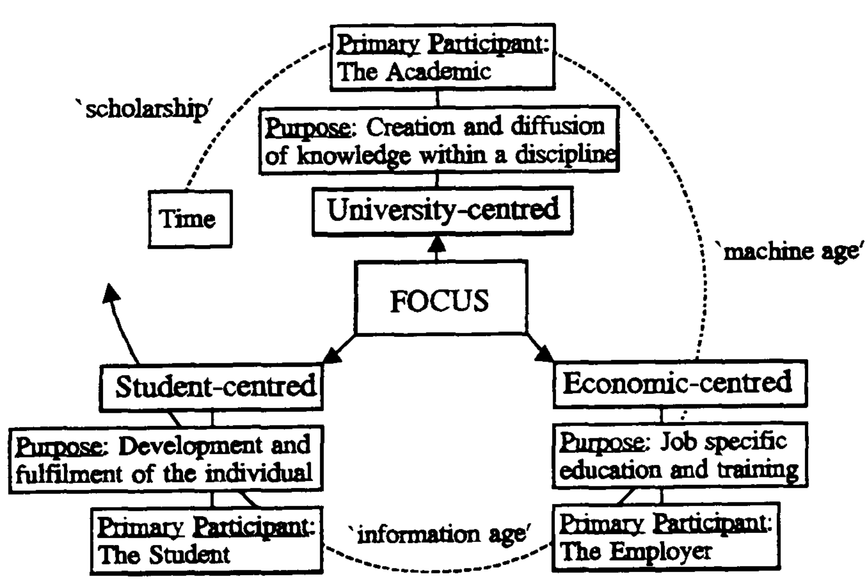

Figure 2.7: The Dynamic Focus and Purpose of Engineering Education.

This concept requires a more student-centred focus (see Figure 2.7), and this dissertation argues that this is related to a transformational orientation that emphasises personal development with a 'world view'. Once this purpose has been established, it is necessary to devise a means of achieving this. This leads in to the next model.

2.4.2 A Model of an Engineering Education System

The entrants into engineering degree courses in Britain are reflecting increasingly varying patterns of previous learning (Bassis, 1992; Chalkley et al, 1995a; de Weert, 1990; Hills, 1994: Johnes, 1992). As demand for engineers increases (Daily et al, 1992; Jaraiedi and Ritz, 1994) and supply falls (Keys and Wardman, 1991; Kuo, 1992; Levin and Wyckoff, 1988), institutions of higher education will have to look at non-traditional sources for students. At the same time, there has been increasing criticism as to the 'quality' of graduate engineers that such institutions are producing (Brookman, 1993; Goodman, 1993). It has been suggested (Goodman, 1993; Leake, 1993; Neill, 1993) that a new kind of graduate engineer is now required - one with a broader knowledge base, a team orientation, the versatility and flexibility to adapt to change, and a continuous ability to learn. This reflects the change in purpose identified earlier, and corresponds to the 'transformational' model introduced in 2.3.1. This dissertation argues that the higher education system is analogous to a manufacturing system (Collins, 1990), as they both have 'inputs' (i.e. student, staff, materials, etc.) 'processes' (i.e. how these inputs are combined), 'outputs' (i.e. the purpose of the process), and some means of 'feedback and control' (i.e. review and improvement). It is these review and development systems, or *quality systems*, that form the basis of the research presented in this dissertation. The changes in 'inputs' and 'outputs' identified earlier (i.e. the changing background of students, changes in the purpose of engineering education, increased external control, etc.) have implications for the higher education process (see Figure 2.8). This simplified view of higher education will be expanded in later chapters.

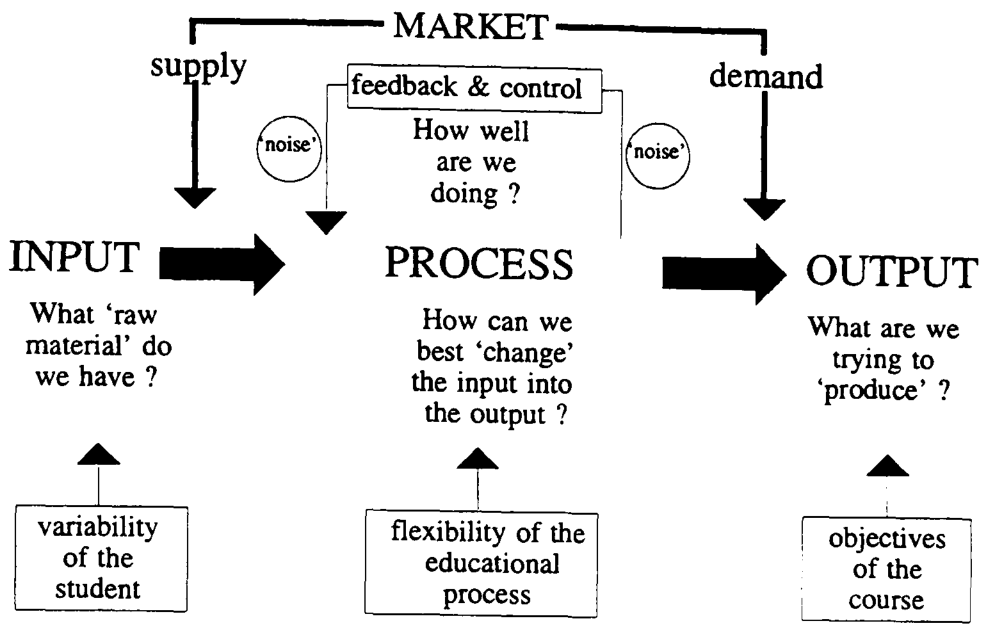

Figure 2.8: A Simple Model of an Engineering Education System.

2.4.2.a Inputs

Continuing with the manufacturing analogy, it can be seen that there are a number of 'inputs' into the educational process. These include (Jaraiedi and Ritz, 1994; Johnes and Taylor, 1990; Noonan, 1994; Taylor and Hill, 1993):

- Capital (e.g. funding from government and industry - see Appendix A);
- Labour (e.g. academics, support staff and administrators);
- Raw materials (e.g. students);
- Facilities (e.g. computers, library stock and buildings); and
- Information (e.g. curricula and syllabuses).

Some authors (Johnston, 1994) see only two inputs: students and staff. As far as this dissertation is concerned, the research has been most interested in the student, and in particular the increase in the variability of undergraduate students (in terms of needs, interests, personal characteristics, and previous learning) that higher education is experiencing (Wilson, 1981).

2.4.2.b Outputs

Some authors (Jaraiedi and Ritz, 1994; Johnston, 1994) describe the output of higher education as being the graduate themselves, whereas others see that output as the 'value added' to students by equipping them with more sophisticated knowledge, understanding, and skills (Brinkworth, 1991; Murphy, 1994; Ross and Mahlck, 1990). A view that maps on to the notion of 'transformation' is that "the end-product is people development" (Race, 1993, p. 41). In the later case, the output is not simply the factual knowledge or skills that a graduate learns on a course, but rather an appreciation and development of the learning process that the graduate underwent to acquire those abilities (Ramsden,1986). It is on this view that the research in this dissertation is based.

2.4.2.c Processes

The process of higher education can be described as the way in which resources and factors (i.e. inputs) are combined to provide outputs (Johnes and Taylor, 1990; Taylor and Hill, 1993), and includes course design (e.g. curriculum and course requirements), organisation of the educational environment, teaching, learning and assessment methods, and interaction between staff and students (Jaraiedi and Ritz, 1994; Johnston, 1994; Ross and Mahlck, 1990; Solomonides and Button, 1994). From Figure 2.8 it can be seen that the required output impinges on the process used. Part of the process, and indeed curriculum design, is evaluation and development.

2.4.2.d Feedback and Control

As stated earlier, manufacturing systems require a function that allows information from outputs and sub-operations to be 'fed back' along the production/transformation process such that action can be taken before any more inputs are processed. Examples of such functions range from post-process (i.e. action on the output stage) to in-process (i.e. action on the process stage), and from reactive (i.e. responding to problems as and when they arise) to active (i.e. anticipating problems before they occur). The need for such a function also exists in engineering education, where students and staff are encouraged to analyse, review and improve the way they approach learning situations. This area will be expanded on in Chapters 3 and 4, and forms the basis of the research presented in this dissertation.

From the above discussion, it can be seen that changes in the available inputs to engineering education (i.e. increased and more variable student intake), and in the required outputs from engineering education (i.e. via a change in 'purpose' from vocational to 'transformational'), have implications on the educational (i.e. learning) and quality systems adopted. This issue of learning will be addressed in Chapter 3, quality in Chapter 4, and the links between the two in Chapter 5.

2.5 The Focus of Engineering Education

It can be argued that, by defining the purpose of engineering education in economic and vocational rather than transformational terms, knowledge is presented as a product rather than as a process, i.e. education focuses on content and a defined body of factual material rather than on developing the ability of the learner to gather, assimilate and utilise information. Therefore, the institution (i.e. the university) is less focused on broad educational development and more focused on the development of practical knowledge that is of value to industry. From a student-centred and 'transformational' stance, this shift of focus is restrictive as primacy is given to the content rather than the process. To engender this transformational approach, changes in input, outputs, and the resulting impact on the educational environment all need to be encompassed by a move (Ramsden, 1986) from what is learned to how it is learned (i.e. the 'process' of higher education). It will be argued in Chapter 3 that this requires the adoption of more learner-centred models of engineering education, where there needs to be as much emphasis on 'learning-to-learn' (i.e. the qualitative 'process' of education) as is on learning (i.e. the quantitative 'product' of education) (Chalkley et al, 1995a).

2.6 Scope of the System in the Study

Becher and Kogan (1980) differentiate between four levels within higher education: the individual (e.g. academic staff, student); the basic academic unit (e.g. a course or department); the institution; and the central authority. As this dissertation is concerned with the relationship between learning and quality systems, it will concentrate on those aspects that relate to the individual learner (i.e. the student). Therefore, reference will be made primarily to the first level (the individual), though some reference will be made to the second level (the academic unit)[7]. The dissertation is, therefore, examining this individual student level, i.e. it is student-centred. It will therefore be concentrating at the 'micro-level' of learning, rather than the 'macro-level'.

[7]This dissertation only covers those aspects concerned with teaching and learning (i.e. it is not concerned with service functions within a university or to functions connected to research).

2.7 Conclusions

In examining the purported link between quality improvement systems and learning, it has been necessary to examine the environment that this relationship occurs (i.e higher education). It has been argued that higher education can encompass a range of institutions offering a range of courses, each aimed at developing particular attributes. Present Government policy has affected the relationship between higher education and society and higher education and knowledge. As higher education institutions are becoming less autonomous and less diverse, through an increasingly centralised policy, they are having to form closer links with industry and commerce. This has involved a shift from traditional academic courses to more vocational courses, and has been particularly noticeable in the engineering disciplines. However, this movement appears to have gone too far, with such courses over-emphasising factual knowledge and narrowly defined skills, with little attention paid to a student's personal development. At the same time higher education is admitting a larger proportion of the population who, in turn, have a broader range of educational experience and abilities. To take account of these changes, it has been suggested that the focus of higher education should be of a more 'transformational' orientation, where features from liberal arts and vocational courses are combined. To achieve this involves shifting the focus of education from the 'product' to 'the process'. To understand this process requires an examination of learning, and how in can be done in a transformational (i.e. 'student-centred') way.

Chapter 3 - Learning

In the preceding chapter, a shift in the focus of higher education from product to process was identified. It was argued that the purpose of such education should encompass elements of the liberal arts and vocational orientations, in the form of a 'transformational' approach. Such an approach involved emphasising 'how' participants (eg. students and staff) learn, as well as 'what' participants learn. This requires an examination of what is 'learning' and the 'learning process'. Therefore, this chapter will concentrate on what is meant by learning, how the required learning can be fostered, and the implications this has on the higher education system. The discussion has implications for quality, in terms of what the objectives of higher education are (i.e. fitness of the purpose,) and how these objectives are achieved (i.e. fitness for the purpose). This, in turn, has implications for quality and quality systems, in terms of what learning is required and how this learning is achieved. In this dissertation it is argued that the purpose of higher education is of a transformational orientation, where the learners' abilities are developed and enhanced through empowerment. These issues will be discussed and developed in Chapter 4. As engineering education is being used as a specific case example in this dissertation, particular attention will be paid to this area.

3.1 Theories of Learning

A number of frameworks have been employed (Hergenhahn, 1988; Richardson, 1994) to understand the nature of academic learning (i.e. learning that takes place in an academic environment). These frameworks direct attention towards different situations in which learning may take place.

3.1.1 Behaviourist Approaches

In order for psychology to be scientific, it needs a subject matter that can be reliably measured. According to this approach, the subject matter is behaviour (Hergenhahn, 1988). This school of psychology can be sub-divided into associationistic, where learning is determined by the laws of association (see Appendix B), and functionalistic, where learning derives from an organism adapting to its environment (i.e. the relationship between learning and adjustment to the environment). Such accounts of learning seek to give a detailed analysis of the relationship between a situation (i.e. stimulus) and the resulting behaviour (i.e. response). Learning at its most basic level is a series of simple stimulus-response associations, rising to a hierarchy of associations at a more complex level. Effective learning is seen to result from control of a learner's behaviour through a linear programme of learning (Beard, 1968; Richardson, 1994; Hergenhahn, 1988). Thus, it is not necessary that the learner wishes to learn, but rather that they be encouraged to follow a logical sequence of organised stimuli, with feedback as to their success serving to reinforce the correct responses (Beard, 1968). Such pure behaviourist theories have limited use in academic learning (Richardson, 1994), but two aspects, self-pacing and the need for feedback on learning, have been applied to individualised self-instruction techniques[1]. Such approaches assume that learning consists of "a process of intellectual development that involves the acquisition of an orderly sequence of increasingly abstract concepts" (Richardson, 1994, p. 2), and are largely based on studies of laboratory animal learning theory (Gibbs, 1991).

3.1.2 Cognitive[2] Approaches

This approach assigns a prominent role to mental events (Hergenhahn, 1988), especially higher mental processes such as perception, reasoning and thinking. The way in which an organism interacts with, and responds to, its environment depends on the kind of cognitive structures that it has available. This approach stresses the relationship between inputs (e.g. stimuli) and outputs (e.g. responses), and views learning as a series of successive stages of information processing (Hergenhahn 1988; Richardson, 1994). Therefore, whatever comes into the system from the environment is information. The output (i.e. behaviour) from a situation is determined by inputs to the situation combined with evaluation of the system based upon memories of the results of similar situations. Therefore, information from the environment is 'processed' (e.g. organised, simplified, ignored, etc.) by cognitive structures before it is translated into behaviour. The cognitive structure is not only affected by experience but also determines what can be experienced. This cognitive structure relies on

[1]An example of such an approach is the 'Keller Plan' or 'Personalised System of Instruction' (PSI), where courses are divided into segments, student performance is evaluated on each segment, and students move from segment to segment at their own pace (Gibbs et al, 1988, p. 79; Hergenhahn, 1988, pp. 448-455.)

[2]'Cognitive' relates to the mental processes by which knowledge is acquired and is "a general term covering all the various forms of knowing - perceiving, remembering, imagining, conceiving, judging, reasoning" (Richardson, 1988, p. 3).

two processes: assimilation and accommodation. Assimilation refers to the matching of existing cognitive structures and the physical environment, and can be likened to knowing or recognition. Accommodation refers to the modification of cognitive structures as the result of an experience that existing cognitive structures could not assimilate, and can be likened to learning (see Figure 2.31). It will be argued later in this Chapter that higher education, by concentrating on a vocational orientation, has encouraged a bias towards assimilation (i.e. short-term goals, primacy of facts and 'measurable' responses, etc.) and neglected accommodation.

As learners interpret the world in a way that is meaningful to them, the learning process involves integrating experiences into existing organisations of knowledge and using the environment in ways that are advantageous to them (Beard, 1968). As there is an emphasis on individual and personal integration, what the individual learner perceives can be selective. Teaching based on such theories is concerned with motivating learners and arranging learning experiences into meaningful wholes, where insight and interpretation are stressed, and the learning situation is more self-directed and problem-centred.

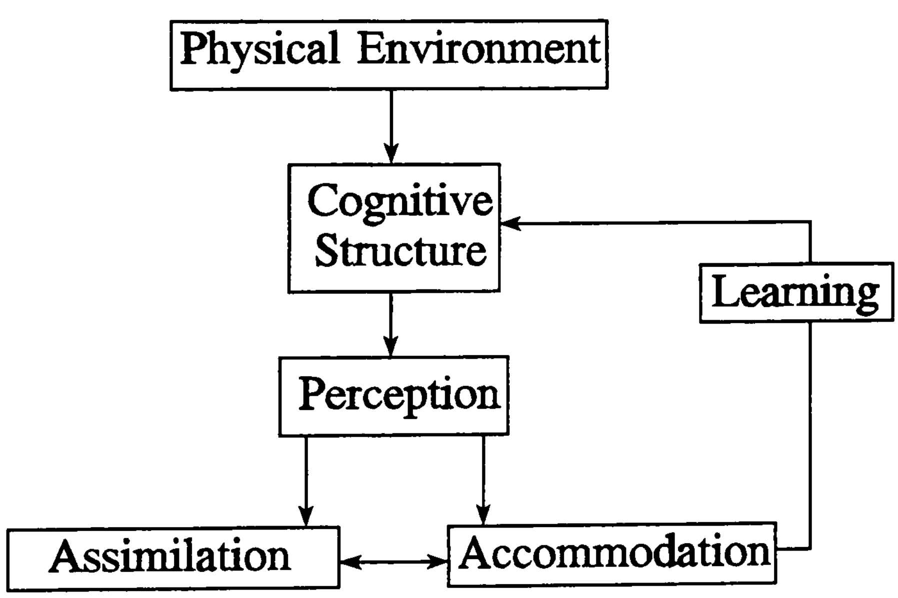

Figure 3.1: The Role of Assimilation, Accommodation and Learning in Cognitive Development (Hergenhahn, 1988, p. 277).

Under the cognitive approach, learning is essentially a matter of receiving information. Any improvements in learning are brought about by optimising the conditions under which the information is presented. As has been argued in Chapter 2, higher education has a number of aims and purposes which go beyond 'low level' repetition of simply communicated information, by moving towards 'higher level' abilities, such as creativity, self-reflection, and problem solving (i.e. 'transformation'). To achieve these 'higher level' purposes, teaching styles have to take account of the learning required to achieve these purposes, and the role of the learner in the process of learning. This distinction between 'higher' and 'lower' level abilities will be discussed later in this Chapter.

3.1.3 Other Theories

As well as the two main theories outlined above (i.e. cognitive and behaviourist), there are two other theories that should be mentioned: neurophysiological and humanist. These only mentioned briefly as they are beyond the scope of the dissertation, but are included so as to provide a balanced background to the discussion on learning. Readers are directed to Hergenhahn (1988) and Richardson (1988, 1994) for more detailed information.

3.1.3.a Neurophysiological Theories

The neurophysiological aspects of such areas as learning, thinking and perception (Hergenhahn, 1988) are related to the functions of the different hemispheres of the brain. Such theories suggest that these hemispheres process information differently, where the left hemisphere is suited to process sequential and mathematical information, and the right hemisphere is suited to process perceptual and simultaneous information. The purported differences between the hemispheres is illustrated in Figure 3.2. Traditional education has been criticised (Hergenhahn, 1988; Murr, 1988) for emphasizing the kind of intelligence associated with the left hemisphere. However, as the two hemispheres do not function in isolation, it is extremely doubtful if an educational experience can be devised exclusively for one hemisphere. Such an approach, therefore, has limited use when discussing methods of engendering and improving certain levels of learning (i.e. 'higher' and 'lower' abilities).

3.1.3.b Humanist Theories

It has been argued that learning is primarily a process of personal growth (Richardson, 1994) developed through interpersonal relationships. Significant learning can only be achieved in situations that are defined by, and under the control of, the learners themselves (e.g. a self-directed discussion group). The role of the educator is that of a 'facilitator' (Hergenhahn, 1988). Rigorous adherence to this orientation can be seen as somewhat impractical in higher education, given the resource and curriculum implications, where

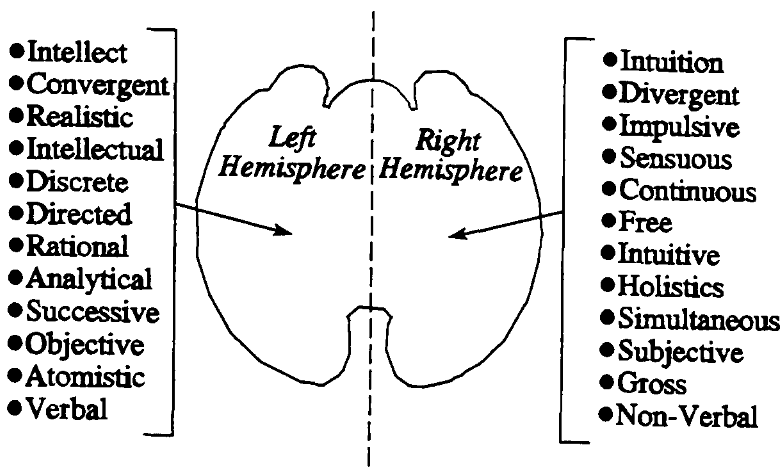

Figure 3.2: Differences Between the Cognitive Abilities of the Left and Right Brain Hemispheres.

learners often have little control over course content or method of assessment. However, this theory does engender some of the aspects of the transformational approach, in that it proposes a high level of self-actualization, i.e. self-fulfilment (Buchanan and Huczynski, 1985).

The discussion so far, from behaviourist theories through to humanist theories, has shown there is a continuum along which learning can be interpreted. At one extreme, learning is tightly controlled (i.e. the teacher decides the content and the manner of learning), whereas, at the other extreme, learning is characterised by the intellectual freedom of the learner. In practice, a higher education course will comprise a combination of these approaches, dependent on the aims or purposes of the task in hand. In order for the discussion on learning to progress, this dissertation will adopt a definition of learning based on observed behavioural change. This provides a view of learning that, for the purposes of the thesis, is easier to work with. In establishing a relationship between learning and quality systems, it has been necessary to examine the different theories that underpin learning. Further detailed discussion of the psychological theory behind this learning is beyond the scope of this thesis. However, a comprehensive introduction to this area is provided in Hergenhahn's book (1988), and readers are directed towards this.

3.2 Defining Learning

From the above discussion, it can be seen that learning is an extremely difficult concept to define (Hergenhahn, 1988, p. 1). Definitions range from "knowledge gained by study, instruction or scholarship" (Collins, 1991, p. 886), to "a more or less permanent change in behaviour brought about by experience" (Greene and Gibbons, 1991, p. 31) and "any relatively permanent change in behaviour that occurs as a direct result of experience" (Collins, 1991, p. 886). The first definition is difficult to work with as it is too simplistic and the language used is too ambiguous. The later two definitions are more useful, as learning is related to changes in behaviour and is, therefore, more discernible (Hergenhahn, 1988). By refining and clarifying these definitions slightly, Gregory Kimble (cited in Hergenhahn, 1988, p. 2) described learning as "a relatively permanent change in behavioural potentiality that occurs as a result of reinforced practice". There are a number of key phrases in this definition which need to be developed (Hergenhahn, 1988).

3.2.1 Behavioural Change

The results of learning must be translated into observable behaviour, i.e. learning enables people to do something they could not do before learning took place. The observable behaviour is studied so that inferences can be made regarding the process believed to be the cause of such changes, i.e. changes in behaviour are used as a surrogate indicator of learning, as the learning process cannot be studied directly. By following this definition, learning can be seen as an intervening[3] variable. Referring to Figure 3.3, we can see that an independent variable (experience) causes a change in an intervening variable (learning), which causes a change in a dependent variable (observable behaviour).

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[3]An intervening variable is "a theoretical process that is assumed to take place between the observed stimuli and responses" (Hergenhahn, 1988, p. 3)

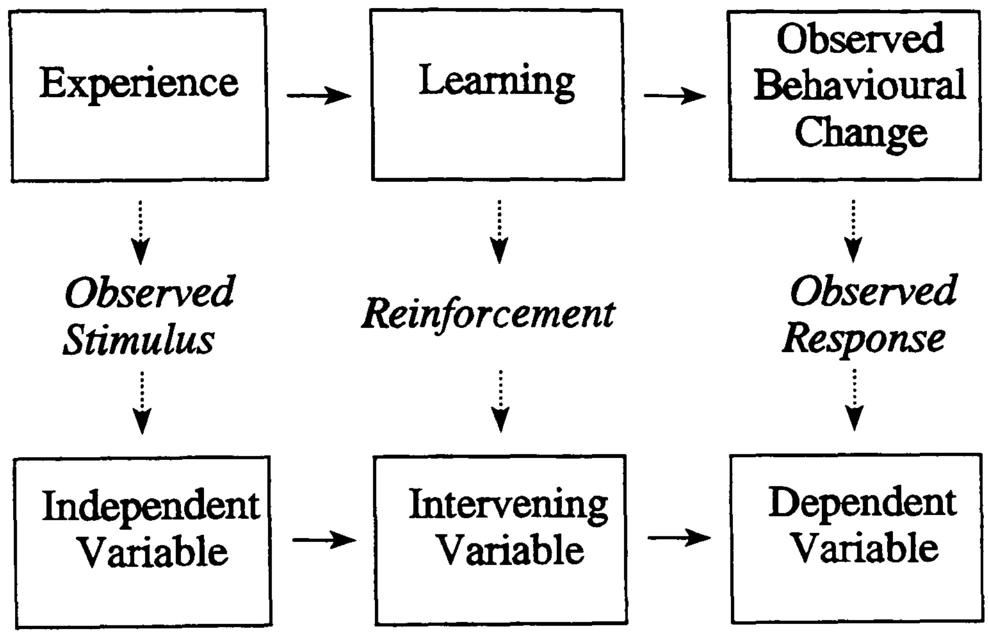

Figure 3.3: The Relationship Between Experience, Learning and Behavioural Change (Adapted from Hergenhahn, 1988, p. 3)

3.2.2 Relatively Permanent

The behavioural change is neither temporary nor fixed, rather it is relatively permanent. Therefore, it is distinct from other causes of changes in behaviour, such as fatigue or illness, which are more temporary. Problems arise when trying to define how long a behavioural change must last before it can be said that learning has been established, i.e. how long is 'relatively permanent'. This dilemma has led to the notion of short-term (i.e. rapidly forgotten) and long-term (i.e. retained for an extended period) memory, though such a discussion is beyond the scope of this dissertation.

3.2.3 Potential

The behavioural change need not arise immediately following a learning experience. Therefore, the potential to act differently may not be translated into an immediate change in behaviour. From this it can be seen that learning refers to behaviour potentiality whereas performance refers to the realisation of this potential, i.e. the translation of potential into observable behaviour.

3.2.4 Practice

The change in behaviour results from practice, training and experience. Kimble's definition, therefore, differentiates between behavioural changes based on experience and behavioural changes that are based on reflex or instinct.

3.2.5 Reinforcement

The practice must be reinforced, and only those responses that lead to reinforcement will be learned. Psychologists disagree over what constitutes reinforcement (Hergenhahn, 1988), and this has led to Kimble's definition being challenged by a number of psychologists.

From the above analysis of Kimble's definition, Hergenhahn (1988) offers a revised definition, where learning is "a relatively permanent change in behaviour or in behavioural potentiality that results from experience and cannot be attributed to temporary body states such as those induced by illness, fatigue, or drugs" (Hergenhahn, 1988, p. 7). This definition stresses the role of experience, but avoids specifying what kind of experience is necessary for learning to arise.

3.3 Approaches to Learning

Differences in the ways in which learners approach learning tasks are well established[4]. It can be argued that all learners are to some extent unique, and that no two people approach learning in exactly the same way. The theories of learning outlined earlier can be seen as abstract models that have been used to aid understanding of this area. In reality, learners 'adapt' their learning, using different approaches depending on the task, the circumstances, and the situation. It is necessary to examine these differences as they relate to the achievement of the purpose of higher education identified in Chapter 2 (i.e. 'transformation'). The discussion will form an introduction into the development of the 'higher' and 'lower' level abilities necessary for such a transformational orientation. Such

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[4] See Boyd and Cowan, 1985; Chisholm, 1990a; Collier, 1983; EPC, 1991, 1993; Fordyce, 1986; Johnson and Gladstone, 1993; Martin and Ramsden, 1988; Matthews and Hughes, 1994; Meyer and Sass, 1993; Pennington and O'Neil, 1994; Ramsden et al, 1988; Richardson, 1994; Sparkes, 1993; Strang, 1987; Trigwell and Prosser, 1991; Wilson, 1981.

differences in approach occur in two dimensions: the referential and the structural (Ramsden, 1986).

3.3.1 Referential Aspect

This aspect relates to the way that a learner approaches a task. For example, do they intend to understand it and extract personal meaning or just reproduce its content. This dimension is generally characterised as a distinction between a deep (i.e. 'meaning') and surface (i.e. 'reproducing') approach.

3.3.1.a Deep Processing

To achieve deep processing, the learner searches for the 'inner core' of the argument, whilst looking to challenge existing ideas and find personal relevance (Collier, 1983). Thus, learning actively employs a learner's ability to organise new information into their existing mental schemes. This involves relating new ideas to old and relating evidence to conclusions (Pennington and O'Neil, 1994). What a discourse (i.e. learning situation) is about (i.e. what is signified) is the focus of a learner's attention (Gibbs, 1991), and involves the learner actively changing their understanding and seeking out meaning (Wilson, 1981).

3.3.1.b Surface Processing

Surface processing involves the the learner attempting to memorise discreet facts or ideas (Collier, 1983), usually with a short-term view (e.g. to pass an exams). With such an approach, learning often takes place by rote and subsequent forgetting is rapid (Beard, 1968). The discourse itself (i.e. the sign) is the focus of the learner's attention (Gibbs, 1991). Learning tasks are viewed by the learner as external impositions (Pennington and O'Neil, 1994), resulting in a lack of reflection about purposes and strategy. Such processing is often characterised by a passive approach that focuses on superficial features, remembering facts and rarely questioning the assumptions or logic of argument (Wilson, 1981). In certain situation surface processing is effective and appropriate. However, this dissertation has argued that, to achieve the 'transformational' purpose, higher education has to develop a range of learning styles, strategies and abilities. It will be argued later in this Chapter that higher education in general, and engineering education in particular, have concentrated on techniques and systems that encourage only a limited set of such styles, strategies and abilities predominantly based on surface processing orientations.

3.3.2 Structural Aspect

The second dimension to this discussion on the different approaches to learning relates to the differing ways in which a learner organises his/her learning (i.e. the 'organising principles' they use). For example, does the learner relate new concepts to old and integrate and build internal connections, or does the learner focus on details, and treat them in isolation and in sequence. This dimension is characterised as a distinction between a holistic and atomistic or serialistic approach.

3.3.2.a Holistic Approach

By adopting a holistic approach, the learner focuses on understanding the overall meaning of a learning situation, and attempts to view a task or problem 'globally' (Gibbs ,1991; Wilson, 1981). Such learners can be described as 'comprehensive' (Wilson, 1981), as they see a learning situation as a 'whole' and try to describe relationships between aspects of the learning situation. It is different, but often complementary, to deep processing, in that the learner attempts to focus on the relations between 'events' rather than the meaning of each 'event'. A deep-holistic approach can be used to develop the 'higher' mental abilities, and this will be discussed later in this Chapter.

3.3.2.b Atomistic or Serialistic Approach

The learner focuses on specific comparisons in a learning situation, focusing on the separate parts in sequence, memorising detail, and lacking an appreciation of the overall message as a whole (Gibbs, 1991; Wilson, 1981). Such learners can be described as 'operational' (Wilson, 1981), as they try to pick up rules, methods and details, but may not see the learning situation as a 'whole'. It is different from surface processing, in that the learner is concentrating on discrete, sequential 'events'.

As argued earlier in this Chapter, to develop the full range of learning abilities requires a combination of these approaches, depending on the task, the situation, and the

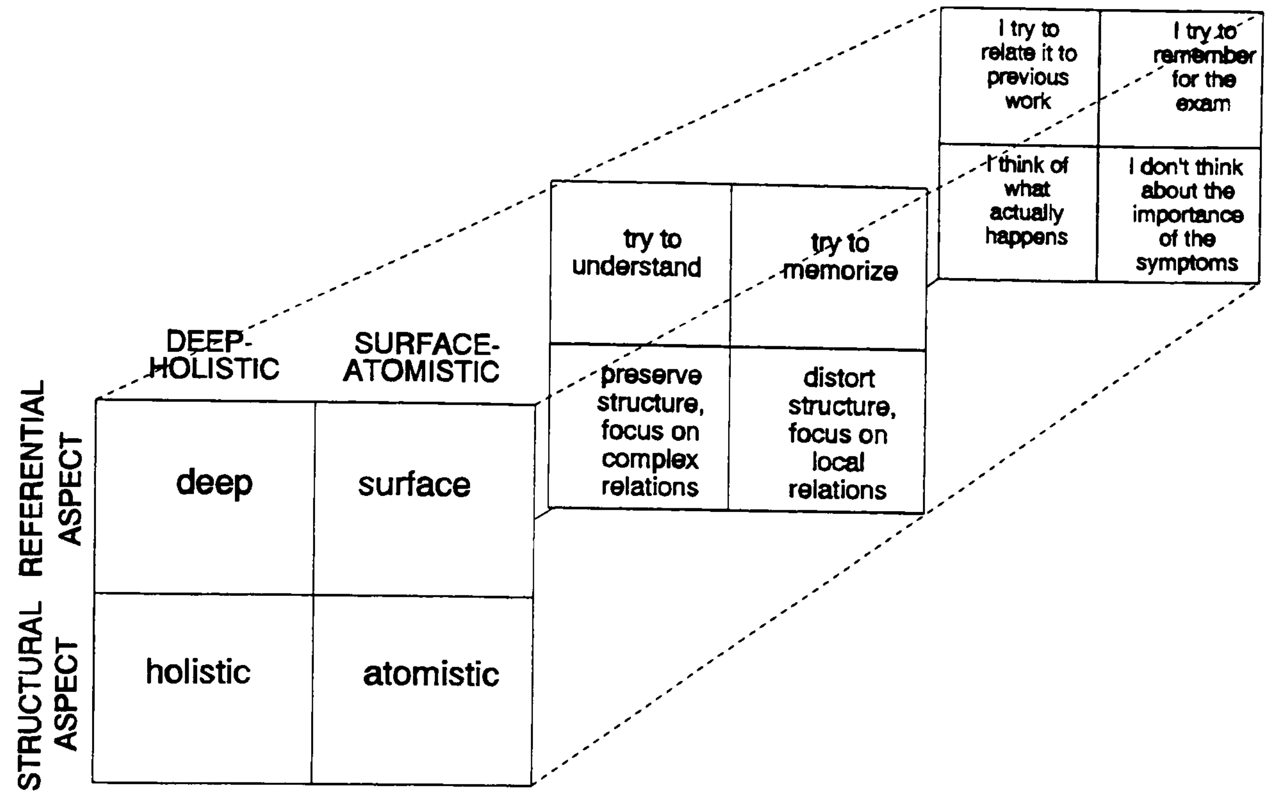

Figure 3.4: Deep-Holistic and Surface-Atomistic Approaches to Learning.

circumstances. An overview of these approaches is given in Figure 3.4.

3.3.3 Other Modes of Learning

To give a more complete understanding of the different approaches to learning, a number of alternate views are described. One such approach is categorised by defining learners as 'verbalisers', 'visualisers' and 'doers' (EPC, 1993; Sparkes, 1993). 'Doers' are learners who prefer to learn through practical activities (e.g. applied and 'hands on') in addition to verbal explanations, 'visualisers' are learners who prefer to learn through visual supports (e.g. diagrams, schematics), in addition to verbal explanations, and 'verbalisers' are learners who prefer to learn through the written or spoken word. The effectiveness of such approaches may relate to the neurophysiological theories of learning (i.e. left-right brain hemispheres), where, for example, those who prefer 'visualising' use the right hemisphere of their brain. Murr (1988) argues that traditional educational methods, heavily based on the written and spoken word, favours 'verbalisers'. Powell and Newland (undated) identify four learning (or 'information acquisition') styles: rigorous, focused, dynamic and contemplative. These styles, when combined with a learning task, result in a particular strategy. However, detailed analysis of these approaches is beyond the scope of this dissertation.

3.3.4 Strategy and Style

The approaches outlined in 3.3.3 can be linked to differing learning outcomes, and can be seen to be context-dependent (Martin and Ramsden, 1988; Wilson, 1981). They vary within the same learner, depending on the task in hand and the learners perception of the learning situation (e.g. teaching) and assessment method, i.e. learners vary their *learning strategy.* Learners impose their own meanings upon information that is presented in defined situations, and it is this that leads to qualitative differences amongst individual learners in dealing with the same learning situation, i.e. learners have a preferred *learning style.* A learning style describes a learner's preferred way of tackling tasks generally, and a learning strategy describes how a learner tackles specific tasks in the light of perceived demands. Therefore, strategies are more flexible, adaptable and modifiable than styles. Learners that can adapt learning styles can be described as 'versatile' (Wilson, 1981), as they can combine the elements of both operation and comprehension learners, depending on their perception of the learning situation. It has been argued (Powell and Newland, undated), that effective communication and learning takes place when a learning situation matches a person's learning style. However, learners will encounter many learning situations in their life, many of which do not match their style of learning. It is, therefore, necessary for learners to gain an appreciation of, and aptitude in, the full range of learning styles and strategies.

3.4 Conceptions of Learning

Learners have preconceived ideas of what learning is, based on previous experiences of learning situations. Roger Saljo (Martin and Ramsden, 1988; Strang, 1987; Zuber-Skerritt, 1992) identified five different conceptions of learning, where learning was seen as:

1 A quantitative increase in knowledge;

2 Memorizing;

3 The acquisition of facts, methods, etc., which can be retained and used when necessary;

4 The abstraction of meaning;

5 An interpretative process aimed at understanding reality.

Therefore, variation in approaches to learning are linked with variation in conceptions of learning, where surface approaches are linked to conceptions 1, 2 and 3, and deep approaches are linked to 4 and 5. To develop such deep approaches it is necessary to create both an appropriate teaching and assessment scheme and an appreciation amongst learners of these, more complex, conceptions of learning.

3.5 Taxonomies of Learning

When discussing the purpose, or outcome, of learning (i.e. what is learning for?), it is necessary to differentiate between different kinds or taxonomies of learning. A useful initial framework is provided by Bloom (cited in Matthew and Hughes, 1994, p. 234-235). Bloom identifies three domains: the affective domain, which relates to attitudes and feelings; the psychomotor domain, which relates to physical skills and abilities; and the cognitive domain, which relates to intellectual abilities. The 'transformational' orientation of higher education requires the development of a range of abilities, and this dissertation will focus, for the moment, on the cognitive domain, though later chapters will touch on the affective domain. In the cognitive domain Bloom identifies a 'hierarchy' consisting of:

- 'knowledge' which relates to the ability to recall information;
- 'comprehension' which relates to the ability to rephrase knowledge;
- 'application' which relates to the ability to apply the rephrased knowledge to a new situation;
- 'analysis' which relates to the ability to break a learning situation into its constituent parts and establish a relationship between each one;
- 'synthesis' which relates to the ability to combine separate elements into a whole;
- 'evaluation' which relates to the ability to make judgements on the worth of something.

A similar taxonomy has been suggested by both Beard (1968) and Sparkes[5] (1989, 1992). Beard distinguishes between:

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[5]The approach taken by Professor Sparkes has been adopted by the Engineering Professors' Conference (EPC, 1991, 1992, 1993)

- 'mechanical and manual abilities', consisting of 'knowledge' (i.e. memorised information from symbolic material, such as words and diagrams) and 'skills' (i.e. non-symbolic information requiring motor and perceptual learning), and;
- 'higher mental abilities', such as critical thinking, making diagnoses, solving familiar problems, creative thinking and solving unfamiliar problems.

Sparkes distinguishes between skills, knowledge, understanding and know-how, where:

- 'skills' refers to things that learners can do without 'thinking' too much about them. He sub-divides this category further into 'measurable skills' (e.g. mathematics and spelling) and 'complex skills' (e.g. communication and interpersonal skills);
- 'knowledge' refers to the ability to memorise and recall information;
- 'know-how' refers to the ability to accomplish learning tasks using accumulated experience (as opposed to the application of concepts);
- 'understanding' refers to the ability to perform complex activities and use concepts creatively (e.g. solve unfamiliar problems).

These three taxonomies are complementary, and a comparison is shown in Table 3.1.

Level of Cognitive Ability	**Model**		
	Bloom	**Sparkes**	**Beard**
Low	1 Knowledge	Knowledge	Mechanical and Manual Skills
	2 Comprehension	Know-how and Measurable Skills	
	3 Application		
Medium	4 Analysis	Understanding and Complex Skills	Higher Mental Skills
	5 Synthesis		
High	6 Evaluation		

Table 3.1: Comparison of the Proposed Taxonomies of Learning.

These different levels of learning require different approaches. By referring to section 3.3, we can see that the lower levels of learning (e.g. knowledge) can be achieved by a predominantly surface-orientated approach, whereas the higher levels (e.g. understanding) require a deep-orientated approach, and that the progression from lower to higher cognitive abilities mirrors the changes in conceptions of learning proposed by Saljo (see 3.4). It has been argued (Matthew and Hughes, 1994) that higher education should enable learners to operate at these higher cognitive levels, and encourage an active transformation of 'knowledge' into 'understanding' (Wilson, 1981). Such objectives are encompassed in the 'transformational' purpose of higher education identified in Chapter 2. These higher cognitive approaches can be seen to match the ethos of 'capability in higher education' (Stephenson, 1992; Stephenson and Weil, 1992), where higher education should provide learners with the ability to solve problems that they are unfamiliar within situations that they are unfamiliar with. This situation is shown in Figure 3.5, where the learner should be developing their abilities not only at point 'Y' (i.e. dependent capability) but also at point 'Z' (i.e. independent capability).

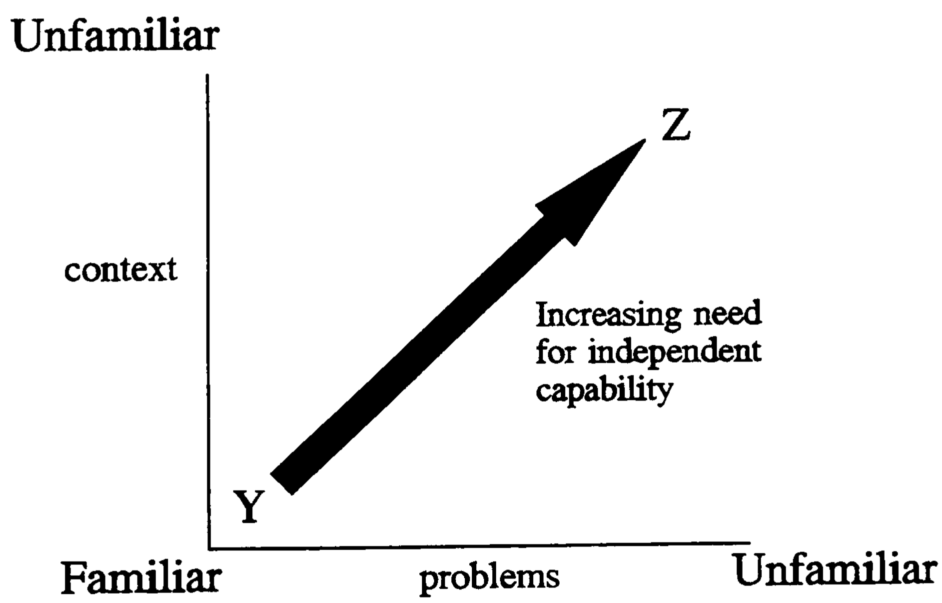

Figure 3.5: Stephenson's Model of Uncertainty and Capability (Stephenson, 1992).

3.6 Fostering Learning

So far it has been argued that the purpose of learning in higher education should be to encourage and develop the range of cognitive abilities (both higher and lower). This has implications for the process of learning in higher education, the inter-relationship between teaching and learning, and the role of the learner (i.e. the student[6]).

[6]The discussion, so far, has used deliberately the term 'learner' in a generic sense, inasmuch as any one can be a learner, and any situation can be a learning situation. This particular discussion focuses on undergraduate students as a particular category of learner, and the higher education environment as a particular category of learning environment.

3.6.1 The Learning Process

The discussion so far has emphasised that there is more to learning than just the subject matter of learning (i.e. its content). As important, is the process of learning itself (Barthorpe, 1994; Matthew and Hughes, 1994; Ramsden, 1986; Stephenson, 1992; Wilson, 1991). The 'transformational' purpose of higher education requires both a grounding in an appropriate discipline and the development of more generic learning abilities. This relationship is shown in Figure 3.6.

What is Learned (*Product*)	← Interlinked →	How it is Learned (*Process*)

Figure 3.6: The Product and Process of Learning.

There are many models of the learning process (e.g. Harri-Augstein and Thomas, 1976; O'Reily, 1993; Race 1993, 1994; Robbins, 1988; Zuber-Skerritt, 1992), and a selection is summarised in Table 3.2. Though the terminology used by the different authors may vary and some of the stages may be in a slightly different order or split in two, the models all have a number of common elements:

- they are learner-centred;
- they are cyclical;
- they are incremental;
- they are 'never ending'(i.e. continuous);
- they involve a stage of active planning;
- they involve a stage where the plan is carried out;
- they involve a stage where the outcome of the plan is diagnosed;
- they involve a stage where the diagnosis is contemplated.

Therefore the general form of the models can be seen in Figure 3.7, where each letter represent a discrete part of the learning process. It can therefore be seen that the "learning

Model:	**Stages:**
Harri-Augstein and Thomas (1976)	Purpose $\Longrightarrow$ Strategy $\Longrightarrow$ Outcome $\Longrightarrow$ Review
Kolb (in O'Reilly, 1993)	Plan $\Longrightarrow$ Do $\Longrightarrow$ Reflect $\Longrightarrow$ Conceptualise
Love and Broughton (1994)	Thinking $\Longrightarrow$ Planning $\Longrightarrow$ Experiencing $\Longrightarrow$ Reflecting
Race (1993)	Active Experimentation $\Longrightarrow$ Concrete Experience $\Longrightarrow$ Reflective Observation $\Longrightarrow$ Abstract Conceptualisation
Race (1994)	Wanting $\Longrightarrow$ Doing $\Longrightarrow$ Feedback $\Longrightarrow$ Digesting
Robbins (1988)	Experience $\Longrightarrow$ Reflection $\Longrightarrow$ Discussion $\Longrightarrow$ Analysis $\Longrightarrow$ Evaluation
Zuber-Skerritt (1992)	Plan $\Longrightarrow$ Act $\Longrightarrow$ Observe $\Longrightarrow$ Reflect

Table 3.2: Proposed Models of the Learning Process.

process is a constant process of constant incremental changes in response to our experiences" (Greene and Gibbons, 1991, p. 32). Wilson (1991) argues that there is more to learning than acquiring factual knowledge, though a body of factual knowledge is vital, and that true learning involves understanding. In the 'transformational' orientation there is a need to develop the higher level cognitive abilities (identified in 3.5), and for emphasising the process of learning in combination with the content and basic skill of acquiring knowledge of a subject. Zuber-Skerritt (1992) refers to this combination of process and content as 'meta-learning'.

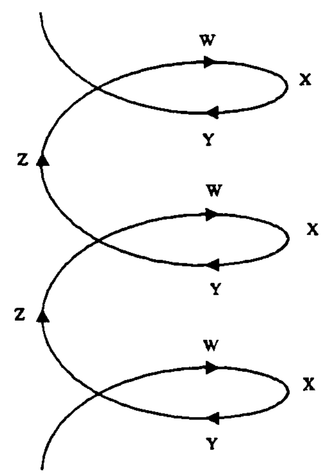

Figure 3.7: A Generic Model of the Learning Process.

Traditional attempts to develop the required 'transformational' learning process have involved workshops on 'study skills' or 'learning skills'. They are usually run separately from the rest of the learning situation (e.g. a separate module on an undergraduate degree course), and such approaches have been criticised for being too prescriptive, superficial and peripheral (Martin and Ramsden, 1987; Race, 1994; Ramsden et al, 1988; Zuber-Skerritt, 1992). Such authors argue that the way forward is to promote 'skill in learning', that is 'learning-to-learn', where students are encouraged actively to adopt the models outlined in Table 3.2 and apply them to their own learning situation (by reflecting and improving on what they do).

3.6.2 Teaching and Learning

The relationship between teaching and learning is extremely complicated. It has been said that "they may be complimentary, but either can take place without each other, and often does" (Zell and Malacinski, 1994, p. 111). Such a controversial view proposes that teaching is not a pre-requisite of learning, and that learning does not always result from teaching.

A less extreme proposition is that teaching should be defined through learning, i.e. if the teaching 'event' does not result in learning then it cannot be described as 'teaching'.

Traditional educational methods (i.e. teaching) have emphasised an approach that encourages surface processing and development of only the lower cognitive levels (Sparkes, 1992). This is usually in the form of information transfer models of teaching (Zell and Malacinski, 1994), aimed at covering the content of a course. The problems associated with such models of teaching are compounded by educators frequently assessing those elements that are easiest to identify (Matthew and Hughes, 1994). Unfortunately this approach, again, emphasises only the lower level cognitive domain (i.e. knowledge and measurable skills).

It has been suggested that the purpose of teaching is to promote learning inasmuch as "teaching defines the framework within which learning occurs" (Wilson, 1981, p. 15) and "teaching is the creation of environments in which students can learn effectively" (EPC, 1993, p. 11). To this end the teaching methods used should promote the more active approaches and develop the range of cognitive abilities identified earlier. This can be achieved by raising learner's and educator's awareness of the different aspects of the process of learning (Harri-Augstein and Thomas, 1976), and not just focusing on what is taught but also how it is taught (Matthew and Hughes, 1994). Educators, therefore, have to find a balance between broad principles and factual knowledge (Miller, 1977). It has been argued (Boot and Hodgson, 1987), that there are two orientations of teaching: dissemination and development. A dissemination orientation views knowledge as a commodity consisting of 'quantifiable' facts and skills. It is assessed by 'experts' who provide certification and is aimed at helping a learner achieve practical tasks. The development orientation views education as developing the 'whole' person and the capacity for independence of mind, as opposed to transmitting knowledge from expert to learner and then the learners' job. A further comparison of these two orientations is provided in Table 3.3. From this it can be seen that the development orientation encourages the higher level cognitive abilities and the ethos of learning-to learn (see Chapter 2).

These orientations provide a framework for three models of learning, outlined in Figure 3.8:

- a teacher-centred model, where the teacher is the source of knowledge and the end product is the knowledge acquired by learners. Such approaches imply a behaviourist

Category:	Dissemination	Development
Purpose of education	Knowledge as a valuable commodity, existing independently of people, that can be stored and transmitted	Knowing as a process of engaging with and attributing meaning to the world, including the self in it
Assumptions about knowledge	Acquisition and addition of facts, concepts and skills	Elaboration and change of the 'meaning-making' process
Assumptions about learning	Dissemination of stored knowledge	Development of the whole person
Meaning of independence	Individualization	Autonomy
Concerns for relevance	Consideration given to problems of application and transfer	Participants own lives are seen as a prime source of learning material
Course structure	Based on the syllabus i.e. the organisation and sequencing of course materials	Based on the processes of planning, deciding and experimenting
To engage successfully with course	Participants are encouraged to improve 'study skills'	Participants are encouraged to 'learn to learn'
Tutor's role	The tutor is the 'subject expert' and is responsible for teaching and instructing	The tutor is a 'facilitator' of student learning, and should be used as a resource
Assessment	Measure of proficiency against an externally recognised standard. The tutor, as the subject expert, is the best person to judge the quality of work	Part of the learning process, and is based on the collaborative assessment of mutually agreed criteria
Centre of educational process	Teacher-centred	Student-centred
Cognitive domain	Targets the lower cognitive abilities	Targets the higher cognitive abilities

Table 3.3: A Comparison of Dissemination and Development Orientations of Learning (Based on Hodgson et al, 1987, p. 8).

approach to learning, where the teacher tightly controls the learning situation by deciding what is taught and how it is taught, thus encouraging the development of only the lower cognitive abilities;

- a process-centred model, where learning is a process by which students achieve results. The learner's approach to the learning task may not be effective (i.e. hidden barriers may exist), so learners are taught how to learn. This involves changes in the 'whole' person and their attitudes to learning. This approach implies a more cognitive approach to learning, where the learner is viewed as a processor of information, so developing some of the higher level cognitive abilities;

- a person-centred model, where learning is not viewed as a mechanistic process, but rather as an activity that is guided by human decisions and intentions. The key to understanding and developing a learner's actions is to understand the intentions and decisions that lead to them. This approach implies a humanistic approach to learning aimed at developing the higher level cognitive abilities, where the teacher is seen as a 'facilitator'.

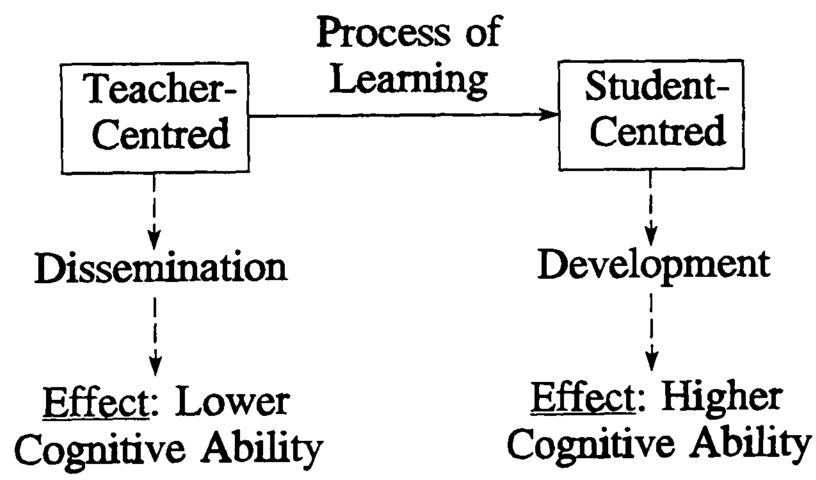

Figure 3.8: The Shift from Teacher to Student-Centred Models.

The tradition of teaching and learning (Solomonides and Button, 1994), assumes that certain subjects are best taught in a certain way. This usually involves an overloaded curriculum presented via a logical and sequential series of lectures, aimed at imparting a defined body of knowledge. Hence, the focus of the teaching is on content (i.e. what is presented) rather than context (i.e. how it is presented). This often results in a surface/serialist approach to learning (EPC, 1993), thereby only developing the lower cognitive abilities. In effect, educational systems are failing to create an environment that fosters the growth and development of the learners cognitive abilities (Noonan, 1994). However, from earlier discussions, it has been argued that education should aim to develop a broad range of cognitive abilities. Therefore, the development of these different levels of cognitive domain (EPC, 1993), identified earlier, require different approaches to teaching and learning (see Table 3.4).

Type of teaching:	Potential for the learning of:								
	Knowledge	Measurable Skills			Complex Skills			Know-how	Understanding
		instruction	demonstration	practice	instruction	demonstration	practice		
Lectures	HIGH	HIGH	HIGH	NONE	LOW	MED.	NONE	MED.	LOW
Tutorials*	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	MED.	LOW	MED.
Laboratories	MED.	HIGH	MED.	HIGH	LOW	LOW	LOW	MED.	LOW
Educational text books	HIGH	HIGH	MED.	LOW	LOW	MED.	NONE	LOW	MED.
Computer-based instruction	MED.	HIGH	HIGH	HIGH	LOW	LOW	NONE	MED.	LOW
Computer simulations	LOW	HIGH	HIGH	HIGH	LOW	LOW	NONE	HIGH	HIGH
Small-group working	LOW	LOW	LOW	MED.	HIGH	HIGH	HIGH	HIGH	MED.
Projects	HIGH	LOW	LOW	HIGH	HIGH	LOW	HIGH	HIGH	VARIABLE
Problem classes	LOW	HIGH	HIGH	HIGH	LOW	LOW	MED.	MED.	MED.
Peer tutoring	HIGH	HIGH	HIGH	HIGH	MED.	MED.	MED.	MED.	MED.
Video tapes	HIGH	HIGH	HIGH	NONE	HIGH	HIGH	NONE	MED.	MED.
Formative assignments	LOW	HIGH	LOW	HIGH	HIGH	LOW	HIGH	HIGH	HIGH

MED. = MEDIUM

* = Adderley, et al (1975) differentiate between tutorials for one students and those for two to five students.

Table 3.4: A Comparison of Teaching Methods and the Cognitive Abilities they Develop (Adapted from EPC, 1993, pp. 11-17, and Adderley et al, 1975, pp. 77-82).

3.6.3 Students as Learners

So far it has been argued that learning is a process of cognitive construction, and that for learning to be effective, under a 'transformational' purpose, the student needs to be involved in this 'construction process' (Zell and Malacinski, 1994). With teacher-centred models of learning this is not the case, as they are based on the needs of the teacher and the content of a course. For education to be effective it must start where the student is (academically, intellectually, personally), not where the educator would like the student to be (Isaacs, 1977). According to Fordyce (1986, p. 241), "the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly". This requires an appreciation of the differences between students (Wilson, 1981), most importantly in terms of learning styles (e.g. holistic, serialist, visualisers, etc.), but also in terms of interests, personal characteristics (e.g. motivations), and social characteristics. Students look for 'cues' from the learning environment[7] and adapt their learning style accordingly. If teaching and assessment promotes factual knowledge and memorised information, then learners will adapt their approach to learning accordingly. When a particular style trait (e.g. holistic or serialist), is combined with a given learning environment (e.g. a lecture based course assessed by a multiple-choice exam), it will lead to a particular strategic response on the part of the learner (e.g. a surface approach aimed at remembering facts and 'model' answers). In such a case learners are concentrating on short term learning, where the objective is obtaining good grades and 'expert certification', rather than developing long term learning, where the objective is to develop what the student 'knows', in terms of cognitive abilities (Beard, 1968). Thus, perceptions of teaching and assessment drive the learning of students (Matthew and Hughes, 1994; Trigwell and Prosser, 1991), and this extrinsic motivation should be acknowledged. The ultimate aim of the 'transformational' orientation should be one of enabling students to take responsibility for their own learning (Solomonides and Button, 1994), and it is the learning environment (including the methods used by the teacher) that can foster this ability.

[7]This is the case for many types of behaviour.

3.6.4 Active Reflection and Planning

To develop students responsibility for their own learning, it is necessary for the learning environment to help students "go about learning in a more thoughtful and purposeful way" (Gibbs, 1991, p. vii). Such an approach goes beyond advice on 'study skills' and 'how to study' guides, and requires students becoming more actively involved in the learning process (Matthew and Hughes, 1994). To aid this involvement requires educational systems that "encourage students' active reflection about their studying" (Gibbs, 1991, p. 90). For this to happen, the student has to be seen as an active participant (Sparkes, 1992) in the educational process, where learning is something that the student actively makes happen, rather than where learning is something that passively happens to the student (Wilson, 1981). Therefore, this dissertation argues that, to achieve the 'transformational' purpose, the student needs to become more self-aware, through active reflection and analysis.

3.7 Relating Learning to Engineering Education

In Chapter 2 it was argued that the environment in which engineering education operates is changing, with the need for graduate engineers to become more flexible, adaptable, and with a continuous ability to learn. The discussion in this chapter has argued that such abilities lie in the higher cognitive domain. This has obvious implications for both the content of engineering degree courses and the educational methods used to convey that content (Bryce, 1993). The current approaches taken in engineering education to develop these higher cognitive abilities have come under increasing criticism (Chisholm, 1990a; EPC, 1993; Sparkes, 1992), and a number of issues have been identified: predominance of lectures; methods of assessment; rigid and narrow curricula; too large a workload; and a short-term outlook on the learning engendered in the student. Each of these issues will now be discussed.

3.7.1 Predominance of Lectures

Many engineering courses rely on conventional lectures as the main teaching method (Kelly, 1988). Lecturing is an effective means as transmitting factual knowledge, but is not particularly suited to the development the higher cognitive abilities within students (Burroughs, 1995; EPC, 1993; Wankat and Oreovicz, 1994). This is because such methods centre on the performance of the teacher rather than the needs of the student, and can foster a passive approach to learning (e.g. memorising factual knowledge), thus developing only the lower cognitive abilities. In order that the full range of cognitive abilities, necessary in a 'transformational' orientation, be developed requires a mixture of learning methods (e.g. case studies, projects, etc.) that encourage planning, reflection and review.

3.7.2 Assessment Methods

Success in engineering education can often depend on passing closed-book exams (Beard and Harley, 1984; Meyer and Sass, 1993), and students opften adjust their learning strategies accordingly. Such traditional assessment methods can encourage students to adopt a surface approach (EPC, 1993), as they predominantly concentrate on testing memorised information and factual knowledge. They also encourage 'competition' amongst students and puts value on an isolationist approach (i.e. students act as 'lone wolves'). This does little for team working and communication, and requires a cultural reversal when students leave higher education and enter the 'real world' (Hilborn, 1994). To develop the full range of cognitive abilities, engineering education should utilise a number of different assessment methods (Sparkes, 1992), such as presentations, group exercises, etc. Such a mixture of methods will assist the development of the range of learning styles and strategies necessary for the 'transformational' orientation.

3.7.3 Rigid and Narrow Curricula

Traditional undergraduate engineering curricula have been criticised for being too rigid in sequence and too narrowly focused and compartmentalised (Karbhari, 1989; Vasilca, 1994). This design of courses can discourage students from adopting the necessary deep approach to learning (Matthew and Hughes, 1994), as the information is usually presented in a linear, serialist way (Love and Broughton, 1994; Murr, 1988). Engineering curricula often focuses on the 'ics' of engineering (e.g. mathematics, physics, electronics, dynamics), whilst only paying scant attention to the 'ings' (e.g. communicating, planning, interacting, synthesising, learning, analysing, reflecting), and such over-theoretical and analytical approaches fail to convey the essential nature of engineering problems (Chisholm, 1990a, 1990b; Love and Broughton, 1994; Matthew and Hughes, 1994; Mortensen, 1988; Parnaby and Donovan, 1987; Sparkes, 1993). Most courses are geared to creating specialists when, as was argued in Chapter 2, what is required nowadays are engineers with broad, inter-disciplinary skills who can act as 'integrationists' (Leake, 1993; Nkasu, 1993; Parnaby and Donovan, 1987). Engineering education that is based on economic-centred models (i.e. a vocational orientation), has created engineers with a narrower range of abilities and experiences. In moving to a 'transformational' orientation, one of the key abilities for engineering graduates to posses, i.e. that which differentiates them from other graduates, is a capacity to think holistically and integratively (Sparkes, 1993). Therefore, their education should be about developing the quality of thinking within a student (Fordyce, 1986), i.e. the full range of cognitive abilities, from knowledge to understanding. This dissertation argues that engineering education can support this by adopting quality systems that encourage students to plan and review their learning, both individually and with their peers and tutors.

The rigid structure in courses can be likened to the approach propounded by Scientific Management (Buchanan and Huczynski, 1985), where "under our system, a worker is told just what he has to do and how he has to do it. Any improvement he makes upon the orders given to him are fatal to success" (F.W. Taylor, cited in McMaster, 1992, p. 249). This leads to a lack of personal development and involvement, thus "students leave with almost the same competencies they had when they arrived - they do not remedy their weaknesses" (Karbhari, 1989, p. 244).

3.7.4 Overloaded Curricula

Engineering courses are often based on an overloaded curriculum that emphasises factual knowledge, which is often obsolete (Bhattacharya and Mandke, 1992; Chisholm, 1990a; EPC, 1993; Kelly, 1988; Keys and Wardman, 1991; Sparkes, 1992, 1993). There is pressure to add more topics and new information, but also a reluctance to remove traditional material. This results in an excessive amount of material being crammed into a finite space (Kelly, 1988; Meyer and Sass, 1993; Vandelinde, 1993). This overloading of engineering students seems to be based on the premise that an undergraduate degree course should provide all the knowledge that will be required during a lifetime, for example "under a traditional system of higher education, a three or four-year degree course would be expected to equip a graduate for forty years of working life" (Allen, 1988, p. 30). However, it has been argued that graduate engineers only use 15% of what was taught on degree course in the first five to ten years of employment (Kuo, 1992), and that in some fields, 20% of an engineers knowledge become obsolete every year (Otala, 1993). Therefore, these changing demands require a shift from educational approaches that emphasise the transmission of specific knowledge that may soon be obsolete, to approaches that emphasise the higher cognitive abilities (Sparkes, 1993).

3.7.5 Short-Term Focus

It has been suggested that engineering courses do not develop, within a student, the strategic capabilities that will help them understand and develop new competencies and skills, i.e. as new technologies, systems and situations are created and encountered (Otala, 1993). Engineering courses "have exactly the same education system as we had in the industrial age and we are using it to equip us for the information age" (John Naisbitt, cited in Daily et al, 1992, p. 56). The focus of engineering education should not be on fostering narrow, short-term abilities, such as knowledge (Parnaby and Donovan, 1987), but rather should focus on promoting and developing the graduate engineers' ability to learn throughout their lifetime, i.e. prepare them for lifelong learning (Otala, 1993; Parnaby and Donovan, 1987; Sparkes, 1992, 1993; Vandelinde, 1993; Vasilca, 1994). A quality undergraduate engineering education would "be one which provides the knowledge base and capability for career long learning" (Karbhari, 1989, p. 247). This entails developing the competence (knowledge, understanding and skills) to perform professional work and the commitment to maintain this competence, so providing the basis for lifelong learning (Engineering Council, 1995), i.e. the ability and motivation to continue to learn. Currently many engineering courses place little emphasis on developing those abilities required for this Continuing Professional Development (CPD) and lifelong learning (Kelly, 1988). Sparkes (1993, p. 88) has argued that "the main purpose of such (engineering) courses should be to enable students to take better control of their own learning", and this entails enabling students to become independent learners, through 'learning to learn' activities (Sparkes, 1992). Engineering education should encourage students to take a more active role in the teaching/learning process and develop an awareness of their own responsibility for their learning (Chisholm, 1990a; Kelly, 1988). This dissertation argues that by encouraging active planning, reflection and discussion of learning activities amongst students, through student-centred quality systems, engineering education can assist in the development of this 'lifelong learning'.

3.7.6 Emphasis on the Product of Learning

Homogenous groups (such as engineers) can become too involved in understanding the subject matter (i.e. the content of learning) and lose sight of the process of learning (Gibbs, 1991). Artificial separation of the knowledge base along subject boundaries, e.g. mathematics is taught separately (Parnaby and Donovan, 1987), compounds this problem. In many engineering courses, attention is given to the content (i.e what is taught), but not to the process or educational methods used (i.e. how it is taught). The emphasis is on teaching knowledge rather than developing the ability to learn (Vandelinde, 1993). It has been proposed that the purpose of teaching is "not to reach a solution but to expose them (i.e. students) to the process of reaching a solution" (Wankat and Oreovicz, 1994, p. 16). However, there is a lack of appreciation amongst engineering educators as to the body of research available on different teaching methods and approaches to learning (Chisholm, 1990b; Rosati, 1993; Sparkes, 1992), and there is a lack of reflection amongst students (Love and Broughton, 1994). This dissertation argues that the use of student-centred quality systems can enable a reflective overview of their course as a whole, and identify areas and strategies for improvement.

3.7.7 Courses Perceived as Boring

As a result of the combination of the above factors, many engineering students perceived their courses to be 'boring' (EPC, 1993; Kelly, 1988; Keys and Wardman, 1991; Sparkes, 1992). This has resulted in higher than average non-completion rates in engineering education, when compared to other courses (Keys and Wardman, 1991). These above average 'drop out' rates are a cause for concern, given the external pressure on higher education, identified in Chapter 2, to increase access to higher education and increase completion rates.

3.8 Fitness of the Purpose

The above discussion raises questions as to what the purpose of engineering education should be. It is argued (EPC, 1991; Sparkes, 1993), that first degree courses in engineering must move from orientations and methods that promote 'memorising' (i.e. this is not a 'fit' or 'appropriate' purpose of engineering education), to those that develop understanding and the associated higher level cognitive abilities. Therefore, the purpose should be to foster learning that enables students to develop a full range of cognitive abilities throughout their working life (the 'transformational' orientation identified in Chapter 2). This requires a refocusing on the process of learning (i.e. how students learn), and the concept of 'lifelong learning'. Sparkes (1995, p.6/1), suggests that the purpose of engineering education can be viewed as "specifying worthwhile learning goals and enabling students to achieve them". The term 'worthwhile' is not fixed, and is open to a number of valid interpretations. Therefore, the purpose of education may be influenced by the expectations of society, demands of employers, aspirations of students, etc. The term 'enabling' involves implementing the research on the different levels of learning (i.e. the cognitive domain), and how teaching can impact on, and encourage, these abilities. Therefore, this dissertation argues that there are two elements to the purpose of engineering education:

- 'Fitness of purpose', where the overall aims and objectives of an engineering course are deemed to be appropriate and 'worthwhile', i.e. to develop the full range of cognitive abilities and lay the foundations for 'lifelong learning' ('transformational'); and
- 'Fitness for purpose', where the methods, techniques and systems employed on a course are appropriate for meeting the stated objectives (i.e. active reflection, planning, discussing, etc.). This theme will be developed in Chapter 4.

3.9 Conclusions

This chapter has provided an overview and discussion as to what is meant by 'learning'. Different theories of learning have been presented, ranging from the simple behaviourist school to the more complex cognitive school. It has been argued that the behaviourist theories are of limited use in academic learning, and that the cognitive theories are more robust and appropriate, as they deal with the higher intellectual abilities. Individual learners differ in their approach to learning, in terms of what they want to get out of the learning situation (i.e. deep or surface) and how they go about the learning task (i.e. serialist or holist). The approach the learner adopts depends upon their perception of the demands of the task in hand (i.e. their learning strategy varies). To this end, higher education must provide students with an environment that develops the appropriate approaches to learning. To develop these more complex forms of learning, it is necessary to understand the 'cognitive hierarchy' of learning, and how different educational methods can develop these different cognitive abilities. It has been argued that the higher cognitive abilities are developed by an active and spiralling process of planning, experience, reflection and modification, with the student at the centre of the learning process. Current engineering education has been reviewed and some common problems identified. These problems have resulted in engineering courses that predominately develop the lower cognitive abilities (i.e. a vocational orientation). It has then been argued that developing only these lower cognitive abilities can result in an inappropriate or unworthy purpose. Therefore, engineering courses must establish an appropriate purpose (i.e. to develop the full range of cognitive abilities), and devise means of achieving this purpose. The systems for achieving this 'transformational' purpose will be discussed in the next Chapter.

Chapter 4 - Quality

In the previous Chapters it has been argued that changes in the higher education environment has led to changes in the focus and purpose of higher education. It was argued in Chapter 2 that the purpose of higher education should be aimed at a 'transformational' orientation towards learners. In Chapter 3 it was argued that this orientation could be achieved by focusing on certain aspects of the teaching and learning process. This Chapter will examine both these areas in terms of 'quality', and will argue that, from a quality perspective, there are two elements to the purpose of engineering education. The first element covers the 'worthiness' or appropriateness of the aims and objectives of a course (the 'fitness *of* purpose' criteria), and it has been argued in Chapter 2 and 3 that the purpose of engineering education should be to develop, within a learner, the full range of cognitive abilities and provide a firm foundation for lifetime learning (i.e. the 'transformational' orientation). The second element covers the ability of the various educational methods employed to meet these stated aims and objectives (the 'fitness *for* purpose' criteria), and is concerned with 'Quality'. It is this second element that will form the main part of this chapter. Therefore, quality is being viewed from two perspectives: the 'fitness for purpose' refers to quality tools and systems, whereas the 'fitness of purpose' refers to the quality of the whole education. The former is used to achieve the latter, and it is the introduction of such quality improvement systems that forms the basis of the dissertation case study in Chapter 7.

In developing the link between quality systems and the 'transformative' purpose of higher education, it will be necessary to examine the progression of, and link between, generic definitions of quality, and the rise of quality systems in manufacturing industry. It will be argued that elements of these systems, developed in the manufacturing and service sectors, can be transferred to engineering education, with a view to supporting the 'transformative' purpose. This discussion will be used to introduce the various conceptions of, and approaches to, quality in higher education. It will be argued that to support the 'transformative' purpose, specific student-centred systems should be encouraged. Based on the discussion presented, 'quality education' in this dissertation will then be defined as "enabling students to examine and develop a range of 'transformative' learning abilities". Therefore, specifying a 'transformative' orientation provides a 'fitness of purpose', and establishing systems that achieve this objective provides a 'fitness for purpose'. The introduction of such 'quality systems' will be discussed in the case study in Chapter 7.

4.1 Definitions of Quality

It is often stated that there is no simple definition of, or single dimension to, quality (Bergman and Klefsjö, 1994; Harvey et al, 1992; Harvey and Green, 1993; Johnston, 1994; Middlehurst, 1992; Muller and Furnell, 1993; Sparkes, 1995). Various definitions of quality have been offered[1], emphasising the range of interpretations the term has. A useful framework of definitions is provided by Garvin (1988), Harvey and Green (1993) and Harvey (1995), and readers are directed to these sources for a more in-depth discussion. According to these authors, definitions of quality can be classified under five broad, generic titles: quality as exceptional; quality as perfection; quality as value for money; quality as fitness for purpose; and quality as transformation.

4.1.1 Quality as Exceptional

Here quality can be placed on a continuum of 'exclusivity', ranging from quality as distinctive, via quality as exceeding high standards, to quality as passing a set of minimum standards (Harvey and Green, 1993). There are a number of problems associated with such conceptions. Firstly, the view of quality as something distinctive and unattainable by most (i.e. something elitist and 'special'), can be criticised as it does not offer any benchmarks against which goals and objectives can be set and compared to. Secondly, defining quality as exceeding a high set of standards can be criticised as it implies that quality output is a function of quality input, i.e. ignores the intervening transformation process[2] (Harvey and Green, 1993). Finally, quality as attaining a minimum set of standards can be criticised on two fronts: if relative measures of standards are used, then such measures cannot be compared; and if absolute measures are used, then they may not be appropriate to an organisation's aims and objectives. The second and third definitions define what the components of quality are but ensure that they are almost impossible to attain, i.e. quality as an externally defined absolute or threshold to be exceeded (Harvey and Green, 1993).

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[1]See, for example, Butler and Yang, 1995; Chalkley, 1994; Doherty, 1994; Ellis, 1993a; Garvin, 1988; Harvey, 1995b; Harvey et al, 1992; Harvey and Green, 1993; Johnston, 1994; McCulloch, 1993; Muller and Furnell, 1993; Plumbridge, 1993.

[2]A process is defined as "the transformation of a set of inputs, which can include actions, methods and operations, into desired outputs, in the form of products, information, services or - generally - results" (Oakland, 1990, p. 6).

Garvin (1988) views such definitions as 'product-based', as they refer to differences in the quantity of some desired attribute (e.g. attaining a minimum set of standards).

4.1.2 Quality as Perfection

This definition views quality as a consistent outcome. It is less elitist than 'quality as exceptional' as it moves the conception of quality from that which only a few can attain, to that which everyone can attain, i.e. it can be translated as 'achievement of standards' (Chalkley, 1994) or 'conformance to requirements'. Quality is achieved by meeting specified standards of performance, ranging from minimum levels of acceptability such as Acceptable Quality Levels (CEPP, 1992) to much higher levels of achievement. Garvin (1988) views such definitions as 'manufacturing based', as they refer to the degree of product conformance to design specification. Such definitions of quality are usually associated with such slogans as 'zero defects' and 'getting things right first time' (Harvey and Green, 1993). In this dissertation, it can be seen as a more acceptable definition of quality as it shifts the emphasis towards processes, rather than inputs and outputs (as espoused by 'quality as excellence' definitions). This definition implies that the perfection is delivered consistently, and that the focus is on culture aimed at prevention rather than detection. The move from detection to prevention-based systems is described later in this Chapter.

4.1.3 Quality as Value for Money

Here, quality is viewed as a 'return on investment', where the emphasis is on the relationship between inputs and outputs. Therefore, if higher output can be achieved at the same costs, or if stable output can be achieved at lower costs, then 'quality' has been attained. Garvin (1988) views such definitions as 'value-based', as they emphasise the relationship between perceived excellence and price or cost. Such conceptions are strongly associated with performance indicators, where a measure of effectiveness is the key. However, the use of such indicators has been skewed towards the measure of efficiency, so strengthening the link between quality and value for money (Harvey and Green, 1993).

4.1.4 Quality as Fitness for Purpose

This definition views quality in terms of fulfilling requirements. Quality is taken to mean fulfilling aims and objectives or 'fitting the purpose' (Ball, 1985). Again, it is a definition that is open to all, as it is quality relative to the stated purpose. Garvin (1988) views such definitions as 'user-based', as they depend on how well the product fits the patten of intended use. It is a functional definition of quality, rather than an exceptional one (Harvey and Green, 1993) and is therefore inclusive (i.e every product has the potential to fit its purpose and therefore be a quality product). Two problems are raised when discussing quality as 'fitness for purpose'. Firstly, there is the problem of who decides the purpose (i.e. is it customer satisfaction or fulfilment of mission statement) and, secondly there is the problem of how the fitness is assessed.

4.1.5 Quality as Transformation

This definition, typified by Pirsig (1974), views quality in terms of a qualitative change from one state to another (Harvey and Green, 1993). Garvin (1988) views such definitions as 'transcendental', as the essential nature of an item or attribute is being changed. This transformative function of quality can be further categorised (Harvey and Green, 1993) into enhancement and empowerment. Enhancement refers to a change within a participant, and is often associated with the concept of 'value added' (where measurements of inputs are compared to measurements of outputs, the difference being the 'value added'). This approach can be criticised as it is trying to attach a quantitative measure to something that is, in essence, a qualitative transformation (Harvey and Green, 1993). Empowerment involves giving participants the ability (or 'power') to influence their own transformation. This involves the participant taking ownership of the process and using it to form a continuous cycle of improvement.

The progression of definitions of quality is summarised in Table 4.1. These developments in the definitions of quality have been paralleled by developments in the scope of quality, i.e. from simple inspection-based systems to complex total quality-based systems (CEPP, 1992), and it is this that forms the next section.

Quality	**Definition**	**Key Concepts**
Exceptional	A traditional concept linked to the idea of 'excellence', usually operationalised as exceptionally high standards of achievement. Quality is achieved if standards are surpassed	Exclusivity, exceeding high standards, or fulfilling minimum absolute standards
Perfection	Focuses on processes and sets specifications that it aims to meet	'Zero defects' via a quality culture emphasising 'right first time'
Value for Money	Assesses quality in terms of return on investment or expenditure	Accountability via performance indicators or customer charters
Fitness for Purpose	Judges quality in terms of the extent to which products or services meet stated purposes	Meeting customer specification or fulfilling organisational mission
Transformation	Sees quality as a process of change for the participants	Enhancing or empowering the participants

Table 4.1: Differing Conceptions of Quality (Based on Harvey, 1995, and Harvey and Green, 1993).

4.2 The Move Towards Quality

Many of the techniques, approaches and systems for developing and introducing quality were devised in manufacturing industry, and have led to the rise of the 'Quality Movement'. The thesis presented in this dissertation argues that such systems can be used in engineering education to develop systems that achieve the 'transformative' purpose. Thus, this section provides an overview of such manufacturing systems.

The Industrial Revolution brought widespread mass production to companies, shifting attention from quality to speed and quantity. By breaking each task into separate specialisations (as advocated by Taylor through 'Scientific Management'), people could perform limited tasks faster. This form of production removed the opportunity and incentive for employees to take responsibility for the quality of their work (CEPP, 1992), thereby removing any sense of 'ownership' of the task in hand. To cope with subsequent errors in production, companies hired teams of inspectors. These inspectors could prevent defective products leaving the factory, but had little opportunity or involvement in stopping errors occurring in the first place. These errors led to increased resource usage and longer delivery times, resulting in increasingly uncompetitive position. In recent years quality improvement has been identified as an essential feature of an organisations growth and long-term survival (PA Consulting Group, 1988) and has led to a large 'Quality Movement'. The historical foundations of this Movement lie in the private sector, in particular those industries associated with manufacturing (CEPP, 1992) where "systems for monitoring and managing quality have been evolving rapidly" (Dale et al, 1994a, p. 4). Such systems[3] range from simple inspection techniques, to more complex arrangements based on control, assurance and 'total quality' which encompass "the organisational structure, responsibilities, procedures, processes and resources for implementing quality management" (BS. 4778). These quality systems can be represented as a hierarchical progression of overlapping stages (see Figure 4.1), providing an effective managerial framework on which to build organisation-wide continuous quality improvement (Dale, 1994b). Such systems are necessary to provide a systematic approach to design and operation in order to prevent failures and provide evidence that agreed quality levels have been attained, in other words: quality has to be managed (Oakland, 1992). The current 'Quality Movement' aims to move the focus from the traditional detection based activities to those based on prevention and continuous improvement.

[3]'System is taken to mean "a group or combination of interrelated, interdependent, or interacting elements forming a collective entity" (Collins, 1992, p. 1565).

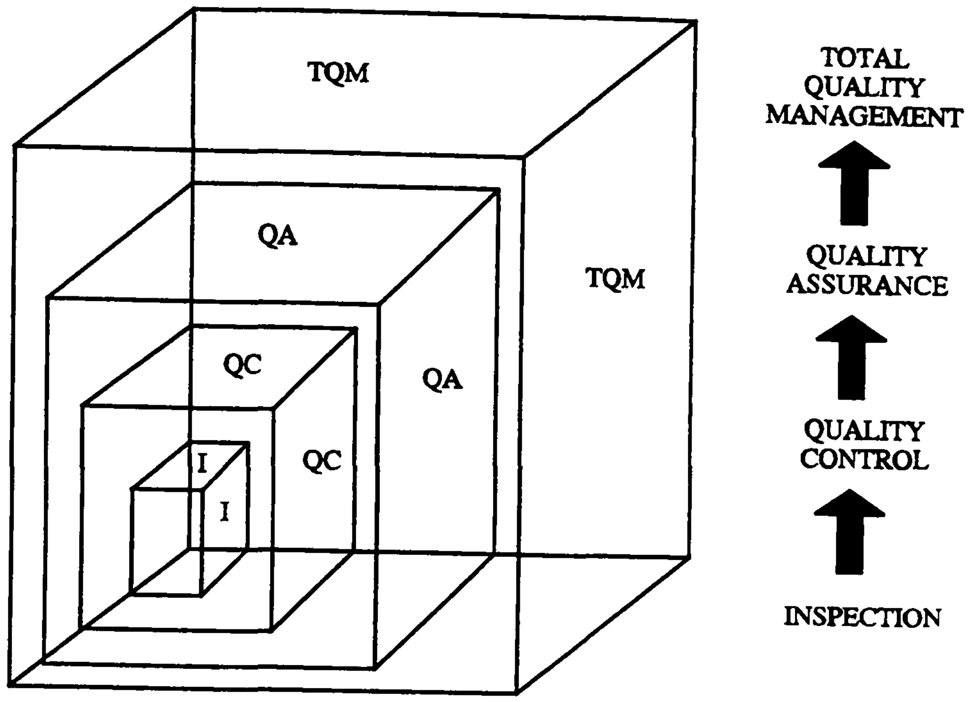

Figure 4.1: Progression of Quality Systems (Adapted from Dale et al, 1994a, p. 5)

4.2.1 Detection-Based Systems

In quality systems that are oriented to detection (i.e 'fighting fires'), the emphasis is on the final product[4]. The quality function is geared towards end-of-the-line inspection and testing, providing reactive solutions to any faulty products (see Figure 4.2). Quality is viewed as the responsibility of a function separate to that of production, and this can lead to conflict and communication problems. Such systems result in an unplanned and unsystematic approach, where the emphasis is on stopping faulty products reaching the customer, rather than preventing faulty products being made in the first place. Therefore, a non-conforming product must be produced before the process can be adjusted. This has implications for time and resource allocation, where lead times may be lengthened and costs re-budgeted owing to the increase in rejected products. Such defects lead to spiralling costs as "defects are not free. Someone makes them and gets paid for making them" (PA Consulting Group, 1988, p. 47). Organisation that adopt such detection-based systems are often more concerned with day-to-day survival than with making long-term process improvements (Dale et al, 1994a). Detection-based systems fall in to two categories: inspection-based and quality control-based.

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[4]Here, product is taken to mean goods or services.

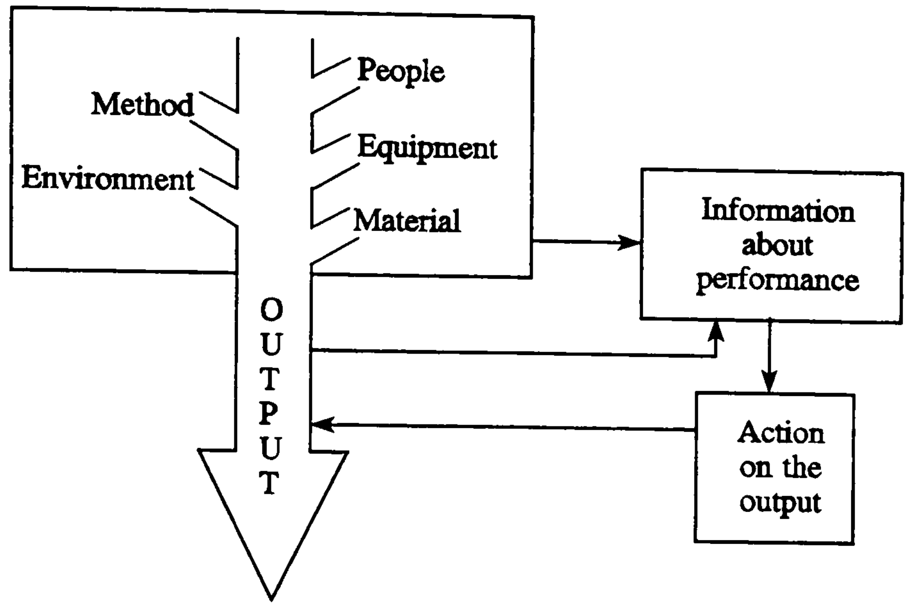

Figure 4.2: Detection-Based Quality System (Dale et al, 1994a, p. 7).

4.2.1.a Inspection

Techniques of mass production (for example, those associated with Taylorism and Fordism) can be seen to result in longer and more complex production processes, where the role of an individual worker's skills and decision-making abilities are reduced. Therefore, tasks are increasingly discrete and compartmentalised, and, as a result of this, the sense of a workers ownership of the quality of the end product is difficult to achieve. In such processes, quality is maintained by inspecting incoming, part-processed and final products, where products at each inspection stage are either accepted or rejected. Under such an inspection-based system, one or more characteristics of an activity are examined and then compared with specified requirements to assess conformity (Dale et al, 1994a). This inspection activity is normally carried out by specialist staff, with any rejected products either scrapped, reworked, modified or passed on as a concession. Dale et al (1994b) notes that products can go through this cycle a number of times. This approach can be criticised, as it is a post-process activity aimed at detecting, rather than preventing, faulty products. Therefore, products have to be made (using time and resources) before a company could be sure that quality is being achieved. The inspection activity, in turn, uses valuable time and resources.

4.2.1.b Quality Control

The detection methods and systems used in quality control are more developed and sophisticated than those used in inspection. There is increased control of procedures, limited self-inspection by workers, and feedback of performance data to relevant personnel. However, such systems still rely on inspection and screening of the end-product (Freeman-Bell and Balkwill, 1993), but instances of non-conformance are reduced. There has been a tendency in the commercial sector to move away from such end-of process methods, and move towards methods that ensure a consistency of purpose, i.e. prevention (Harvey and Green, 1993).

4.2.2 Prevention-Based Systems

To move to a more robust quality system, organisations must "cease dependence on mass inspection. Instead build quality in at every step in the process.... Inspection to improve quality is too late, ineffective and costly.... Inspection, scrap, downgrading and rework are not corrective action on the process" (W.E. Deming cited in Collins, 1990, p. 470). Therefore, organisations must divert their attention from detecting poor quality to preventing poor quality. This is achieved by concentrating on the role of process design (Dale et al, 1994a; Oakland, 1990), as poor quality is seen to emanate from unsuitable designs or processes. Thus, action is taken at the design stage rather than the control stage, as such approaches take the view that quality cannot be inspected in it but must be built in (unlike detection-based systems). It is, therefore, based on a proactive approach (i.e. 'preventing fires'), that emphasises 'upstream' processes rather than 'downstream' products (see Figure 4.3). Moving from a detection to a prevention-based system requires not only a new set of management tools, but also the development of a new management philosophy and culture. This important aspect will be discussed later. Prevention orientated companies ask '*Are we capable of doing the job correctly?*', whereas detection oriented companies ask '*Have we done the job correctly?*'. Prevention-based systems fall in to two categories: Quality Assurance (QA) and Total Quality Management (TQM).

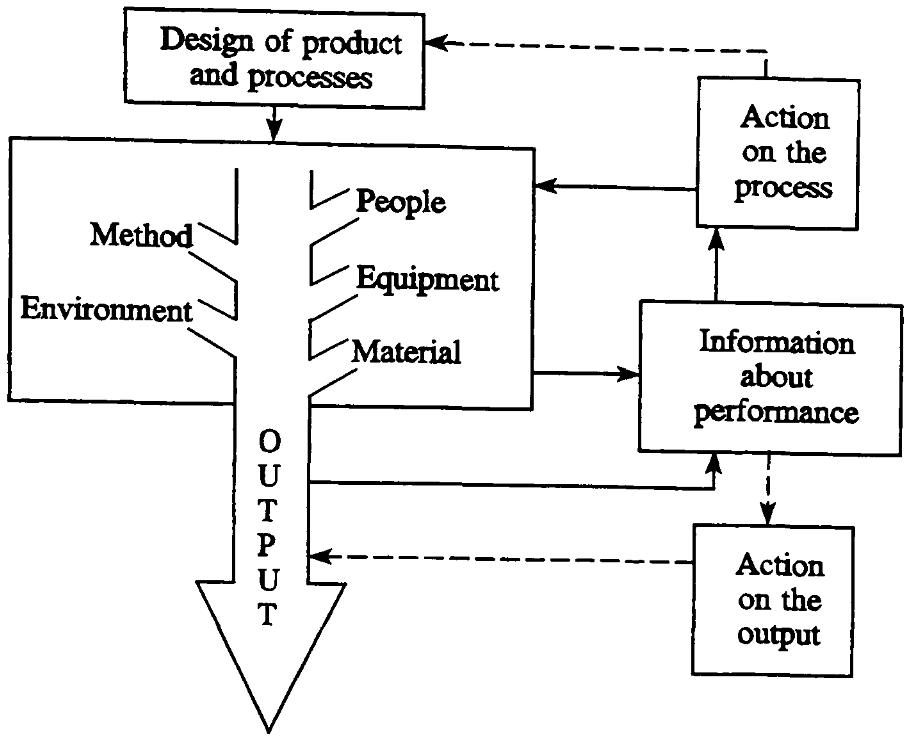

Figure 4.3: Prevention-Based Quality System (Dale et al, 1994a, p. 9).

4.2.2.a Quality Assurance

A lasting and continuous improvement in quality can only "be achieved by directing organisational efforts towards planning and preventing problems occurring at source" (Dale et al, 1994a, p. 8). There is, therefore, a shift in emphasis from detection towards prevention of non-conformance, with more emphasis being placed on planning and improving the design and control of processes, and of involving and motivating people. Attention is moved to the front of a process (Oakland, 1990), and ensures that inputs are capable of meeting the requirement of the process. Quality assurance is, therefore, about ensuring that mechanisms and procedures exist to ensure that the desired quality is delivered. Attached to this is an implicit assumption that if such mechanisms exist then quality can be assured. There is a danger, however, that quality becomes defined in terms of these quality assurance mechanisms (Harvey and Green, 1993).

4.2.2.b Total Quality Management

Total Quality Management involves senior management acceptance and integration of prevention-based systems into organisational policy and objectives. By doing this, quality principles permeate all aspects of an organisations activities. It is, therefore, a company-wide approach, with "improvements undertaken on a continuous basis by everyone in the organisation" (Dale et al, 1994a, p. 10). Therefore, immediate improvements in quality can be made by empowering workers to identify problems and develop their own solutions (CEPP, 1992). This approach requires a broader outlook than assurance-based systems, as there is an increased emphasis on the role of people and a refocus on the customer, as well as the use of a more sophisticated range of quality management tools. In effect, quality assurance methods are extended both vertically and horizontally in organisations (CEPP, 1992), so that quality is not the responsibility of just one department, but is everyone's concern. It has been suggested (Dale et al, 1994a; Harvey, 1995a; PA Consulting Group, 1988; Sallis and Hingley, 1992a) that there are a number of key elements that together comprise a TQM approach:

- Commitment and leadership of senior management, so as to provide permanency and direction, where "quality begins at the top" (PA Consulting Group, 1988, p. 43);
- Planning and organisation, so as to provide a clear, organisation-wide, prevention-based strategy and infrastructure;
- The use of quality tools and techniques, so as to enable and enhance continuous improvement and involve all personnel;
- Continuing education and training, so as to engender the appropriate skills, behaviour, attitudes and self-development amongst all personnel;
- Involvement of all personnel, so as to increase their participation in, and contribution to, the quality improvement process, especially those processes within their sphere of responsibility;
- Teamwork, so as to facilitate effective and widespread communication and cooperation;
- Measurement and feedback, so as to gauge progress against aims and objectives, and devise plans that span any mismatch or shortfall;
- Organisational culture change, to one that enables and encourages everyone to take personal responsibility to improve continually processes under their control, and views all mistakes as an improvement opportunity.

TQM is user driven, and cannot be imposed from outside the organisation as quality standards can (Oakland, 1990). It is a way of "confronting organisational challenges" (Harvey and Green, 1993, p. 27), where organisations are reduced to a series of communicating nodes and attention is focused on the interfaces between these nodes. In this respect it involves both organisation and cooperation, as every person and activity affects, and in turn is affected, by others. Therefore, there is a concept of internal customers and quality chains (see Figure 4.4), which results in a need to develop teamwork (Oakland, 1990) via communication and interdependence. The commitment to continuous improvement is a cyclical process that moves beyond *'are we capable of doing the job correctly?'* towards *'do we continue to do the job correctly?'*. One of the most difficult tasks within a TQM approach is that of changing behaviour and attitudes, and this requires careful motivation, commitment, patience and persuasion (Dale and Plunkett, 1995) via a combination of "planning, systems, people and hard work" (Bendell, 1990, p. 3). Therefore, TQM is associated with notions of quality that encompass both culture and fitness for purpose, where fitness for purpose is seen in the context of a quality culture (Harvey and Green, 1993). To achieve this cultural change, a transformative conception must also be adopted, as it involves a change in attitudes and behaviours. This change can be established in a number of ways, and leads us into the next section.

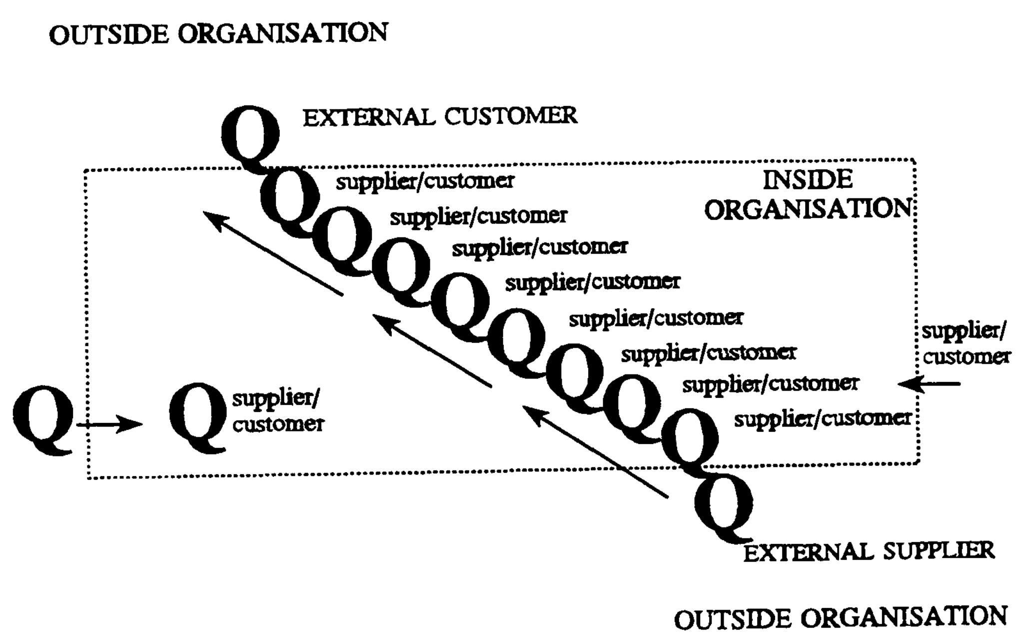

Figure 4.4: Internal Customer and Quality Chains (Oakland, 1990, p. 3).

4.3 Implementation of Quality Systems

According to Deming "Nobody has to do quality. Survival is not compulsory" (quoted in Hadgraft and Holecek, 1995, p. 10; Taylor and Hill, 1993b, p. 20). Those organisations that do choose to follow the 'quality road' (Oakland, 1990) can utilise three generic approaches to the implementation of 'true' quality systems: 'top-down'; 'bottom-up'; and what will be referred to as 'organisation-wide'. Top-down and bottom-up orientations are well established approaches (Taylor and Hill, 1993b; Training and Development, 1992), but have a number of drawbacks. An amalgamation of the advantages of each of these approaches is presented in the form of an organisation-wide approach.

4.3.1 Top-Down

Top-down approaches are those that emanate from senior managerial levels within an organisation, and it is based on the premise that a quality strategy must be built on continuous and consistent commitment from top management (Bergman and Klefsjö, 1994). A 'top-down' approach is more likely to secure coordination and consistency, but at the expense of employee involvement (CEPP, 1992), and must be implemented carefully, otherwise it will not reflect the needs and values of those involved.

4.3.2 Bottom-Up

Bottom-up approaches are those that emanate from the 'grass root' levels of an organisation. A bottom-up approach is seen to produce strong ownership by employees, but may lack coordination (CEPP, 1992). Becher (1992) argues that a bottom-up approach is better that an authoritarian and coercive top-down approach (that is seen to engender token and superficial compliance), though it may take longer to evolve and do less to modify the current value system within an organisation.

4.3.3 Organisation-Wide

Employee motivation toward Continuous Quality Improvement (CQI) will not develop if there is no commitment to quality from top management, no organisational quality climate, or no team approach to quality problems (Oakland, 1990). Therefore, senior management must create a culture that engenders a grass-roots approach (i.e. top-down to encourage and support bottom-up), where there is a focus on the continuous improvement of processes through an organisation-wide commitment to quality (Bergman and Klefsjö, 1994). Such an approach requires clear leadership ('top-down'), long-term prevention-based strategies, continuous company-wide improvement, training to help solve problems, education to help change attitudes, involvement and commitment by employees ('bottom-up'), involvement through teamwork, measurement and feedback so as to develop action plans and meet objectives, and, in general, create an organisation culture that is conducive to Continuous Quality Improvement via changes in peoples attitudes, behaviours and working practices (Dale and Plunkett, 1985). Creating such a quality organisation involves a four phase cycle, shown in Figure 4.5:

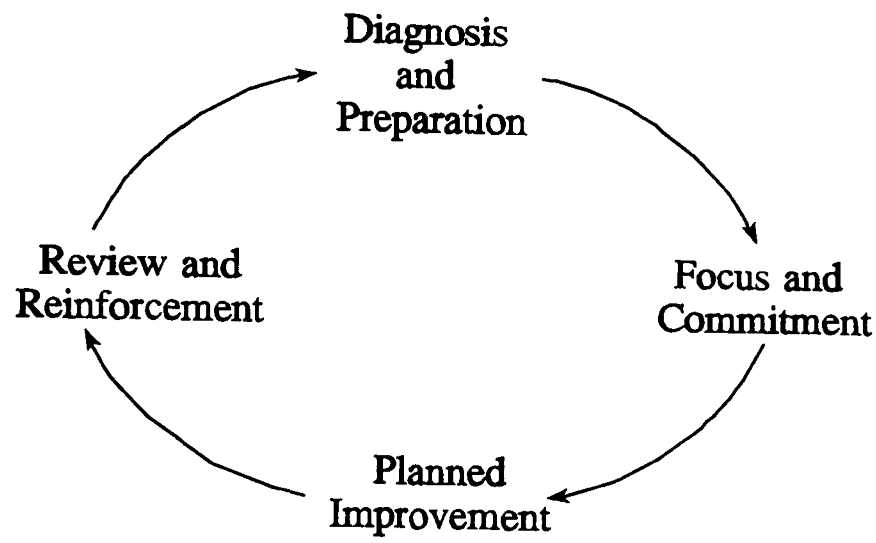

Figure 4.5: Cyclical Phases of a Quality Organisation (Based on PA Consulting Group, 1988).

- Phase I involves diagnosis and preparation, where information is gathered on how an organisation actually operates, not how it would like to operate or pretends to operate, so as to prepare the ground for organisation wide CQI. Suggested sources are costs of quality, and views of employees and customers;
- Phase II involves management focus and commitment, where top management has both the understanding of the requisite principles of quality, and the readiness to implement them;
- Phase III involves planned improvement, where quality issues are identified by communication, training and action;
- Phase IV involves review, reinforcement and restart, where progress is measured, success is consolidated, new initiatives are launched, and the improvement spreads throughout the organisational quality chain.

Therefore, organisations carry out a cyclical process of 'Plan-Do-Check-Action' (see Figure 4.6) (Dale, 1994a; Murphy, 1994; Sallis and Hingley, 1992a), whilst focusing on internal and external customers (Bergman and Klefsjö, 1994; Oakland, 1990). The use of certain techniques can aid this transition to a quality culture (Bergman and Klefsjö, 1994; PA Consulting Group, 1988; Dale et al, 1994b; Sallis and Hingley, 1992c), and include: customer perception surveys; collecting and analysing Costs of Quality (i.e. failure costs, appraisal costs, and prevention costs) so as to help identify problem areas and measure any progress made; Departmental Purpose Analysis (DPA); Quality coordinators; Quality Function Deployment (QFD); Quality Circles; Statistical Process Control (SPC); Pareto charts; Organisation-Wide Training; Brainstorming; and Cause and Effect analyses.

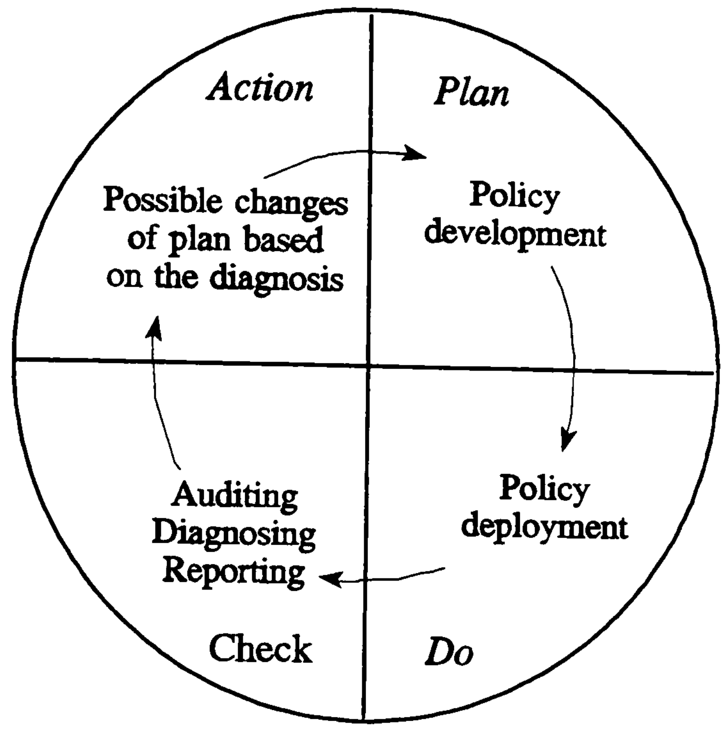

Figure 4.6: Plan-Do-Check-Action Cycle (Dale, 1994b, p. 85).

4.4 Quality in Service-Based Industries

So far the discussion has viewed 'products' as physical goods and services. It has been argued (Bergman and Klefsjö, 1994; Booms and Bitner, 1981; Brown and Fern, 1981; CEPP, 1992; Lewis, 1989, 1994; Lovelock, 1981; Zeithaml et al, 1988), that there are a number of essential differences between goods and services, all of which impact on the definition and achievement of quality. As education is viewed as a service (Lewis, undated; Shostack, 1981), it is important that these distinctions are highlighted. The existence of these differences has led to debate over whether quality models developed in the manufacturing sector are appropriate to the service sector (CEPP, 1992). If the student is viewed as a product, then it can be argued that they are a passive entity to be manipulated and controlled. It was argued in Chapter 3 that traditional education methods follow this orientation, and that learning is seen as something that happens to the student, rather than something that the student makes happen. If the students, however, is seen as integral part of the process of education (i.e. a participant), then more complex and 'higher level' systems are required. This dissertation argues that, given the 'transformative' purpose, the latter case is applicable to engineering education. Services, such as education, are seen to be different from goods inasmuch as:

- services are essentially intangible;

- the production and consumption of services is simultaneous, i.e. they are consumed as they are produced, so traditional quality techniques may be difficult to apply (e.g. in traditional manufacturing operations there is a longer time available to monitor and analyze processes);
- services are essentially 'perishable' and cannot be stored, owing to the above relationship;
- the quality of a service is partly dependent on the part played by the customer or consumer (e.g. in Chapter 3 it was argued that deep learning involved the active involvement of the student);
- services are heterogeneous, as variability often exists as a function of labour inputs; the non-standardisation of services; and the experiential nature of a service (which is unique, depending on a customers expectations and interactions with the service organisation);
- quality assurance procedures in manufacturing are used to reduce variation in production processes, whereas in a service it may be important to increase the variation so as to emphasise the individual needs of customers.

According to Lewis (1994), service quality is essentially concerned with meeting customer requirements and how well a delivered service matched customers expectations. Therefore, service quality "becomes a consumer judgement and results from comparisons by consumers of expectations of service with their perceptions of actual service delivered.... if there is a shortfall, then a service quality gap exists" (Lewis, 1994, p. 237). Authors (Berg and Klefsjö, 1994; Lewis, 1989, Zeithaml et al, 1988) have described service quality as a function of the gap between a consumers expectations of a service and their perceptions of the service actually delivered. This relationship is shown in Figure 4.7, where we can see that this major gap ('Gap 5') is influenced by other, smaller, gaps. 'Gap 1' is between consumer expectations and the organisations perception of consumers' expectations; 'Gap 2' is between the organisations perceptions of consumers' expectations and the service quality specification actually set; 'Gap 3' is between service quality specifications and actual service delivery; and 'Gap 4' is between actual service delivery and external communications about the service.

The problem with this approach, with regard to higher education, is that it requires the identification of a customer, and assumes that the customer has enough experience or information on which to base expectations. In engineering education there are a number of potential 'customers' who may have confliction demands, perceptions, etc. There are also differences between eliciting customers' views about a service and empowering them to become involved in improving the process (CEPP, 1992). This issue of who is the customer of engineering education is addressed later in this Chapter.

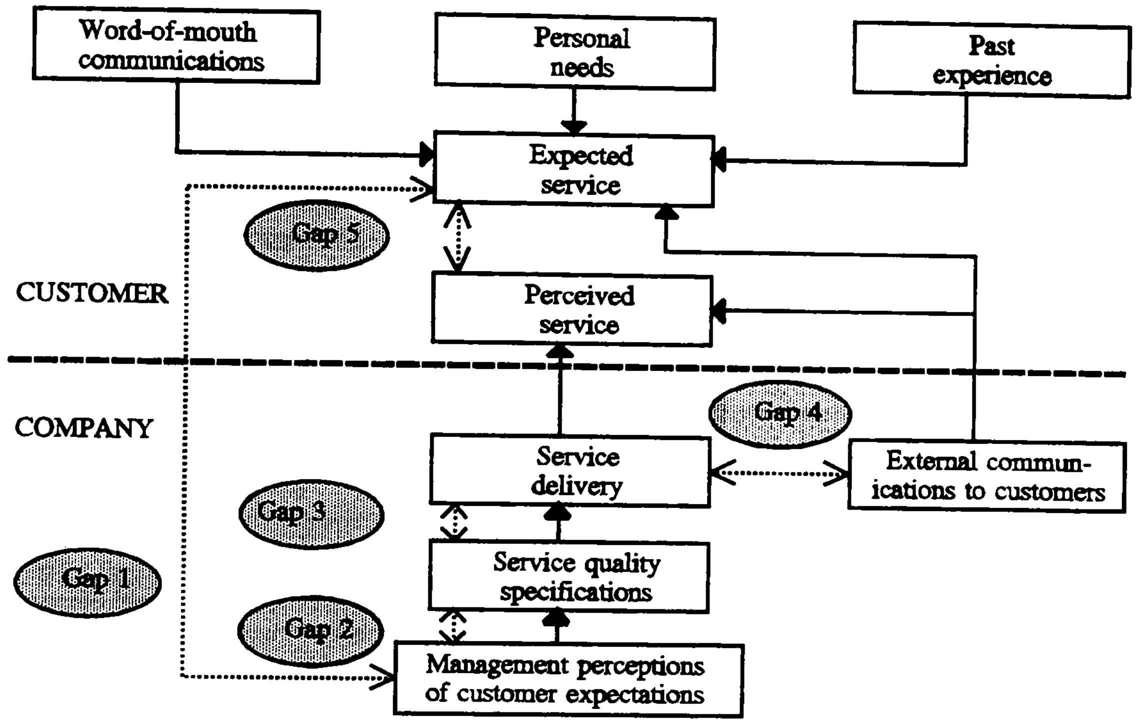

Figure 4.7: Service Quality Model (Adapted from Zeithaml et al, 1988, p. 36)

4.5 Defining Quality in Higher Education

Quality is an increasingly important issue in higher education (Clayton, 1993; de Rudder, 1994; de Weert, 1990; Harvey and Green, 1993; Hedberg and Riis, 1994; Jennings, 1989), and its profile has been raised by such issues as increased levels of participation (Bassis, 1986), widening access and increased student heterogeneity (de Weert, 1990), pressure on resources through reduced funding, increased input and influence from industrial and commercial organisations, the expansion of external monitoring initiatives (i.e. Quality Assessment and Quality Audit), the removal of the binary line between Universities and Polytechnics (see Chapter 2), the separation of HEFC funding for teaching and research, and increased accountability (Ellis, 1993c). Chalkley (1994) identifies a number of underlying motivations for this rise of quality. Firstly, there is growing pressure from central government for taxpayers to receive value for money on the public expenditure that goes toward higher education sector. Secondly, there is increased emphasis on public accountability, where higher education institutions have to show not only *what* they are doing, but also *how well* they are doing it. Finally, there is a "growing transfer of ideas into education from the world of business" (Chalkley, 1994, p. 164), where there is a trend to move the public sector toward the private sector and make higher education more business-like, both in terms of its operating systems and the abilities of the students that graduate. Indeed there have been increasing calls from industry that the output from the educational system (i.e. graduates) were "ill prepared for the economic world they were entering into" (Pring, 1992, p. 5).

This combination of situations has lead to two possible alternative positions (de Weert, 1990): a higher education system tightly controlled by central government (i.e. complete state authority intervention), and a market system in which competition amongst institutions and students decides the structure (i.e. a market dictated system). From these factors, we can see evidence of a move from academic oligarchy towards increased state control and market influence (see Chapter Two), and conceptions of achieving 'purpose' (see Chapter 3). According to the 1987 Government White Paper *'Higher Education: Meeting the Challenge'* (cited in Beresford-Hill, 1993), the purpose of higher education is to serve the country more effectively, pursue basic research and scholarship, and forge closer links with industry. University initiatives that brought them closer to the world of business would be rewarded. This can be seen as a direct challenge to the liberal arts (i.e. 'academic') tradition of universities, forcing them to adopt a more vocational orientation to courses.

There has been external pressure from both the private and public sectors, and internal pressure from within institutions (Middlehurst, 1992). The private sector argues that economic survival is linked to producing quality graduates, i.e. those that are 'fit for purpose', the purpose and attributes being defined by industry and commerce. The public sector, through the auspices of Government Agencies (e.g. the HEFCs), views quality as a means to allocate funds and decide priorities. This is supported by a Government policy aimed at reducing public expenditure through value-for-money and efficiency concepts of quality, where accountability must be explicit and measurable. Pressure for quality from within institutions emanates from two sources: management, where quality is a means of planning, organising and analysing institutional purposes; and the professional academics, where quality is seen as a commitment to continuous high levels of achievement.

The move between academic oligarchy, state authority and the market is mirrored in shifting conceptions of quality in higher education. By referring back to 4.1 ('Definitions of Quality'), it can be seen that there has been a progression in definitions of quality in higher education from excellence through value-for-money to fitness for purpose, with the rudimentary beginnings of a move towards transformation (see Figure 4.8). This dissertation argues that it is this fitness of purpose (i.e. 'transformation') and fitness for purpose (i.e. enabling and achieving this 'transformation') that should be the focus of the quality and learning systems in engineering education.

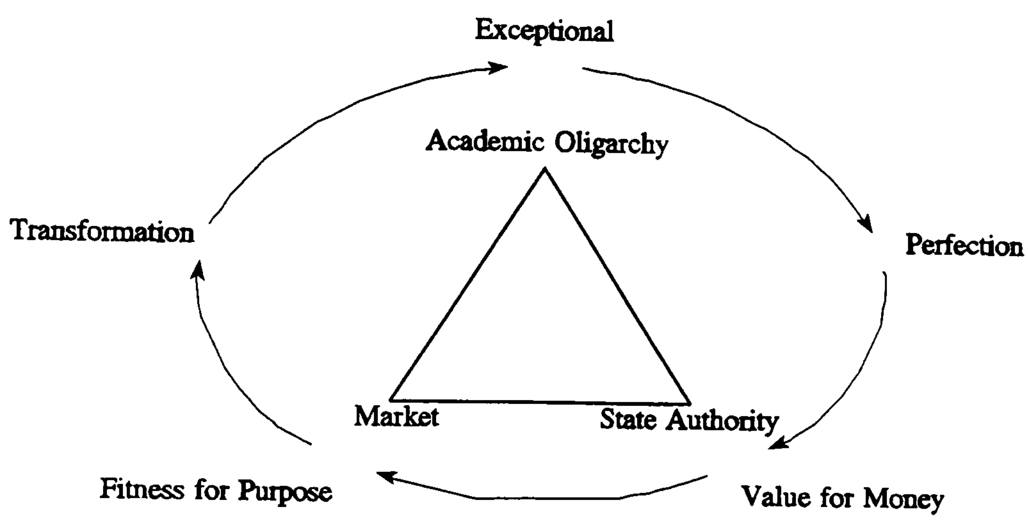

Figure 4.8: Relating Shifts in Higher Education to Changing Conceptions of Quality.

4.5.1 Excellence

It can be argued that definitions of quality based on excellence were extolled by the traditional academic oligarchy, so as to maintain the 'elitism' and 'freedoms' of higher education, i.e. higher educations was only open to a select few so as to maintain its 'exclusivity'. Such a conception has diminished with Government policy aimed at broadening access to higher education.

4.5.2 Perfection

Such definitions can be seen to mark a shift from academic oligarchy to increased state authority influence, as they require higher educations institutions to articulate some form of 'specification'. The degree to which this is set by the academic oligarchy or the state authority, depends on the position along the continuum of control (see Chapter 2). It can be argued that this definition does not fit well with education and learning, as effective learning often involves making, and learning from, mistakes (Muller and Funnell, 1993). As the adage goes '*if you don't make mistakes, you won't make anything*'.

4.5.3 Value for Money

Within higher education, this definition reflects the growing trend towards central authority accountability, where the emphasis is on assessing the effectiveness of public spending (Chalkley, 1994), the key criterion being cost-effectiveness (where specified standards are achieved at the lowest possible outlay). At the centre of such approach is accountability to both the Government and the 'customers' of higher education (Chaston, 1994; Harvey and Green, 1993; Tasker and Packham, 1994). Therefore, quality in higher education is seen to move from conceptions based on the transfer of knowledge of high culture to a select number of students, to quality being viewed in terms of a more market oriented curricula, where public funds are spent properly (Neave, 1991). Ross and Mählck (1991) view quality in term of educational resource inputs and processes which, when combined, aim to produce specific educational outputs. Such an approach calls for the explicit use of indicators of performance, and this area will be discussed later. It has been argued (Harvey and Green, 1993) that rather than focusing on the inputs and outputs of the educational process, attention should be shifted to the learning process itself, i.e empowering the participants.

4.5.4 Fitness for Purpose

Defining quality in higher education as 'fitness for purpose' is deceptively simple. It involves stating what the objectives of higher education are, and then ascertaining if those objectives have been met. The problem with such a view is that it there is disagreement as to what the purpose of higher education is (Harvey and Green, 1993) and how it can be evaluated, i.e. higher education has multiple 'stakeholders' and purposes. Such definitions can be seen to mark a gradual shift from state authority to the market, as higher education acknowledges the existence of, and responds to, 'customers' and 'purposes'. However, Pring (1992) argues that though 'purpose' may be established partly by customers of the service, the Government still has overriding control (as conceptions of 'purpose' are linked to state funding). The concept of the 'customer' raises new problems when applied to higher education, and will be discussed later. Supporters of such 'fitness for purpose'

(Beresford-Hill, 1993; HMI, 1991; Wicks, 1992) argue that one of the benefits of this definition is that it means explicitly stating what the purposes of higher education are, though they may encourage a competence based approach, where education is seen as a product (Muller and Funnell, 1993). In recent years this purpose has been taken to be meeting the needs of the economy through a vocational orientation to education, though this orientation is being increasingly challenged as too narrow and prescriptive (e.g. through the 'Educating for Capability' Movement). There is a problem in defining 'learning' as the purpose of higher education. Firstly, learning can be taken to mean the *process* by which people develop their knowledge, understanding, etc, and secondly, it can be taken to mean the *product* of this change (Elton, 1988). Allied to this 'fitness for purpose' conception should be some notion of 'fitness of purpose' (Chalkley et al, 1995b, 1996; Johnston, 1994), i.e. achieving 'worthwhile' or 'appropriate' educational objectives. In this dissertation, such a notion involves establishing systems that support and enhance the 'transformational' orientation.

4.5.5 Transformation

It is argued that "education is not a service for a customer but an ongoing process of transformation of the participant" (Harvey and Green, 1993, p. 24). In higher education, quality as 'transformation' is concerned with the enhancement and empowerment of learners and the development of knowledge, and closely match the current ethos of 'lifelong learning' and the 'Educating for Capability ' Movement (Stephenson, 1992). Such an approach can be seen to combine elements of the 'liberal arts' and 'vocational' orientations (see Chapter 2), and forms a link between the market and the academic oligarchy. Chalkley (1994) and Muller and Funnell (1993) view such definitions as emphasising the 'value-added' element of the educational experience, where a learner's ability in a defined area has been developed. However, such value added notions of transformation in higher education can be criticised as they seem to adopt a summative approach to the quality of inputs and outputs, rather than the qualitative ethos of the transformation process. Harvey and Green (1993) identify four methods of empowering learners: via evaluation by learners (e.g. satisfaction surveys); via a guarantee of minimum standards and a responsibility for monitoring them (e.g. customer charters); via control over their own learning (e.g. elective subjects and learning contracts); and via developing a learner's critical ability (e.g. self-review and analysis, learning-to-learn and lifetime learning). This later method matches closely the development of the full range of cognitive abilities (see Chapter 3). Elton (1986) proposes a similar conception, viewing quality in higher education as excellence through personal and professional duty. These links between approaches to learning and quality will be discussed in Chapter 5.

It is argued (Barnett, 1992) that these rival definitions of quality result from the three forces identified in Chapter 2 (the state, the market and the academic oligarchy) acting on higher education. The state favours numerical performance indicators, as it can then gauge and promote efficiency and productivity; the academic community will favour peer review, as it can then promote the values of knowledge advancement and development; and the market will respond to consumer preferences, which may change over time and so cannot be predicted. Therefore, the debate over quality in higher education is a power struggle between the three forces to impose their own definitions on what the purpose of higher education is.

Quality requires a system that helps to establish purposes, decide the criteria that will demonstrate the achievement of said purposes, and for ensuring that these criteria have been applied. The multitude of interested parties within higher education complicate this matter, perhaps more so than in any other public or private sector, and leads into the next section.

4.5.6 Participants in Higher Education

As has been shown, quality is a relative concept (Bergman and Klefsjö, 1994; Harvey and Green, 1995; Green, 1993), as it is relative to the user of the term and the circumstances in which it is used. When discussing quality it is essential that an organisation focuses on a well defined customer (Bergman and Klefsjö, 1994; Ellis, 1993a; Leaney, 1992; Oakland, 1990). However, it can be argued that terms such as '*customer*', '*consumer*' and '*stakeholder*' are artificial to higher education, as they imply an informed decision to purchase educational services for personal use. This dissertation will, therefore, use the term '*participant*' to describe the various constituencies involved in higher education. Therefore, quality means different things to the various participants in higher education, and these participants may apply different definitions at different moments. The identity of the participants in higher education has long been the subject of analysis and redefinition[5], and are seen to include: students, potential and actual employers of graduates, teaching and non-teaching staff, local and national government, the funding agencies, professional bodies, society, and parents of students (see Figure 4.9).

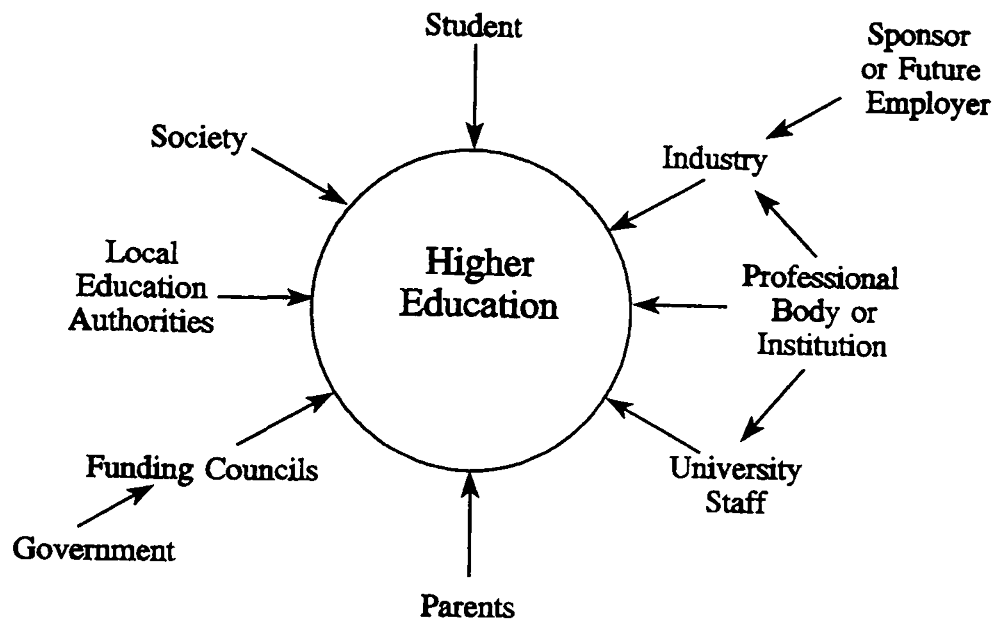

Figure 4.9: Participants in Higher Education (Based on Chalkley et al, 1995c).

Each participant may have a different, conflicting conception of educational objectives and quality, and this multitude of objectives and participants within higher education further compounds the problem of defining educational quality (Middlehurst, 1992). For example (Harvey and Green, 1993), students may focus on the educational process whereas employers may focus on the educational output. Professional institutions and accrediting bodies often focus on the content of courses (i.e. to be an engineer you have to study certain subjects that cover a defined syllabus). However, attempting to view quality from only one participants perspective can result in a partial conception of quality (de Weert, 1990). To avoid this confusion, it has been suggested (McCulloch, 1993) that there are three levels of participant in higher education: primary customers (those who benefit); secondary customers (those who pay); and tertiary customers (society). Unfortunately this categorisation of customers is not entirely clear, for example: students benefit from education, but so do employers (in terms of some of the abilities that education has developed); parents and Government (both locally and nationally) pay for education, but so do students (both financially, in the form of loans, and with resources, in the form of

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[5]See, for example, Brinkworth, 1991; Chalkley et al, 1995a; Chisholm, 1990a, 1990b; Hadgraft and Holecek, 1995; Hansen, 1993; Harvey and Green, 1993; Higgins et al, 1991; Jaraiedi and Ritz, 1994; Lindström, 1994; McCulloch, 1993; Middlehurst, 1992; Roxby, 1992.

time and effort) and employers (in the form of sponsorship or work placements). However, to clarify the discussion many authors cite the student as the primary, direct participant (Ellis, 1993a; Fry, 1995; Williams, G. 1993), and it is this group that this dissertation focuses on.

4.5.7 The Role of the Student

Tannock (1991) observes that the student has a confusing 'dual aspect': that of product and of participant. Likewise, Harvey and Green (1993, p. 19) ask are "students the customers, the product, or both ?". If progress is to be made on developing a 'transformational' orientation towards educational quality, then this dichotomy needs to be addressed. Saunders and Walker (1991), view the students as neither a 'customer' or 'product', but as part of the educational process, whereas others (e.g. Brinkworth, 1991; Chalkley, 1994; Jennings, 1989), define the product as either the graduate or the education that a graduate acquires (the level of attainment being decided by examination and other forms of assessment). It can be argued that definitions that emphasise such product-based definitions of a students role, encourage the view that students are a passive entity that is to be manipulated, measured, quantified and 'enhanced' in a mechanistic way (i.e. primarily developing the lower cognitive abilities). It can also be argued that such a view encourages quality initiatives based on inspection and control, as they are product-based, reactive with a short-term view. However, by viewing the student as an active and lucid participant in the process of learning (i.e. developing the full range of cognitive abilities), then more holistic quality initiatives can be employed, as they are process-based, proactive and longer-term view.

In Chapters Two and Three, it was argued that the primary aim of higher education is 'transformational' learning (i.e. the development of the higher and lower level cognitive abilities). It was also argued that if teaching was to promote this learning, it should encourage and develop the active participation of the learner (Fry, 1995; Williams, G. 1993). If students are viewed as the primary participants (i.e. 'workers'), as in this dissertation, then, according to TQM theory, they must be involved in the management of the process, through empowerment, ownership and self-reflection. By encouraging students to become more self-reflective, self-critical and with an external focus, they should also develop the higher cognitive abilities. Therefore, to achieve the 'transformational' purpose, the primary focus of quality initiatives should be on the student and should be concerned with developing learning ability (i.e. the full cognitive domain).

4.5.8 Quality in Engineering Education

As engineering education is used in this dissertation as a particular case study, it is necessary to examine quality in this particular discipline. Definitions of quality in engineering education are largely based on the notion that quality is linked to the full range of cognitive abilities. Sparkes (1995, p. 6/1) views quality in higher education as "specifying worthwhile learning goals and enabling students to achieve them", which can be roughly be translated as 'fitness for purpose'. In Chapters Two and Three, it was argued that conceptions of worthwhile in engineering education were moving from academic and vocational orientations, towards more transformational and holistic orientations. Murphy (1994, p. 263) argues that quality in engineering education can be defined as "opportunities for students' personal transformation as engineering learners and doers", where students' develop understanding and attain complex skills and the emphasis is on student and learning outcomes. Murphy (1994) goes on to suggests that a quality engineering course has specified relevant and comprehensive professional learning outcomes, in the form of values, attitudes, knowledge, skills and understanding, and promotes autonomous learning and critical self-reflection. To achieve this, quality in engineering education has to have a student-centred view aimed at continuous improvement (i.e. attainment of the 'transformational' purpose). According to the discussions on quality and learning presented in this dissertation, such approaches are most effective when they are adopted and 'internalised' (i.e. result in a change in behaviour and ability) by individual learners. Based on this premise, the rest of this Chapter will examine the various quality initiatives and how they relate to the attainment of this 'transformational' purpose.

4.6 Achieving Quality in Engineering Higher Education

It was argued in Chapter 2 that there are two approaches to higher education: Liberal arts (i.e the academic tradition) and Vocational (i.e. economic centred). When viewing quality, the traditional academic view sees quality as an implicit intellectual endeavour that, by its very nature, cannot be predetermined or anticipated (Pring, 1992). Conversely, the vocational view sees quality in terms of the attainment of specific attributes, where the market identifies its requirements and translates these into a series of competencies, i.e. a 'fitness for purpose' approach (Pring, 1994). Therefore, vocational quality and performance criteria are definite and explicit, whereas traditional academic quality is rather more vague and implicit. The third approach discussed in Chapter 2 (that of 'Transformation') argued that there were core capabilities and transferable skills that are sufficiently generic as to apply to a wide range of unpredictable, job-independent situations. Therefore, quality is not tied to specific job-related competencies that may become outdated, or discipline-related understanding that, without regular use, are soon forgotten. Instead, it is argued (Wicks, 1992, p. 62) that the objective of quality mechanisms should be to "maintain and enhance quality, and promote scholarship and learning". It can be argued (Chalkley et al, 1995a) that quality systems already established in engineering education range from simple inspection models (e.g. setting end of year exams that students must pass) and quality control models (e.g. use of rudimentary student feedback), through to more complex quality assurance models (e.g. matching educational methods to learning goals) and continuous improvement models (e.g. learning-to-learn and lifelong learning). This simple progression is illustrated in Figure 4.10.

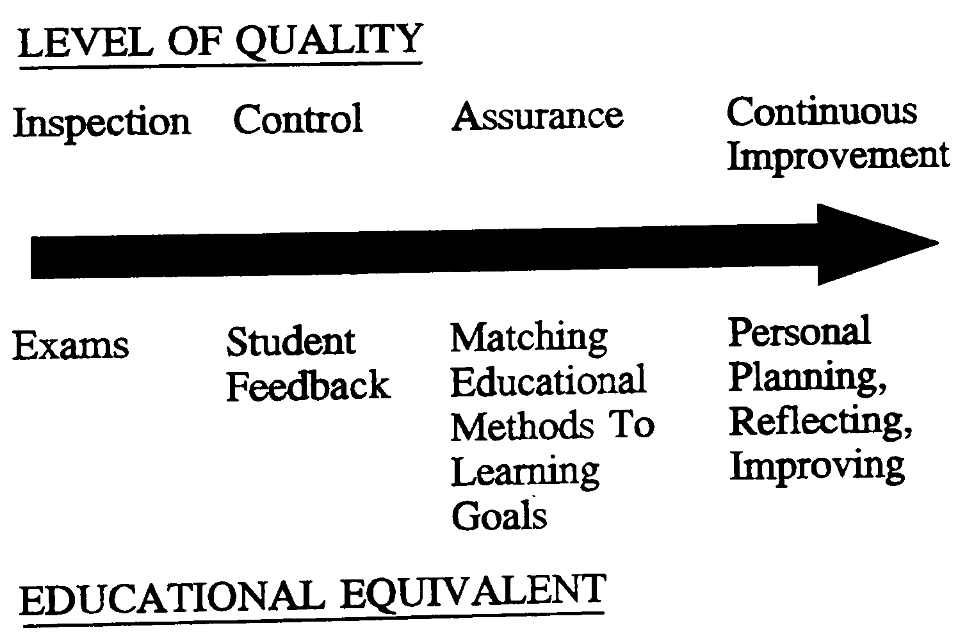

Figure 4.10: Progression of Quality Systems in Higher Education.

4.6.1 Inspection

Such approaches are based on an 'accept-reject' criteria, and are commonly adopted by universities (Chalkley et al, 1995a, 1996; Hadgraft and Holecek, 1995). Knowledge and skills are seen as quantifiable and mechanistic, and the student is seen as passive. Students who fail assessments or exams (i.e. fail to meet 'specification') are often required to resit or rewrite exams, repeat a year, leave a course, or are given a condoned fail and allowed to pass to subsequent years (Collins, 1990; Chalkley et al, 1995a). Such schemes are analogous to the terms inspection, rework, scrap, downgrading and concessions used in manufacturing. Often, corrective action is not taken and students are passed on to subsequent years or courses as 'damaged inputs'. To achieve the 'transformational' orientation effort must be made to move beyond such simple detection based approaches to more complex prevention based ones, where the student is encouraged to plan, review and improve their learning abilities.

4.6.2 Control

Burge and Tannock (1992, p. 5) define educational quality control as "the operational techniques and activities that are used to fulfil requirements for quality, usually interpreted to mean conformance to required specifications". This involves the internal monitoring of courses to check that they are operating as planned (Chalkley, 1994; Pring, 1992). Quality control mechanisms must be clear about what they are measuring and how they will help maintain and enhance learning quality (Wicks, 1992). According to Middlehurst (1992), quality control lies in the hands of frontline staff (i.e. academics). Under such conceptions, little mention is made of the role of students, or how such systems enhance student learning (i.e. where is the planning, reflection, review and improvement on the part of the learner?). It can, therefore, be argued that the lower level systems of inspection and control do little to enhance educational quality or promote learning, as they are reactive and post-process and work *above*, rather than *with*, the student (i.e. the student is a passive 'product'). It is argued in this dissertation that this lack of learner control and involvement predominantly develops the lower cognitive abilities.

4.6.3 Assurance

Quality assurance in higher education is viewed as an extension of quality control, where design of programmes of study is a central activity (Burge and Tannock, 1992; Chalkley, 1994; Pring, 1992). Therefore, it is about ensuring that standards are specified and met continuously for a product or service (Ellis, 1993a). Williams (cited in Becher, 1992, p. 53), observes that "quality assurance procedures that are externally imposed are more likely to be seen as regulations to be reluctantly complied with and evaded wherever possible".

Williams goes on to argue that quality is best assured when those who are involved in the process have a direct sense of ownership. Therefore, mechanisms that are devised to satisfy secondary or tertiary participants (i.e. the three levels of customers identified in 4.5.6), may actually work against the interests of the primary participants (i.e. the student). Therefore, it can be argued that such quality assurance measures are seen by many as a summative tool (i.e. for 'external' control and assessment) rather than as information on which to improve teaching/learning interface.

4.6.4 Total Quality Management

As seen in 4.2.2, for TQM to evolve in higher education, there needs to be an "internal culture in which all parties are committed to working together to optimise organisational performance" (Chaston, 1994, p. 121). Continuous quality improvement, one of the underpinning principles of TQM, is vital (Higgins and Messer, 1990; Pring, 1992), and is analogous to learning-to-learn, Continuing Professional Development or CPD (Chisholm, 1990b; Engineering Council, 1995) and lifelong learning in education (Chalkley et al, 1995a, 1995b, 1995c, 1996). Such an approach requires viewing the student as a participant in the process of learning, where the objective is to enhance and develop the full range of cognitive abilities within the student, through active, in-process self-reflection and self-analysis. It requires clear and visible leadership and the engagement of all participants in improvement initiatives (Lindström ,1994). It is, therefore, based on course, departmental and institutional *culture*.

4.7 Current Approaches to Quality Improvement in Engineering Education

Fry (1995) argues that the quality initiatives in higher education have not been driven from an internal, bottom-up approach, but have evolved from a series of managerial interventions and external control. Many techniques, with the exception of TQM, involve external rather than individual responsibility, and are seen to work against the culture of many higher education organisations. She goes on to argue that quality evaluation is central to quality improvement. However, the current external quality systems in higher education are biased towards evaluation rather than enhancement. From this, it can be argued that current approaches to quality within the UK higher education system can be classified according to their level of operation (i.e. 'Micro/Macro'), and their impetus for operation

('Internal/External'). This situation is shown in Figure 4.11, and provides a framework on which to base the discussion of quality initiatives in UK higher education.

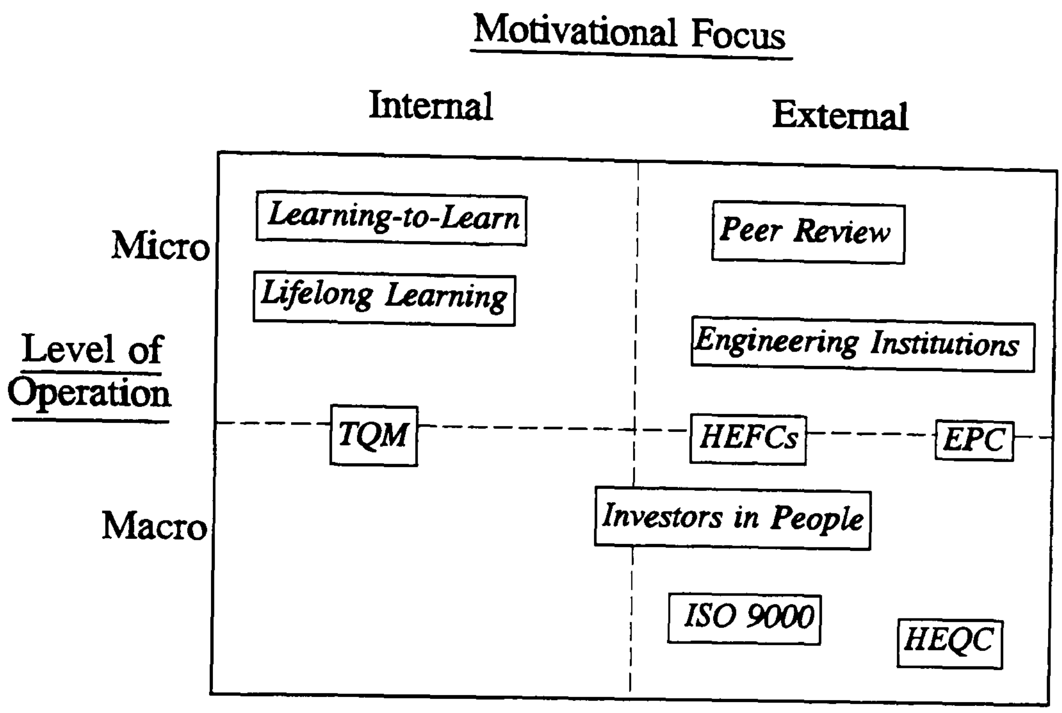

Figure 4.11: Quality Initiatives in Engineering Higher Education.

4.7.1 External/Micro-Level

Systems under this category cover those that are motivated by external factors and work at the micro-level (i.e. at and below the individual-department interface).

4.7.1.a Quality Assessment

In response to 1991 White Paper (See Chapter Two), the Government established Higher Education Funding Councils. The rationale for such an approach was that it would result in improved standards of teaching and learning, brought about by these agencies encouraging university departments to strengthen internal quality control and assurance procedures. However, some (Chalkley, 1994) have viewed these new bodies as a threat to the tradition of academic autonomy by bureaucratic and unreliable methods. It is also argued that real quality is being superseded by institutions devoting time and resources to activities aimed at satisfying auditors and assessors and "winning points in the quality game" (Chalkley, 1994, p. 166). Such approaches can be linked to the shift from academic oligarchy to state authority control, with many viewing the HEFCs as agents of government control, dictating a new educational agenda and ideology (Chalkley, 1994, Yorke, 1994). The government is seen to be imposing two definitions of quality: value for money (in the form of diminishing per capita resources) and perfection (via pressure to improve standards). The higher education sector has been critical of the statutory requirements for quality placed on the funding councils, whilst the Government has been unconvinced that university self-regulation is sufficiently rigorous.

Quality Assessment involves external review and judgement by the HEFCs, through performance indicators and direct observation, of the quality of teaching and learning on particular courses and departments (Chalkley, 1994; Elton, 1991, Holmes, 1994; Plumbridge, 1993; van Vught and Westerheijden, 1994). It was based on a self-assessment document and a possible visit by assessors, resulting in one of three threshold standards (unsatisfactory, satisfactory and excellent)[6]. The standard reached has implications for the level of funding that institutions of higher education receive from the HEFCs. There is some evidence (Fry, 1995; Yorke, 1994) that the HEFCs assessment visits do have an impact on the way that institutions view their students, and that external scrutiny does raise the issue of quality of teaching and learning within institutions. However, as it is externally focused, it is unclear as to how far the activities are internalised by individuals. Assessment is supposed to measure quality against self-assessment and self definitions, though it is suspected (Fry, 1995; Johnston, 1994) that the HEFCs may be operating to some hidden agenda (i.e. quality as a 'standard', 'value for money' or 'value added'). This approach has also encouraged external comparison and competition through the use of league tables (Fry, 1995). The approach has also been criticised (de Weert, 1990), as it is essentially hierarchical (i.e. dictated by government policy), based on external evaluation (i.e. primacy is given to external control), and predominantly summative in nature (i.e. how far are government defined goals attained). Also, as the accent is on summative evaluation, there tends to be a focus on explicit goals for which indicators were readily available, i.e. "greater weight is given to goals that are measurable than to those which are not" (de Weert, 1990, p. 64). This leads to mechanistic notions of quality control (Thompson, 1992). It can be argued that quality systems that require uniform standards, based on a governmental frame of reference, are contrary to the need for diversity in education identified in Chapter 2.

[6]The HEFCs Assessment system is currently under review.

4.7.1.b Engineering Institution Accreditation

Harris and Owen (1994) cite the need to demonstrate provision of high quality courses to accreditation bodies, such as the engineering institutions (e.g. Institution of Mechanical Engineers, Institution of Electrical Engineers, etc.), where accreditation is based predominantly on the examination of course documentation and course syllabus. Quality is important to employers (Harvey and Green, 1993), and as professional bodies are so closely linked to the engineering industry, accreditation is seen as desirable. However, orientation towards such institutions can result in a narrow, vocational based definition of purpose. Therefore, fitness for purpose under such schemes is based traditionally on vocational rather than 'transformational' criteria, and where purpose is predominantly product (i.e. content) based.

4.7.1.c Peer Review

This involves selecting experts from a range of backgrounds (e.g. academia, industry, professions) to make judgements about the academic standards and review processes (Wicks, 1992). A range of methods and sources are used (e.g. discussions with staff and students, reviewing course documents, observing teaching and learning situations, etc.). The process is two-way, as these experts share their experiences of best practice. However, the involvement of the student in this process is limited, and it does not specifically encourage the students to reflect, review and improve continually. From this it can be argued that such method does little to involve students or develop their approach to learning.

4.7.2 External/Macro-Level

Systems under this category cover those that are motivated by external factors and work at the macro-level (i.e at and above the department-institution interface).

4.7.2.a Quality Audit

In response to the 1991 White Paper, the Committee for Vice Chancellors and College Principles (CVCP), established the Higher Education Quality Council (HEQC). This approach is concerned with meeting a standard set by an external agency and involves the checking of an institutions quality assurance procedures and quality control mechanisms (Ellis, 1991; Fry, 1995; Holmes, 1994; van Vught and Westerheijden, 1994;Wicks, 1992). It adopts a top-down approach and is essentially bureaucratic (Fry, 1995), as it is based on peer assessment of documentation of procedures. Like the HEFCs assessments, audit, can lead to external comparisons, but it has raised the profile and status of quality in universities (Yorke, 1994). Each institution is responsible for defining and maintaining its own distinctive quality, leading to a non-standardised approach (Wicks, 1992). However, this approach is not strongly associated with improvement (Fry, 1995) as the prime aim is to measure and be judgemental.

It has been shown (Yorke, 1994) that audit and assessment lead to a duplication of effort and a large area of overlap. In order to minimise this duplication, some universities and departments are modifying their internal review processes to fit the requirements of these external agencies - perhaps neglecting the essential differences between each institutions or departments culture or purpose. Yorke (1994, p. 7) argues that Assessment and Audit fail to provide a "convincing expression of how, in the evolving higher education system, the enhancement of programme quality might be encouraged strategically. Is there.... an alternative approach to quality that could give primacy to enhancement while meeting the expectations of.... accountability?". Fry (1995, p. 75) criticises assessment and audit as they have "been used for comparative purposes when like is not being compared with like and when there is no accepted and explicit criteria". From the students' perspective such an approach does little to develop their personal planning, reflection, review and improvement of learning. However, the audit may assess the documentation that states that students should do this. It can be argued that such macro level approaches are aiming to engender the micro level approaches of personal review, reflection, etc., though evidence of the success of such an approach is yet to appear, as "the quality audit may well have zero impact on a particular department" (Weitzman, 1993, p. 15).

4.7.2.b British Standards (BS EN ISO 9000 series)

This is a series of national standards to which "a quality management system must conform, and against which it must be assessed if a system registration is sought" (Middlehurst, 1992, p. 29). To achieve registration, an organisation must analyze, describe and document each element of a production or service process and set down the procedure to be followed. Registration under the scheme indicates that the systems which are described and documented are followed, and that the company has the means to produce consistent quality in goods and services. The assumption (Wicks, 1992) is that if the control procedures are working then the product is a quality one. The standard, when applied to higher education, views the 'product' of the education process as being the 'added value' passed on to the learner (Jewitt, 1994), though Doherty (1993) defines the product as 'learning experiences'. The standard seems to emphasise a top-down approach (Fry, 1995), where interlocking systems aim to assure the quality of a product. Some of the advantages of the ISO 9000 approach are that it focuses organisations on what they do (Kinchin, 1992), and can improve communication and customer-led service (Harvey, 1995a).

Though rudimentary guidelines on applying the standard to education exist (BSI, 1991; Ruston, 1992; Stoke on Trent, 1992), a number of criticisms are raised (Harvey, 1995a; Tannock and Burge, 1992; Tannock, 1994). Firstly, as it is concerned with meeting a standard, emphasis is seen to be more summative (Fry, 1995). Secondly, it has been argued that it is costly in terms of time and resources (Ellis, 1993c). Thirdly, the standard "tells you nothing about the quality per se only that there are processes in place in the institution for monitoring quality" (Harvey and Green, 1993, p. 20). Therefore, it only sets standards for the system. Fourthly, there is no product or service standard that covers teaching, as judgements are made on design and production (Ellis, 1993b). Fifthly, it is seen as encouraging a rigid and bureaucratic, i.e. McGregors 'Theory X', approach to quality management, with little emphasis on integration or communication (Tannock, 1991, 1994) or "using quality as a means to transform our educational environment" (Hadgraft and Holecek, 1995). Sixthly, it is criticised for being paper based (Geddes, 1993), rather than a people based philosophy, such as TQM (Jaraiedi and Ritz, 1994; Harvey, 1995a). Geddes (1993) also argues that, though many quality initiatives aim to produce zero failures, failure in education is inevitable due to reasons beyond the providers control (i.e. external factors). Seventhly, its application to universities is questioned, as too many of the values of higher education are not covered, and may lead to inappropriate management systems (Burge and Tannock, 1992; Harris and Owen; 1994 Wicks, 1992). Finally, it is criticised for being too confusing, having generated a whole industry of consultants (Ellis, 1993b).

4.7.2.c The Engineering Professors' Council (EPC)

The Engineering Professors' Council[7] (EPC), have proposed an alternative approach to quality improvement in education (Burge and Tannock, 1992; Tannock and Burge, 1992, 1994). The approach they recommend is based on "the fundamental principles of quality assurance.... a structure and content equivalent to that of the British Standard with material from.... the CVCP Academic Audit Unit" (Professor Graham Ellison in Burge and Tannock, 1992, p. 2). It advocates a 'top-down' approach, where quality starts at the top level of an institution and then cascades down to all lower levels (e.g. academic departments, and in support and administrative services). It is explicitly aimed as an alternative to the ISO 9000 series (though many EPC definitions are taken from ISO 8042 'Quality Vocabulary'), and emphasises documented formal procedures. A strong element of the EPC model is that, though it is a top-down approach, detailed planning and operation of procedures is delegated to academic units (see Figure 4.12). There is a strong theme of internal audit and review running through the model, linked to a regular cycle of continuous improvement (one of the central principles of TQM). Harris and Owen (1994) argue that the EPC model has little to offer in addition to the ISO 9000 series, and criticise the model on a number of areas, particularly its vague viewpoint (e.g. who is the primary customer and what is the product or service?).

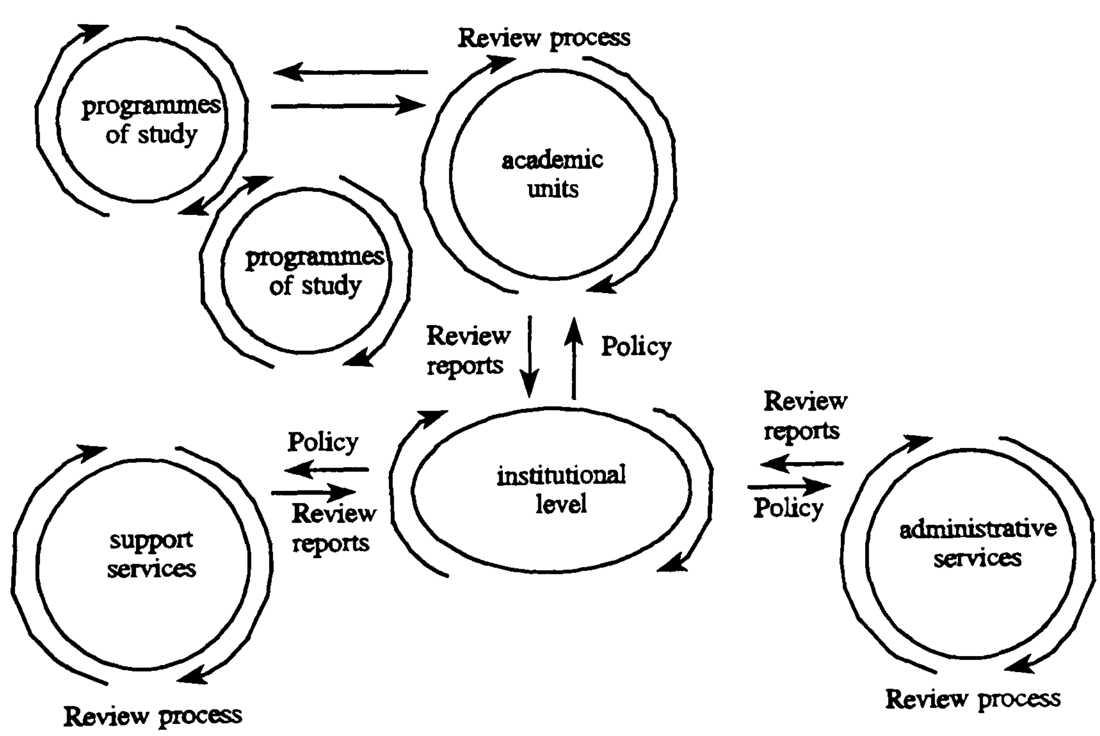

Figure 4.12: EPC Model of Quality Improvement (Tannock, 1994, p. 141).

[7]The EPC was formerly the Engineering Professors' Conference.

4.7.2.d Investors in People

This is a national standard for effective investment in employees (Thackwray, 1995), and involves a top-down commitment towards employee development. It is based on a cycle of planning, executing and evaluating employee development in reference to organisational objectives. It is, therefore, viewed as a process towards continuous improvement and is seen to support TQM initiatives (Sallis and Hingley, 1992d; Thackwray, 1995). However, such approaches may fail in higher education because of the need for business objectives and support from senior levels. Such initiatives are also primarily aimed at staff, and so do little to develop the students 'transformational' orientation.

Macro forms of quality assurance are driven by two forces (Barnett, 1994): firstly, there are those efforts aimed at making judgement on quality (i.e. state surveillance), and these are seen to be summative; and secondly, there are those efforts aimed at improving quality (i.e. enlightenment), and these are seen to be formative. These two views form a division, with the state on one side and academe on the other. Barnett (1994) argues that such overt summative state quality methods are aimed at steering higher education towards producing graduates required by the labour market.

4.7.3 Internal/Micro-Level

Systems under this category cover those that are motivated by internal factors and work at the micro-level (i.e. at and below the individual-department interface).

4.7.3.a Learning-to-Learn

The focus of such initiatives is to increase learners awareness of how they learn and how this can be enhanced and developed. Therefore, emphasis is placed on the process of learning, rather than just the content of learning (Gibbs, 1991). This approach goes beyond simple advice on study skills by encouraging learners to review and analyze how they undertake learning tasks (i.e. the learning strategy they adopt), and make them aware of alternative styles, strategies and learning situations (Zuber-Skerritt, 1992). Therefore it moves from 'study skills' (i.e. superficial and peripheral) towards 'skill in studying' (i.e. where learning approaches and conceptions are internalised by the learner).

4.7.3.b Lifelong Learning

An example of a lifelong learning approach is the 'Educating for Capability' movement (Stephenson, 1992; Stephenson and Weil, 1992). The emphasis of such approaches is to develop a student's confidence and ability to take responsibility for their own continuing personal and professional development. It increases the quality of learning by emphasising the application of knowledge and skills, collaboration with others and structured reflection and review on progress. This approach builds on the foundations laid by a learning-to-learn approach, leading to a cycle of continuous improvement, increased teamworking and a deeper approach to learning.

4.7.4 Internal/Macro-Level

Systems under this category cover those that are motivated by internal factors and work at the macro-level (i.e at and above the department-institution interface).

4.7.4.a Total Quality Management

Middlehurst (1992) identifies the main themes of TQM in higher education as: a focus on continuous improvement; the centrality of internal and external customers; an emphasis on institution-wide commitment and participation led by top management; a strategy based on prevention; and the use of data to facilitate the change process, i.e. the development of a self-disciplined working environment. It is seen as a "metaphor for the process and management of change, designed to realign the mission, culture and working practices of a business to the pursuit of continuous quality improvement" (Middlehurst, 1992, p. 31). Therefore, the assumption is that quality can always be improved and that quality is part of an organisations culture through individual responsibility (Geddes, 1993; Kinchin, 1992; Wicks, 1992). Quality within educational TQM is not a simple conception, but rather the "dual notions of excellence and purpose exist side by side in that excellence within purpose is always sought" (Fry, 1995, p. 64). There is much debate over which implementation approach to adopt: bottom-up approaches from those that do the actual teaching and learning, or top-down from those with an organisational overview (Williams, P., 1993). It is argued that a top-down approach to TQM is best suited to higher education (Doherty, 1993; Geddes, 1993), though Fry (1995) favours an organisation-wide approach (i.e.

top-down supporting bottom-up), so as to provide an internal focus on an organisation-wide culture committed to continuous improvement, and with an external focus on the customer. It aims to achieve this via formative self-assessment and reflection, rather than summative judgements, through a continuous process of plan-do-check-action. Overall, it is a holistic approach to customer satisfaction through enhancement, empowerment and development. The student/learner is seen as the primary participant (Tannock, 1994), and it is important to focus on such groups through the use of 'Plan-Do-Check-Action' cycles (EDC, 1994; Hansen, 1993; Saunders and Walker, 1991).

A TQM approach is seen to have a number of benefits. Firstly, many of the macro-approaches say little about the role of the learner/student in quality. As stated in earlier, quality methods should also utilise and develop full range of cognitive abilities (identified in Chapter 3). TQM in higher education emphasises the centrality of the learner in the learning process (Muller and Funnell, 1993), where quality is related to the transformational process, through which learners are increasingly empowered to take control of their learning. Secondly, it is argued that by making explicit what an organisation is about, who its customers are and what its products are, should lead to a clear articulation and shared image as to its purpose (McCulloch, 1993). Doherty (1993) argues that the explicit procedural system of ISO 9000 links well with the company-wide TQM philosophy. Thirdly, TQM emphasises involvement, participation, responsibility and individual autonomy (McCulloch, 1993), and this is seen to fit in well with the 'transformational' view of academia (see Chapter Two) that this dissertation has been arguing for. Fourthly, TQM emphasises the link between the different levels of an organisation hierarchy, i.e. institutional and individual levels (McCulloch, 1992), as it emphasises the importance of the organisational culture rather than the bureaucratic processes. Fifthly, it is argued that TQM is better suited to the existing culture of higher education than other quality approaches (Tannock, 1994). Finally, Yorke (1994) identifies a number of features from industrial total quality that are generally applicable to academia. These include: designing and building quality into educational programmes rather than concentrating on post-process rectification; continual quality improvement based on reflective practices; delegation of responsibility to the most appropriate level for action; and trust in colleagues (i.e. the concept of the 'internal customer'). Such an approach would rely on a greater degree of self-regulation, a culture of continuous quality improvement, open self-appraisal, and a focus on customers, whether they be external or internal (Yorke, 1994).

However, there are a number of drawbacks and barriers to the TQM approach. Firstly, a 'Total Quality' approach needs to be integrated into the teaching-learning process if real breakthroughs are to be made (Hansen, 1993). However, at present internal barriers exist which preclude the implementation of TQM into many British universities (Chaston, 1994; Coate 1993; Harvey, 1995a; Yorke, 1994), e.g. lack of top management support, lack of effective teamwork, and the strong academic commitment to subject disciplines. Secondly, it is argued (Coate, 1993; Doherty, 1993; Middlehurst, 1992; Porter and Oakland, undated; Tannock, 1991) that full implementation of a TQM approach is difficult, as the process is a long-term one involving changes in organisational culture and philosophy resulting in a never-ending commitment to quality improvement. Such cultural change can take a minimum of five years (Coate, 1993). Thirdly, these problems are compounded by the multiple participants and complex accountability relationships in higher education (Yorke, 1994), where it is important to identify both internal and external 'customers' (Choppin, 1992). Fourthly, many supposed quality initiatives do not involve everyone, for example Hansen (1993) advocates setting up teams to ensure continuous improvement, but such teams only included a few select students (i.e. not 'organisation-wide' involvement). Fifthly, there are a number of 'cultural barriers' to implementing TQM and continuous improvement (Lascelles and Dale, 1990; Materna and Rothe, 1992; Newall and Dale, 1991). Those identified include: poor management commitment, poor employee involvement, cultural differences, short term focus (i.e. the attitude "if it ain't broke, don't fix it"), lack of understanding (i.e between the 'goal' of TQM and the 'enabling mechanism' of continuous improvement), transactional leadership (i.e. reacting to events) rather than transformational leadership (i.e. shaping future events), fear of change (where change is seen as a threat rather than as an opportunity), fear of self-analysis (i.e. problems are always someone's fault), inadequate skills or training, and poor availability of accurate and relevant information. Finally, TQM can be can be seen as a 'power model', where the emphasis is on increasing productivity and reducing waste, or a 'quality model', where the emphasis is on developing the individual (Williams, P. 1993), whether they be students or staff.

4.8 The Role of Performance Indicators

When discussing conceptions of quality, and the role that quality plays in higher education, it is necessary to introduce the issue of 'performance indicators' (PI). These are measures designed to assess how well (i.e. to what degree) objectives have been met, by providing a statement against which achievement in an area or activity can be evaluated (Hertfordshire Evaluation Team, 1990). The rationale for such measures appears to have its roots in the natural sciences (see Chapter 6), where, according to Lord Kelvin, "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind" (quoted in Jones, p. xvi). Within quality improvement initiatives it is important to base decisions on facts (Bergman and Klefsjö, 1994) and have a means of measurement and feedback (Dale and Plunkett, 1995). Frank Price (cited in Lascelles and Dale, 1990, p. 141) argues that there should be "no measurement without recording, no recording without analysis, and no analysis without action" in systematic quality improvement. It will be argued later that these measures do not have to be quantitative. According to Pring (1992), performance indicators are used to assure that quality exists, by helping to define and assess whether a specific purpose has been achieved. Certain conceptions favour quantitative indicators (e.g. 'value added', 'conformance to requirements', value for money'), and indicators often used (Johnes and Taylor, 1990) include non-completion rates by students, distribution of degree awards, percentage of graduates entering employment, percentage of graduates entering further study, and average course entry qualifications. However, "different views of quality lead to different methods of assessing quality and.... generate alternative sets of performance indicators" (Barnett, 1992, p. 3). There has been much debate and criticism for the current 'trend' towards purely quantitative methods in higher education, and many qualitative indicators have been ignored. Barnett (1992, p. 13-14) argues that such numerical indicators "can prompt investigations which in turn can lead to insights into quality.... by themselves they are devoid of informational content".

The criticism of quantitative indicators is based on a number of arguments. Firstly, indicators aimed at assessing the transformative orientation of higher education are difficult to attain (Pring, 1992), where such measures tend to be based on outputs or inputs, rather than the transformation process that links the two (Johnes and Taylor, 1990). Therefore, performance indicators are used as a surrogate measure of the quality of the educational process (Ball, 1985; Barnett, 1992), i.e. these indicators do not provide direct information as to the quality of the process. TQM is centred around individual involvement in organisation-wide quality improvement. However, many organisation appear to concentrate on the quantitative processes (Newall and Dale, 1991). To this end Bassis (1986) argues that quality of education should be measured by the development of learners rather than traditional criteria that focus on the resources used (i.e. value for money). Barnett (1992, p. 9) argues that "conceptions of higher education do not easily lend themselves to evaluation by numerical performance indicators. The complexity and open-endedness of the human transactions involved are not captured by the simplicity and fixity of numbers". This observation leads to the second criticism, where convenient measures are identified and a rationale constructed to give them credibility in measuring quality (Harvey and Green, 1993, Muller and Furnell, 1993; Sallis and Hingley, 1992b). Johnes and Taylor (1990) argue that much of the work on performance indicators concentrates on methodological issues, and there have been few attempts to construct or evaluate specific performance indicators. They also observe that the choice of indicator is often motivated by data availability, rather than by any attempt to define a set of objectives and then produce data which relate specifically to these objectives. Often, only the easiest and most visible (and possibly least important) variables are measured (Bayley, 1992), and Harvey and Green (1993, p. 29) observe that "convenient measures are seized upon and a rationale constructed to give them credibility in measuring quality". The third criticism is that quantitative performance indicators can lead to a too detailed specification of objectives (Elton, 1988), where they may restrict the transformative process of learning (e.g. a concentrating on vocational and economic centred skills, may lead to less emphasis on developing the higher cognitive abilities). Fourthly, measurable things are often out of date (Ball, 1985; Barnett, 1992), where there is a danger of "making judgements on assessments of past quality, and assuming that they will apply in the future" (Ball, 1985, p. 100).

Barnett (1992) criticises approaches to quality that only focus on inputs and outputs (e.g. increased throughput of students, number of students entering employment, increased diversity of students' background), and ignore the quality of the educational process or the type of learning accomplished by a student. He argues that quality that is based on the product of higher education is flawed, and that what should be examined is the quality of the educational process. In effect, indicators of educational 'product' are being used as surrogate indicators of the educational 'process'. Bolton (1986) reports on an initiative at Bath University, aimed at designing a course that encourages students to develop skills, abilities, attitudes and motivations that would be suited to a dynamic and complex environment (i.e. innovative, rather than maintenance, learning). He reports that traditional evaluation method, aimed at measurable outputs, would have resulted in distortion of the course curriculum, where "our attempts to reduce complexity may deny us the full experience of the whole and will restrict our ability to communicate to others the fullness of that complexity; for we reduce and quantify according to our own value system and require the receivers to reconstruct our vision as best they can" (Bolton, 1986, p. 181). Such quantitative measures would, in effect, 'destroy' that which was being created. To overcome this problem, new instruments were introduced that were less 'precise' than traditional academic tests, but which were more 'valid' (e.g. student peer rating of oral presentations, student self-assessment of teamworking exercises).

It is argued, therefore, that the use of such rigorous performance indicators has distorted the purpose of higher education, from a 'transformational' orientation, to a more economic-centred,' value for money' orientation. The indicators gathered are rarely used to inform the participants in the education process (i.e. staff and students) as to how they can improve their own performance (i.e. they do not 'feed' the learning cycles), and often encourage systems that concentrate on the product of education (e.g. how many graduates are employed?, how many student received a first class degree?, etc.). This dissertation argues that to develop the systems that promote and engender the transformational 'purpose' of engineering education, it is necessary to develop systems that support this purpose (i.e. that concentrate on developing the students full range of cognitive abilities through active learning cycles). This thesis forms the basis of Chapter 5 and the Case Study in Chapter 7.

4.9 Barriers to Quality in Higher Education

There seem to be a number of generic barriers to achieving quality in higher education. Firstly, there are differing conceptions of quality and confusion over alien the vocabulary of quality, e.g. 'customer' and 'process improvement'(Coates, 1993; Geddes, 1993; Hansen, 1993; Middlehurst, 1992). Secondly, there is difficulty in achieving consensus about what quality is and how it can be achieved due to the large number of participants in higher education, i.e. what is the 'purpose' of higher education (Middlehurst, 1992, Saunders and Walker, 1991). Thirdly, there are difficulties over who should be the judge of whether quality exists and what kind of judgement should be involved (Middlehurst, 1992). Internal resistance to quality initiatives has resulted from perceptions that such initiatives are identified with Government emphasis on reducing unit costs and increasing student numbers (Harvey and Green, 1993). Fourthly, the nature of the education process itself causes confusion, i.e. what is the 'product'?, what is the 'process'? (Middlehurst, 1992). Fifthly, there is the cost in resources and time on implementing quality initiatives (Coates, 1993; Geddes, 1993; Hansen, 1993; Levine et al, 1988; Middlehurst, 1992). Finally, there is the supportive culture necessary for quality. Such cultures take a long time to develop and, once developed, can become fixed and difficult to change (Taylor and Hill, 1993b). The loose management structure and the nature of academic work can all potentially inhibit the development of this culture (Saunders and Walker, 1991), e.g. university bureaucracy and management structures, and unreceptive attitudes (i.e. an unwillingness to change). The eradication of the binary divide can be seen to have provided many former Polytechnics with 'restart' opportunities, and this is backed by the number of ambitious quality initiatives emerging from these institutions (e.g. Doherty, 1993; Geddes, 1993). From the above discussion, quality improvement can be seen as a form of organisational change (Lascelles and Dale, 1990), motivated by internal and external factors (e.g. competitors, customer demands, chief executives and restart ventures). Achieving this quality improvement involves a cultural change, and the thesis presented in this dissertation argues that such quality improvement systems can assist this cultural change. This argument is developed in the rest of this dissertation.

4.10 Conclusions

It has been argued that the purpose of engineering education should be that of a 'transformational' orientation towards the student. This involves developing the full range of cognitive abilities as a foundation for 'lifelong' learning. To achieve this purpose requires certain systems and techniques. In this Chapter the broad range of generic definitions of quality, and the various systems for achieving quality have been discussed. It has been demonstrated that prevention-based systems, emphasising a culture of proactive process design, continuous improvement and organisation-wide involvement are essential for the attainment and maintenance of quality. As higher education can be seen as a service 'industry', peculiarities of quality in such settings were highlighted. The increase in quality initiatives in higher education was attributed to movements in the triangle of forces in higher education, particularly increased state authority control and market influence. This multitude of participants, each with their own quality agenda, has led to much confusion.

The primary participant was identified as the student, as the primary aim of higher education is developing the full range of learning abilities (i.e. the cognitive domain). Current quality initiatives within engineering higher education were seen to do little to enhance and develop the full range of cognitive abilities within a student, as they are seen to act at a macro-level, were motivated by external factors (i.e. any quality initiatives are not 'internalised' by the learner) and relied on a quantitative and summative assessment (i.e. via numerical performance indicators). There were a number of barriers to quality in higher education, mostly related to problems of inappropriate or unsupportive organisational culture. From this chapter it can be argued that a quality system that promotes and develops an organisation-wide culture of continuous self-critical analysis and reflection, should also have an impact on developing the full range of cognitive abilities, with such systems requiring a more flexible set of qualitative performance indicators. From this focus on self-reflection, analysis, and improvement, it can be seen that there is a relationship between learning and quality. It is this issue that forms the next Chapter.

Chapter 5 - Quality Systems to Improve the Learning Process

So far it has been argued that the purpose of engineering education should be orientated towards 'transforming' the student by developing the full range of cognitive abilities (the fitness of purpose criteria). This requires action on the learning process, and involves encouraging and enabling students to plan, enact, review and improve their approach to learning. It has also been argued that such a purpose requires systems that ensure that the purpose is being achieved (the fitness for purpose criteria). In the previous chapter it was shown that a robust form of such systems involved continuous personal improvement, via cycles of self-review, analysis and reflection, on an organisation-wide basis. This chapter takes the discussion one stage further, and argues that the systems necessary for ensuring the fitness of purpose criteria (i.e. continuous learning cycles) and the fitness for purpose criteria (i.e. continuous improvement cycles), are inter-related. Thus, such learning and quality improvement cycles are one in the same. The introduction of the systems that support such cycles is dependant on the culture of the host organisation. The thesis presented in this dissertation, therefore, contends that quality improvement systems, based on developments in manufacturing industry, can be used in engineering education to promote a culture that engenders a positive learning approach. This chapter aims to clarify this link between learning and quality, and to provide a link to the research methodology.

5.1 Learning

From the discussions in Chapters 2 and 3, it was argued that the purpose of engineering higher education is to develop the competence of learners to learn across the full range of cognitive abilities. This competence is necessary in both the process of learning (i.e. learning-to-learn), where emphasis is placed on personal development, and in the product of learning (i.e. a grounding in engineering theory and applications), where the emphasis is on dissemination. Therefore, engineering education needs to provide learners with both the knowledge base and capability for future learning. It was shown that these competencies are most effectively fostered in educational systems that encourage a learner to reflect actively on their studying. To this end, the learner must engage in a continuous cycle of self-analysis and self-improvement, i.e. planning, doing, reflecting, and conceptualising (see Figure 5.1). This is because learning is a process of cognitive construction, and that for learning to be effective the learner needs to be involved in the construction process. Therefore, engineering education requires the active involvement of learner in the learning process and an awareness of the learner's own responsibility for learning.

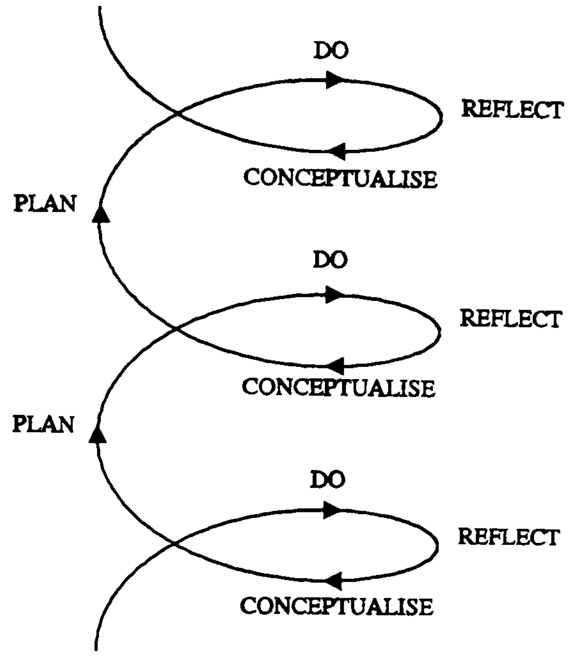

Figure 5.1: The Learning Cycle

5.2 Quality Improvement

In Chapter 4 it was shown that the success of quality initiatives partly lies within the cognitive and affective domains, where participants are empowered to take ownership of the process and use it to form a continuous cycle of improvement, i.e. improvements undertaken on a continuous basis by everyone in the organisation. To this end, the participant must engage in a continuous cycle of self-analysis and self-improvement, i.e. planning, doing, reviewing and acting (see Figure 5.2). It was stressed that such quality initiatives need to be proactive rather than reactive, and oriented to design and in-process methods rather than post-process rectification. Therefore, underpinning all the quality initiatives are the concepts of active, in-process self-reflection, self-analysis and self-improvement (i.e. learning). Therefore the focus is on the 'internal/micro' and 'internal/macro' levels (see 4.7.3 and 4.7.4).

5.3 Matching Learning to Quality

From the discussion above, and those in Chapters 2, 3 and 4, we can see that learning and quality improvement have a number of factors in common. They both:

- Involve a change in attitudes and behaviours, i.e. they both involve a transformational orientation;

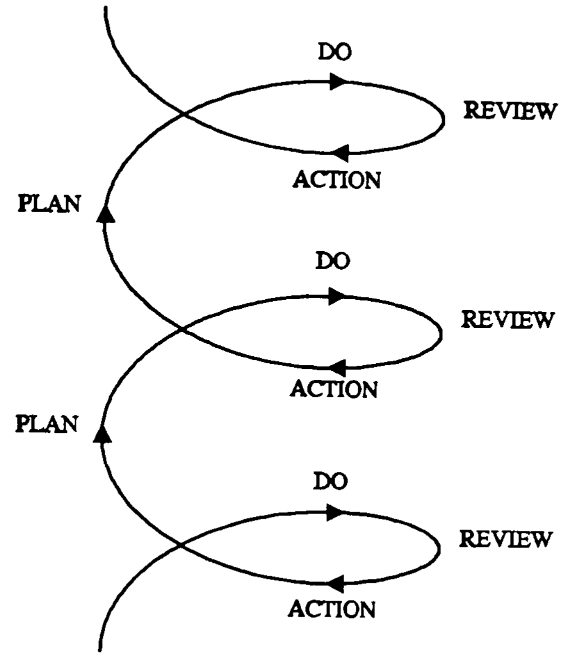

Figure 5.2: The Quality Cycle

- Require a shift from a short-term to a long-term focus;
- Require active participation;
- Are dependent on organisational culture;
- Involve individual responsibility;
- Involve empowerment of participants;
- Require some individual autonomy;
- Involve continuous improvement based on reflective practices;
- Must work with, rather than above participants;
- Must be internally generated, not externally imposed;

The foundation to this link between learning and quality is the strong connection between the respective continuous improvement cycles (see Figure 5.3). By encouraging a 'transformative' view of both learning and quality, where there is an integration of evaluation, enhancement and learning, a quality system becomes a learning system, and a learning system becomes a quality system. Therefore, learning and quality systems need to be active, integrated, cumulative and aimed at understanding. Both these cycles require an environment that involves bottom-up commitment and top-down encouragement, in other words, *organisation-wide continuous quality and learning improvement*. Such changes require not only a new set of systems, but also the development of a new management philosophy and culture.

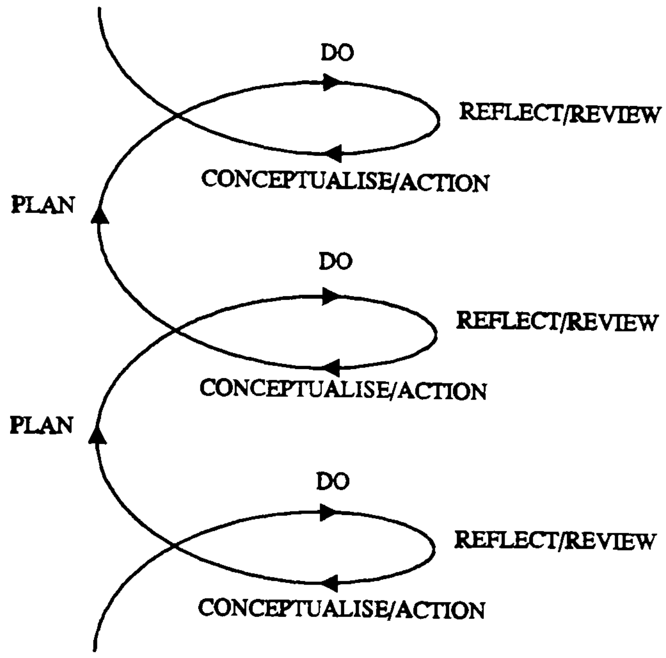

Figure 5.3: The Learning and Quality Improvement Cycle.

5.4 Organisational Philosophy and Culture

A quality culture in higher education is concerned with developing the analytical and critical abilities of a learner (Harvey and Green, 1993). In order to bring about the organisational change necessary for quality, it is necessary to change the norms and values within that organisation, so that greater attention is paid to teaching, learning, and the relationship between them. In effect the organisational culture has to be rebuilt so as to support central aims and high quality (Bassis, 1986). Organisational culture has been described as "the philosophy and values which create a common understanding among organisational members concerning the organization's mission and how its members should behave" (Taylor and Hill, 1993b, p. 16). In order to accommodate new ways of thinking and performing, there needs to be an organisational culture change (Liberatore, 1993). This is difficult, as most established organisational systems (whether formal or informal) are resistant to change, 'soft', essentially holistic, historically determined, and socially constructed. Liberatore (1993, p. 61) observes that "as the systems develop, they reinforce that culture in a symbiotic relationship. Any attempt to change the culture declares war on the systems". Informal and undocumented systems are a major hurdle to cultural change, and so thorough audits prior to improvement initiatives is required. Before such initiatives are started it is necessary to change management styles from those that focus on results to those that focus on processes, i.e. so that the environment supports continuous improvement (see Figure 5.4).

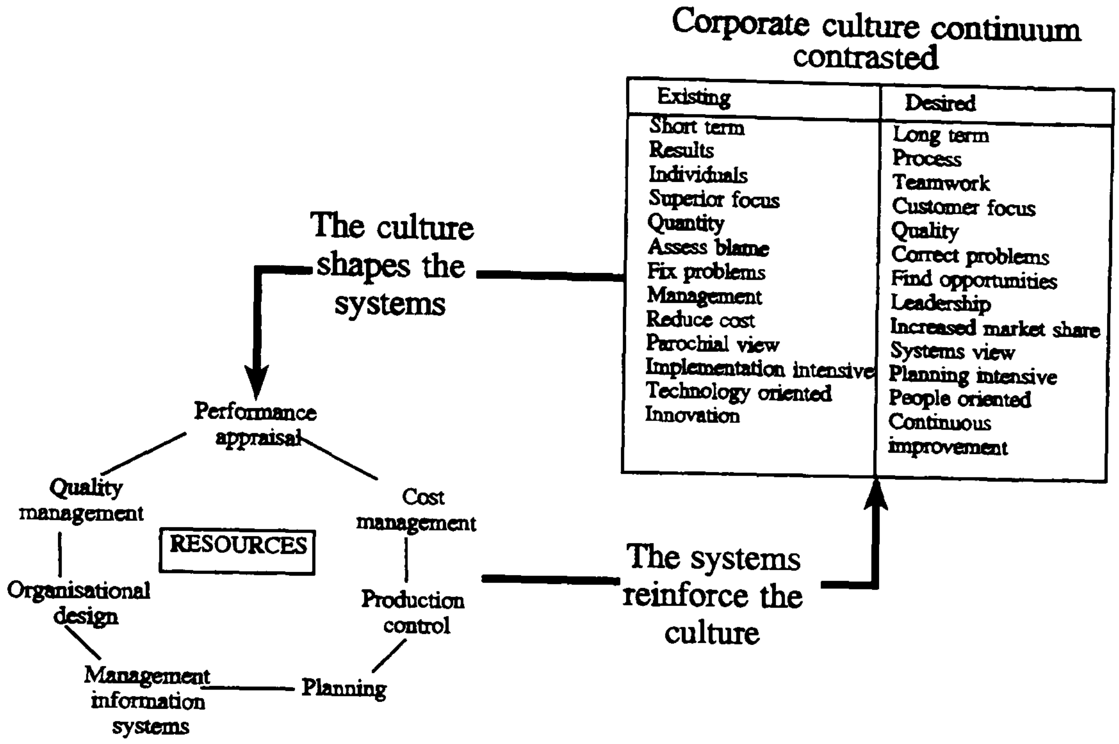

Figure 5.4: How Cultures Develop Within an Organisation (Liberatore, 1993, p. 62).

TQM requires a culture that promotes continuous improvement, creative problem solving, customer requirements, and that values its human resources. Senior management 'create' and reinforce inasmuch as more 'value' is placed on what they view as important, what they measure and how they control. In higher education, a cultural change is difficult as there is a tradition of conflict between academia and bureaucracy, of a diverse and differentiated organisation structure, and of a number of diffuse and ambiguous goals (Bassis, 1986). There is a need for senior management to provide support and encouragement that motivates and empowers staff (Burge and Tannock, 1992; Clayton, 1993; Doherty, 1993). Therefore, a culture change that ensures top-down support develops bottom-up initiatives is required, resulting in organisation wide continuous improvement.

It was noted earlier that both quality and learning require critical self-analysis, self-reflection and self-review. Therefore, the student/learner must engage in a structured approach to these activities. Such commitment is not restricted to the student/learner - the educators (i.e. academics) are also lifelong learners (Mathhew and Hughes, 1994). Being a professional academic requires a continuing programme of critical reflection where "a course team should be charged with.... a thoroughgoing review of the course for which it is responsible.... (calling for) a continuing programme of critical reflection" (Barnett, 1992, p. 15). Within the engineering institutions this is backed by a commitment to 'Continuing Professional Development' (CPD). Becher (1992) also views critical self-reflection as a cornerstone of quality. In Chapter 3 it was argued that development of the full range of cognitive abilities requires the learner (i.e. student) to participate actively in a self-critical cycle of self-reflection and improvement. Therefore, the culture within a department should set out to support systems that develop such abilities.

5.5 The Way Forward

As discussed earlier, learning and quality systems need to be active, integrated, cumulative and aimed at understanding. This should result in a more effective system as "processes of performance review aimed at illuminating the character of educational processes will have more impact if they are intended to improve the quality of what is on offer (that is, have future orientations), rather than have judgements on what has happened in the past" (Barnett, 1992, p. 17). Therefore, the numerical performance indicators are not as important as the action taken as a result of those indicators. An example of such a system is given in Figure 5.5.

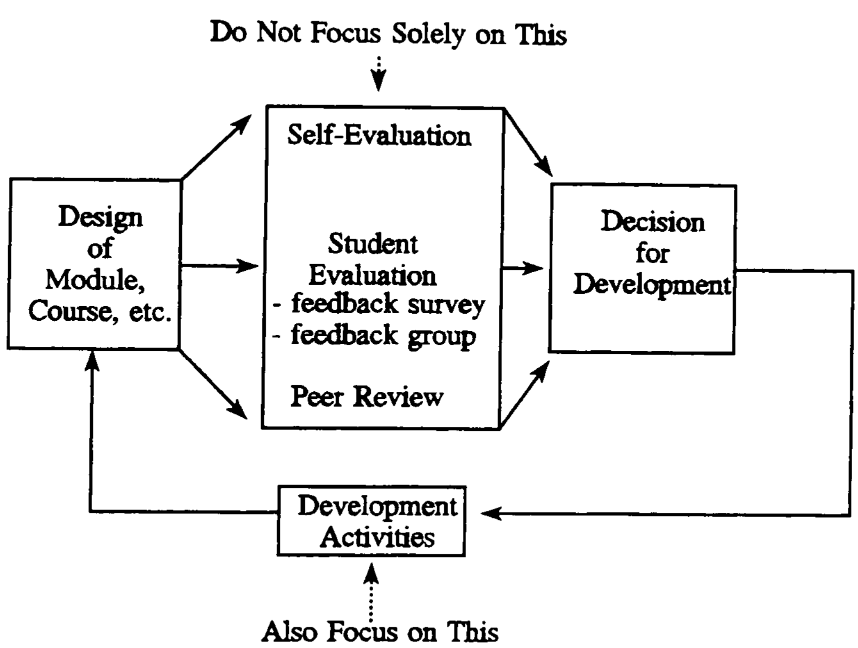

Figure 5.5: A Quality System Based on Development and Action

Many approaches to quality evaluation are motivated by curriculum design considerations (Muller and Funnell, 1993), where the data gathered is retrospective and of greater use to future learners. Traditional methods used are dominated by the use of questionnaires, which do little for the learners sense of ownership or for integration in to the learning process. As was argued earlier, TQM is based on building quality into the process rather than excluding defective products at the end of the process. In higher education, there is the dichotomy of the learner as both this 'process' (i.e. the application of personal cognitive development) and the resulting 'product' (i.e. developed abilities). This dissertation has argued that the emphasis should be primarily on the 'process', and this is where quality initiatives should be focused (i.e. build quality into the process). It was argued in Chapter 3 that this learning process can be developed by qualitative forms of feedback, based on analysis, dialogue and discussion. It was also argued that such qualitative methods will be of greater use than retrospective quantitative feedback, as the focus of such systems is often on evaluation rather than enhancement and empowerment. Qualitative systems also allow the learner to gain control of the learning process and form a 'deep' approach, where the higher level cognitive abilities are developed.

Based on the above argument, it is necessary to find mechanisms that encourage this approach. One method is by placing "the learner at the centre of the evaluation of the learner process and outcomes by focusing on qualitative approaches to exploring learner perceptions of quality. To achieve this the responsibility for evaluation must be built into the learning process itself and must be owned, in partnership, by learners and tutors" (Muller and Funnell, 1993, p. 31). By adopting a TQM approach, systems can be introduced that enhance both quality and the cognitive range of learning. This is because TQM organisations are essentially learning systems (Tannock and Burge, 1992; Taylor and Hill, 1993a, 1993b), where the emphasis is on self-improvement, and more focused on the learning process than curriculum content. This requires a view of education as a learning process rather than a teaching process (Roxby, 1992), where the emphasis is on how a subject can best be learnt rather than how it can best be taught.

By focusing on the process, the thesis presented in this dissertation implicitly proposes engineering education should aim to empower students with the ability to learn how to learn. This involves a move away from staff lecturing to a passive cohort of learners, and implies that learners must be more pro-active in integrating their cognitive abilities (Solomonides and Button, 1994). Learning interventions (e.g. learning-to-learn, reflective workshops, etc.) are of limited value if the educational environment does not support and encourage the requisite attitudes and values of continuous improvement (Solomonides and Button, 1994; Zuber-Skerritt, 1992). A call for improvement in student learning will only be accepted by learners if they perceive that the educational culture and environment supports such initiatives. This can be achieved by emphasising the process of learning in combination with the content and basic skills of acquiring subject knowledge. Zuber-Skerritt (1992), calls this focus on process and content *Metalearning*, i.e. a move from study skills to learning-to-learn. Methods of facilitating such student development (i.e. develop the learning process) include (Gibbs, 1991; Zuber-Skerritt, 1992):

- Integration of the content of a course and learning discussions, where students reflect on the process of teaching and learning immediately after or during studying;
- Taking a student-centred approach, i.e. what conceptions do students have of learning;
- Giving responsibility to students, i.e. "Developing as a learner is a continuous process.... and unless the student takes responsibility for this process.... aware of how he is learning and noting what works and what does not.... then change will be impeded" (Gibbs, 1991, p. 88);
- Emphasise purpose rather than technique, i.e what study methods are for;
- Emphasising student awareness, i.e. "need to encourage students' active reflection about their studying (the cornerstone of their development)" (Gibbs, 1991, p. 90);
- teaching staff, rather than educationalist or skills counsellors, as learning facilitators;
- the administrative integration of the learning skills programme into the normal timetable of the course.

Therefore, the combination of such approaches, with student and staff commitment, form a positive learning environment. Students learning strategy depends on their perceptions of lecturer expectations and assessment requirements. Staff need to gain a better understanding of the learning process and how teaching methods impact on, and develop, this learning (Gibbs, 1991). Student discussion is seen as vital and should be the main focus (Zuber-Skerritt, 1992), as it allows reflection, analysis and improvement both individually and as a group. In such discussion students need space and time to examine the process of learning itself, not just the subject matter of their learning (Gibbs, 1991). Formative evaluation is seen as a powerful tool (Fordyce, 1986), as it provides the learner with responsive information on which to make decisions.

5.6 The Thesis

From the previous discussions presented in this dissertation, it can be argued that quality improvement systems, based on developments in manufacturing industry, can be used in higher education to create a culture that engenders a positive learning approach. The following Chapters document the approach taken to investigate this thesis, and report on the findings of a three and a half year longitudinal research project undertaken in a general engineering department of a British University.

5.7 Conclusions

The purpose of engineering education is to develop student's cognitive abilities via a 'transformative' orientation. Such effective engineering education requires the active involvement of the learner in the learning process, via a cycle of self-reflection and self-improvement. Such cycles also form the basis of robust, long-term quality initiatives. From this 'transformative' link in engineering education, quality cycles are learning cycles and learning cycles are quality cycles. To implement such cycles requires a certain management philosophy and organisational culture, where there is organisation-wide commitment to continuous quality and learning improvement. The systems adopted must encourage an integrated approach to personal reflection and review on the part of the learner. The thesis argued that manufacturing quality systems, based on reflection and review cycles, can be used to develop a culture that encourages an effective approach to the full range of cognitive abilities (i.e. learning). The next chapter presents the particular methodology and research approach that was adopted to investigate this thesis.

Chapter 6 - Methodology

It has been argued that the purpose of engineering education should be based on a 'transformative' orientation, where the focus is on developing the students' range of cognitive abilities via a positive learning environment. This environment involves the adoption and support of continuous cycles of learning improvement, via planning, reflecting, etc., on a department-wide basis. The thesis outlined in chapter 5 requires investigation into whether changes in organisational culture and quality systems can lead to the development of such a positive learning environment. To examine this requires a particular methodology that moves beyond quantitative measures and numbers. The underlying methods adopted in the Case Study presented in this dissertation are examined and evaluated, and an introduction to the Case Study is given.

6.1 The Role of Research

When studying the natural sciences, there are a number of underlying assumptions (Mouly, 1978). These include: *determinism*, where events have causes and that these causal links can be identified and explained in a regular and predictable manner; *empiricism*, where reliable knowledge can only originate from experience verified by observation; *parsimony*, where observations should be explained in the most economical way; and *generality*, where observations on the particular can be inferred to the greater environment.

These assumptions are based on three interrelated approaches to understanding the environment in which we exist: experience, reasoning and research (Anderson, 1990; Mouly, 1978). The first approach, *experience*, is based on an accumulated body of knowledge and skills. It has been criticised for its haphazard manner, and lack of basis in scientific and empirical methods. The second approach, *reasoning*, can be sub-divided into *deductive*, *inductive*, and *deductive-inductive*. Deductive reasoning is based on a progression of logical steps, moving from the general to the particular. However, it has been criticised for being too far removed from observation and experience (i.e. its empirical foundation was weak), and being susceptible to bias. Such criticisms gave rise to approaches based on inductive reasoning, where the main focus was observation. With inductive reasoning, a number of individual cases are observed, which in turn leads to a hypothesis and a generalisation. Therefore, the basis is on impartial data collection and presentation of empirical evidence. These two approaches have been combined to form an inductive-deductive approach where, through a series of iterations, an investigator operates *inductively* from observations, and then *deductively* from the hypothesis to its implications, so as to check its validity when compared with accepted knowledge. The third approach, *research*, can be defined as the "systematic, controlled, empirical, and critical investigation of hypothetical propositions about the presumed relations amongst natural phenomena" (Kerlinger cited in Cohen and Manion, 1994, p. 4). It is, therefore, a combination of experience and reasoning, and to this end must be regarded as the most effective approach to understanding our environment.

6.2 Education and the Social Sciences

Education, as a subject area, has been criticised for its reliance on experience over research, leading to slow and unsure progress (Cohen and Manion, 1994). To overcome this weakness, they advocate the adoption and application of social science methods to education and its problems. This, in turn, has lead to a debate over which view of social science to adopt: the *traditional view* or the *radical view*. The traditional view treats social sciences as exactly the same as the natural sciences, in that it is concerned with discovering natural and universal laws that regulate and determine human and social behaviour, i.e. it is *objective*. The radical view shares the rigour and concerns of the natural sciences and traditional social sciences, but "emphasizes how people differ from inanimate natural phenomena" (Cohen and Manion, 1994, p. 5), i.e. it is *subjective*.

6.3 Objective and Subjective Approaches

These two views (objective and subjective) stem from different conceptions of *social reality* and of individual and social behaviours, resulting in different approaches to educational research (see Table 6.1). According to Burrell and Morgan (cited in Cohen and Manion, 1994), there are four assumptions underlying these two views: *ontology*, *epistemology*, *human nature*, and *methodology*.

6.3.1 Ontology

The first assumption, ontology, is concerned with the nature of being, and asks whether social reality is external to the individual (i.e. imposes itself on an individuals

Dimensions of comparison	**Conceptions of social reality**	
	Objectivist	***Subjectivist***
Philosophical basis	Realism: the world exists and is knowable as it really is. Organizations are real entities with a life of their own.	Idealism: the world exists but different people construe it in very different ways. Organizations are invented social reality.
The role of social science	Discovering the universal laws of society and human conduct within it.	Discovering how individual people interpret the world in which they live.
Basic units of social reality	The collectivity: society or organizations.	Individuals acting singly or together.
Methods of understanding	Identifying conditions or relationships which permit the collectivity to exist. Conceiving what these conditions and relationships are.	Interpretation of the subjective meanings which individuals place upon their action. Discovering the subjective rules for such action.
Theory	A rational edifice built by scientists to explain human behaviour.	Sets of meanings which people use to make their world and behaviour within it.
Research	Experimental or quasi-experimental validation of theory.	The search for meaningful relationships and the discovery of their consequences for action.
Methodology	Abstraction of reality, especially through mathematical models and quantitative analysis.	The representation of reality for purposes of comparison. Analysis of language and meaning.
Society	Ordered. Governed by a uniform set of values and made possible only by those values.	Conflicted. Governed by the values of people with access to power.
Organizations	Goal oriented. Independent of people. Instruments of order in society serving both society and the individual.	Dependent upon people and their goals. Instruments of power which some people control and can use to attain ends which seem good to them.
Organizational pathologies	Organizations get out of kilter with social values and individual needs.	Given diverse human ends, there is always conflict among people acting to pursue them.
Prescription for change	Change the structure of the organization to meet social values and individual needs.	Find out what values are embodied in organizational action and whose they are. Changing the people or change their values if you can.

Table 6.1: Alternative Bases for Interpreting Social Reality (Based on Cohen and Manion, 1994, pp. 10-11).

consciousness) or is a product of the individuals consciousness? This dichotomy is known as the *nominalist-realist* debate.

6.3.2 Epistemology

This second assumption is concerned with the nature of knowledge, and asks whether knowledge is real and tangible or whether it is more personal, subjective and transcendental? If knowledge is hard and objective, then a researcher can take an observer role and apply the methods of natural science (i.e. *positivist* stance). However, if knowledge is personal and subjective (i.e. *anti-positivist* stance), then researchers reject natural science methods and become more closely involved with their subjects.

Positivism entails a belief that methods and procedures of the natural sciences are appropriate to the social sciences (Bryman, 1993), i.e. *methodological naturalism*, and that only phenomena that are observable can be regarded as knowledge. The positivist doctrine is based on the argument that all knowledge is a result of experience and can only be advanced by means of observation and experimentation. Therefore, phenomena which cannot be observed have no validity. This rules out subjective notions, such as 'feelings' or 'experience', unless they are observable, i.e. *phenomenalism/empiricism*. This stance, therefore, argues that knowledge is the result of both accumulated facts, which in turn result in theories and 'laws'(i.e. *inductivism)*, and the subjecting of such hypotheses to empirical testing (i.e. *deductivism*).

However, such an approach is less successful when applied to human behaviour, where "the immense complexity of human nature and illusive and intangible quality of social phenomenon contrast strikingly with the order of the natural world" (Cohen and Manion, 1994, p. 12). If education is viewed as a process (see Chapter 3), then there is a need for research methods which themselves are process-oriented, flexible and adaptable to changes in variable circumstances (Anderson, 1990).

Arguments over positivist and non-positivist can be explained in terms of *normative* and *interpretive* models. The normative paradigm argues that human behaviour is governed by rules and should be investigated using natural science methods, whereas the interpretive paradigm is concerned with the individual, and avoids methods that impose external structure. These differences between these approaches is shown in Table 6.2

Normative	Interpretive
Society and the social system	The individual
Medium/large-scale research	Small-scale research
Impersonal, anonymous forces regulating behaviour	Human actions continuously recreating social life
Model of natural sciences	Non-statistical
'Objectivity'	'Subjectivity'
Research conducted 'from the outside'	Personal involvement of the researcher
Generalizing from the specific	Interpreting the specific
Explaining behaviour/seeking causes	Understanding actions/meanings rather than causes
Assuming the taken-for-granted	Investigating the taken-for-granted
Macro-concepts: society, institutions, norms, positions, roles, expectations	Micro-concepts: individual perspective, personal constructs, definitions of situations
Structuralists	Phenomenologists, ethnomethodologists

Table 6.2: Differing Approaches to the Study of Human Behaviour (Cohen and Manion, 1994, p. 39).

6.3.3 Human Nature

This third assumption is concerned with the connection between human beings and their environment, and asks whether human beings respond mechanistically to their environment (i.e. external conditioning) or whether humans are initiators of their own actions (i.e. internal creativity)? The former is concerned with *determinism* and the later is concerned with *voluntarism.*

6.3.4 Methodology

The three assumptions outlined above impact directly on the methodologies adopted by researchers, as differing views will require different research methods. This leads to the fourth assumption, *methodology.* Traditional methods (e.g. surveys, experiments, etc.) would be favoured by researchers adopting an objective approach to the social world, and who treat it like the natural sciences as being 'hard' and external to the individual. Such approaches will be primarily quantitative, and involve analysing relationships between factors with the aim of discovering general laws. This approach is termed *nomothetic.* Conversely, radical methods (e.g. personal accounts and observations) would be favoured by those adopting a more subjective approach, where the social world is more personal and human-centred. This view stresses the importance of an individual's subjective experience, and focuses on qualitative ways in which an individual modifies and interprets their environment. This approach is termed *idiographic.*

The range of views that encompass these four underlying assumption are summarised in Table 6.3.

6.4 Quantitative Approaches

Those adopting a positivist stance favour quantitative research methods (Bryman, 1993). Quantitative research has a logical structure in which theories determine the hypotheses. These hypotheses take the form of expectations about likely causal links between the constituent concepts of the hypotheses. Data are collected and analyzed, so that the causal link specified by the hypothesis can be accepted or rejected. The results are then fed back into the theory, illustrated in Figure 6.1. Therefore, the research process is both rational and linear.

6.4.1 Essence of Quantitative Approaches

There are a number of preoccupations in quantitative research (Bryman, 1993), including concepts and their measurement; causality; generalization; replication; and individualism, and these areas are discussed below:

- Concepts and their measurement, argues that the concepts in the hypothesis need to be observable so that they can be measured. In social sciences, this tends to be through using questionnaires and structured observation. As such measures are central to quantitative research, there is much concern about the technical requirements, i.e. validity and reliability (Bryman, 1993). Validity refers to the certainty the researcher has that a measure really does reflect the concept to which it supposed to refer (i.e. *internal validity*). Reliability refers to the certainty the researcher has for the consistency of measurement.

Dimension	**Dichotomy**	**Objectivist Approach**	**Subjectivist Approach**
Ontology (i.e. the nature of being)	Does social reality impose itself on the individual (i.e. external to the individual) or is it a product of the individual consciousness?	Realism: Objects have a separate, independent existence and are not dependent on the individual.	Nominalism: objects of thought are merely words with no independently accessible thing constituting the meaning of the word.
Epistemology (i.e. the nature of knowledge)	Is knowledge real and tangible or is it softer and more transcendental?	Positivist: Natural Science methods can be used as knowledge is hard and objective. A normative stance is taken, as human behaviour is governed by a series of rules.	Anti-positivist: Rejection of Natural science methods as knowledge is more personal and subjective. An interpretive stance is taken, as the focus is on the internal reality of the individual (i.e. avoid imposing an external structure).
Human Nature (i.e. the relationship between individuals and their environment)	Do individuals respond mechanistically to their environment or are individuals initiators of their own actions?	Determinism: Individuals and their experiences are products of the environment (i.e. external conditioning).	Voluntarism: Individuals are the creators of their own environment (i.e. internal creativity)
Methodology (i.e. the research methods used)	Which method is most appropriate to each approach?	Nomothetic: As social reality is hard and external to the individual, a Natural Science approach can be used. Normative and quantifiable methods are used to establish relationships between factors with the aim of discovering a general law (eg. pre-determined questions, surveys, experiments, etc.).	Idiographic: As social reality is personal and more human-centred, the focus is on individual subjective experiences. Interpretive methods examine the qualitative ways in which individuals modify and interpret their environment (eg. observation, non-directive depth interviews, etc.)

Table 6.3: Assumptions Underlying the Objectivist and Subjectivist Approaches.

- Causality, argues that quantitative research is concerned with establishing the causal relationship between concepts. Techniques used to ascertain with this are usually either *experimental*, via the random assignment of control and experimental groups, or *cross-sectional analysis*, where data is collected at a single point in time. Non-experimental research is seen as relatively weak, as the researcher is unable to manipulate aspects of

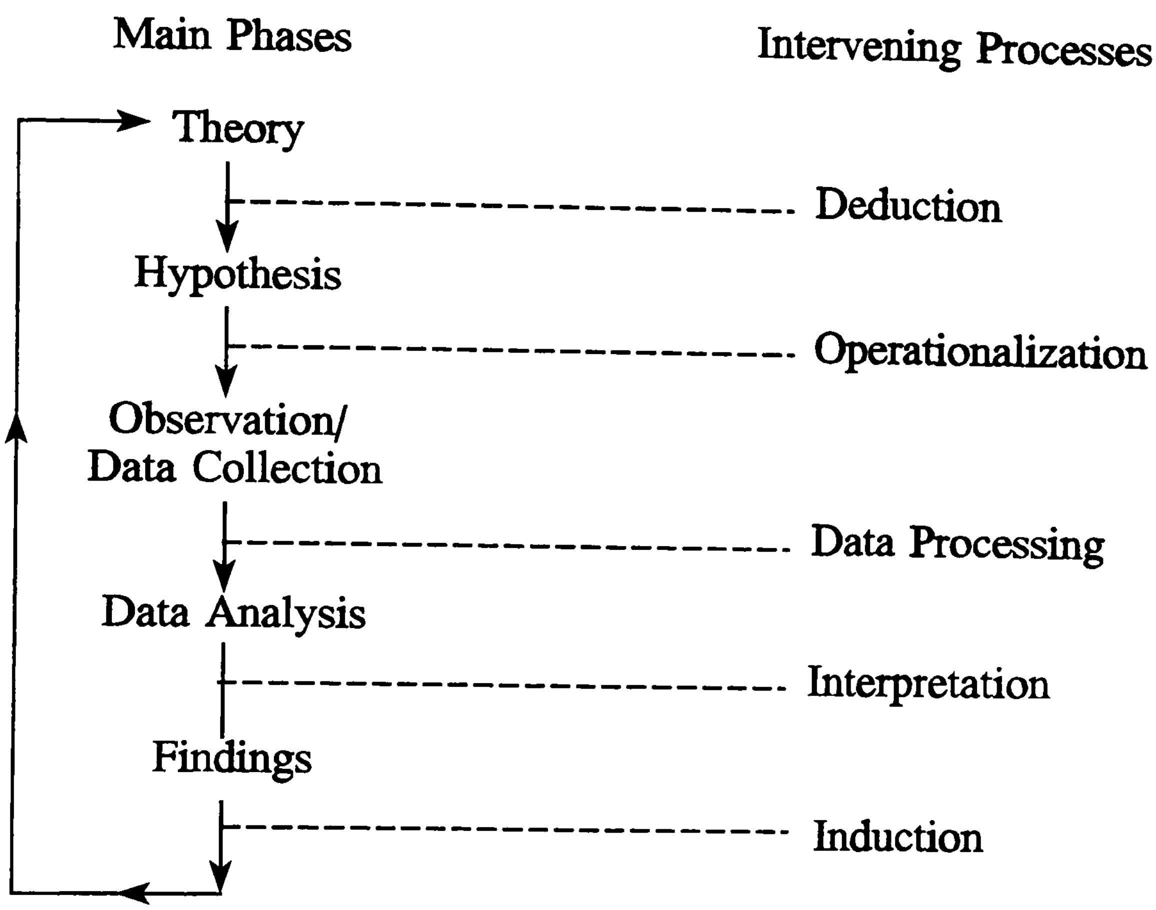

Figure 6.1: The Logical Structure of the Quantitative Research Process (Bryman, 1992, p. 20)

the social environment.

- Generalization, argues that the results of a study ought to be generalized beyond the limits of the research location. Therefore, great attention is paid to representative sampling issues, i.e. that findings "can be legitimately generalized to a wider population of which the sample is representative" (Bryman, 1993, p. 35). Therefore, general 'laws' can be established. This is referred to as 'external validity', and describes the extent to which the findings can be generalized beyond the experiment.
- Replication, argues that experiments performed under the same conditions should lead to the same results. Therefore, replication is a means of checking researcher bias and the applicability of findings to other contexts.
- Individualism, where quantitative research focuses on the individual, as survey instruments are given to individuals as discrete objects of inquiry. The responses are then totalled, though the respondents often do not know each other. Therefore, society is viewed as an "aggregate of disparate individuals" (Bryman, 1993, p. 39).

It can be argued that researchers who subscribe to an objective view of the social sciences, adopt research mechanisms and techniques that focus on the areas outlined above.

6.4.2 Criticisms of Quantitative Approaches

The rational and linear approach, outlined above, has been criticised (Bryman, 1993) as it overstates the centrality of theory in much quantitative research. Bryman also criticises the approach for its apparent orderliness and linearity, and the lack of concern over the influence of resource constraints on decisions. In fact, it can be seen as a "depiction of the reconstructed, rationalised logic of the research process that is often enshrined in research reports" (Bryman, 1993, p. 21). In other words, it can be seen as an exercise in 'post-decision rationalisation'. Scientific observation, the basis for many quantitative methods, has also been criticised (Chadwick et al, 1984), namely:

- You cannot observe something without changing it, i.e. reactivity and the 'Hawthorne effect'. Here, observable changes in those being studied are attributed to the subjects awareness that they are part of an experimental group, rather than to any variations in the conditions which were the intended factors under investigation. Also measurement can be a change agent, where the initial measurement activity introduces a real change in what is being measured;
- You cannot observe something without misperceiving it, as human perception is selective;
- You cannot interpret (attribute meaning to) an observation without misrepresenting it;
- You cannot communicate an interpretation of an observation without an additional misrepresentation.

Positivism demands an absolute level of generalizability and relies on measurable evidence. It is exemplified by the scientific method and predominates the natural sciences, where there is a high degree of control over phenomena. However, social sciences are concerned with human beings and the methodology must recognise the variability that is inherent in human behaviour. Situations such as these demand the use of approaches that take account of these phenomena, as it is argued (Allison, 1993) that every phenomena is unique. The events that form a phenomena are conditioned by interacting variables (e.g. time, culture, etc.). Because of this interaction, no two situations can be identical and cannot be the basis for a wider generalisation. Therefore, the nature of problems is revealed by examining the situations in which these problems exist.

The controversy above has led to the questioning of the appropriateness of natural science approaches to the social sciences and education (Anderson, 1990; Bryman, 1993). This argument is based on the failure to take account of the differences between people and the objects of the natural sciences. In other words, research methods that revealed and utilized the character of people as objects of enquiry are required. Social phenomena are concept-dependent (Dey, 1993), unlike natural phenomena, as observations are concept-laden abstractions based on experience. Therefore, the principle of applying the scientific method to the study of people is questioned, and more qualitative approaches are favoured.

6.5 Qualitative Approaches

Qualitative approaches to research involve the "study of the social world which seeks to describe and analyze the culture and behaviour of humans and their groups from the point of view of those being studied" (Bryman, 1993, p. 46). Such approaches are, therefore, based on:

- commitment to viewing actions, values, etc. from the perspective of the people being studied;
- providing a detailed description of the social settings they investigate;
- understanding events, behaviour, etc., in their context;
- viewing social life as a process rather than static (i.e. longitudinal);
- avoiding imposing inappropriate 'frames of reference' on the subjects being studies, by using a relatively open and unstructured research strategy;
- the formulation and testing of theories in tandem with data collection.

The rationale for qualitative research is based on a number of premises (Marshall and Rossman, 1989). Firstly, human behaviour is significantly influenced by the setting in which it occurs, therefore it is necessary to study this behaviour in these settings. The physical setting and internalised norms, roles and values are crucial, and the research must operate in a setting where these variables exist. Therefore, qualitative research provides a systematic, empirical strategy for answering questions about people in a bounded social context where "people make sense of their own experience and in doing so create their own reality" (Locke et al, 1993, p. 99). Secondly, some research techniques, associated with experimental approaches, influence the findings of that research (e.g. the laboratory setting or use of questionnaires become artifacts). They affect the subject's behaviour and may not be able to 'measure' that which the research is interested in, as the subject cannot articulate it through this research tool (e.g. feeling, interaction, behaviours). Finally, a researcher cannot understand human behaviour without understanding the framework in which subjects interpret thoughts, feelings and actions.

6.5.1 The Philosophical Foundations of Qualitative Research

Qualitative research is underpinned by the intellectual fields of phenomenology, symbolic interactionism, *verstehen*, naturalism, and ethogenics. These fields embrace more than data gathering techniques (Bryman, 1993), rather they provide a firm philosophical foundation.

Phenomenology is concerned with the constructs that people use in order to make the world meaningful and intelligible to them. This approach argues that the subject matter of social sciences is fundamentally different from that of natural sciences (i.e. people and their social reality as opposed to atoms or molecules), and that any attempt to understand this social reality must be based in the participant's experience of that social reality. Therefore, the researcher must identify the participant's interpretive devices which provide the motivations for their actions. Failure to recognise the "meaningful nature of everyday experience runs the risk of losing touch with social reality and imposing instead a fictional non-existent world constructed by the scientific observer" (Bryman, 1993, p. 52). Therefore, actions must be examined by researchers in terms of the subject's own interpretation of his or her actions and motivations.

Symbolic Interactionism views social life "as an unfolding process in which the individual interprets his or her own environment and acts on the basis of that interpretation" (Bryman, 1993, p. 54). Therefore, a stimulus to act undergoes an interpretive process before a response is carried out. *Verstehen/understanding*, where this 'understanding' has two facets: direct observational understanding of the subjective meaning of an act; and the explanatory understanding, in which the act is placed in a sequence of action, the understanding of which "can be treated as an explanation of the actual course of behaviour" (Bryman, 1993, p. 57).

Naturalism involves researchers treating the phenomena being studies as naturally as possible. Therefore, the researcher should get 'close' to his or her subjects and not impose the 'artificial' methods of quantitative research on them. *Ethogenics* rejects the use of experimentation, viewing it as the creation of a "mechanistic conception of people who are viewed as simply responding to experimentally induced stimuli" (Bryman, 1993, p. 59).

6.5.2 Advantages of Qualitative Research

Qualitative research emphasises getting close to the subjects of study, and that experience is the best way to understand social behaviour (i.e. discover subjects definition of the situation) Therefore, the objective is to describe social realities from the perspective of the subjects, not the observers (Chadwick et al, 1984). This has the advantage of viewing behaviour in its natural setting; providing a greater depth of understanding; and allowing greater flexibility. In some cases the researcher avoids the elaboration of a theory before the research study so as to increase the 'impartiality' of the study (Bryman, 1993).

6.5.3 Problems with Qualitative Research

Research using a qualitative approach encounters a number of contentious areas (Bryman, 1993). Firstly, the ability of the researcher to interpret events from the subjects point of view is questioned. Secondly, the relationship between theory and research can be weak, where qualitative research is criticised for not instilling theoretical elements (Bryman, 1993). To overcome this the researcher must show how, in examining a specific setting or set of individuals, he or she is studying a *case* of a larger phenomena. The linking of specific research issues to larger theoretical constructs shows the research study illuminates a larger issue, and is, therefore, of significance (Marshall and Rossman, 1989). Finally, the extent to which qualitative research from case studies can be generalized beyond the confines of the particular case are questioned (i.e. limited external validity). Researchers can overcome this problem by demonstrating that the research was guided by theoretical concepts and models, and that a number of methods were used, i.e. triangulation techniques that involve the use of multiple-data-collection methods to increase the accuracy of the data (Cohen and Manion, 1994). However, qualitative research does not pretend to be replicable, as controlling the research setting destroys the interaction we are interested in. The emphasis is on recording these interactions as they occur, and they cannot be replicated as the real world changes.

In addition to these larger issues, there are a number of smaller problems, namely: the ethics of researching human behaviour; the danger that the research may be too unstructured as to be meaningless; the loss of detachment of the researcher (i.e. 'going native'); and potential poor reliability, as they can involve single events observed by a single researcher (Chadwick et al, 1984).

6.6 Quantitative Research Versus Qualitative Research

Quantitative and qualitative methods operate with "divergent principles regarding what is knowledge about the social world and how it legitimately be produced" (Bryman, 1993, p. 50), and these differences are illustrated in Table 6.4. Researchers are conditioned to think of research as a process that uses instruments and is analyzed by reducing the collected data to numbers (i.e. quantitative approaches). Quantitative researchers seek "explanations and predictions that will generalize to other persons and places" (Glesne and Peshkin, 1992, p. 6), and their role is to observe and measure objectively (i.e. without 'contaminating' the data). Qualitative research is concerned with "coming to understand and interpret how the various participants in a social setting construct the world around them" (Glesne and Peshkin, 1992, p. 6), and research designs involve interacting with, rather that acting on, subjects through in-depth, long-term association. Generally, a positivist approach (where there are positive facts and observable behaviour) uses quantitative methods, and a phenomenalist approach (where there are descriptions and classifications of phenomena) uses qualitative methods (Allison, 1993). Therefore, quantitative and qualitative research approaches have differing objectives and orientations.

It is argued that this quantitative/qualitative dichotomy is somewhat artificial, and that most research involves a combination of approaches and methods (Bryman, 1993). These research *hybrids* contain elements of both traditions, either through a combination of methods of data collection, or a method using qualitative methods of data collection within a research design typically associated with quantitative research. Reasons for adopting a predominantly qualitative approach include (Marshall and Rossman, 1989):

Category	Quantitative	Qualitative
Approach	Test the validity of theories. Begins with hypothesis and theories. Manipulation and control. Experimentation. Deductive. Component Analysis. Seeks consensus, the norm Reduces data to numerical indices. Abstract language in write-up.	The respondents of the study form the focus. Ends with hypotheses and grounded theory. Emergence and portrayal. Researcher as instrument. Inductive. Searches for patterns. Seeks pluralism, complexity. Makes minor use of numerical indices. Descriptive write-up.
Assumptions	Social facts have an objective reality, as social reality is static and external to participants. Primacy of method. Variables can be identified and relationships measured. Outsider's point of view.	Social reality is processual and socially constructed by participants. Primacy of subject matter. Variables are complex, interwoven, and difficult to measure. Insider's point of view.
Purpose	Research highly defined at the beginning. Generalizability. Prediction. Causal Explanations.	Less standardised approach, focusing on observations, conversations and informal interviewing. Contextualization. Interpretation. Understanding respondent's perspectives.
Relationship between theory/concepts and research	Confirmation, where theory is starting point for investigation	Emergent, where theory is discovered form investigation
Role of qualitative research	Preparatory, in that it helps identify hypotheses	Means to explore the participants interpretations
Sample Selection	Carefully chosen and pre-defined.	Determined by who researcher meets during the course of field-work. The 'sample' is constantly shifting.
Research Strategy	Structured and closed	Unstructured and open
Results and Analysis	In the form of causal propositions, and reflect what the researcher thought important about the subject.	Descriptive accounts concerned with respondents perceptions, and reflect what respondents thought important about the subject.
Scope of findings	Nomothetic, relating to the establishing of general 'laws' that are not reliant on time or place	Ideographic, relating findings to a specific time and place, so that the generalizability is unknown
Nature and Presentation of Data	Hard, rigorous and reliable (i.e. 'precise', 'systematic' and verifiable), in the form of tables, graphs, etc.	Rich, deep (i.e. 'detailed' and 'penetrating'), in the form of quotations and detailed descriptions.
Relationship Between Researcher and Participant	Distant and fleeting	Close and sustained
Researchers Role	Detachment and Impartiality. Objective portrayal.	Personal involvement and partiality. Empathic understanding.

Table 6.4: Comparison of Quantitative and Qualitative Research.

- research that cannot be done experimentally
- research that takes an in-depth look at processes
- research that seeks to explore why policy and practice do not work
- research on innovative systems

- research on informal and unstructured linkages and processes in organisations (i.e. *culture*)
- research on actual, rather than stated, organizational goals and practices.

Therefore, researchers use qualitative approaches for "research that is exploratory or descriptive and that stresses the importance of context, setting and the subjects' frame of reference" (Marshall and Rossman, 1989, p. 46). Qualitative research is "not a clear cut sequence of procedures following a neat pattern, but a messy interaction between the conceptual and empirical world, deduction and induction occurring at the same time" (Bechhofer quoted in Bryman and Burgess, 1994a, p. 2), where research design, data collection and analysis are simultaneous and continuous processes.

6.7 Educational Research

Research in education is "a disciplined attempt to address questions or solve problems through the collection and analysis of primary data for the purpose of description, explanation, generalization and prediction" (Anderson, 1990, p. 4). However, this does not mean that educational researchers must adopt positivist/natural sciences approaches. The following quote illustrates this point:

> "How does one design research to capture educational acts in a spirit of enquiry? One way is to attempt to catch them in the form of an experiment; another is to observe them and carefully record them. An experiment is shaped to sharpen the bearing of observations on certain questions and if possible to enable observations to be expressed as measurement. Naturalistic observation responds to the natural shape of events and attempts to portray them in a way that makes them open to people who did not have first-hand experience of them.... in experiment we are fishing for generalizations; in case study we are portraying experiences that while they do not offer general laws, can be applied to new situations we meet."
>
> (Lawrence Stenhouse quoted in Rudduck, 1984, p. 189).

Therefore, the testing of hypotheses is of limited use in educational settings, rather research should be a means of solving problems (Anderson, 1990), i.e. applied research.

6.7.1 Applied Research

Applied research can be distinguished from theoretical research through its "requirements to meet specific information needs and its potential for actionable outcomes" (Ritchie and Spencer, 1994, p. 173). In applied research, qualitative methods have a variety of objectives: contextual, diagnostic, evaluative and strategic (see Table 6.5). Most researchers attempt to address more than one of these groups of questions. This in turn has implications for the type of educational research to be carried out, and this is illustrated in Table 6.6. Applied research uses the scientific method to "answer a specific question for a specific group at a given point in time" (Chadwick et al, 1984, p. 9).

Contextual	**Diagnostic**	**Evaluative**	**Strategic**
Identifying the nature and form of what exists	Examining the reasons for, or causes of what exists	Appraising the effectiveness of what exists	Identifying new theories, policies, plans or actions
Example: • what are the dimensions of attitudes or perceptions held? • what is the nature of peoples experiences? •what elements operate within the system?	Example: • what factors underline particular attitudes or perceptions? • why are decisions or actions taken, or not taken? • why are programmes not being used?	Example: • what affects the successful delivery of programmes? • how do experiences affect subsequent behaviours? • what barriers exist to systems operating?	Example: • what types of programmes are required to meet needs? • what actions are needed to make programmes more effective? • how can systems be improved?

Table 6.5: Objectives of Qualitative Research.

6.7.2 Action Research

Many of the advances in educational theory have had little significant impact on learning and teaching practice in higher education. This is largely because most academics are unaware of recent theories, principles and methods of learning and teaching (Zuber-Skerritt, 1992). Action research is a means to overcome this barrier, and involves a "collaborative, critical enquiry by the academics themselves (rather than expert educational researchers) in their own teaching practice, into problems of student learning and into curriculum problems. It is professional development through academic course development, group reflection, action, evaluation and improved practice" (Zuber-Skerritt, 1992, p. 1). Therefore,

Research Type:	Descriptive	Explanatory (Internal Validity)	Generalization (External Validity)	Basic (Theoretical)
Major Questions:	What is happening? What happened in the past?	What is causing it to happen? Why did it happen?	Will the same thing happen under different circumstances?	Is there some underlying principle at work?
Traditional Associated Disciplines:	Anthropology History Natural Sciences Sociology	Anthropology Behavioural Sciences History Natural Sciences Psychology Sociology	Behavioural Sciences Natural Sciences Psychology	Behavioural Sciences Natural Sciences Psychology Philosophy
Methods/ Approaches:	Case Study Content Analysis Ethnography Observation Policy Research Programme Evaluation Survey Research	Case Study Comparative Correlational Ethnography Observation Time Series Analysis	Causal-Comparative Experimental Meta Analysis Case *Studies* Predictive Quasi-Experimental	Experimental Meta Analysis Policy Research Time Series Analysis

Table 6.6: Four Types of Educational Research (Anderson, 1990, p. 7)

teachers are disseminators of an action research approach (Rudduck, 1984), and involves them documenting their teaching approach and learning about their educational actions. It is, therefore, "a small scale intervention in the functioning of the real world and a close examination of the effects of such interventions" (Cohen and Manion, 1994, p. 186). The objective is to design research from which teachers and researchers learn as much as possible from their educational actions. The principle of action research is that action has to be justified in professional rather than research terms. The researcher has to work alongside teachers, respecting their educational aims and professional judgement, but trying to learn as much as they can for a wider audience about the research topic. This combination of needs involves supporting teachers in developing a research role alongside their teaching role. The resulting research may inform practice and lead to action, with the aim "to improve practice in a systematic way.... to suggest and make changes to the environment, context or conditions in which practice takes place, and which impede desirable improvement and effective future development" (Zuber-Skerritt, 1992, p. 11).

6.7.2.a The Process of Action Research

Action research involves those involved in education following a continuous and iterative cycle of 'Plan-Act-Observe-Reflect' (Zuber-Skerritt, 1992). It focuses on specific problems in specific settings and, as such, sacrifices much generalizability for precise knowledge of a particular situation. Such cycles are similar to those of quality and learning identified in chapters 3, 4 and 5. In the case of action research:

- 'Plan' involves problem analysis and strategic action;
- 'Action' involves implementation of the strategic plan;
- 'Observation' involves evaluation of the action by appropriate methods and techniques;
- 'Reflection' involves reflecting on the results of evaluation and on the whole action and research process. This may lead to the identification of a new problem, and therefore a new cycle.

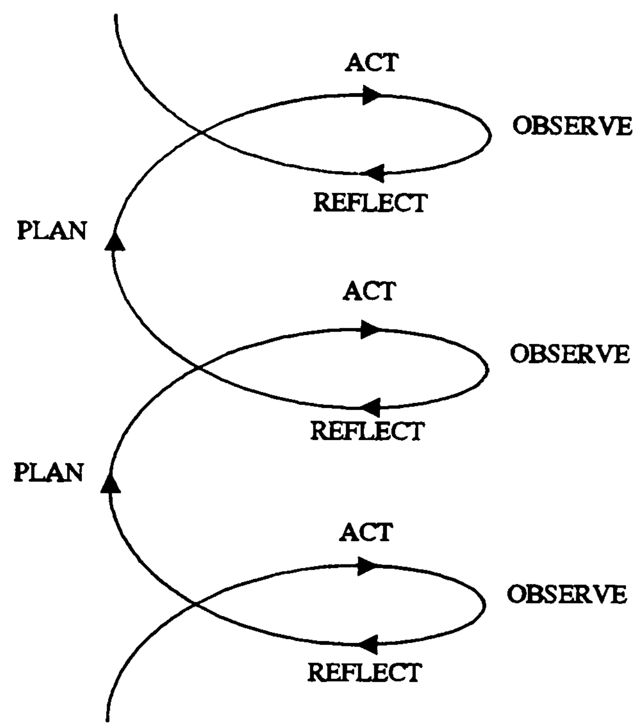

Figure 6.2: The Iterative Process of Action Research.

This step-by-step process is monitored over time by a variety of methods (see 6.8), so that any feedback can benefit the process immediately. To this end, action research is both flexible and adaptable. Therefore, there could be a spiral of 'Plan-Act-Observe-Reflect' cycles (see Figure 6.2), where participants can learn and create knowledge (Zuber-Skerritt, 1992):

- on the basis of their concrete experience;
- through observing and reflecting on that experience;
- by forming abstract concepts and generalisations;
- by testing the implication of the concept in new situations, which lead to a new concrete experience and hence a new cycle.

6.8 Research Methods

Methods in educational research refers to the range of approaches used to "gather data which are to be used as a basis for inference and interpretation, for explanation and prediction" (Cohen and Manion, 1994, p. 38). These methods can be positivist or non-positivist, and normative (e.g. predetermined questions) or interpretive (e.g. non-directive interviewing, participant observation). Therefore, methods are the techniques and procedures that researchers use to gather data. It will be argued later in this Chapter that the thesis presented in this dissertation requires a predominantly qualitative approach, and, as such, a number of research techniques can be utilised.

6.8.1 Participant Observation

Participant observation is "the sustained immersion of [a] researcher among those whom he or she seeks to study with a view to generating a rounded, in-depth account of the group, organization, or whatever" (Bryman, 1993, p. 45). It has also been described as a "systematic description of events, behaviours and artifacts in the social setting chosen for study" (Marshall and Rossman, 1989, p. 79). Participant observation can use a range of data gathering methods, including unstructured interviewing, documentary evidence and more structured interviews and questionnaires. This allows 'triangulation', where findings from one data source can be corroborated with another. The use of questionnaires and interviews may also glean information that is not available via observation alone (e.g. attitudes). They, therefore, increase the scope and breadth of the participant observation research. Therefore, participant observation is not a single method, but rather embraces a number of different methods and styles. This greater variability has led to the term 'field research' being applied (i.e. distinct from something that is laboratory-based and controlled), where its value is its flexibility and adaptability. Field notes are kept for later analysis and interpretation.

In reality, participant observation is a range of methods along a continuum, 'participant' at one extreme and 'observer' at the other extreme. Therefore, research can range from complete participant, through participant as observer and observer as participant, to observer (Burgess, 1984; Glesne and Peshkin, 1992; Marshall and Rossman, 1989; May, 1993).

6.8.2 Interviews

An interview is defined as "encounters between a researcher and respondent in which the latter is asked a series of questions relevant to the subject of the research. The respondent's answers constitute the raw data analyzed at a later point in time by the researcher" (Ackroyd and Hughes quoted in May, 1993, p. 91). More simply, it can be viewed as " a conversation with a purpose" (Marshall and Rossman, 1989, p. 82). The interview can vary in the degree of structure and the amount of freedom respondents are given in replying to question, and provides a flexible, broad and deep method of gaining data. The interviewing can be classified as:

- structured, where there is greater comparability between responses but a reduction in flexibility;
- semi-structured, where specified questions are asked with more freedom to probe;
- group, where there is increased focus on interaction, group dynamics, consensus views;
- unstructured or focused, where the format is more open-ended in character, flexible and aimed at discovering meaning.

In all interviewing situations, the interviewer must avoid biasing the data. There is the danger that the involvement of the researcher may 'taint' results, by introducing an 'artificial' variable (May, 1993). Also, owing to small-scale (i.e. local) setting, the results may not be generalizable (i.e. lack external validity).

The purpose of interviewing is not simply to gather data. It is also a means of considering relationships, meanings and explanations, with which to pose future questions or understand later responses. Exploratory interviews are heuristic, and are aimed at developing ideas and hypotheses, i.e. how respondents think and feel about a particular subject, situation, etc. It is, therefore, aimed more at collecting ideas rather than data (Oppenheim, 1992). The interviewer plays a minimal role, so as to avoid leading the respondents. More in-depth interviewing requires a list of topics to discuss, as there can be no (or few) fixed questions, and group interviews involve a round table discussion, so that respondents lead off each other. The issue of question types (i.e. free or closed-response) is discussed later in this Chapter.

Unstructured interviewing requires that the researcher provides minimum guidance, allowing less constraints for interviewees. The interview itself can be completely unguided or within a loose structure of themes that are of interest. Therefore, there is considerably more freedom, scope and depth than, say, survey research, as the interviewee may reveal a previously unrealised matter of importance to the researcher. In particular, the research described in this dissertation focused mainly on group interviewing. This is a form of unstructured interviewing with more than one participant, though sometimes based round a series of key topics and questions. It allows differences between participants to be highlighted. There is a danger that the interview can cause a disruption to the natural flow of events (i.e. opposed to the idea of 'naturalism'), though this can be offset by the systematic knowledge about subjective experience that the technique allows. These personal interviews produce the fullest and most detailed data, though this more detailed data is not so easily handled, so that more involved analysis is required (Theodossin and Thomson, 1987).

6.8.3 Questionnaires

The purpose of questionnaires is to measure some characteristic or opinion of its respondents (May, 1993). Questionnaires involve a respondent filing out and returning to the researcher, a self-administered 'interview' (Chadwick et al, 1984), where the questions and instructions are such that the respondent can act as the 'interviewer'. They can provide easily quantifiable data, but can also restrain respondents (Theodossin and Thomson, 1987), by limiting the number and variety of responses, thus simplifying the recording of client perceptions in the interest of ease of analysis. Respondents are selected via quantitative methods, as the aim is usually to select a sample that is representative of a wider population, so that the generalizability of findings can be shown (Bryman, 1993). These samples can be random, purposive, quota, etc. Questionnaires should use simple language (i.e. avoiding jargon); aim all the content at the respondent; use simple instructions and uncomplicated layout; and should be of limited length (Oppenheim, 1992; Theodossin and Thomson, 1987).

6.8.3.a Advantages and Disadvantages of Questionnaires

The advantage of questionnaires is that they are very efficient, in terms of data gathered. If completed over time, the responses can be more thoughtful and considered. They are also useful for sensitive topics (especially if anonymous). However, the use of questionnaires also has a number of disadvantages. They must be brief in order to increase response, and cannot probe or follow up interesting comments (though open-ended questions can help). They may be filled in by someone other than the intended respondent, and the respondent can change or 'tweak' answers.

Questionnaire surveys can be accurate (i.e. repeatable and controllable), generalizable (providing appropriate sample is available), and quantifiable. However, they provide little insight in to complex social relationships or indicate patterns of interaction, as they usually offer only limited range of responses (Marshall and Rossman, 1989). In general, questionnaires are seen as rigid and fixed (i.e. by their very design, questionnaires presuppose what are the important issues), whereas participant observation and interviewing can react to circumstances and situations.

6.8.3.b Question Types

Open-ended or free response questions are more likely to reflect peoples actual responses, thoughts, etc. (Dey, 1993). They provide a freedom and spontaneity of answers, and an opportunity to probe. However, they are more time consuming; more costly in interviewer time; harder to analyze; and require more effort from respondents (Oppenheim, 1992).

Closed-response questions offer a choice of limited but alternative replies. The advantage of using such questions, rather than open-response, is that they require limited time; involve no extended writing on the part of the respondent; involve lower costs; are easier to process; and are easier to make comparisons of responses. However, there is a loss of spontaneous response; possible bias in answer categories; and can be too crude.

The choice between free or closed-response questions very much depends on the purpose of the interview or questionnaire.

6.8.3.c Attitude Measurement

An attitude is a "state of readiness, a tendency to respond in a certain manner when confronted with a certain stimuli" (Oppenheim, 1994, p. 174). Attitudes are reinforced by beliefs (i.e. the cognitive aspect). An attitude has both content and intensity (e.g. strongly disagree). Attitudes and opinions are not isolated units, but interlink and are interdependent (both vertically and horizontally). Questions aimed at ascertaining respondent's beliefs and attitudes are more difficult to verify and less reliable, as they rely on the respondents state of mind. They are also more prone to situational and other biases. Factual questions are fairly straightforward, but attitude questions are more complex and multi-faceted (Oppenheim, 1992) and it is, therefore, unwise to rely on a few questions when asking non-factual questions. In such instances, interviews can be preferable as they allow more depth and involvement.

6.8.3.d Attitude Rating Scales

Ratings give a numerical value to some kind of assessment or judgement (Oppenheim, 1994). One of the most commonly used rating scales is the Likert scale, where respondents place their responses on an 'attitude continuum', running from 'strongly agree' to 'agree', 'uncertain', 'disagree' and 'strongly disagree'. These positions are then given simple weights of 5, 4, 3, 2, 1 for scoring purposes (i.e. an *attitudinal scale*). Respondents are asked to judge statements on one of the five positions above, which are then sometimes totalled. It has been argued that on a five point scale, respondents tend to cluster at the positive end of the spectrum (Theodossin and Thomson, 1987). To this end, some researchers use a seven-point degree-of-agreement (Oppenheim, 1994).

The Reliability of Likert scales is good. However, the scale is criticised for its lack of reproducibility (i.e. the same score can be achieved in a number of different ways, so two identical scores could have two different meanings). Therefore, Likert's scales provide a reliable, rough ordering of respondents with regard to a particular attitude (Oppenheim, 1994). They are easily constructed, provide precise information about levels of agreement or disagreement. Attitudinal scales, in general, are harder to validate owing to their abstract and indirect nature. They are useful for general descriptive purposes, but are not suited to precise predictive situations (Oppenheim, 1994).

6.8.4 Case Studies

A case study is "an interpretive presentation and discussion of the case, resting upon evidence gathered during the fieldwork" (Rudduck, 1984, p. 202). The researcher is "permitted to enter, for a limited period, the world in which teachers and pupils act out their daily routines" (Rudduck, 1984, p. 201). The event does not exist outside the period in which it is being studied. Data analysis carried out simultaneously with data collection enable the study to be focused and shaped as it occurs. This can involve writing a reflective journal, keeping files, etc. In such circumstances, the case study method is useful, but does not readily permit generalization (Anderson, 1990). In case study research, researchers observe the characteristics of an individual 'unit' (e.g. student, class, department, faculty, etc.). The purpose is to identify and analyze the "phenomenon that constitute the 'life cycles' of the unit with a view to establishing generalisations about the wider population to which that unit belongs" (Cohen and Manion, 1994, pp. 106-107). In the case study described by Rudduck (1984), the researchers did not suggest a 'best strategy' for teaching, but aimed to alert teachers to potential problems of each strategy. They identified a risk from teachers wanting recipes for action, as well as problems with the dissemination of the results of action research.

The methods outlined above will now be used as a basis for an introduction to the specific methodology used in the research case study in Chapter 7.

6.9 Methodology for the Dissertation Research Study

This section aims to describe the methodology adopted for the case study presented in Chapter 7. It will provide a rationale and framework as to why the particular methods and strategy were used, and will provide a brief overview to the development and revision of the methodology as the research study progressed. As the research study adopted an iterative (i.e. action research) strategy, the progression of the research study and the development of the methods were carried out in tandem. This progression and development is, therefore, explored in more detail in Chapter 7.

6.9.1 Background to the Thesis

The thesis presented in this dissertation postulates the existence of a link between the various quality initiatives in manufacturing industry and a culture to encourage and improve the full cognitive range of student learning in engineering higher education. The original thesis was based on (Lascelles and Dale, 1990; Allison, 1993):

- The literature on higher education, quality management and learning;
- Speculation and a 'felt need' on the part of the researcher;
- Discussions with practitioners and those involved in higher education.

The information gained from this exercise was used to identify the main areas of the research study. These areas, in turn, were used to devise and develop an appropriate methodology for examining the thesis.

6.9.2 Foundation of the Chosen Methodology

The research into the thesis was underpinned by a number of factors which, in turn, influenced the approach taken and methods used. These factors included:

- the setting (i.e. to examine the culture and systems within a particular engineering higher education environment);
- the subjects (i.e. to primarily involve students, but also academic staff as these two groups of participants shape the learning 'interface');
- the scope (i.e. deep analysis and examination of the inter-relationship between quality improvement systems and learning cycles);
- the span (i.e. a longitudinal study so as to gain an appreciation of the culture of the host department and the impact of the research interventions);
- the strategy (i.e. to establish if a link, as proposed in the thesis, existed the research needed to be interventionist, where 'new' quality systems were introduced and their impact assessed).

Therefore, the objective of the research study was to introduce and evaluate quality systems that were based on the learning and quality improvement cycles described in Chapters 3, 4, and 5.

6.9.3 Research Strategy

The formulation and the 'testing' of the theoretical link between quality improvement and learning systems was carried out in tandem with the data collection, the results being used to inform both the learning cycles of the subjects of the study and the research cycle of the researcher (see Figure 6.3). Based on this broad range of factors, and the discussion outlined in this Chapter, it can be seen that a particular 'hybrid' methodology was required. This involved the use of a traditional quantitative approach (i.e. postulated causal links between constituent concepts of the hypothesis, collection of data), but with a more qualitative implementation (i.e. case study with qualitative data collection and analysis methods, intervening in a department to establish whether a link between quality improvement and learning culture exists). The research was, therefore, predominantly qualitative (i.e. relatively 'open' with data 'feeding' further iterations of the research study) and applied (i.e. solving 'problems' in a specific setting).

6.9.4 Rationale for the Strategy

Such a qualitative approach was necessary as examination of the thesis required close relations with the subjects, an appreciation of individuals perspectives involving an interpretive and subjective orientation, a student-centred focus, as human-behaviour is influenced by the setting in which it occurs, and an in-depth study of processes and organisations (i.e. culture). With such an approach, replicability was not viewed as an important factor, as this would destroy the interaction that the research was interested in (i.e. mechanisms aimed at replication would destroy the unique nature of culture and human interactions). Rather, by examining one engineering department, in the form of a case study, it was hoped to identify issues that were of use to the wider higher education community. Therefore, the research aimed not only to gather data (i.e. via interviews, group discussions, questionnaires and some observation), on which to initially inform the students' learning cycles and modify their approaches to learning, but also to provide academic staff with information on the modules they ran (i.e. action research). The progress of the study was also to be monitored via these data gathering techniques, so that feedback could benefit the process immediately.

6.9.5 Qualitative Methodology

As the thesis involved an in-depth examination of the culture necessary for the adoption of quality improvement and learning initiatives, i.e. human beings in a bounded social context (Locke et al, 1993), a qualitative methodology was most appropriate. The objective of the research was not to provide generalizable statistical results from random samples but to provide initial indicators of quality improvement and learning culture, and to implement and examine a suitable system for use by the case study department to enable the introduction of such initiatives. It therefore pointed to a two level action research approach:

- The first level, involving students and academics, aimed to encourage those involved in the educational setting to adopt practices in line with those quality initiatives developed in manufacturing industry (as discussed in chapters 4 and 5);
- The second level, involving the researcher, aimed to analyze these attempts and provide guidance and advice.

Therefore, the researcher would use a number of methods (to ensure triangulation) to inform the quality improvement and learning cycles that the students were being encouraged to adopt. The information would also guide the academic staffs own action research cycles. To this end, the research set out to be both experimental and descriptive, as it attempted to account for events that had occurred and use this information to make events happen in the future. Therefore, the feedback was designed to provide an 'evaluation' that would promote enhancement and development, i.e. summative. An overview of the research method is provided in Figure 6.3.

6.9.6 Research Intervention

The case study involved encouraging and facilitating a cultural shift that would enable the quality improvement and learning cycle initiatives and policies (identified in Chapter 5) to be implemented and developed. Such new policies are a matter of grass roots negotiation (Becher, 1992), and so it is important to 'map' the existing attitudes and values of those

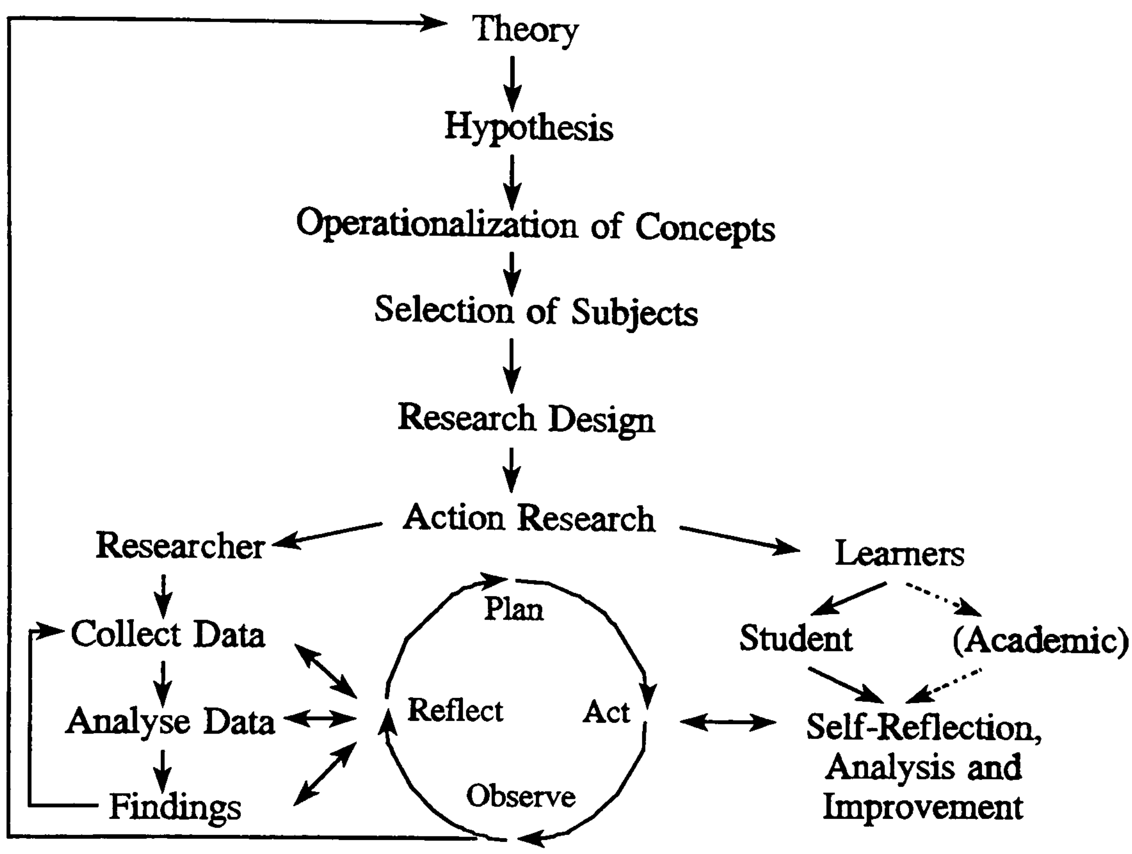

Figure 6.3: Schematic of the Research Methodology Used in the Case Study.

likely to be centrally engaged in putting any new scheme into effect. This involved a series of extensive discussions and consultations with the two groups of primary participants: the students and the academic staff. Primary empirical research evidence was obtained from action research and case study work carried out on the causation and execution of a quality and learning improvement process in the department over a three and a half year period. This involved the use of group interviews, questionnaires, and fieldwork (to investigate attitudes and interaction between students and tutors), as the research study was examining some aspects of culture. The research made use of student-centred self-directed learning, where participants reflected on their own experiences and then opened these up to others. In cases such as these "it is conventional to use unstructured groups and open, undirected discussion" (Gibbs, 1991, p. 93). The implementation and development of these methods and mechanisms is described in Chapter 7, however a brief overview and rationale to them is given below.

6.9.6.a Questionnaires

The questionnaire, that was traditionally used by the case study department, focused on factors that were 'external' to the students (see Appendix D). The questions, asked on a module by module basis in a single end of year questionnaire, were seen to be staff-centred and staff-controlled and did not encourage student reflection on their contribution to, and role in, the learning process (i.e. '*Amount Learned*' and '*Course Organisation*'). The questionnaire was developed to include a broader range of quantitative questions and more specific qualitative questions (see Appendix E). Specific questions were included on:

- Students' motivation (i.e. '*I have a great deal of interest in the module area*', '*I have put a great deal of effort into this module*; '*My Attendance on the module was high*');
- Students' perceived ability (i.e. '*I find the module subject difficult to understand*'),;
- Students' perceived overall benefit of the module (i.e. '*I have learnt a great deal from this module*');
- Students' alternative learning strategies to the lecture-based material (i.e. '*If you did not consistently attend these lectures, why? How did you cover the subject matter?*).

The inclusion of these student-centred questions was aimed at raising the profile of issues connected to the student role in learning and quality improvement (i.e. from passive to active). They were also used as a basis for the interviews and group discussions (see below), and to give academic staff an appreciation of the students' perception of the course modules. More usual and 'typical' questions were also asked on areas such as:

- Module organisation (e.g. '*The objectives of the module were clear*', '*The module materials were well prepared*', etc.);
- Pedagogic approaches (e.g. '*The lecturer explanations were clear*', '*Feedback on assignments was constructive and valuable*', etc.).

Qualitative questions were also included, asking students to highlight areas of 'best practice' (i.e. '*What 2 features of the module have you found most useful and interesting?*') and areas that needed improving (i.e. '*What 2 changes would you like to see made to this module?*'). In general, the questionnaire was designed to be a tool that would, on the one hand, gather data for module and staff improvement, and on the other, focus students on their role in the quality and learning improvement cycles. To aid this dual role, the questionnaire was moved from an end of year activity, to a mid-semester activity. Discussion meetings were also established where students could elaborate on the responses given, as well as a more focused and reflective examination of approaches to learning (see 6.9.6.c).

The attitudinal rating scale was originally changed from a 5-point scale to a 7-point scale, so as to increase the response options available to students. However, after discussions with academic staff, the range of options was reduced to a 6-points scale. This was because staff perceived that students were grouping their responses around the mid-point (i.e. '4' on the 7-point scale). By removing this mid-point it was hoped to generate more extreme (i.e. less 'non-committal' responses).

6.9.6.b Interviews

In designing the quality improvement system (i.e. the range of questions, the rating scale, the format of discussion sessions, the timing and frequency of the system, etc.), a purposive sample of staff and students were interviewed. These individual interviews were carried out over the duration of the case study (i.e. three and a half years), and were predominantly used to 'feed' and inform the case study research cycle. They provided information on student and staff perceptions of the quality improvement system, and formed the basis for some of the issues raised at the discussion meetings.

6.9.6.c Group Discussions

In order to provide a forum that would support the development of the quality improvement and learning abilities described in Chapters 3 and 5, discussion meetings, initially between the researcher and a particular student cohort, and subsequently between the year tutor and relevant student cohort, were introduced and developed. These sessions were initially designed as a support mechanism for the student questionnaires (i.e. why did students respond as they did?), but soon became the main focus of the quality improvement system. Within these meetings students were encouraged to review on their progress and contribution to modules, and basic learning theories and strategies were introduced. It was within these sessions that students were encouraged explicitly to adopt the learning improvement cycles described earlier in the dissertation (e.g. '*Plan-Do-Reflect-Conceptualise*'), and were thus the main form of intervention.

6.9.6.d Observation

An important aspect of such case study research is the qualitative dimension provided by observation. This gives a general insight into the behaviour of the subjects under study. Therefore, the researcher immersed himself into the day-to-day life of the case study department, with a view to gathering information on the perceived culture and general 'way of doing things'.

6.9.7 Development and Revision of the Methodology

The specific methods described in 6.9.6 were used to develop the research approach within the case study. To this end, the research process could be seen as iterative. The analysis of the data from these mechanisms (usually in the form of staff and student perceptions) was used to direct the research. Therefore, elements of the system that appeared successful (e.g. the discussion meetings) were focused on and developed, whereas elements that appeared more peripheral to the objectives of the research (e.g. staff-centred questionnaires) were given more secondary attention. Therefore, the research in the case study set out to introduce and evaluate those mechanisms that would support the move of departmental culture towards student-centred quality systems (i.e. quality improvement systems that support learning cycles). To this end, it can be seen that the research cycles and the quality improvement cycles are interlinked (see Figure 6.3). To enhance the culture necessary for student learning, it was felt necessary to move from quality improvement systems that were 'post-process' and where the students' role was 'passive' and 'reactive', to systems that were 'in-process' and the students' role was more 'active'. It is this planed movement of quality improvement systems that forms the basis of the case study in the next Chapter.

6.10 Conclusions

This Chapter has argued that the thesis stated in Chapter 5 requires a particular methodology, and it was proposed that methods associated with the social sciences could be applied to an educational setting. As the thesis is studying organisational culture and systems, where individuals are bounded in a variable and unique social context, a 'softer', more in-depth, more subjective approach had to be taken. As the study was examining a specific situation, an applied/action research approach was adopted. This approach required a hybrid of research methods, ranging from group discussions to questionnaire analysis. Here, the case study attempted to introduce systems that would engender the required quality improvement culture, and then evaluate the success of such systems through a series of action research cycles. The information from these cycles would be used to primarily inform the students self-improvement cycles, and the researchers research strategy. The implementation, progression, and evaluation of the research case study, from 'passive/post-process' to 'active/in-process' forms the basis of the next chapter.

Chapter 7 - Research Case Study

The objective of the research presented in this dissertation has been to ascertain if quality improvement systems, based on developments in manufacturing industry, can be used in a higher education environment to create a culture that engenders a positive learning approach (i.e. the development of the full cognitive range via continuous learning cycles, thus achieving a 'transformative' orientation). In the previous Chapter it was argued that, owing to the nature of this thesis, a qualitative longitudinal applied/action research case study methodology was most appropriate. The objective of this case study would be to investigate attempts within a specific higher education environment (i.e. a manufacturing engineering department of a UK university) to introduce systems that would support the quality improvement and learning cycles identified and discussed earlier in this dissertation. This Chapter provides a description of the research case study that was carried out in the Department of Manufacturing and Engineering Systems, Brunel University (henceforth called '*the Department*'), and gives a background to the Department and the staff-based quality systems that existed before the research project. An account is then given as to the progression of initiatives from *staff-centred* and *student-based* quality systems, towards more *student-centred* quality improvement systems. This required the introduction of novel systems to the Department, with the aim of changing the quality and learning culture from 'post-process, passive' towards 'in-process, active'. The introduction of such systems and their inter-relationship with Departmental culture is discussed, and this is then related back to the theory introduced in earlier Chapters and the thesis discussed in Chapter 5.

7.1 Department of Manufacturing and Engineering Systems

The Department is a broad-based, multi-disciplinary general engineering department, and was formed in 1986, by the merger of the Department of Production Technology and the Department of Engineering and Management Systems. The Department ran three distinct undergraduate courses: broad-based programmes in Manufacturing Engineering (around 45 first year students) and Environmental Engineering (around 18 first year students), and an 'enhanced' Special Engineering Programme (around 35 first year students). Each course had a reputation for innovation in teaching (Clark et al, 1985; Griffiths, 1988; Life and Wild, 1981; van der Vorst, 1993), as well as having its own identity and objectives. Much of the study was carried out with the students from the Manufacturing Engineering course (henceforth called *'the Manufacturing Course'*), though work was later done with students from the other two courses.

Over the period of the research project, the number of teaching staff in the Department fell by around six (from a total of around 30); there was increased external pressure from the HEFCE Research Selectivity exercise, and from Engineering Institution Accreditation visits (i.e. the IEE and the IMechE); and internal pressure from the university 'centre' to increase student numbers (see Chapter 2). A summary of the changes in undergraduate admissions is given in Table 7.1. In particular the reader's attention is drawn to the overall percentage increase in students with non-traditional (i.e. non A-level) qualifications, and the reduction in the entry grades of those with A-levels. These changes in student population had a potential impact on the teaching and learning interface, and this issue is discussed later in this Chapter. The Head of Department at the beginning of the study, was viewed by many in the Department as a forward thinking individual who placed great emphasis on people and human 'systems'. Given this top-level support, it was felt that the environment and culture were right for the move toward more student (and learner) centred systems.

Year of Entry:	1991/92	1992/93	1993/94	1994/95	1995/96
Target Intake	92	85	100	100	100
Actual Intake	72	75	87	94	86
A-Level Entry	85%	71%	62%	70%	50%
Mean A-Level Points	24.6	24.1	20.7	22.2	20.7

Table 7.1: Undergraduate Admissions to the Department(1991/92 to 1995/96).

7.1.1 Departmental and Course Structure

Each course had its own management structure, consisting of a Course Director aided by Year Tutors for each cohort of students (e.g. Manufacturing Engineering Year 1 Tutor, Special Engineering Year 1 Tutor, etc.). There were also Departmental Subject Panels, which consisted of inter-course groups of staff who oversaw the teaching of particular disciplines (e.g. Mechanical Engineering, Electrical Engineering, Management, etc.). These various bodies fed into the Departmental Board of Studies. This structure is shown in Figure 7.1.

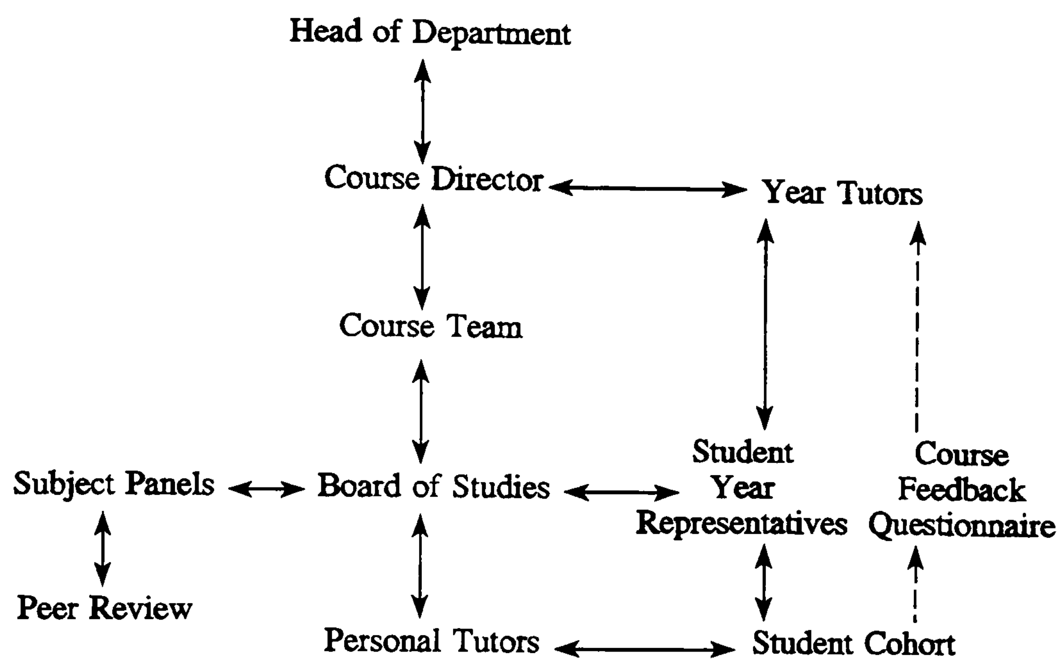

Figure 7.1: Schematic of the Internal Quality Monitoring Systems of The Department.

7.1.2 Existing Departmental Quality Monitoring Systems

The Department had always placed an emphasis on some form of student feedback, so as to gain an insight into students' perceptions of the modules and courses they undertook. The main focus of this feedback can be seen to be on monitoring so as to enable staff improvement, and in this way they can be regarded as *staff-centred*, as they were aimed at the information requirements of academic staff. The mechanisms used to gain student feedback were an end of year questionnaire, a students representatives' system, a board of studies, and a personal tutor system. In recent years, and before the case study, a more student-focused initiative, the Brunel Diploma in Personal and Professional Development, was introduced. These respective areas are now described:

- The feedback system in the Department, prior to the research project, was based on an anonymous end of year questionnaire (an example of an older feedback form is given in Appendix C), with two questions for each subject/module studied. Students were asked to rate '*Course Organisation*' and '*Amount Learned on Course*' (see Appendix D). There was space on the form for the students to rate each of the twelve modules that they had undertaken that year. There was also a small space under each of the modules to give additional comments. Historically, the quantitative results from these surveys were circulated to each relevant member of staff, and the qualitative comments were attached to a board for all to see. The results of the feedback were not circulated to students and no check was made of staff action based on the feedback. It can be seen that these forms were very much based on the 'mechanics' of teaching and lecturing (e.g. '*Ease of note taking*', '*Course Organisation*', etc.), and were predominantly based on the needs of the academic staff (i.e. they could use the information to improve their 'performance').

- Each student cohort elected a small number of student representatives. There were usually two from each cohort, but varied depending on the total number of students within that cohort. These students were to liaise with year tutors, providing feedback and comments on the course in general and specific modules in particular. The idea was that this mechanism would provide more immediate feedback than the end of year questionnaire. Again, the information gleaned was predominantly aimed at staff improvement, with little emphasis on student reflection.
- The student representatives also sat on the Departmental Board of Studies. This committee had more of an administrative function, and its aim as to provide an overview of the courses within the Department as a whole.
- Each student in the Department was allocated a Personal Tutor from the academic staff, and it was this tutors responsibility to oversee the students personal well being. This role also involved some aspects of the personal and professional development of the student (e.g. carry out industrial visits to placement companies, check on academic progress, etc.).
- The Brunel Diploma in Professional Development[1] (BDPD) was a novel mechanism for getting students to provide evidence of personal and technical transferable skills. It encouraged students to focus on their approach to aspects of their own academic and personal life, by getting them to set objectives and targets, and then review the success of these initiatives. It required the maintenance and assessment of a portfolio of projects, and was, therefore, auditable.

[1]It was originally called the Brunel Diploma in Personal and Professional Development. The scheme has now been withdrawn, owing to perceived lack of academic staff support, and is due to be replaced with a less rigorous 'Diploma in Industrial Studies' (DIS).

7.1.3 Brunel Manufacturing Engineering

The Manufacturing Course was normally four years in duration[2], with most students spending around a quarter of that time on industrial placements. Changes had been observed within the Manufacturing Course (see Table 7.2).

Year of Entry:	1992/93	1993/94	1994/95	1995/96
Actual Intake of Students	35	39	47	41
A-Level Entry	51%	41%	34%	46%
Mean A-Level Points	21.8	15.1	17.6	14.3

Table 7.2: Changes in the Manufacturing Course Student Intake.

The readers attention is drawn to the increase in the number of students, the changing academic background of students (i.e. a smaller percentage with academic qualifications), and the lower 'ability' of those with academic qualifications (i.e. a fall in the average A-level points score). The changes, and those linked to reductions in the number os staff, etc., are seen to contribute towards increased instances of student 'rework'(see Figure 7.2).

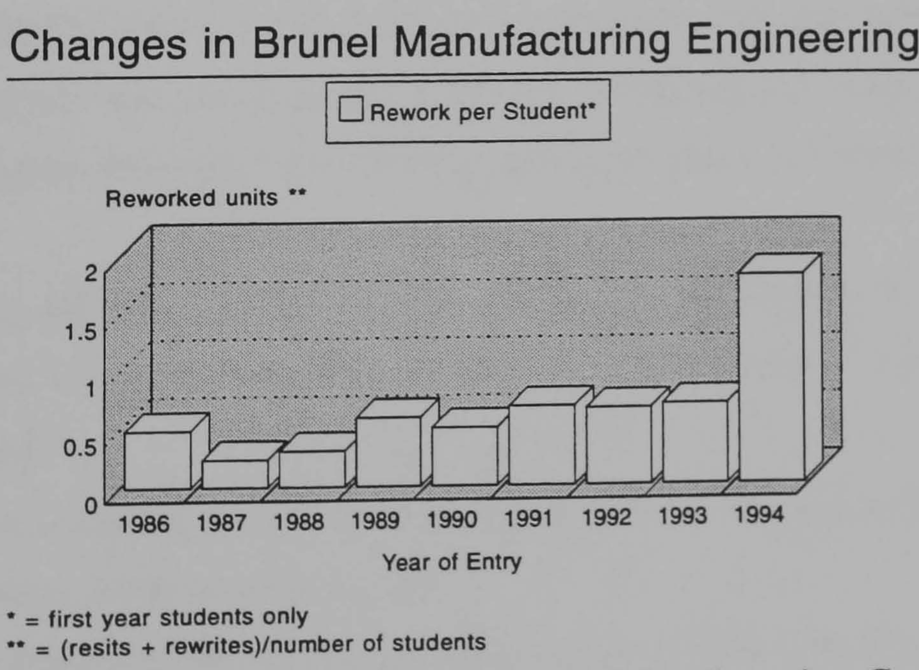

Figure 7.2: Rework by First Year Students on the Manufacturing Course.

[2]There is now a three year full-time version of all the courses within the Department.

7.2 Pilot Study

The research project started in the summer of 1992, when students were either on industrial placements or on vacation. Therefore, the first few months were spent investigating the current systems within the Department (see 7.1), staff perceptions of these systems, and gaining a general grounding in the background of the students and the courses in the Department. The first months of the 1992-1993 academic year were spent carrying out a pilot study on the Manufacturing Course. The results from this would be used to set up a Department wide system. The pilot study involved initial exploratory interviews and discussions with fourth year students on the Manufacturing Course, analysis of the previous end of year questionnaires, and discussions with selected members of staff.

7.2.1 Students

Information was gathered from students in the form of two group discussions within their particular cohort. Fourth year students were chosen as they had experience of the course and modules, had carried out three industrial placements, had experience of working together and with members of staff, and had an appreciation of the Departmental and university systems. Such discussions were well attended, with 90% attendance common. This can be seen as indicative of students feelings in this area. From these relatively informal, and initially unstructured, discussions it became clear that students felt that the existing mechanisms was aimed at administrative considerations rather than learning or quality consideration. Examples of students' typical comments included:

- *"I fill these [feedback] forms in, but never find out what happens to them"*
- *"The [student] representatives don't ask our views or opinions - I don't feel involved or represented"*
- *"Whenever we complain we're told that students make the same complaints every year. Nobody seems to listen to what we say"*
- *"It would be interesting to know if anything is done in light of what we've said"*
- *"As the feedback is at the end of the year, it has no effect on the modules I've done, so what's in it for me!".*
- *"Nothing seems to happen with them [the feedback forms].... It's all a bit of a joke really!"*

- *"I don't see how any of this relates to what I do on the course"*

Many students admitted that, when they did fill in the questionnaires, they did not usually consider their responses. This was because they could not remember the particular module very well (i.e. problems of recall) or that they felt that the feedback exercise did not really involve them (i.e. problems of relevance). From this it became clear that the existing mechanisms were not suitable for the development of the 'internalised' self-analysis and self-improvement cycles that were necessary for quality improvement (as identified in Chapter 5). These mechanisms, therefore, did not promote the change in behaviour or promotion of abilities that would help develop the cognitive domain. There was also despondency that the results of the feedback exercise were not communicated back to them, i.e. the feedback loop was not closed. Therefore, the students felt that they were, at best, passive participants in the system. It was felt by the researcher that these quality monitoring mechanisms needed to be developed, so that more emphasis was placed on quality improvement via student involvement.

To gain some idea of a way forward for quality improvement systems, a number of more structured 'brainstorming' sessions were held. These typically posed a problem (i.e. an 'effect') and asked students what factors may contribute to this problem (i.e. the 'cause'). An example of such 'cause and effect' analysis is shown in Figure 7.3, and was based on a session aimed at identifying causes of student underachievement.

From these sessions it was found that the questionnaire mechanism gave students little opportunity to explain why they responded as they did, and what could be done to change this (i.e. it did not enhance learning behaviour). This appeared to confirm the researcher's earlier concern that the existing mechanisms did little to promote the student reflection and review, identified in Chapter 5, that was necessary in a 'transformative' orientation. Recently, such purely questionnaire-based approaches have been criticised from both a learning and quality perspective (HEQC, 1994; Hill, 1994; Sanders, 1994), and the pilot study appears to confirm these criticism. It was also felt that the student representative system was ineffectual, as there was a certain amount of filtering of ideas and problems. From a learning point of view, it can be argued that such representatives do little to develop the learning abilities of the majority of the student cohort. From a quality point of view, such a mechanism rarely involves many students, and is therefore contrary to the

'Fishbone' Diagarm Examaning the Causes of Student Underachievement

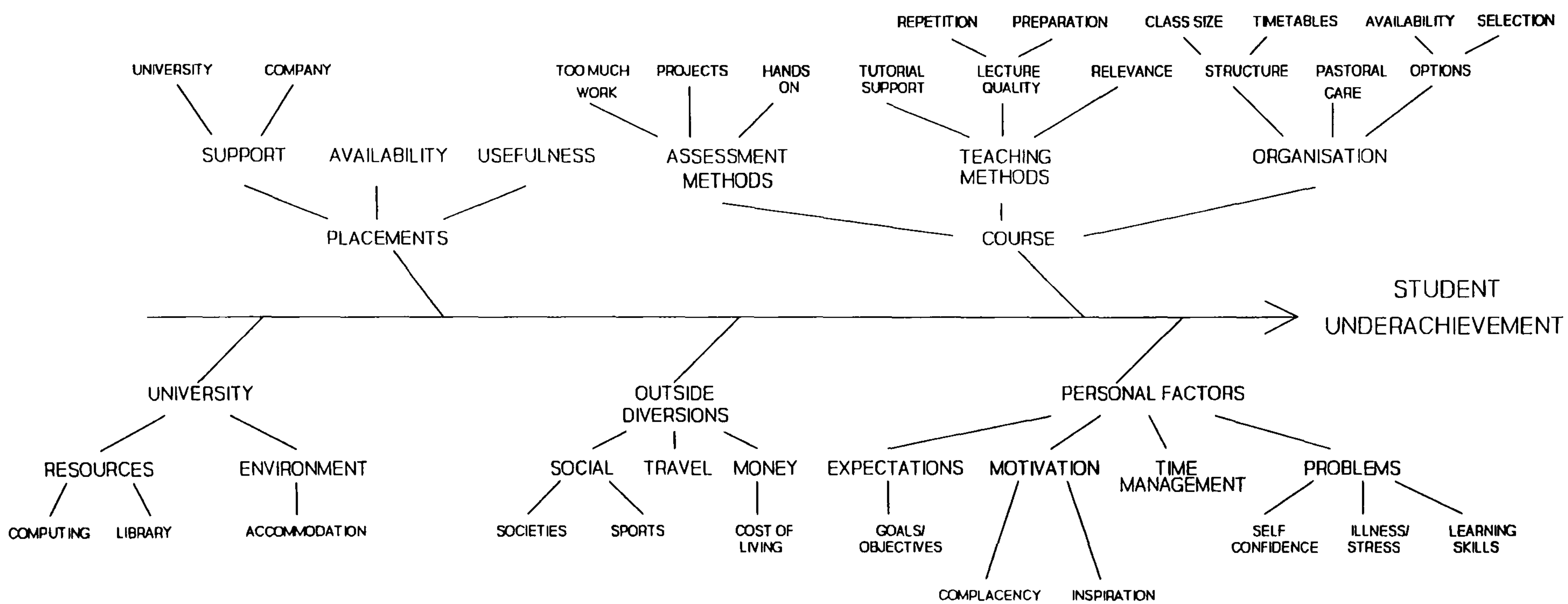

Figure 7.3: Example of Student Brainstorming on the Manufacturing Course.

ethos of TQM and empowerment.

The objective of the existing system was clearly not a CQI or TQM one and was not specifically aimed at supporting or improving student development (the 'transformative' purpose outlined in Chapter 2). It appeared to be aimed at providing a minimum level of quality provision and gave some feedback on this. However, the effectiveness of this monitoring can be questioned in the light of the results of the pilot study. If progress was to be made, the researcher felt that the emphasis on the systems had to be changed from what could be regarded as ineffective quality monitoring (i.e. feedback loop not closed) to effective quality improvement (i.e. critical self-improvement cycles). This required the expansion and refocus of the quality system, and the strategy to achieve this will be described later in this Chapter.

7.2.2 Staff

Five members of staff were interviewed informally. Three were long serving and senior members of the Department, at the Reader or Senior Lecturer level, and two were more junior members of staff. The senior staff members, when interviewed, did not appear to attach much weight or importance to student feedback. They appeared very defensive and generally dismissive of student comments. It was admitted by some that they tried to identify students handwriting on the qualitative sections of the questionnaire, though to what end was unclear. These members of staff generally saw student feedback as irrelevant and somewhat irksome. Typical comments included:

- "*When I was at University we never had this [student feedback]. We just played sport and stayed in the bar*"
- "*I never used to fill feedback forms when I was a student.... I think they are irrelevant*"

The more junior member of staff were more willing to listen and respond to feedback, and saw it as a useful input into the improvement of both their courses and their teaching strategies. However, they were concerned that focusing purely on numbers, rather than improvement activities, would lead to a system that promoted evaluation rather than action. For example:

- *"I'm worried that too much emphasis is placed on evaluating the lecturer rather than thinking about what the student contributed"*
- *"We should be emphasising Continuous Quality Improvement, not this end of year scheme. It is too focused on measurement rather than action"*

There was also confusion as to the role of the student. The senior members of staff saw the student as a product and employers as the customer. Therefore, more credence was given to feedback from sponsor and employer organisations. The younger members saw the student more as a 'joint participant', but still gave precedence to industry views. This distinction mirrored the attitude held towards student feedback, i.e. 'as students are a product why should we listen to them?'. This confusion over the purpose of engineering education, and the reluctance to incorporate students into quality improvement activities, would turn out to have a detrimental effect on the research case study, and this issue is discussed later in this Chapter.

7.2.3 Analysis of Questionnaires

An examination of the questionnaire returns from the previous year showed that the information content, on which to base corrective action and development, was very poor (e.g. why did a student feel that the course was badly organised? why did they feel they had learned little?). Therefore, the questionnaire mechanism gave staff little insight into why students responded as they did. It also encouraged the view that poor student learning was due to poor teaching, i.e. that students were passive receptacle of knowledge. To this end, the mechanism did not develop the students' self-analysis and self-critical abilities (i.e. one of the foundations of the learning cycle). The student pilot group reported that the questionnaires were only effective if there was a forum for them to discuss the results of such a mechanism. They felt that group meetings between the year tutor and all students in that year would possibly fulfil this need.

7.2.4 The Way Forward

Based on the above discussion, and the discussion in previous Chapters, it was felt necessary to develop a system that would move from this 'quality audit' mode into a 'quality development and enhancement' mode. By effecting this move, it was hoped to create a quality improvement system that would support and complement the 'transformative' purpose of engineering higher education. Consequently, the system would aid the development of the full range of cognitive abilities (as outlined in Chapter 3) via an increased emphasis on individual student reflection and analysis.

The pilot study had helped to define parameters for the proposed quality system, in terms of the type and scope of feedback mechanisms and data collection methods, as well as giving information on the value of such a system. Staff felt that the system was biased towards evaluation and 'control' rather than focusing on the role that students play in developing their own learning. From discussions with students, the researcher felt that the existing quality system in the Department was not effective as:

- the results of such feedback activities were never communicated to students;
- the timing of the feedback collection was such that it had no impact on the modules that the students had taken;
- the format (i.e. questionnaire based) did not allow any student involvement or allow students to expand on what they thought (in terms of problem identification, analysis, and solution).

It was decided by the researcher, and with tacit approval of the Head of Department, to try to introduce a system that would move the learning and quality culture from 'post-process, passive' to 'in-process, active' (as advocated in manufacturing quality improvement systems). Rather than try to execute this shift in one manoeuvre, it was hoped to adopt a more gradual and phased introduction of the quality/learning system. An outline of the proposed strategy is given in Figure 7.4. The rationale behind this is summed up by Keith Noble:

> "To improve in traditional Higher Education Institutions, small reforms must be implemented; small reforms that nurtured over time, can succeed; not excessive and forced reforms that will be resisted and circumvented"
>
> (Noble, 1994, p. 71).

It was decided not to focus solely on the feedback questions asked, but rather to engender a system where students were encouraged to plan, enact, review, reflect and improve on

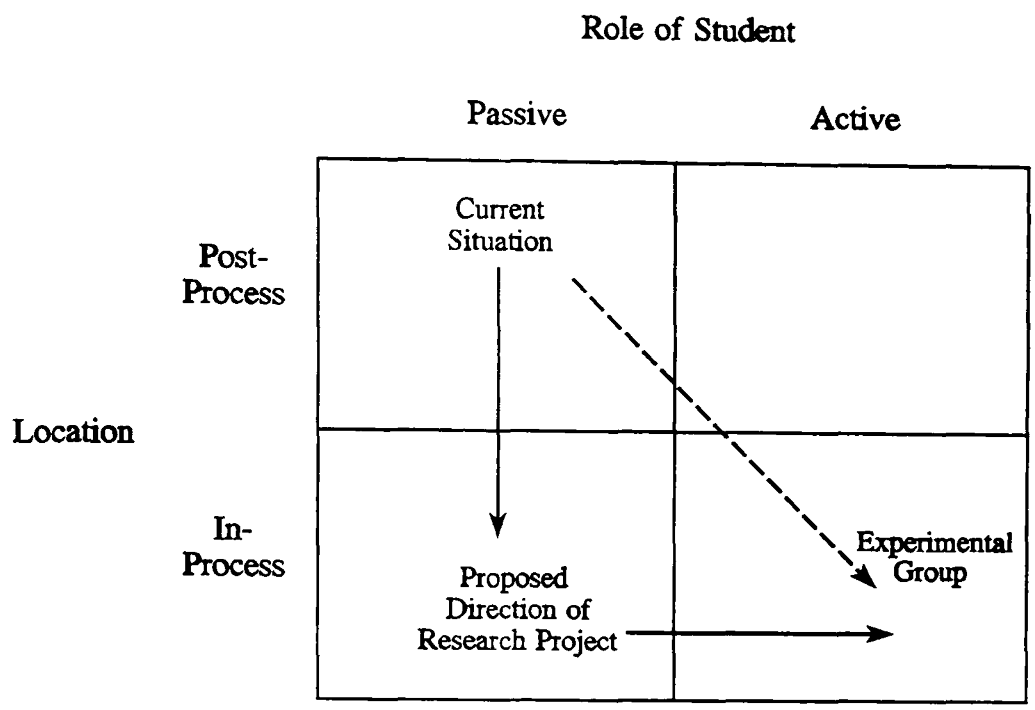

Figure 7.4: Strategy for the Research Project.

their approach to learning. The emphasis of the mechanisms would, therefore, be changed (i.e. more reflective and personal questions on student feedback questionnaires, more discussion and review meetings). However, it was important that the system still provided information for quality monitoring, so questions on lecturing methods, etc., still remained. The study was, therefore, taking a holistic approach to the whole system, rather than only focusing on one part of that system. By introducing such a quality improvement system, it was hoped to change the culture of the Department from one that appeared to be staff-centred and content focused, to one that was more focused on developing and supporting students' learning improvement cycles (i.e. one that supported the 'transformative' purpose of higher education). To achieve this purpose required a culture and quality system that was primarily focused on the student, as it with (and within) the student that these abilities are developed. It was for this reason that the quality system was intended to be 'student-centred'. The discussion will now progress to the attempts made, via the research project, to generate the requisite 'student-centred' culture within the Department.

7.3 First Run of the Quality System (1992-1993)

Taking the results and information from the pilot study, the next stage was to carry out a trial run with one cohort of students form the Manufacturing Course (i.e. slow expansion of the system). The system used in this trial run was designed to increase participating student reflection and review, via two discussion sessions per term, and one mid-term questionnaire. The first run of the quality improvement system under the research project, therefore, ran on two parallel lines (see Figure 7.5). From this figure it can be seen that the majority of students in the Department would continue to use the existing quality system (i.e. post-process, passive), whereas the third year students on the Manufacturing Course, one of the pilot study groups, would be exposed to a different system (i.e. in-process, active). This would help evaluate the ideas of quality improvement systems as a means to increase student involvement in, and focus on, their approaches to learning, that had been developed in the pilot study. The evaluation would be via in-depth interviews with participating students from both groups, as well as some observation on the part of the researcher.

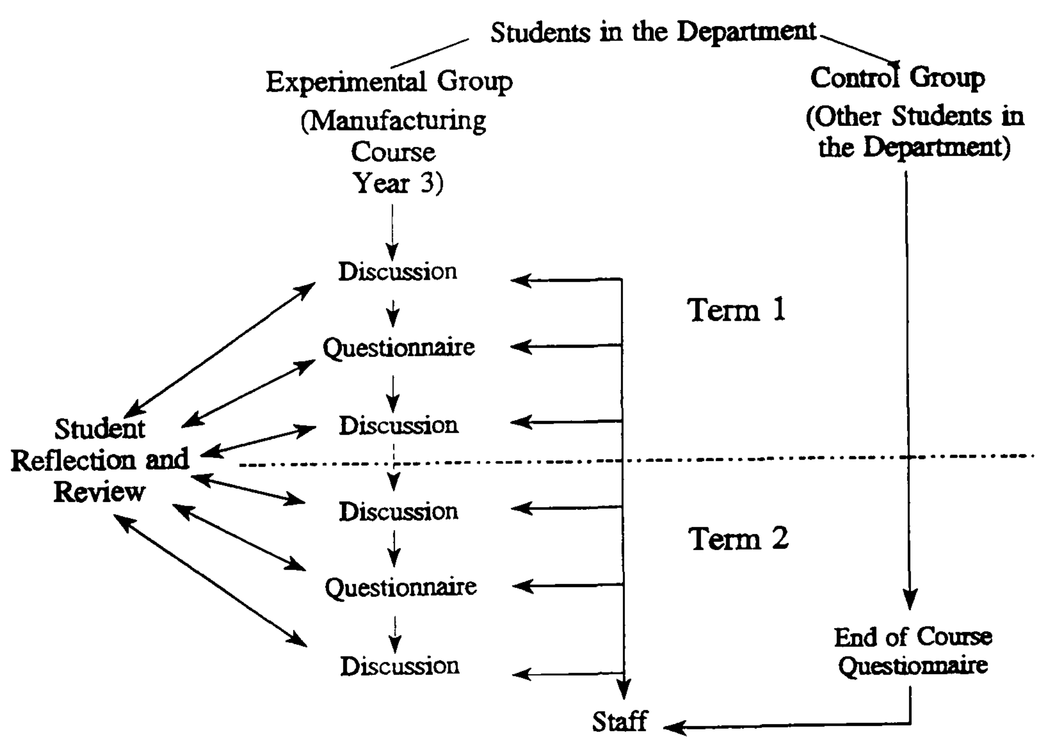

Figure 7.5: First Run of the Quality Improvement System (1992-1993).

7.3.1 Students Under the Existing System

The control group of students were given the standard feedback questionnaire (see Appendix D) at the end of the academic year (i.e. the students were 'passive' and the questionnaire was 'post-process). The researcher had no dealings with this group, and the questionnaire was administered and analyzed in the usual manner.

7.3.2 Students Under the Experimental System

In order to develop a system that encouraged both active participation and reflection on the part of the students, and that was within the education process (as opposed to after it), students in the experimental group used various types of questionnaire (i.e. they 'experimented' with different questions and different question formats). The students were also introduced to the concept of learning discussion groups (Gibbs, 1991). Within these groups, participating students were encouraged to share experiences, reflect on past 'successes' and 'failures', and suggest ways of improving based on this reflection. They were also encouraged to specify learning goals, and then devise strategies for achieving these goals, and means of reviewing their success or otherwise. In effect, they were beginning explicitly to develop and use the learning cycles described in Chapter 3.

7.3.2.a Questionnaires

The researcher, working with members of staff, experimented with differing types of questionnaire (i.e scope of questions, format, timing, delivery methods). The formats tried in this initial run included questionnaire booklets for the whole of the first term (i.e. students were asked to assess all modules individually but at the same time) and individual sheets for each module studied (i.e. students were asked to assess modules in a more phased way). The primary role of the researcher was that of providing guidance, i.e. to provide information from the questionnaires and discussion groups that would, hopefully, inform the academic members own action research cycles. Questionnaire delivery and collection methods included:

- anonymous course-wide questionnaires left in the undergraduate office (around 28% response rate);
- named course-wide questionnaires put in student Departmental pigeon holes (around 35% response rate);
- module-specific questionnaires given out and collected by the lecturer during the relevant module lecture (around 70% response rate).

It was found that students preferred the third option (complete the questionnaires during a lecture) as they could focus on the relevance of each question to the module itself. They also reported that it meant that they did not take the questionnaire home and forget it. The questionnaire was expanded to include more closed and open response questions (see Appendix E and Chapter 6), and was based on a brief review of the literature on student feedback questionnaires[3]. Many of these texts viewed student feedback purely as a mechanism for evaluating academic staff lecturing 'performance'. Few, with the exception of Partington et al (1993), dealt with the qualitative issue of using feedback as an information source for both student and staff review, reflection, and development. If the culture within the Department was to support quality improvement systems that encouraged the development of students' learning abilities, it was important that student feedback was viewed from this 'transformational' perspective. The questionnaire also provided members of academic staff with information as to the suitability of their approaches to teaching, given the changes in student background, and the increase in student numbers.

The choice of questions was based on consultation with a purposive sample of senior and junior staff and student year representatives. The researcher had the final choice of questions and wording (based on the interviews with staff and student representatives), though it was agreed that these would be reviewed as the quality system progressed. The questions chosen aimed to strike a balance between focusing on the module itself, the lecturer, and the student.

In constructing the questionnaire, a compromise had to be reached between the detail of the questionnaire (e.g. length and detail of questions, scope and number of questions, etc.), and the practicality of administering it. It must also be remembered that the research was not aiming to develop an accurate instrument for measuring student opinion or attitude, but rather was aiming to engender a culture that developed and enhanced learning and quality. It was felt a general, rough indicator of student attitude was better, given the holistic objectives of the research project (i.e. it was better to be 'roughly right than precisely wrong'). By focusing on statistically rigorous and controllable questionnaires, the qualitative nature of the research could have been damaged (i.e. the 'transformative' essence of the system would have been lost). Initially the attitude scale on the questionnaire was increased from five to seven points (McBean and Al-Nassri, 1982) at the request of some members of staff. The staff concerned felt that this would further reduce the clustering around the central point. This scale was then reduced from seven to six points, again at the request of some staff members. This six-point scale now mirrored that of degree classifications, where '1' could be seen to be a '1st', a '2' could be seen as a '2.1',

[3]See Abrami et al, 1990; Aleamoni and Hexner, 1980; Arubayi, 1986; Cangelosi, 1991; Chinnery, 1993; Flood-Page, 1974; Marsh, 1987; McBean and Al-Nassri, 1982; Partington et al, 1993.

and so on, down to a '5' for a pass degree and a '6' for a 'fail'. It was decided that the questionnaire should include a number of standard questions, so as to allow for comparability when discussing the feedback at the course and subject panels. It would also help individual staff members gauge the effectiveness of any corrective action or continuous improvement in light of the feedback.

The students reported that a mid-term questionnaire was preferred, as the results could be fed directly into the courses they were undertaking, i.e. they felt there was immediate benefit, especially if there was an opportunity to discuss the results of the feedback and action taken in the light of those results. From this it can be seen that the students were advocating a system that emphasised in-process mechanisms.

7.3.2.b Discussion Sessions

The researcher worked closely with the experimental group, running two feedback discussion meetings over each teaching term. The aim of these meetings was to encourage students to review and reflect on what they had done on their undergraduate degree courses, (e.g. what went well?, what did not go so well?, how could it be done better?, how could the students do better?). They were normally informal and attracted around 85% of the third year Manufacturing Course student cohort. The researcher acted as a facilitator, but largely took a 'back seat' role. The key was to get students used to running such sessions themselves. It was found that this experimental group of students were able and keen to discuss, consider and analyze the educational experience they had participated in. These sessions were not so much learning-to-learn or study skills sessions, but rather were sessions aimed at raising students awareness as to the impact they have on their own learning (i.e. to encourage active, even proactive, behaviour and reflection).

7.3.3 Analysis of the Two Groups

At the end of the 1993-1994 academic year, interviews were carried out with samples of students from the two parallel groups.

7.3.3.a Students Under the Existing System

A self-selecting sample of students who had been exposed to the existing quality system were invited to a free and open discussion, and there was a broad range of students from different courses and years (around 12 students in total). They were assured of the confidentiality of their comments. It was hoped to run the discussion as a relatively unstructured event. However, as the meeting progressed it became necessary to prompt participating students for responses. This may have been due to the fact that the students were from a number of different courses and years, and so did not have a group 'cohesion'. Nonetheless, students reported many of the same problems identified by the original pilot group, e.g. lack of action by staff on results of the feedback, failure to communicate results to students, lack of students sense of involvement or ownership of the feedback process, etc. It was felt that there was such a poor response to questionnaires due to the belief that the feedback would not change anything.

7.3.3.b Students Under the Experimental System

Again, a self-selecting group of students who had been exposed to the experimental quality system were invited to a free and open discussion. They too were assured of the confidentiality of their comments. Around 27 students turned up (85% of that particular cohort of students), and a lively, if unstructured, discussion ensued. The general consensus was that the feedback meetings were more beneficial than the questionnaires, as students had an opportunity to discuss issues they felt were important. They also felt that the act of discussing, i.e. identifying areas of strength or weakness, devising solutions, critical self-analysis and reflection, peer debate, etc.), was more meaningful and helped put their problems and ideas in context. The experimental group reported that the questionnaires were only effective if there was such a forum for them to discuss the results of such a mechanism. In general, staff did still not respond to the feedback. They felt that group meetings between the year tutor and all students in that year would fulfil the need for a constructive discussion and obtain staff feedback (i.e. involve a relevant staff member, not just the researcher). It was conceivable that the experimental group were more coherent and lucid as they had become used to interacting as a group in such a way. It was also possible that the students responded to the extra attention that had been placed on them over the preceding year, resulting in a type of 'Hawthorne effect'.

7.3.4 Evaluation of the First Run

From the findings and discussions above, it appeared that the way forward (i.e. to assist the move towards a 'transformative' orientation based on individual learning improvement cycles) was indeed to move towards an in-process, active system, involving mid-term questionnaires and discussion meetings between students and staff. However, such a rapid system shift may have been too much of a 'culture shock' for the Department, as there was still confusion as to the purpose of engineering education and to the role of the student within that purpose. The research, therefore, had to address two areas:

- How to identify problem areas, both within a module and within an individual student;
- How to identify and implement solutions, both for a module and for problems within the student.

This required the development of a progressive questioning approach, whereby all learners were involved in the quality and learning improvement cycles identified in Chapter 5. The problem now was how to develop a non-threatening protocol between staff and students so as to enable and enhance improvement. It was felt that perhaps the use of the questionnaire widened the gulf between the two groups of participants as it was relatively impersonal, and is seen to enhance assessment and summative evaluation. Based on these reservations, it was decided to move cautiously. The next step, therefore, was to move to a system where the feedback was moved 'in-process' (see Figure 7.6).

7.4 Second Run of the Quality/Learning System (1993-1994)

At the beginning of the 1993-1994 academic year, Brunel University changed from a three term academic year, to a two semester academic year. This change was not universal, as a dual system was run, with first and second years following a semesterised timetable, and third and fourth years following a term-based timetable. The consequence of this was a great deal of confusion and inconvenience over the ensuing year for staff and students alike. Semesterisation was seen by many to increase the workload on an already depleted number of staff within the Department, as the number of assessments and exams increased. It was during this academic year that the Head of Department, who had initially supported the project, left to take up a position at another university. This left the Department in a

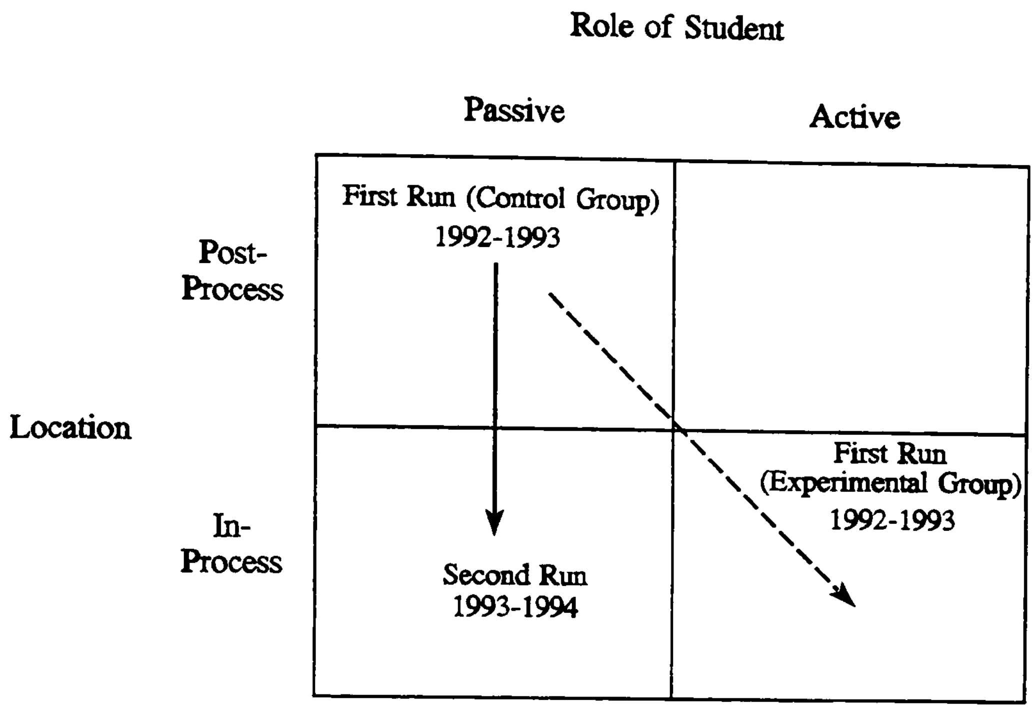

Figure 7.6: Strategy for the Second Run of the Departmental Quality Improvement System (1993-1994).

state of limbo for some months.

7.4.1 Expansion of the System

During this period, the scope of the research project was now expanded to cover all the undergraduate courses in the Department. It had been felt that the results from the first run with the experimental group had been sufficiently encouraging to attempt this more ambitious step. The plan was to move the questionnaires from the end of the academic year to the middle of each semester. This would have the effect of moving the data collection (i.e. 'measurement') and staff response ('action') to within the education process. There would also be one discussion meeting at the end of each semester, in which students could discuss the results of the questionnaires and the action taken in light of these results. The system is summarised in Figure 7.7.

The system was now being administered centrally, inasmuch as the questionnaires were distributed, collected and processed by the researcher, who then communicated a summary of the results to the relevant staff member. This was done to ease the administrative load on the staff, and ensure that each module had some form of feedback. There was an understanding, agreed at a special staff meeting, that staff would communicate the results of the feedback to students and comment on any action to be taken. Therefore, the academic staff had to consider student comments, rather than just distribute and collect the

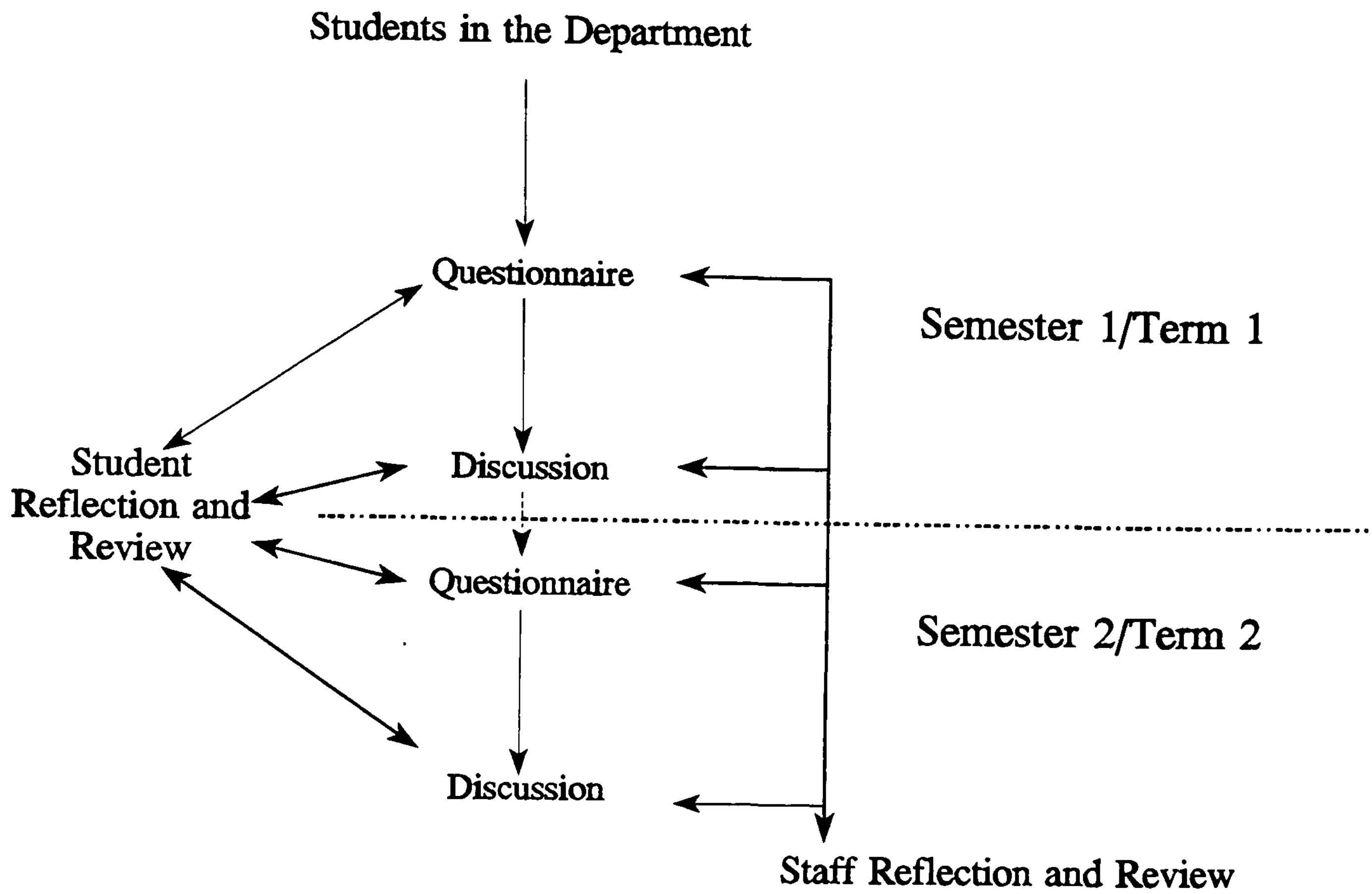

Figure 7.7: Second Run Of Departmental Quality Improvement System (1993-1994).

questionnaires during lectures (i.e. they had to close the feedback loop). The students could then comment on the action in the subsequent end of semester discussion meeting. This meeting would also focus on the students' learning strategies and encourage them to plan, reflect, review, and so on (i.e. the learning and quality improvement cycle identified in Chapter 5).

7.4.2 Problems with the System

However, as the system expanded, a number of familiar problems began to appear. During the first semester, there was reluctance on the part of staff to respond to student comments. Staff also appeared reluctant to organise and run the student discussion meetings. This latter problem was due to two identifiable factors. Firstly, most members of staff were unfamiliar with the educational theory behind such sessions, and did not have practical experience of tackling the issues that the sessions were meant to raise and address (i.e. students' approaches to learning); and secondly, it was evident that some members of staff did not agree with the ethos behind the sessions (i.e. they had a different conception as to the purpose of engineering education and how this could be achieved). It was therefore agreed that the researcher would be available to run the sessions for these members of staff. These sessions were attended by fewer students than in the first run experimental group, with typically eight to twelve students attending. However, those attending reported that they found the sessions a useful forum in which to raise and reflect on problems and to help discuss and develop solutions. At these sessions, students reported their frustration at having no feedback from staff on the feedback they had given, via the questionnaire. It was also reported that the personal tutor system was seen to be failing by students, and that there was little support or guidance for the BDPD.

This lack of response from staff had a knock on effect in the second semester, when student returns on questionnaires were reduced. Interviews with students identified a vicious circle where students did not feel their views were taken 'on board', so they did not respond to feedback requests. This led to a small sample size, so lecturers saw views as being unrepresentative. Because they see the views as unrepresentative, they take no action, and so on. It has been argued (Chalkley et al, 1995b) that these delays in closing the feedback/quality loop, result in deterioration in the participation rates and effectiveness of such systems.

In order to gain a balanced view from both groups of primary participants, interviews were held with two members of staff. These interviews showed that there was resistance to the system as they perceived it to concentrate on staff appraisal rather than staff development, and ignored the role of the student in the education process. The increased workload from semesterisation, increased student numbers, and reduced staff numbers had reduced the time available for personal tutees. However, staff felt that personal tutees did not approach them, and that students used staff non-availability as an excuse. The BDPD was seen as an extra administrative load, and many staff were either unsure of its purpose or unconvinced as to its benefits. The quality improvement system and the BDPD appeared to be at odds with the prevalent culture within the Department, which seemed to view the purpose of engineering education in 'vocational' rather than 'transformational' terms.

As the researcher was running the feedback sessions for staff, the staff were now passive in the system. Again, informal interviews showed that staff were reluctant to get involved owing to their perception that it would increase their already heavy work load. Therefore, some staff saw the discussion sessions as either an additional burden or were unconvinced as to the benefits of such a system, and it seemed that this group of staff members dismissed the concept that students were partners in the learning process.

It was important to try to break this circle and, to this end, the researcher organised a staff review of the quality system. It was a hoped that an acceptable Departmental procedure, that encompassed the aims of an in-process and active system, could be developed from the meeting.

7.4.3 First Staff Feedback Review Meeting

A discussion and review meeting was held with lecturing staff, year tutors and course directors, to gather their views on the scope, style and value of such a quality system. A brief explanation and suggested agenda was circulated prior to the staff meetings, and staff were encouraged to decide which areas they wished to concentrate on (see Appendix F). The discussion lasted two hours, with around 60% of academic staff attending. Some who could not attend submitted written comments to the meeting. The style was interactive, in that both the researcher and the academic staff were encouraged to test out their own thoughts and ideas, so as to elicit views of all concerned. Notes were taken during meeting by the researcher, so as to form the basis of the proposed Departmental procedure. Staff views were mixed, with roughly 50% of attending staff supporting a rationalised and coherent approach to a staff/student quality system. There was a significant minority (around 20%) that were not too bothered about the exact details of such a system, as long as the department was 'seen' to be doing something. A typical comment from such a staff member was:

> *"What is the minimum we have to do to keep the university happy?"*

This dichotomy of thought could be seen as 'we want to do something' versus 'we have to be seen to be doing something'. It can be argued that the former position is internally driven, leading to a change in attitude and behaviour, where as the later position is externally imposed, leading to no behaviour or attitude change. The meeting raised a number of important issues, which are summarised below:

- Staff felt that it was important for individual lecturers to take responsibility for their own feedback. It was proposed that ownership of the feedback be given to the academic staff, i.e. at the point of delivery;
- There was a need to explain the mechanisms behind the feedback to students with a view to engendering a 'bottom up' approach;
- Staff should respond to student feedback i.e. feedback on feedback. To this end it was proposed that checks were made to ensure that staff were implementing the feedback procedures. The danger with such 'control' mechanisms is that they ignore the understanding and intrinsic motivation necessary for a 'transformative' orientation. This element will be discussed later;
- A cultural change in the Department was required, as students and staff were, on the whole, not prepared to give feedback or respond to it. Therefore, 'top down' encouragement was seen as important, so that staff and students could take it seriously;
- Students should have identifiable goals that they can work towards, and should be encouraged to undertake self-analysis;
- The quality improvement system should use the discussions to generate positive as well as negative feedback, and emphasise constructive comments;
- The system must be built into the courses, not 'bolted on';
- Some staff felt that any quality improvement system would not work as the attitude of many staff was too entrenched to change behaviour. To overcome this required effective mechanisms to ensure that everyone follows the system. The system could not progress until all participants understood what, and why, they had to do and took it seriously;
- The quality improvement system should use the Subject panels as a support mechanism for staff, as they can give an overview and advice on feedback for each subject area.

It was generally felt that it was important not to inspect at 'the end of the line', but to encourage small incremental steps (i.e. 'continuous improvement'). Significant items were collated, and subsequent findings were circulated in the form of a discussion document on a Department procedure for feedback (see Appendix G). This formed the basis for a second review meeting, held one month later.

7.4.4 Second Staff Feedback Review Meetings

The second review meeting endorsed the circulated procedure (see Appendix G). Staff felt that the document had cultural implications, as it hoped to increase student (and staff) self-analysis. It was strongly reiterated that ownership of the process should be retained by those involved in the teaching, i.e. it should not become an administrative mechanism. The main thrust of the procedure was to develop a culture amongst undergraduates and staff that participation in feedback is valuable for their own personal development and the development of the course as a whole. It was agreed that the researcher would introduce the procedure to new intake of students in their first week in the Department. This would give information on reasons for doing it, benefits to students, processes in the Department, etc. It was suggested that students should keep a log of their progress through their course (i.e. maintain their own records of achievement). It was also felt that there must be an opportunity during course to make changes to modules, and that summaries and analysis from staff should be circulated to year tutors and course directors, so as to ensure that the system was being adhered to. Induction week was seen as an important area, as it is usually in the first year that the required culture that encourages student participation is created and reinforced.

7.4.4.a Student Learning Log

The introduction of a 'learning diary' or 'learning log' was discussed. In this portfolio, a student would review lectures, as well as set and review personal objectives, reflect on the methods they used, and suggest improvements for next time, i.e. plan and review their own learning strategy. This would help students maintain and develop the quality of their learning as they went along so that they could take their own corrective action. It was felt that this could be an important step towards developing an in-process, active system, and the researcher agreed to pilot it in the third run of the system. The log would provide a record of progress and be a valuable aid to developing a professional attitude. It would also have the benefit of being auditable in HEFCE Quality Assessment visits.

7.4.5 Evaluation of the Second Run

The participation rates on the quality improvement system were still low, and there was still a generally poor response from staff. It was felt that it was important to remind staff and students as to why the system was being developed:

- Information is needed if unsatisfactory areas are to be improved;
- Under a 'transformative' orientation, there is a need to help learners identify problems and suggest strategies for improvement, as well as encourage and develop learner self-appraisal;
- Under CQI, the quality improvement system should be a mechanism for action, not an end in itself.

It was agreed that the delivery and collection of feedback questionnaires should be carried out by the relevant member of staff concerned, i.e. to retain ownership of the process. The forms would be processed centrally by the researcher. It was also agreed that the system would only cover those modules taught directly by the Department, so as to avoid imposing the Departments 'culture' on another department, and to restrict coverage to those modules that the Department had direct control over. The discussion meetings were to be increased to two a semester: one early to mid-semester and one at the end of the semester. This increase in discussion, planning and review activities aimed to move the system towards in-process, active (see fig Figure 7.8).

7.5 Third Run of the Quality System (1994-1995)

During this period a new Head of Department was appointed, and the BDPD was dropped. An introductory presentation was given to the new first year students by the researcher (see Appendix H), with a view to generating the required 'mind set' amongst the students. Unfortunately, the quality improvement system was lambasted by a senior member of the Department in a following presentation, so reducing the effectiveness and impact of the researcher's presentation. This member of staff felt such initiatives were not suited to the purpose of engineering education as he saw it. Attempts were made during the first weeks to pilot the log books. However, it was difficult to gain student cooperation. Informal interviews with first year students found that they were unwilling to take part in any

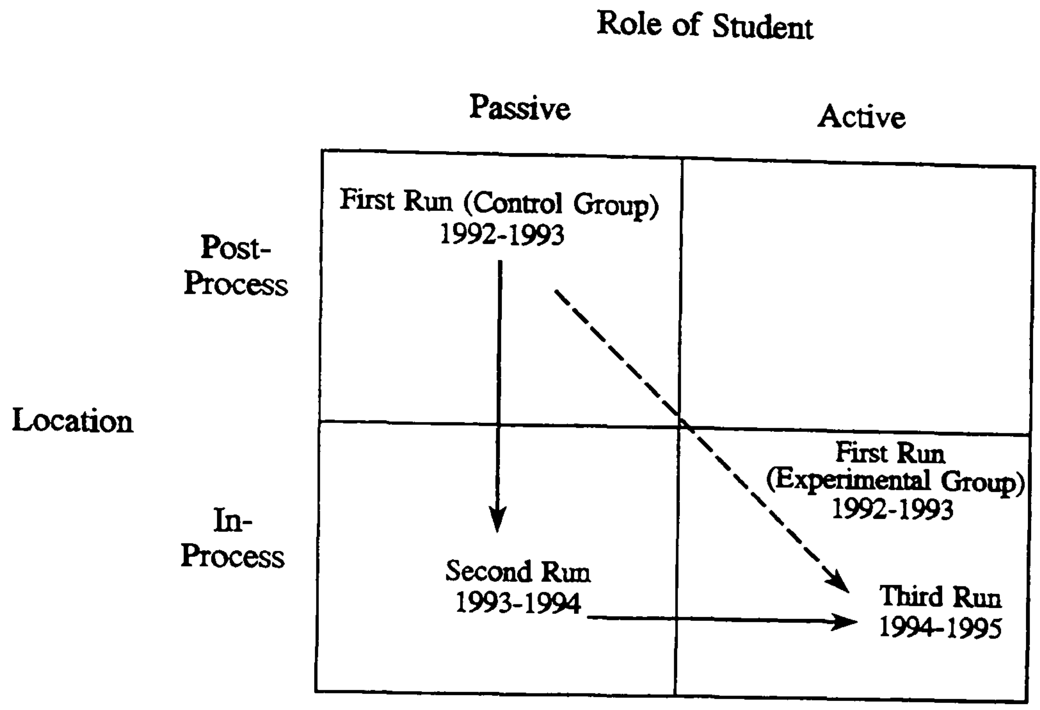

Figure 7.8: Strategy for Third Run of the Departmental Quality Improvement System (1994-1995).

scheme that was not explicitly connected, via assessment, with the course. Even at this early stage students were focused on course assessments (i.e. learning to pass exams). As the BDPD had been dropped owing to lack of staff support, it was felt that the 'learning logs' would not survive in such a 'hostile' environment. It was with some reluctance that the researcher abandoned the scheme[4]. An example of the learning log explanatory note and *pro forma* is given in Appendix I, and outline of the proposed system is given in Figure 7.9.

Despite this setback, the Departmental quality system had evolved into a more robust system, using a number of different review and reflection mechanisms. The developed quality improvement system now comprised of six stages (see Figure 7.10):

- Stage (1) was an initial feedback and discussion session between the students and the relevant year tutor, held in the first few weeks of the semester. Its purpose was to raise students' awareness of what the quality system involved and what their role was (i.e. what was expected of them). It also gathered information on students' impressions of their first few weeks on the course. Staff running such sessions had to submit a single-sided sheet of A4 summarising the main issues raised at the meeting. Examples

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[4]As of this academic year (1995-1996), students have been introduced to, and encouraged to develop, learning logs as part of the first year 'Communications' course. This initiative was instigated independently of the research described in this dissertation.

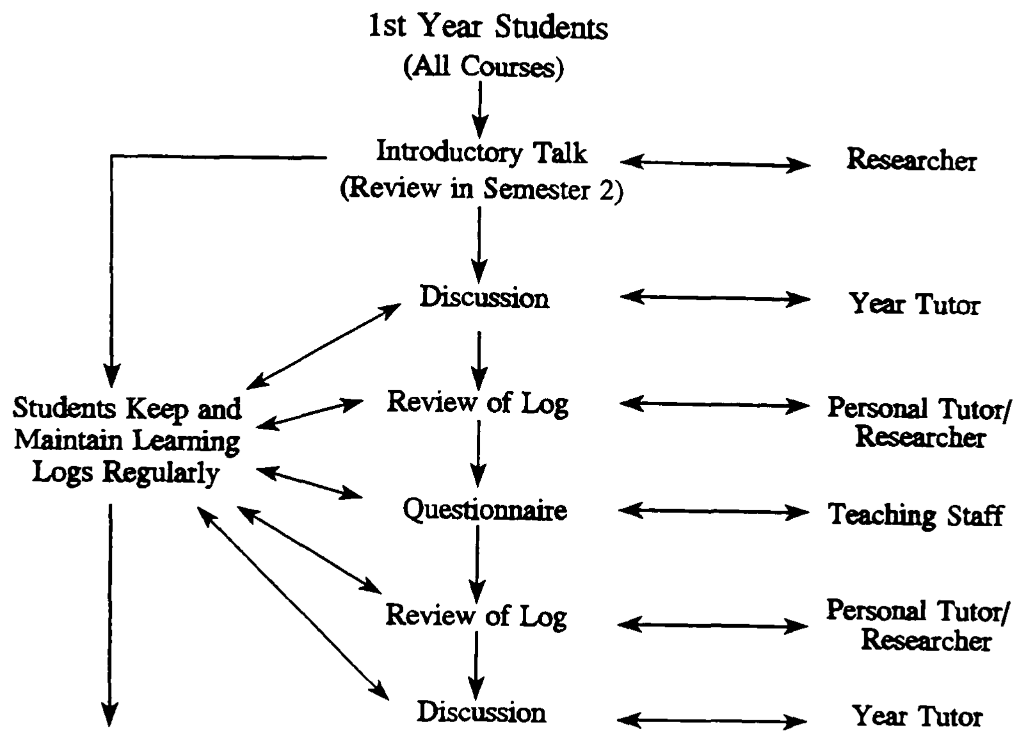

Figure 7.9: Proposed Quality Improvement System for First Year Students in the Department (1994-1995).

are given in Appendix J.

- Stage (2) was a mid-semester module questionnaire, consisting of 16 closed and 4 open response questions, which was aimed at gathering a number of 'performance indicators'. The questionnaires were analyzed by the researcher, and the results were communicated to the relevant member of teaching staff and to the year tutor. Examples of feedback summary forms sent to staff are given in Appendix K. There was a requirement that teaching staff would inform both the students and the year tutor of any action they proposed to take in light of the feedback. However, these indicators were not used as an end in themselves (i.e. summative), but rather they provided 'sign posts' for further investigation and action (i.e. formative).
- Stage (3) was a further discussion session run towards the end of the semester. It gathered more detailed information as to the background of Part (2) and checked on how effective students felt the proposed remedies had been. During the academic year, each course team (e.g. the Manufacturing Course) and subject team (e.g. Mechanical Engineering) in the department would also hold review meetings to discuss the results from the quality system and decide on any general action to be taken.
- Stage (4) was the personal review and analysis carried out by the relevant student cohort.
- Stage (5) was the personal review and analysis carried out by the relevant member of staff on the feedback from the relevant student cohort. This was to be supported by the relevant course and subject panels.

- Stage (6) was an end of year course level questionnaire, aimed at gathering information on students' perceptions of the general running and management of the course, as well as the other Departmental and university systems.

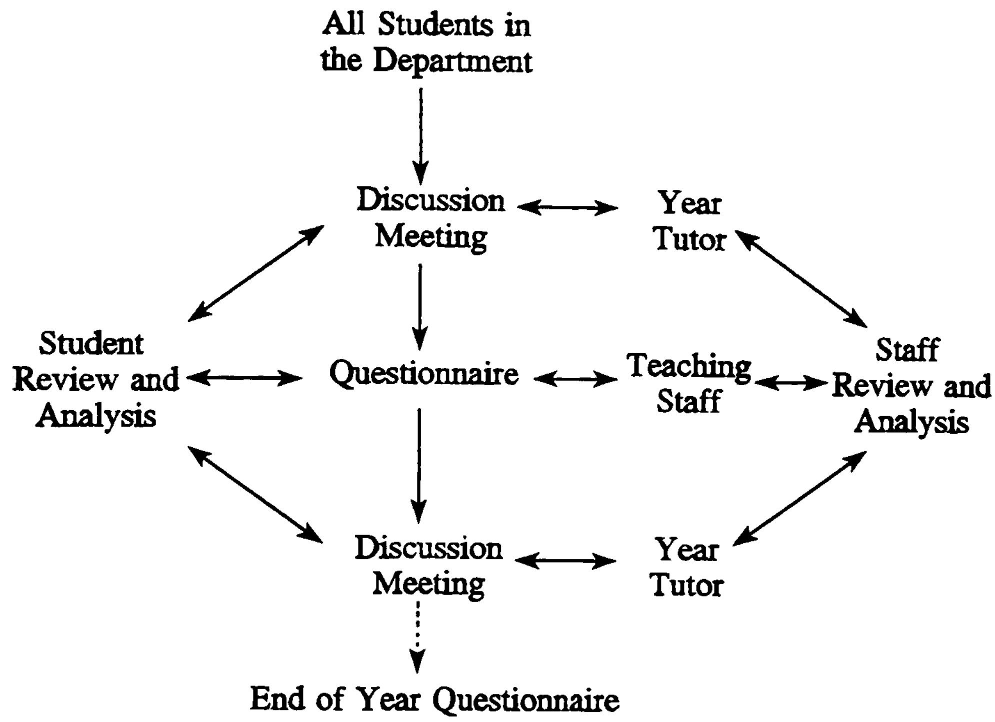

Figure 7.10: Third Run of the Departmental Quality Improvement System (1994-1995).

As previously stated, the Departmental procedure required staff to submit a response form to the researcher and year tutor, outlining their reaction to the student feedback and stating what their course of action would be. This system could be seen as a rudimentary version of the student learning logs, inasmuch that the thrust of the system was to get staff to focus on how they could improve. Staff were also given a chance to comment on the actual system itself. Examples of some of the forms received are given in Appendix K.

7.5.1 The Discussion Meetings

These discussion meetings aimed to encourage students to review and reflect on what they had done on their undergraduate degree courses, (e.g. what went well?, what did not go so well?, how could it be done better?, how could the students do better?). By requiring staff to communicate to students and year tutors on any action taken or not taken, it was hoped to close the 'feedback loop'. At each stage, staff and students were also given the opportunity to comment on the actual quality system and how it could be improved. Early on in the research it became clear that the system had to be 'transparent' (i.e. every one could see what was going on and what needed to be done), and that some staff were unused to, and uncomfortable with, running such sessions, and that students often felt 'intimidated' by the staff running the sessions. To overcome this covert 'collusion' (Stoddart, 1994), the researcher (i.e. 'independent' party) helped run the sessions. The course and subject team meetings allowed staff to take a broad view of all the modules taken by a particular year or all students taking a particular module, and spot any common areas of concern or best practice. The meetings also provided a supportive forum in which staff could discuss particular ideas or problems.

7.5.2 Evaluation of the Third Run

As the research project progressed it became increasingly clear that students found the bi-semester meetings most useful, as they had a chance to discuss and interact with fellow students, year tutors, and the independent party. These meetings were normally informal and attracted eight to twelve students (around 30-40%, depending on the year of the course), with the year tutor acting as a facilitator. Students were able and keen to discuss, consider and analyze the educational experience they had participated in. Indeed, some student groups ran their own feedback meetings, and communicated the minutes back to staff.

7.5.2.a The Focus of the System

The focus of the quality system was now changing to promoting student learning rather than just checking that students felt that such learning was taking place. The quality improvement system, therefore, was taking 'measurements' from the questionnaires and using these to formalise students' and lecturers' thoughts, ideas, etc., for improvement. Through these small feedback loops it was planned that the learning and quality process was being improved. If this were the case, then a well supported quality system could be used as a vehicle for change, i.e. to get students to be more proactive, to reflect and analyze on what they have done, and to suggest strategies for improvement. In quality terms, what the system was trying to do was move the Departmental culture from a one of inspection and control, to one of continuous improvement of quality (Chalkley et al, 1995b; Dale, 1994), where quality development and improvement was disseminated amongst all learning activities (rather than concentrated in a separate one).

The quality system implemented in the Department aimed to encourage a more mature and active approach to learning, and to help students and staff focus on the learners' attitude and the educational process. It developed as a formative rather than summative approach, via a progression of small iterations from the feedback process. The system also aimed to discover how students perceived what they were learning and whether teaching methods were effective.

7.5.2.b Staff and Student Responses

From comments received during the third run of the quality system it became clear that lecturers were focusing on improvements in the educational product (usually in terms of student pass rate), whereas the students' emphasis was on improvements in the educational process. For example, a staff meeting to discuss problems with undergraduate engineers mathematical ability might focus wholly on what should be taught rather than the way it was taught. There seemed to be little reflection or review on the part of some staff members as to how they could improve their approach to teaching. Typical student comments included:

- *"I have passed the exams but still don't really know or understand the subject"*,
- *"We learn in spite of what is taught us, not because of it"*,
- *"I don't see the point of why we are learning this - I can't relate it to anything!"*.

To have an impact on the 'reflection/review' activities, students suggested that the quality system would be more effective if developed in the early stages of the undergraduate course. They felt that any quality system needed to be heavily promoted and resourced, should aim to motivate students, should support them as independent learners, and encourage team-working skills. However, it must be remembered that this was a self-selecting group of motivated students. It proved impossible to persuade any of the students who had not participated in the system to come for an informal interview.

Students felt that reflecting on outcomes of actions helped the students extend their understanding of how they went about learning (i.e. intra-personal abilities), improved communications skills, and developed inter-personal abilities: the transferable skills that are seen as important (Goodman, 1993; Leake, 1993). However, they reported that time-constraints and work-load on the undergraduate courses still forced them to adopt a *'plan-do'* approach, with little emphasis on *'reflection/review'* activities. Students also reported that it was difficult to plan and review if they did not know the objectives of the modules they are studying. They also felt that they needed advice and skills in organising and planning their time and projects, i.e. skill in studying and learning to learn.

Some of the staff who ran the sessions had a very negative attitude to the sessions. One particular senior member of staff dismissed many student suggestions out of hand and misrepresented student comments at course team and review meetings. The staff member often derided the initiative and the BDPD. As students look to cues from staff members, this had a detrimental effect upon their participation in the system.

One of the key issues at both staff review meetings was that ownership of the system should reside with the academic staff. This, however, created a problem of coverage of questionnaires, discussion meetings, and responses from staff regarding their proposed action in light of the feedback (i.e. the 'right of reply' form in Appendix K). As the individual staff members could chose to participate in all, some or none of the system, a piecemeal and variable system began to emerge. On average, only around 20% of staff returned forms stating what developmental action (i.e. 'continuous improvement') they would take.

7.5.3 Student Review of the Third Run

Students were invited to attend a number of informal discussion sessions in March 1995. Four meetings were held, with around seven self-selecting students participating in each session. There were representatives from each of the courses and years. The purpose of the meetings was to elicit students perceptions of the quality system, and whether they thought the agreed Departmental procedure was being adhered to. There was a strong consensus that there was still no real opportunity to discuss the courses and modules. Some staff had been running the discussion mid semester sessions, but this group was in the minority. Information and action based on student questionnaire comments was still not communicated to students. Those that had attended the mid-semester discussion meetings between the year tutor and the relevant student cohort felt they were more effective than the questionnaires, as they were immediate and interactive. There was also criticism of the student representative system, in that there appeared to be a 'filtering' of information.

The students' comments appeared to confirm the researcher's fears that, by making the system voluntary, the effectiveness of the system had been reduced. Students were receiving contradictory cues from staff, some of whom welcomed and responded to student feedback, and others who ignored it or avoided eliciting it. Thus, attempts to form a coherent culture that encouraged student participation, reflection, etc., appeared to be foundering.

7.5.4 Staff Review of the Third Run

A formal discussion and review of the implemented quality system was carried out in July 1995 by the year tutors and course convenors of the Manufacturing Course and the Special Engineering programme. Staff on the Environmental Engineering course had provided constructive comments and suggestions throughout the project, and it was felt that such a meeting was unnecessary. It was felt by some staff that the system was still too heavily questionnaire-based, and that staff at certain levels of the course were not following the agreed procedure (see Figure 7.11). It was found, from the discussions with staff and students, that other forms of feedback were seen to be more appropriate to modules in later years. This was because:

- group sizes were reduced (due to the range of options available to students), therefore facilitating more open discussion;
- as students progressed through the relevant courses, they become more confident and able to discuss any problems they had directly with the member of staff concerned or with their peers.

Some participating staff viewed the questionnaires as a useful means of gathering formative feedback, and that students' comments correlated well with exam performance. Some staff still felt, however, that students used the feedback forum maliciously, for example:

- *"This is what happens when you get a few students with an axe to grind"*
- *"How can students comment on my module, when they've never been to my lectures!".*

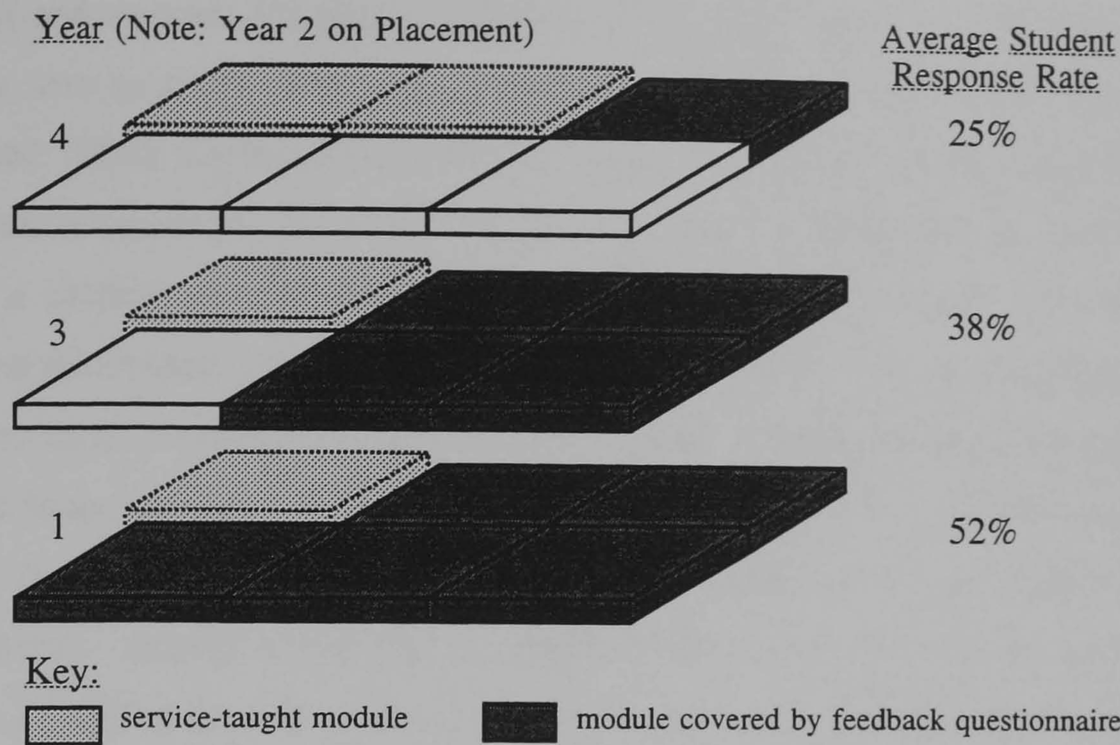

Figure 7.11: Questionnaire Coverage in Semester 1 (1994-1995).

Some staff resisted the suggestion that such information should be used in formal annual appraisals (i.e. summative judgements), with many stating that they would boycott such a system. Others felt that they should be given credit for being proactive and receptive to the ethos of Continuing Professional Development (i.e. demonstrating a commitment to continually reviewing their own strengths and weaknesses and taking action based on this personal reflection and analysis).

From the meetings it became clear that some staff members had not internalised the system. Typical quotes from such members included:

- *"I'm not sure why we are doing this. Is it to do something useful or just help X (the researcher) get a PhD?"*
- *"Is this just an exercise for X's PhD?"*
- *"Three years of going through the motions so we can get back to normal"*

Some senior staff were running feedback sessions with only student representatives, and it was felt that this defeated the object of the exercise, which was to get all students involved in reviewing the course and their own contribution to it. Some staff felt that staff participation was low as it was not linked to some tangible benefit, and that it needed a link with a more coherent approach to staff development. Junior members of staff were annoyed that many senior members of the Department had not participated in the system, implying that senior members of the Department did not need to improve.

Both staff and students felt that the meetings between the year tutor and relevant student year were seen as a particular strength of the system, and one that should be retained and encouraged. These meetings were seen to be more effective than year tutor/student year representative meetings, as they reduced the filtering of information, and allowed all students a chance to join in the discussion. They were also less time and resource consuming than blanket questionnaires. However, it was felt that these meetings should be reduced to once a semester. Staff generally felt that the questionnaires, though useful on an ad hoc basis, took too long to fill in and were not always an appropriate mechanism for the method of teaching adopted (e.g. some teaching staff used group project work rather than lectures - clearly a different questionnaire would be needed for each case). No members of staff requested or issued a 'course management' questionnaire, though some did run informal feedback discussion sessions after the summer examinations.

A major concern of the researcher was that the Department still did not have a student-centred focus (i.e preparing students for 'lifelong' learning), and that any initiatives designed to move towards this purpose were not being adequately supported. A certain amount of friction between the researcher and some senior members of the Department arose because of this. The researcher viewed the problems with the system as staff related, whereas the senior members of staff viewed the problem with the system as research related. The researcher perceived that some members of staff wanted a completely functioning system, but without any of the effort and commitment that this would require (i.e. not a Department-wide commitment to personal continuous quality improvement). There was also a feeling that some members of staff who supported the staff/student discussion meetings, may have done so as they saw it as an 'easy option'. Such staff often ran these as student 'moan' sessions, focusing purely on things such as course content, assignment workloads, and so on. By focusing on such superficial and 'safe' factors, they were easy to run. However, if they were run as a session that endeavoured to get students to reflect, review and plan their approaches to learning, then they became challenging and relatively complex. The added advantage, to staff, on focusing on these discussion sessions was that they did not take much staff time and did not generate large amount of administrative paperwork. It also became clear that students and staff were suffering from a certain amount of 'feedback fatigue'. With these comments in mind, the quality system was developed further (under the ethos of continuous improvement).

7.6 The Final Run of the System (1995 onwards)

At the time of writing the main focus of the system was now the student/year tutor meetings (see Figure 7.12). These meetings would be the main mechanism for identifying and reporting areas of concern. If more information on these identified areas was needed, a questionnaire would be issued. The information gathered from these meetings would be circulated to the relevant staff as before, as would any relevant action taken by the staff concerned.

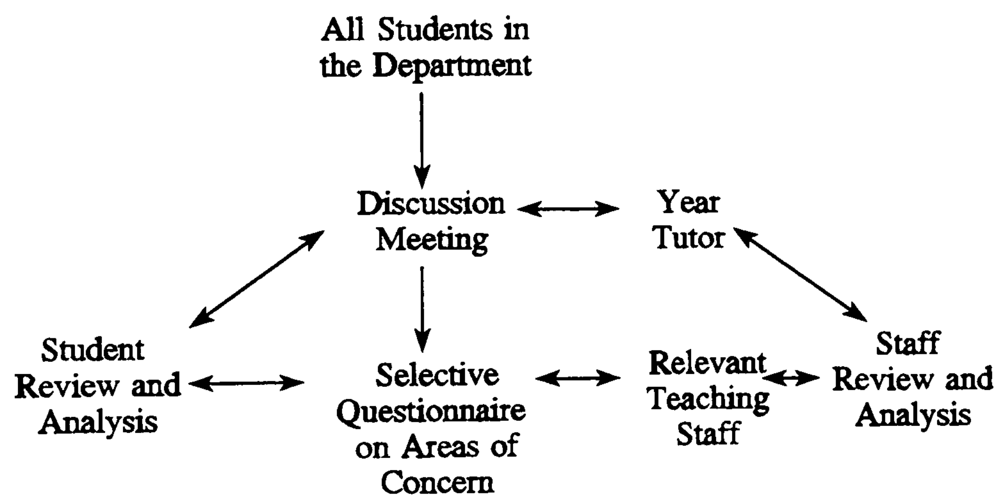

Figure 7.12: Fourth Run of the Departmental Quality Improvement System (1995 Onwards).

The Department still had a means, in theory, of eliciting student and staff reaction and views on the modules they undertook, but had shifted the focus from exhaustive use of questionnaires, to more interactive review and analysis:

- Between the year tutor and students, and within the group of students themselves i.e. inter-personal).
- within the student (intra-personal), where students were to be encouraged to review and analyse their own approaches to learning and use this as a basis for improvement.

Some concern has been expressed over the increased information 'lead time', i.e. the time taken between problem identification, analysis, solution and implementation has potentially increased, as there was only one 'sampling point'. In earlier runs of the system, there had been three points where staff and students could elicit feedback on which to base self-reflection and improvement activities. This consideration had to be offset against the needs of a system that had to be both viable (in terms of resource and time) and repeatable (in terms of regular staff/student participation).

7.7 Overview and Discussion of the Research Case Study

The progression of iterative changes to the Departmental quality improvement system has been outlined above. To take a more 'holistic' view of the system and the implications it had on the Departmental culture, the role of staff and students, and changes in behaviour and attitudes, it is now necessary to provide an overview of the research case study. This overview will relate the findings of the case study to the wider (i.e. external) environment.

7.7.1 Objective of the Research Project

The objective of the research project was to move from a quality system that emphasised measurement to one that emphasised development, and attempted to show that, to achieve quality improvement, engineering education must emphasise 'learning-to-learn' and not just learning. Therefore, the system attempted to shift the focus of staff and students from simple evaluation towards the developmental action taken after that evaluation. This required a change in perceptions of quality and quality improvement, where the system involved a move from simple monitoring and feedback to a system that implicitly encourages the application of learning theories using reflection, dialogue and feedback. This required a system that allowed a re-appraisal and clarification of purpose, input from all participants, and increased focus on continuous improvement. It became difficult to motivate participants towards this aspect of the system in the research case study, once ownership was given to individual lecturers. However, this was essential if the system was to operate once the researcher had left.

7.7.2 Departmental Culture

The fact that the system became fragmented once it was fully immersed in the Department shows that a certain, one could say 'conservative', culture existed. Indeed, it is said that "every advance in education is made over the dead bodies of 10,000 resisting professors"

(Robert M. Hutchins, quoted in Jellama, 1986). As seen in Chapter 5, systems feed culture and culture feeds systems, providing a vicious circle (see Figure 7.13). In the research project, it appeared that the quality system was seen to be fighting against the underlying Departmental culture.

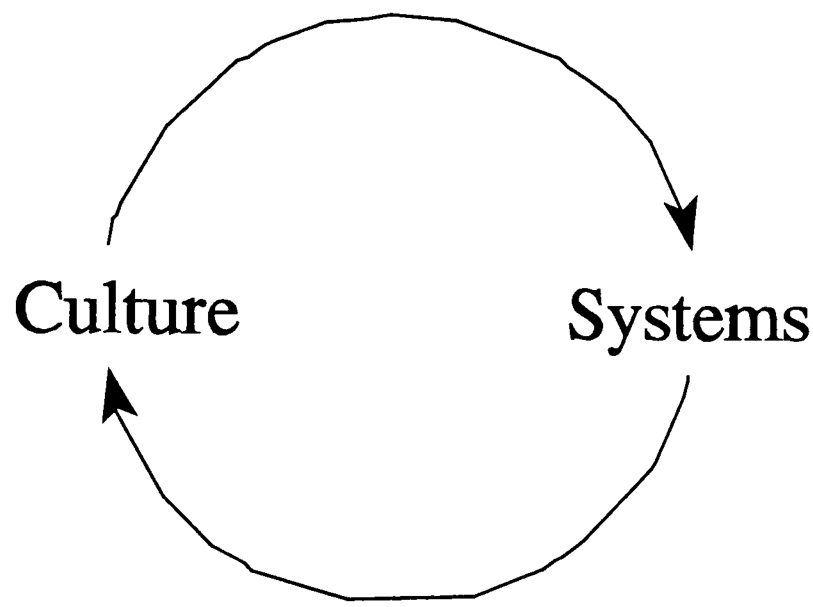

Figure 7.13: The Vicious Circle of Organisation Culture and Systems.

The thesis proposed that quality systems, based on developments in manufacturing industry, could be used in higher education to create a culture that engendered a positive learning approach (i.e. the development of the full cognitive range via continuous learning cycles, thus achieving a 'transformative' orientation). This apparent conflict, between the introduced systems and the existing Departmental culture, had obvious implications for the thesis. However, this conflict was by no means universal, and the adoption of the quality improvement system by some staff and students indicates that there was a connection between quality systems and a learning culture, as indicated in the thesis.

7.7.3 The Role of Staff and Students

Systems that focus on students' involvement in the decision-making process require a significant and demanding contribution from both staff and students. This requires the development of an appropriate culture. There appeared to be confusion amongst staff between systems that focus on course monitoring and evaluation, and systems that focus on quality improvement, where the former is not a quality improvement system as there is no explicit 'enabling' mechanism. It can be argued that there is more to quality than student feedback - feedback is just one means of providing information that informs the quality and learning improvement cycle. It also requires active planning, reflection, and a willingness to change, and these personal improvement cycles formed the foundation of the quality improvement system outlined in the case study. With the benefit of hindsight, the system could be seen to be imposing a new definition of 'quality' and a new culture on the established systems of members of staff. These systems can be viewed as 'external' (e.g. group norms and accepted protocols) and 'internal' (e.g. individual cognitive and affective domains). It can be argued that the quality improvement system outlined in the case study was at odds with the group norms and individual affective domains of some staff and students, thereby resulting in some level of dissonance (i.e. conflict). This issue is discussed in the next Chapter.

It can also be argued that staff, as engineering educators operating under an ethos of CPD, have a professional responsibility to monitor their own quality, and that such feedback provides one means of doing this. Viewed in this light, student feedback can provide information with which academic staff make decisions (i.e. could be used to provide information for staff personal improvement cycles).

7.7.4 Changing Behaviour and Attitudes

From the previous section (7.7.3) it can be seen that some of the barriers to implementing quality improvement systems to create a positive learning culture exist in the affective domains of staff and students, i.e. participants need to be encouraged to develop and implement their own learning cycles. From the research case study it was identified that there was a need to invest in such a system in the first year of a student's course, so as to develop the appropriate student and staff 'mind set', and the appropriate organisational culture. This requires a 'bottom-up' approach, where quality is built into a course rather than imposed on it. It can be argued that the research project was largely seen as a piece of research, and so was never fully integrated into the philosophy and culture of the Department. Because of the lack of some staff and student involvement, the quality improvement system and its constituent mechanisms were not 'internalised' by all the participants, inasmuch as they did not lead to a change in attitude or long-term behaviour. Attempts to introduce such an 'investment' in the first year of undergraduate courses proved to be fruitless. Initially students reacted positively to the quality improvement system, but motivation faded because of missing support by staff. This problem of 'inappropriate' behaviour and attitudes points to the need for a coordinated programme of staff development and support.

It has been argued that the focus of the system in the research case study was on development and enhancement rather than audit. As has been stated, the research attempted to show that, to achieve quality, engineering education must emphasise 'learning-to-learn' and not just learning. Therefore, the system cannot work solely with traditional educational methods or attitudes (i.e. passive learning). What is required is for students (and staff) to reflect upon their own learning, i.e. student centred learning rather than student delegated learning. It was found that the key to enabling this transition lies in changing culture, behaviour and attitudes of lecturers and students via motivation, persuasion and education. In systems involving student feedback, it is vital that the feedback loop is closed (i.e. any action taken or not taken, or decisions made, should be reported back to students). To achieve this there needs to be a change in attitude within engineering higher education. Departments have to overcome the difficulties in progressing towards a learning organisation, inasmuch as teaching has to be determined by the needs of the learner as well as the needs of the lecturer. It is important to ensure that those actually responsible for teaching and for learning, (i.e. lecturers and students), have the encouragement, information, understanding, attitude and capability to enable them to secure continuous quality improvement.

7.7.5 Findings

The research case study found that real developmental benefits did emerge if students were encouraged, and able, to examine critically what they had achieved and suggest ways for any improvements. By referring to the two education models developed in Chapter 2, it can be seen that the system in the research case study was designed to develop a student-centred process, where 'feedback and control' is personal and internal feedback and control over learning. By emphasising the move towards development and enhancement, it was hoped to encourage a transformational approach to engineering education. The adoption of the quality improvement system by particular staff and students provides evidence that this objective was achieved, even in a department with an overriding culture still very much geared to vocational education. This resulted in the quality improvement system being at odds with the culture of the Department and the majority of the Departments systems (e.g. students seen as passive entities; employers are the customers, students are the products, etc.). In common with much traditional engineering education (see Chapter 2), the 'total student experience' in the Department was seen to overemphasise some elements of passive behaviour and serialist, surface-level learning (i.e. little development of the capacity for 'lifelong' learning), though some modules did focus on an experiential learning approach.

The three and a half year research project achieved mixed success, depending on the degree course and module culture, with some staff members and students being fully supportive. However, problems were encountered with:

- indifference from some staff to student-led initiatives and their own continuing professional development, i.e. little apparent emphasis was placed on personal reflection, analysis and improvement by some staff members;
- increasing apathy from some students to the quality improvement system and the concept of 'lifelong' learning ;
- a general lack of familiarity, amongst staff and students, with the research on what the objectives of engineering education are, what kinds of learning are required to meet this objective, how students learn, and how educational methods impinge on this;
- the lack of full integration of the quality system into the undergraduate courses, possibly due to the above;
- students confusion as to their role in the quality system, owing to conflicting messages from some senior staff;
- a Departmental culture that was perceived to focus still on economic-centred models and training students for specific employment areas (i.e. a vocational orientation);
- Some staff resistance to the implementation of the quality improvement system, possibly from the distinction between *change* (internally directed) and *being changed* (externally imposed);
- Some staff seeing themselves as engineers rather than engineering *educators*, where the focus was on the content of what was taught rather than the way it was taught;
- A Departmental culture that, owing to pressure from an economic-centred university system, focused on short-term objectives, e.g. the first year was directed to run 'cheaply' and more emphasis was placed on specialisation in the final year and research activities.

Based on the findings of the research case study, it can be argued that to overcome this, a policy of staff support and development would be required, with its feedback culture more integrated into course philosophies and more emphasis on CPD and continuous self-improvement. Given the 'transformative' purpose of higher education identified in Chapters 2, 4, and 5, engineering education needs to stimulate and encourage effective learning (EPC/UCoSDA, 1994). Engineering educators need to encourage students to develop as 'lifelong' learners by changing the way they both teach and ensure quality, i.e. encourage participation, discussion, review, and reflection. The quality system described goes part of the way to achieving this, but such initiatives cannot flourish without Department wide support (i.e. a meeting of 'top-down and 'bottom-up').

The quality improvement system developed initially allowed students to take a more active part in their education and to close the learning cycle, by encouraging them to review and reflect on what they have experienced. It has been shown that this review and reflection activity should also make them more productive as lifelong learners (i.e. more effective). The research has found, therefore, that it is necessary to make explicit what was assumed to be implicit. If engineering education should be preparing students for the 'information age', then the focus and purpose of the education system (and inherent quality system) should be adjusted accordingly. This, therefore, requires a move towards more student-centred models, where the emphasis is as much on context and 'process', as on content and 'product'. After promising initial results with the experimental group, problems were encountered when the system was opened up to a wider community of staff and students. This wider exposure found that the quality improvement system was at odds with the prevailing culture. It can be argued that the external-micro and external-macro initiatives identified in Chapter 4 (eg, HEQC, HEFCE), aim to change the culture within a department so that they become more receptive to such systems. Based on this research project, it must be questioned how effective such systems will be in actually changing the behaviour and attitudes of the participants in engineering higher education, i.e. whether such systems are actually reflected at a 'grass roots' level. The introduction of these systems could be facilitated by a more rigorous and defined staff and student development programme. When introducing such quality improvement and development systems it must be remembered that differing universities have differing cultures, therefore there is no universal procedure. The task is to encourage the evolution of departmental culture that supports a progressive quality improvement system. Complicated systems are unnecessary as long as staff and students talk and listen to each other, and engage in a meaningful process of individual planning, analysis, reflection and improvement. Therefore, such quality mechanisms must support the individual participants (i.e. students and staff) and empower them as independent learners.

7.7.6 Relating the Findings to the Thesis

The dissertation has shown that there was a strong theoretical link between continuous quality improvement models developed in manufacturing industry, and the deep learning models developed in psychology and education. Both focus on cycles that promote personal and individual planning, reflection and improvement. It was argued that for such cyclical systems to work, a particular culture was necessary. This culture involved organisation-wide commitment to personal improvement. It was postulated that, by introducing systems that promote these learning and quality cycles, this culture could be developed.

The research case study attempted to introduce such systems into a manufacturing engineering department of a British university, with a view to realising this culture. It was found that there was already a strong prevailing culture within the Department, that gave primacy to external considerations (e.g. a vocational emphasis to engineering education, where employers' views and those of the engineering institutions were given most credence). In the case of the Department, it was found that this conservative culture was stronger than the systems aimed at developing change, where change was viewed as a threat, rather than an opportunity. It can be argued that such cultures and systems do not operate in isolation, but rather they are shaped by both internal and external forces. In the Department, the internal desire to maintain the *status quo* was seen as stronger than the external pressure to change. If such external pressure is not met by a similar desire from within, then the systems become defensive. The required change in attitude and behaviour that such external pressure aims to engender were not attained, as the participants have not fully internalised the required mechanisms and systems. However, the introduction of the quality improvement system in the Department did achieve successful adoption with particular members of staff and students. This success indicates that there is evidence to support the strong theoretical relationship between quality systems developed in manufacturing industry and the development of a learning culture.

By referring back to Chapter 4, it can be seen that initiatives at the external/macro level (e.g. HEQC, HEFCE) aim to influence the participants in higher education at the internal/micro level (e.g. cognitive and affective domains). These two forces meet to form a particular culture and set of systems (see Figure 7.14). However, if there is a mismatch between these internal and external pressure, as in the case of the research project, then it has been shown that the result can be confusion, contradiction and tokenism.

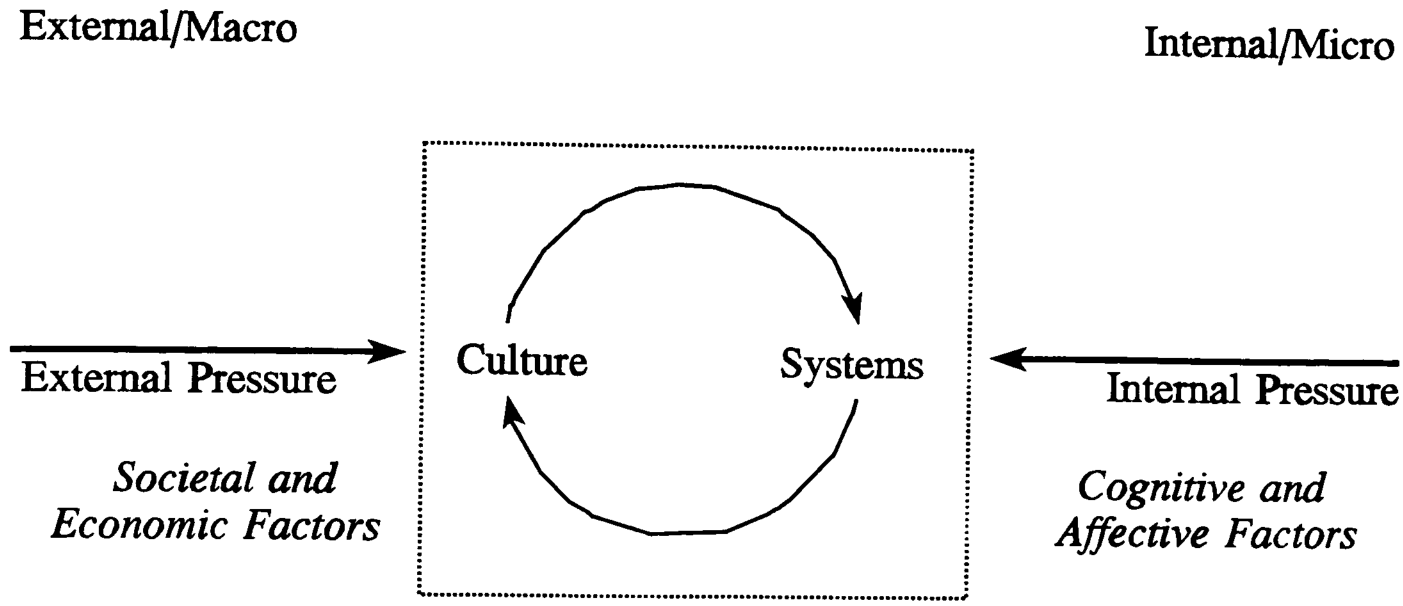

Figure 7.14: Pressure on Departmental Culture and Systems.

Looking back, the quality improvement system was not sufficiently universally integrated into the mechanisms and culture of the whole Department and its courses. There was success with particular students, staff members, modules and courses, indicating that the thesis was valid. In these instances students and staff did respond to the quality improvement system, resulting in improved motivation, increased sense of 'ownership' of their own learning, and a rise in proactive behaviour and thinking. For such systems to develop they need to be linked to larger, organisation-wide programmes, requiring a more holistic view of quality improvement systems and culture, i.e. how they impact and impinge on each other, rather than the stand alone approach the research case study was required to take, i.e. it was examining one aspect of the Department's culture and systems. To achieve this requires action at the design stage of courses (i.e. pre-process/pro-active). In attempting to bring around the required cultural change, the intervention outlined in the case study may have been too ambitious, given the short time frame (i.e. three years and half years), the sensitivity of the research area (i.e. staff and student relationships and interactions), and the developments in the external environment (i.e. increased participation rates and accountability). The pressure to introduce a quality improvement system in such a short period of time meant that a more gradual and subtle introduction was not possible.

The evidence presented in this dissertation shows that 'manufacturing' quality improvement systems can be applied to engineering higher education. The application of quality improvement systems requires an initially receptive culture that is open to change.

7.8 Conclusions

This chapter has given an overview of the research project carried out in the Department of Manufacturing and Engineering Systems, Brunel University, and its findings connected with different approaches to quality systems. The iterative cycle of methods used to re-design the quality systems from a student-based approach to a student-centred approached were described. This involved introducing a quality system that emphasised active, in-process continuous improvement on the part of both students and staff. The primacy of staff was assured throughout the project, with ownership of the system firmly in their hands. The system had to adapt to both the changing external conditions that impacted on the Department, and the underlying culture within the Department. The strength and 'direction' of the Departmental culture and external environment had implications for the scope and success of the research case study. The objective of the research was to examine the introduction of quality systems aimed at developing and enhancing student learning. It was found that the quality system introduced was at odds with elements of the culture that existed within the Department. This culture appeared to have a more short-term, reactive focus, whereas the quality system required a longer-term, proactive focus. Because of this mismatch, problems were encountered with changing some participants' behaviour, attitudes and internalising the quality systems. To overcome these problems requires an 'open' culture that allows a learner (e.g. student) centred focus, that emphasises internal/micro level approaches. The strong theoretical link between quality improvement systems and learning cycles has been shown to be valid, however effective implementation is dependent on both the prevailing culture within a department and the external forces that act upon a department.

Chapter 8 - Conclusions and Meta-Evaluation

The purpose of this Chapter is to provide an overview of the thesis, dissertation, and methodology used. A more personal reflection, on the part of the researcher, on the issues underlying the research carried out is presented and, from this, advice is offered as to future directions for the progression of further research case studies.

8.1 Overview and Conclusions

In this dissertation it has been argued that, owing to changes in the external environment in which they operate, the purposes of institutions of higher education have been undergoing a transition. This transition has resulted in the emergence of a move from objectives that are aimed at vocational considerations, towards objectives that are aimed at more 'transformational' considerations. This change in purpose has been particularly noticeable in engineering education. Such a 'transformational' purpose is based on the development of the full range of students' cognitive abilities together with an external (i.e. 'real world') view, as a means to support lifelong learning. To develop these cognitive abilities requires an emphasis on students' approaches to learning, which in turn requires a focus on learning improvement and the adoption of individual learning cycles. Thus, the achievement of this 'transformational' purpose requires the development of educational systems that encourage the use of these learning cycles. From this, a link between systems that support learning improvement in education, and systems that support quality improvement in industry was identified, and a strong theoretical relationship was demonstrated. Therefore, the thesis presented in this dissertation set out to show that quality systems, based on developments in manufacturing industry, could be used in higher education to create a culture that would engender a positive learning approach. This required the introduction of quality improvement systems that would develop the full cognitive range within students, via continuous learning cycles. It was argued that such cycles were necessary if the 'transformative' purpose of higher education were to be achieved.

Investigation into the thesis required the adoption of a particular methodology, based on an in-depth longitudinal qualitative applied/action research case study. This involved the researcher using an interventionist strategy in a particular university manufacturing engineering department, aimed at introducing such quality improvement systems. Over the period of the research case study, particular students and members of staff adopted and implemented the quality improvement system. From this it was shown that there was a link between such systems and changes in the departmental culture necessary to promote a positive learning approach (i.e. active planning, reflection, review and improvement on the part of the student). The thesis was, therefore, valid. The adoption of the quality improvement system within the department was not universal, though it did point to the emergence of a cultural shift. Considerations relating to the increased adoption of such quality improvement systems are discussed in the next section.

8.2 Reflection and Meta-Evaluation

The research case study presented in this dissertation has shown that there is a link between quality improvement systems and the development of a culture that supports learning cycles to achieve students' 'transformation'. From this, it can be seen that the thesis is valid. The evidence is provided by the acceptance and utilisation of such improvement systems by particular students and members of staff. The adoption of the system was not Department-wide, and some personal reflection and analysis of the research case study (i.e. meta-evaluation), as is usual in such action research projects, has identified a number of factors that may have contributed towards this:

- The research focused on, and was predominantly carried out with, undergraduate students, i.e. much attention was given to student considerations, and thus may have 'excluded' staff at the key early stages of the research;
- The research focused on students as 'learners', whereas learners can be seen to encompass both students and staff (i.e. they both need to develop their own learning cycles). It was assumed that all staff regularly reflected, reviewed and improved what they did;
- It was assumed by the researcher that, as the Head of Department supported the research, that the other members of academic staff would also be supportive and that they could see the purpose of introducing the quality improvement systems;
- The research was adopted and promoted a 'transformative' view of the purpose of engineering education, whereas some staff and students were focused on a 'vocational' view. This mismatch led to some confusion and conflict. If a vocationally orientated system had been introduced, the effective implementation may have been more widespread;

- The research was carried out in a period of great change, where student numbers were increasing and their background was changing, and there was increased external influence on institutions of higher education;
- It was assumed that staff and students' would be sufficiently motivated to participate in, and help develop, the quality improvement system;
- In order to complete the research in the allotted time frame, the gradual and phased introduction of the novel quality improvement system had to be 'compromised', i.e. the introduction strategy had to be 'artificially' accelerated if any meaningful conclusions were to be reached;
- It was assumed that the benefits that had been identified with the experimental group would be translated to a larger group. The importance of educating, informing and convincing staff as to the benefits of the novel system was not fully appreciated;
- The Departmental culture was not as 'open' as anticipated, possibly due to the increased pressure from the external and internal environment;
- The high level of support and contribution necessary from staff and students was not realised at the research design phase;
- There was confusion between quality monitoring and quality improvement amongst some students and staff, possibly due to differing conceptions of quality and learning;
- In some instances the 'feedback loop' was still not closed, resulting in incomplete quality improvement cycles (and their implicit learning cycles).

However, the involvement in, and adoption of, the quality improvement system by particular members of staff and student groups was a positive outcome, with active planning, review, reflection and improvement on the part of these participants. This shift in the quality improvement process can be seen to engender a corresponding improvement in the learning (i.e cognitive abilities) process. Such an examination of cognitive improvement was beyond the scope of the research case study and is an area for future work.

Based on these personal observations, areas of particular interest for the improvement of future research can be seen to include:

- The explicit involvement of members of academic staff, where staff are viewed not only as enablers or facilitators but also as learners (i.e. not aimed solely on students);

- A coordinated programme of staff development and support, focusing on cultural issues, learning and quality improvement;
- Clarifying the purposes and objectives of engineering education, and defining the processes by which these objectives can be achieved;
- Action at the design stage of courses, where the stress should be on more pro-active, pre-process interventions (i.e. design issues) that emphasise learning-to-learn and lifelong learning amongst staff and students (see Figure 8.1). This would require overt action on specifying the range of learning (i.e. cognitive) abilities to be developed at the individual module level;
- An appreciation and investigation of group norms and personal definitions amongst staff and students, where participant's conceptions of quality and learning are explored;
- Linking the quality improvement systems more explicitly to continuing professional development (CPD) of both staff and students;
- More action on the encouragement and motivation of staff in particular, and students in general. This should have the effect of creating a culture that is more receptive and open to change;
- A longer-term implementation strategy (eg. five to seven years rather than three and a half).

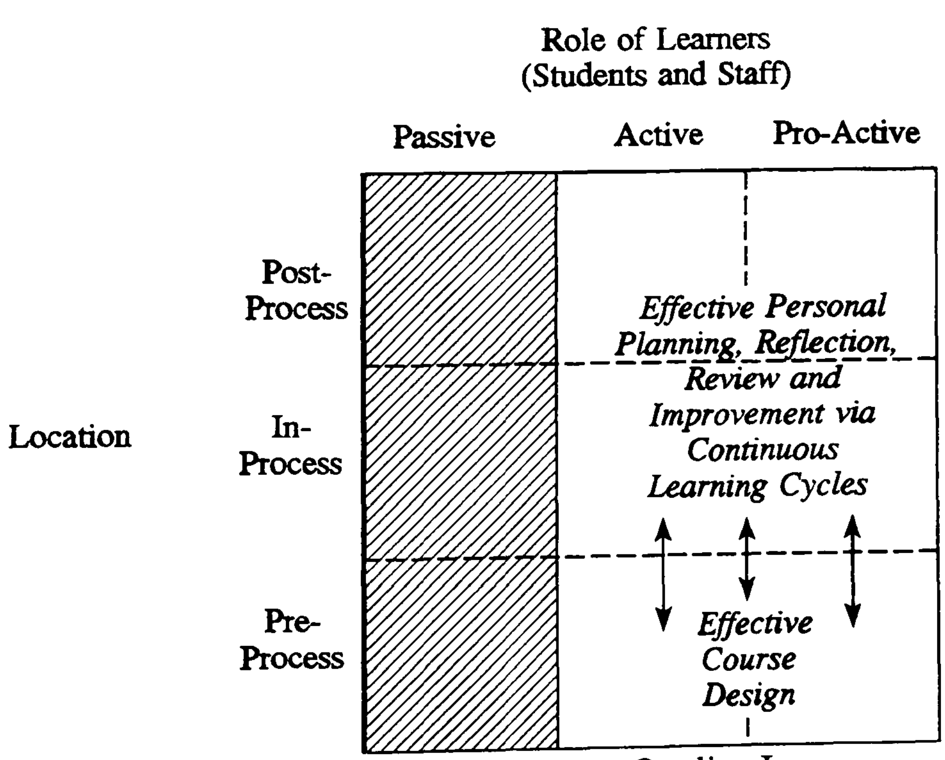

Figure 8.1: Strategy for Pro-Active, Pre-Process Quality Improvement Systems.

The research undertaken has contributed towards a specific area of quality improvement system. The evidence presented in this dissertation shows that manufacturing quality systems can be applied to higher education with a view to supporting a culture that engenders a positive learning approach. However, the introduction of such systems requires a more integrated, department-wide strategy emphasising pro-active, pre-process design considerations.

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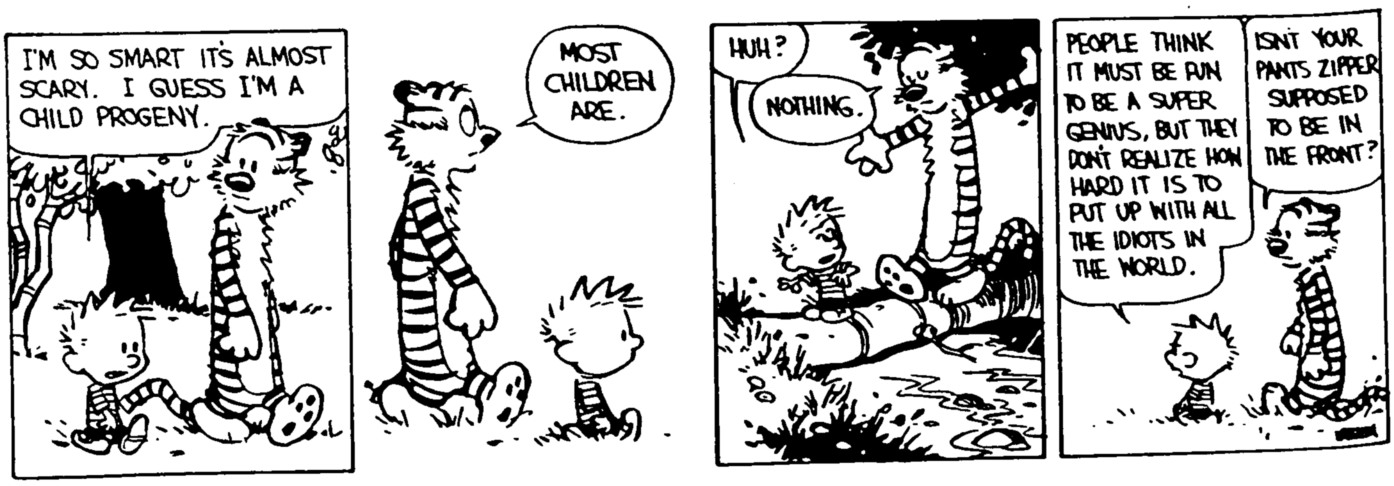
Afterthought

Every PhD student is worried about the standard and quality of the research presented in their Thesis. This concern is summed up by the following quote:

> "Your work is both good and original. Unfortunately, the good bits aren't original and the original bits aren't any good".
>
> Anon.

The defence of the Thesis presented in this body of work, both at international conferences and at the viva voce, has shown that it is both 'good' and 'original'.

However, in case I ever get too complacent or conceited....



Watterson, 1991, p. 100.

Appendix A

Changing Relations Between the State and Higher Education[1]

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[1]*Appendix A* only refers to those relationships concerned with the teaching function of higher education (i.e. it excludes the research function of higher education and the role of the research councils).

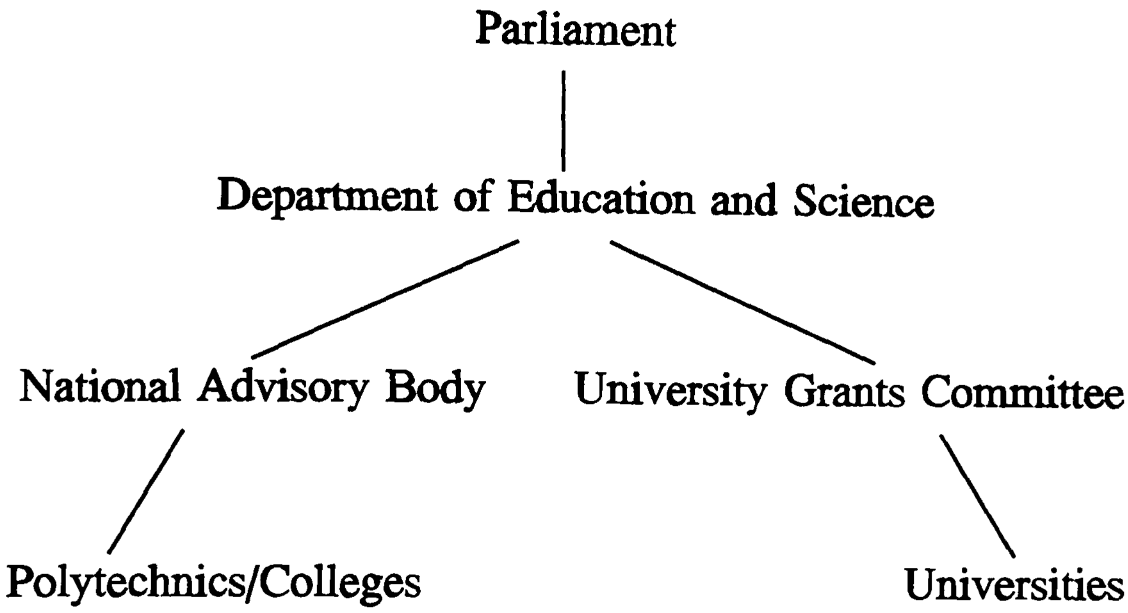

Figure A1: From the creation of the Department of Education and Science to the 1988 Education Reform Act, 1964-1988 (adapted from Salter and Tapper, 1994, p. 219).

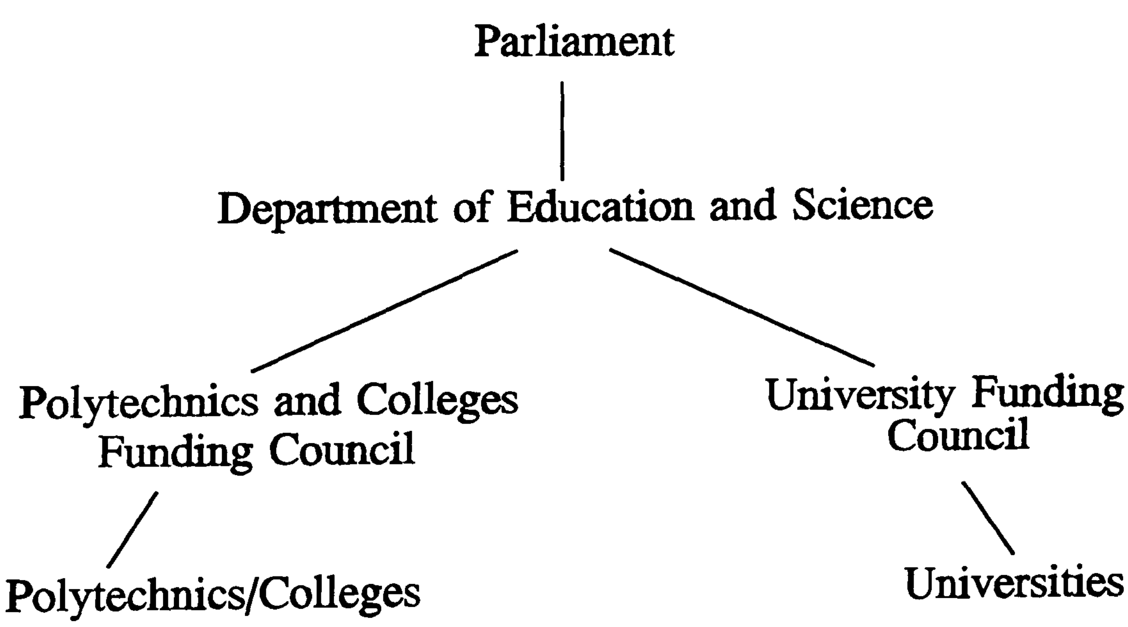

Figure A2: From the Education Reform Act, 1988, to the Further and Higher Education Act, 1992 (adapted from Salter and Tapper, 1994, p. 220).

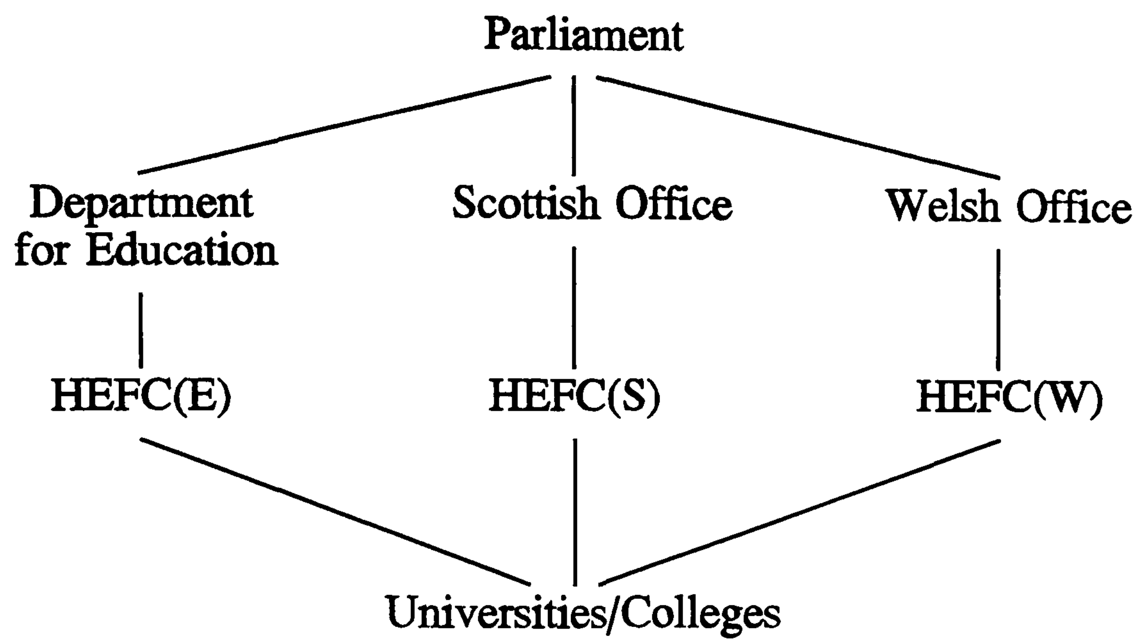

Figure A3: From 1993 to mid-1995 (adapted from Salter and Tapper, 1994, p. 220)

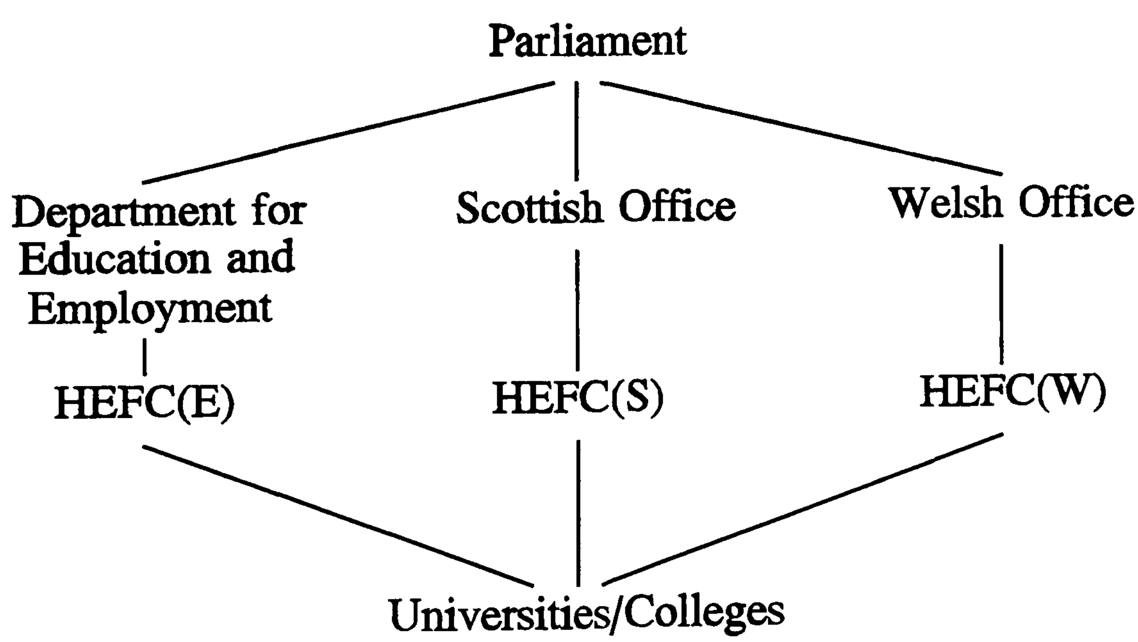

Figure A4: From mid-1995.

Appendix B

Aristotle's Laws of Association

According to Aristotle, all knowledge is based on sensory experience and thinking (Hergenhahn, 1988, p.33). In elaborating this view of knowledge, Aristotle formed his 'laws of association'. These laws consisted of the law of similarity (the recall or experience of one object will elicit the recall of things similar to the object), the law of contrast (recall of opposite things), the law of contiguity (the recall of things originally experienced with the object), and the law of frequency (the more frequently two things are experienced together, the more likely that recall of one will stimulate recall of the other). From this it can be argued that mental activity (i.e. learning) is based on connections between basic mental events, such as feelings or sensations.

Appendix C

Departmental Student Feedback Form Circa 1985

SEP STUDENT COURSE EVALUATION

SEP YEAR NO: 1   1985/86

Please place a figure 1 to 5 in every relevant box.

NB. 5 = V.High   2 = Low
4 = High   1 = V.Low
3 = Neither

	QUESTIONS	U 1.2 Eng.Systems & Com^{n}.(CDE)	U 1.3 Design (AJM)	U 1.4 Problem Solving (AJM)	U 1.5 Artefact Study	U 1.6 Elect.Eng. (RTR)	U 1.6 Elect.Eng. (BO'C)	U 1.6 Elect.Eng. (CH)	U 1.6 Mech.Eng. (GM)	U 1.6 Mech.Eng. (CC)	U 1.7 Maths (Dr Newby)	U 1.8 Materials (CDE)	U 1.8 Materials (Dr Bowman)	U 1.8 Materials (Mr Cochrane)	U 1.9 Accounting (T Webb)	U 1.9 Economics (Dr Burningham)	U 1.9 Law (Mr Woodroffe)	U 1.10 Marketing (Davis + Simor	U 1.10 Computing (AF)	
A Course as a whole	1. The amount I learned from this course was:																			
	2. The total work load associated with this course was:																			
	3. The extent to which this course was related to/integrated with other courses was:																			
	4. The degree of difficulty of the course was:																			
B Lectures	1. The degree of clarity & organization of the lectures was:																			
	2. The amount I learned from the Lectures was:																			
	3. Ease of note taking was:																			
C Tutorials Seminars	1. The quality of the organization of these was:																			
	2. The amount I learned from the tutorials/seminars was:																			
D Practical Work	1. The amount of work required was:																			
	2. The degree of organization of the work was:																			
	3. The amount I learned from the practical work was:																			
E Course Materials	1. The clarity of the course materials was:																			
	2. The value/usefulness of the course materials was:																			
F Setwork, course Assignments	1. The amount of work required was:																			
	2. The quality and value of the feedback on the work was:																			

Appendix D

Departmental Student Feedback Form Circa 1992

BME Year 2 Course Feedback

Please grade each aspect of each course on a scale of 1 (bad) to 5 (good).

Please use the space provided to make comments about the course. Do not write on the back of the sheets. Add extra sheets of paper if you like.

Please be constructive in your comments and suggest ways for improvement if you identify any shortcoming.

Materials	BJG	Organisation of course		Amount learned	

Materials	DF	Organisation of course		Amount learned	

Materials	RJG	Organisation of course		Amount learned	

Materials Labs.	DF	Organisation of course		Amount learned	

Appendix E

Departmental Student Feedback Form Circa 1995

Department of Manufacturing and Engineering Systems, Brunel University **Level__ Semester__**

Module Title: .... **Lecturer:** ....

Name (optional): ....

Course: BME/ SEE/ SEP **With: Management/ Languages**

Objective:

As part of its Continuous Quality Improvement Process, the Department wishes to ask your views on the modules you have taken. Please, therefore, complete this questionnaire and give it in at the end of this lecture/ exam. The resulting information will be used to improve future runs of this and other modules.

Instructions:

Please indicate the most appropriate choice for each statement, depending on how strongly you agree or disagree with it. All information will be treated in the strictest confidence. The following rating scale is to be used:

Strongly Agree	1	2	3	4	5	6	Strongly Disagree

or

'n.a.' if you feel the question does not apply or you have no opinion on this particular area.

1) I have learnt a great deal from this module		(1)
2) I have a great deal of interest in the module subject area		(2)
3) I find the module subject difficult to understand		(3)
4) The lectures have helped my understanding of the subject matter		(4)
5) I have put a great deal of effort in to this module		(5)
6) The objectives of the module were clear		(6)
7) The module materials were well prepared		(7)
8) The lecturers explanations were clear		(8)
9) Feedback on assignments was constructive and valuable		(9)
10) The lecture notes, assignments and recommended readings were useful		(10)
11) The lecturer was available outside of lecture time to give help and advice		(11)
12) My attendance at the lectures on this module was high		(12)
13) The lab materials were well prepared		(13)
14) The lab enhanced understanding of the lecture material		(14)
15) The tutorial materials were well prepared		(15)
16) The tutorials enhanced understanding of the lecture material		(16)

Please use the space overleaf to answer the following questions:

17) If you did not consistently attend these lectures, why? How did you cover the subject matter?
18) What 2 features of the module have you found most useful and interesting.
19) What 2 changes would you like to see made on this module.
20) Do you have any other comments? (please use other side of sheet)

Appendix F

Agenda of Staff Feedback Meeting (1994)

BRUNEL UNIVERSITY

DEPARTMENT OF MANUFACTURING AND ENGINEERING SYSTEMS

UNDERGRADUATE FEEDBACK REVIEW MEETING NO. 1

TO BE HELD ON THURSDAY, 14TH APRIL 1994

IN ROOM 004A AT 10.00A.M.

AGENDA

1.1 Apologies

1.2 Objective

To develop a usable (ie inexpensive and easy to administer) *mechanism that provides meaningful* (ie relevant), *reliable* (ie consistent and non-contradictory) *and representative* (ie accurately measured) *feedback on a variety of areas.*

1.3 Review of current UG feedback

a. What we are doing (questionnaires; meetings; tasks [eg brainstorming])
b. Why we are doing it (identify unsatisfactory areas [ie Quality Improvement]; increase student awareness and appreciation of learning; formative/diagnostic information; increase involvement of students in educational process; satisfy University requirements; less contact hours means new feedback mechanisms are needed; assist students to compare their perceptions of the course with their peers)
c. Problem areas (student response rates; promptness of student response; 'feedback fatigue'; are we asking the right questions\looking at the right areas?; how should we deal with the resulting information?)

1.4 Discussion areas

a. **Feedback culture** (how can we encourage students to respond and participate in the feedback process; can we integrate feedback in to courses more)
b. **Increase focus on the student** (ie how can we ascertain how much effort student puts in to course; which methods suit their learning styles; what their learning styles are; etc)
c. **Participation** in the process (how to increase student response rates; staff 'right of reply'; what control mechanism should we use (ie traceability of non-respondents)
d. **Analysis and Reporting** (what is the best method?)
e. **Format** of feedback mechanism (questionnaires, meetings, etc)
f. **Scope** of feedback (lectures, labs, tutorials, the mechanism itself)
g. **Frequency** of feedback (how often in the semester)
h. **Timing** of feedback (when in the semester)
i. **Content** of the feedback mechanism (what information do we need?, what sort of questions should we be asking)

1.5 Any other business

1.6 Date of next meeting

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Appendix G

Departmental Procedure on Undergraduate Student Feedback

Brunel University

Department of Manufacturing & Engineering Systems

Departmental Procedure on Undergraduate Student Feedback

1994-95

Manufacturing and Engineering Systems
Brunel University

Authors: Dr Clive Butler & Simon Chalkley

Departmental Procedure on Undergraduate Feedback

Mission Statement:

To adopt a policy of Continuous Quality Improvement in teaching and learning by monitoring, analysis, and action based on student and staff feedback.

Objectives:

1) *To develop a usable* (ie simple, inexpensive and easy to administer) *mechanism that provides meaningful* (ie relevant), *reliable* (ie consistent and non-contradictory) *and representative* (ie accurately measured) *student feedback on aspects of the Undergraduate experience.*

2) *To communicate to staff the relevant feedback so as to permit changes in such matters as organisation, presentation, and curriculum development.*

3) *To communicate to students the summary of the analysis and actions (if any) proposed by staff.*

4) *To communicate each Semester a summary of the analysis and actions to Subject Panels* (peer review), *Course Directors, and the Head of Department (via the Departmental Undergraduate Teaching Committee).*

5) *To communicate to the appropriate University administrative authorities the required Quality information (for their records).*

Strategy:

To develop a culture amongst undergraduates and staff that participation in the feedback process is valuable for their own personal development and the development of the course as a whole.

Tactics:

1) *Develop a feedback 'culture'*
As part of the Year 1 students introductory week, there will be a presentation to students on the feedback process (document #1). The actual process will work on 2 levels:

Level 1
This involves gathering information at the **Module Delivery Level**. The mechanism involves distributing a questionnaire (document #2) given out between weeks 6 and 8 of each Semester (***'Progress Review Weeks'***) by each module lecturer. This will be distributed at the start of the lecture, with 10 minutes allocated for completion, and then collected at the end of the lecture. The forms will be processed and analysed centrally. In conjunction with the questionnaire, the Year Tutor will organise 2 informal feedback meetings (roughly an hour in length) held during weeks 4 (to discuss all modules general terms) and 10 (to discuss all the modules in light of the questionnaire analysis and any proposed corrective action). A specific slot should be timetabled for this activity. These sessions could make use of 'buzz group' and 'snowballing' methods (ie divide group in to small units to discuss course/ modules, then slowly open the discussion to larger groups).

Level 2
This involves gathering information at the **Course Management Level**. The mechanism involves a questionnaire (document #3) distributed to students at the end of Semester 2, 3, 4 and 6. It will normally be distributed during the 1st examination, and must be returned before the end of the Semester in order for them to receive their placement folders (alternative arrangements will have to be made for 3 year courses). It is aimed at gaining an overall picture of the course and the students who are studying on it. The informal feedback meetings will also be used to gain an insight in to this area.

2) *Increase focus on student*
Students will keep a log of their progress during the course, using a standard form that will chart progress relative to the objectives set by the lecturer at the beginning of the module (document #4). To facilitate this students will be issued with a 'Guide to Learning Logs' (document #5) and refer to the '*Scheme of Studies*'. Existing mechanisms can be used to ensure students maintain their own achievement records (ie via the personal tutoring system).

3) *Increase focus on staff*
To facilitate (1) and (2) it is necessary for staff to introduce themselves to students; to state learning objectives of modules and learning resources available (stated in the '*Scheme of Studies*'); to report to students/ subject panels on any actions taken (or not taken) in light of the feedback; to have (and use) the 'right of reply' (document #6); and to receive support and advice through their subject panels.

4) *Analysis and reporting*
The analysis should be carried out centrally (initially by Simon Chalkley, but will need to be part of staff members 'job description' after July 1995). The reporting will be on 5 levels:

Level a
From the 'analyst' to the individual staff members, ie Lecturers and Year Tutors (document #7);

Level b
From the staff members to the undergraduate students of any action taken (copy sent to 'analyst');

Level c
From the Year Tutors the Course Directors on the results of the feedback and the action taken;

Level d
From the Course Directors to the Head of Department on the Subject Panel and the Course Management aspects;

Level e
From the Head of Department to the University, demonstrating that M & ES has an effective student feedback mechanisms.

Responsibility:

1) Of Students - to maintain an accurate learning record (ie emphasise the focus on student learning) and participate in the feedback process
2) Of Staff - to respond to feedback and advise students, Year Tutors and Subject panels of any actions.
3) Of Year Tutors - ensure that staff and students are following the '*Procedures on Undergraduate Feedback*';
4) Of Subject Panels - to offer constructive advice (*corrective action*) and support to staff and Course Directors
5) Of Course Directors - to develop curricula and produce appropriate documentation for the Head of Department
6) Of the Head of Department - to forward the appropriate Quality documentation to the University, and develop an environment where feedback is encouraged and acted upon.

Documents to be generated:

#1) Outline of presentation for the introduction week;

#2) Guide to learning logs;

#3) Model (*pro forma*) of student progress record, ie *'the learning log'*;

#4) Module Delivery Level questionnaire;

#5) Course Management Level questionnaire;

#6) Analysis Presentation to staff and Subject Panels;

#7) Staff feedback process/ format (ie the mechanism to record staff action);

#8) Timetable of the process.

Review of Feedback Process:

To be carried out by the Departmental Course Convenors.

Addendum on the rationale behind the proposed system

i) The information gathered should only be used for diagnostic/ formative purposes. The feedback process is designed to provide information to staff on the modules they teach on, so as to facilitate student learning. It is not designed to be used as part of a formal staff appraisal system.

ii) Although students can only answer questions based on their current experience, this does not invalidate their views on the modules they take. It is important that the staff and the Department take their views on the planing, management, organisation and delivery of modules seriously.

iii) It is vital that the progress evaluation mechanism is built in to each module (and the course as a whole), rather than 'bolted on'. 'Ownership' of the mechanism should be kept at the student/ staff interface as much as possible. It must be performed in a systematic and holistic way rather than *ad hoc*.

iv) We need to get the student to focus on how <u>they</u> learn as an individual. Therefore we must place as much emphasis on students review of their learning strategies as is placed on students feedback on lecturers and modules. The learning log is an integral part of the review process (where the student plots progress against the module objectives and the stated strategy for meeting those objectives). Feedback must therefore be seen as part of the overall education process.

v) The department must beware of overwhelming students and staff (ie avoid *'feedback fatigue'* and *'analysis paralysis'*).

vi) As part of the ethos of *'continuous improvement'*, the department must realise that the procedure is not static, but must be reviewed and improved.

Manufacturing and Engineering Systems
Brunel University

Document #1
Outline of Introductory Week Presentation

---

1) Objectives:
a) Mission Statement;
b) Development of Gradaute Engineers;

2) "Forward thinking - why are you at College?":
a) Increase students focus on themselves and their own learning styles: ie,

i) Where have I been;	Relevant prior learning
ii) Where am I now;	Present knowledge and skills
iii) Where do I want to get to:	Learning aims and objectives
iv) How am I going to get there:	Resource implications
v) How will I know that I have arrived:	Assessment scheme

b) Changes/ differences between school etc and University study (ie "reading for a degree in ..."):

3) Resources available to aid learning:
a) "Organising your Studies";
b) "Making Learning Tools";
c) "Lectures (How best to handle them)";
d) "Tutorials (Getting the most from them)";
e) Computer packages (eg CALM & CALMAT);
f) Videos (eg Accounting, Maths, etc);

4) Reasons for carrying out feedback (*'Progress Evaluation'*):
a) Part of Quality Assurance and Continuous Quality Improvement;
b) Student developmental aspects;

6) Benefits to students of Progress Evaluation:
a) Greater participation in education process;
b) Focus on the students strengths and weaknesses;

7) What is expected of students (participation in process):
a) The learning logbook;
b) Questionnaires - module level,
- course level;

c) Review Meetings;

8) What is expected of staff (reporting back to students);

9) How the resulting information is fed through 'the system';

10) Common problems encountered by UG students in M & ES.

11) Timetable of Progress Evalaution events
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Department of Manufacturing and Engineering Systems
Brunel University

Document #2
Guide to *Learning Logs*

Introduction

One of the objectives of a University is to develop a capacity in you (as a student) to go on learning through life (for example, the concept of *Continuing Professional Development*). This, therefore, involves not only 'learning' the subject matter of your degree, but also 'learning-to-learn'. It is this ability and skill that will prove most useful to you when you embark on your industrial training and when you graduate, ie your ability to adapt to new situations quickly.

The Learning Log

One of the functions of the M & ES Departmental Undergraduate Feedback Procedure is to not only get you to provide information on the modules (ie the lectures, seminars, labs, organisation, etc) that you undertake, but also to get you to think on how you went about learning the module content (a copy has been sent to you via e-mail, and will shortly be available on the electronic notice board 'gopher'). **What you need to develop is a systematic approach to recording your experiences on the modules you undertake.** This information should not just focus on the teaching staff, but rather it should also focus on your own effort and approach to the module.

To this end we would advise that you use the attached 'learning log' sheets. The learning log is a means of an individual tracking their own development. By writing up learning experiences, the likelihood of doing things better in the future is increased (ie your learning becomes less haphazard and a more conscious and learner-centred process). This clarification of objectives and reflection of activities should raise the quality of learning, ie

Purpose ---> Strategy ---> Outcome ---> Review

The objectives for each module you study can be found in the *"M & ES Scheme of Studies"*, a copy of which is held on the computer network on the 'gopher' electronic noticeboard .

The sheets should be attached to your log book (though the format is be no means prescriptive - what is important is that you record your approach to and progress on the modules you undertake). Those aiming for CEng should get into the habit now of routinely undertaking such exercises. You should also get into the habit of methodically keeping a log book (this is not the same as your lab book!), as you will have to do this for your industrial placement. **You should fill in 1 sheet per module per Semester.**

To access and save 'gopher' - after you have logged in (ie at the 'H:\' prompt) type **'use gopher'** then **'pcgopher'**. Then select (1) 'Faculty of Technology', (2) 'M & ES', (3) 'Scheme of Studies', (4) either 'BME' or 'SEP', and (5) the level that you are studying. These can be saved to disk by following the instructions.

To access and save 'e-mail' - after you have logged in (ie at the 'H:\' prompt) type **'nfsmail'**. Once you have re-entered your password, you are in your mailbox. Press the 'F9' key to get the menus (the '↓' key moves you down each menu, and the '→' moves you along the menus). The first menu is the one we want. The '+' and '-' keys allow you to move backwards and forwards between mail items. To save as a 'DOS text file' (that can be retrieved by *Word Perfect*) press the 'W' (for Write) key. Then enter the filename you want to save the mail item as (remember to put the disk drive letter first , eg A:\bmelvl1). Once you have exited your mailbox (by pressing the 'Esc' key), you can retrieve the document in *Wordperfect* and print it out on the line printers (for free!) in the Computer Centre (these printers should be prefixed by 'lp').

When filling in the formal feedback questionnaires (weeks 6-7), you should consult the log and use it to provide CONSTRUCTIVE feedback. Your personal tutor should discuss your progress on the course, and the log will provide a useful framework for this.

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Department of Manufacturing and Engineering Systems
Brunel University

Document #3
Student 'Learning Log' ***pro forma***

Module title: ....

Date: .... **You should consult your 'Scheme of Studies'**

Objectives of module (ie learning goals):

Methods/ resources by which objectives will be met:

Methods/ resources actually used:

How successful were these methods in light of the objectives:

How would you change the way you went about fulfilling the objectives:

Please attach to log book.

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Department of Manufacturing and Engineering Systems, Brunel University **Document #4**

Level___ Semester___

Module Title: .... **Lecturer:** ....

Name (optional): ....

Course: BME/ SEE/ SEP **With: Management/ Languages**

Objective:

As part of its Continuous Quality Improvement Process, the Department wishes to ask your views on the modules you have taken. Please, therefore, complete this questionnaire and give it in at the end of this lecture/ exam. The resulting information will be used to improve future runs of this and other modules.

Instructions:

Please indicate the most appropriate choice for each statement, depending on how strongly you agree or disagree with it. All information will be treated in the strictest confidence. The following rating scale is to be used:

Strongly Agree	1	2	3	4	5	6	Strongly Disagree

or

'n.a.' if you feel the question does not apply or you have no opinion on this particular area.

1) I have learnt a great deal from this module		(1)
2) I have a great deal of interest in the module subject area		(2)
3) I find the module subject difficult to understand		(3)
4) The lectures have helped my understanding of the subject matter		(4)
5) I have put a great deal of effort in to this module		(5)
6) The objectives of the module were clear		(6)
7) The module materials were well prepared		(7)
8) The lecturers explanations were clear		(8)
9) Feedback on assignments was constructive and valuable		(9)
10) The lecture notes, assignments and recommended readings were useful		(10)
11) The lecturer was available outside of lecture time to give help and advice		(11)
12) My attendance at the lectures on this module was high		(12)
13) The lab materials were well prepared		(13)
14) The lab enhanced understanding of the lecture material		(14)
15) The tutorial materials were well prepared		(15)
16) The tutorials enhanced understanding of the lecture material		(16)

Please use the space overleaf to answer the following questions:

17) If you did not consistently attend these lectures, why? How did you cover the subject matter?
18) What 2 features of the module have you found most useful and interesting.
19) What 2 changes would you like to see made on this module.
20) Do you have any other comments? (please use other side of sheet)

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Department of Manufacturing and Engineering Systems, Brunel University **Document #5**

Course:.. **Level:........** **Course Management Level**

Please spend a few minutes filling in the following questionnaire.

Name (optional):..

A) **Personal Tutor Support** Name of Tutor:..

1) a) How many times per term did you meet with your tutor: ________times

b) Was this adequate: Yes/No

2) How useful were these meetings:

Very Useful 1 2 3 4 5 6 7 Not At All Useful

3) How could they be improved?

4) Did personal tutors actively support work placement activities (ie, checking of CV, etc): Yes/No

5) Did you actively seek help and advice from your personal tutor: Yes/No

B) **Course Handbook**

6) How useful was the M & ES handbook:

Very Useful 1 2 3 4 5 6 7 Not At All Useful

7) What additional information would you like:

C) **Support/ Administration**

8) How helpful was the service provided by the Undergraduate Office:

Very Helpful 1 2 3 4 5 6 7 Not At All Helpful

9) How could the service be improved:

D) Communal Facilities

10) How often did you use the student common room during the term (please tick one only):

a)Every Day____ b)Every Other Day___ c)Twice a Week___ d)Once a Week___
e)Once a Fortnight___ f)Once a Month___ g)Once a Term___ h)Never___

11) How could the common room facility be improved so you would use it more:

E) Electronic Information Systems

12) How often do you log on to the computer network (please tick one only):

a)Every Day____ b)Every Other Day___ c)Twice a Week___ d)Once a Week___
e)Once a Fortnight___ f)Once a Month___ g)Once a Term___ h)Never___

13) Would you accept memos/information sent via electronic mail rather than via pigeon holes Yes/No

F) Course Overview

14) Write 3 positive things about the course:

a)

b)

c)

15) Write 3 things about the course that need improving the most:

a)

b)

c)

16) Any Other Comments:

18 May 1994

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Department of Manufacturing and Engineering Systems
Brunel University

Document #6
Analysis and Reporting

Module:
Level:
Response Rate:
Feedback Mechanism:

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module		
Student interest in module subject		
Module subject difficulty		
Lecture usefulness		
Student effort on module		
Clarity of module objectives		
Preparation of module materials		
Clarity of lecturer explanations		
Constructiveness of Feedback		
Usefulness of recommended readings		
Lecturer availability		
Student attendance at lectures		
Preparation of lab material		
Usefulness of labs		
Preparation of tutorial materials		
Usefulness of tutorials		

Comments on your module:

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Memorandum

To: M & ES staff teaching on undergraduate degree programmes

From: Simon Chalkley, ext 2940

Re: Undergraduate student feedback, Semester 1

Date: 6 December 1994

Please find attached the feedback analysis from the forms you distributed earlier in the Semester. In general, any rating of between 1 and 3 is for the 'module average' is good, and any 'module standard deviation' of 1 or below is representative of the group that the questionnaire was administered to.

I would be grateful if you could:

a) fill in and return the 'staff feedback' form (attached); and

b) spend 5 minutes at the beginning/end of a lecture/seminar/tutorial showing a summary of the analysis findings and explaining to students what remedial action (if any) you propose to take. One overhead transparency would suffice.

If the process is to be meaningful, it is important that you take the time to respond to students feedback in this manner. By closing the 'feedback loop' you will demonstrate to students that:

a) the time and effort they put in to the feedback process is worth it; and

b) that their views and experiences are taken seriously.

<u>By doing this students will be more willing to participate in future runs of the process.</u>

Regards

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Department of Manufacturing and Engineering Systems **Document #7**
Brunel University **Staff feedback form**

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: ....

Module Taught: ....

Comments on your student ratings/module comments:

Any proposed action you will take in light of the feedback:

Comments on the actual feedback mechanism:

Any questions/areas you would like the feedback mechanism to cover:

(Please use additional sheets if necessary)
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Timetable for M & ES Departmental Undergraduate Student Feedback (Semester 2 1995)

Week	Action	Purpose	Responsibility	Document
3	Informal feedback meeting #1 with whole of year/level. Year Tutor will feed relevant feedback to Module Teaching Staff and Course Convenors (ie 1 page summary).	To discuss course and modules in general terms.	**Year Tutors** (SC will be available if required).	1 page summary to Course Convenor.
6	Formal Module level Student Questionnaire to be distributed and collected during lecture. Forms available in Communications Room. **Forms passed on to SC for analysis.**	Identify specific areas of good practice or improvement.	**Module Teaching Staff**	Student Questionnaire.
7	Return summary of information from student questionnaires to relevant Teaching Staff and Year Tutors.	Provide information that can be used as part of continuous improvement.	**Research Student** (SC)	Analysis and Reporting *pro forma*.
8	Communicate information on any action to be taken/not taken to students (verbally or via e-mail) and Year Tutor (using *pro forma* - copy to SC please).	To close the 'feedback loop' by keeping students and Year Tutors informed.	**Module Teaching Staff**	Staff Feedback *pro forma*.
12	Informal feedback meeting #2 with whole of year/level. Year Tutor will feed relevant feedback to Module Teaching Staff and Course Convenors (ie 1 page summary).	To discuss Modules in light of the questionn-aire information and the action taken by Staff.	**Year Tutors** (SC will be available if required)	1 page summary to Course Convenor.
15	Review of Undergraduate Student Feedback Procedure. To be carried out by Course convenors of SEP, SEE and BME (Specific date and time to be agreed). NOTE: ***This activity may be moved to week 37 (ie after Course Management Questionnaire).***	To maintain the policy of Continuous Quality Improvement.	**Course Convenors & Research Student** (SC)	Report to Departmental meeting
16	Formal Course Management level Questionnaire distributed during exams. Forms available in Communications Room. **Forms passed on to SC for analysis.**	To gain an overall picture of the course and its management.	**Year Tutors & Research Student** (SC)	Course Questionnaire
17	Return summary of information from Course Questionnaires to Year Tutors & Course Convenors.	Identify specific Course strengths & weaknesses.	**Research Student** (SC)	2 page Summary

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Appendix H

Outline of Introductory Presentation to First Year Students in the Department (1994)

Manufacturing and Engineering Systems
Brunel University **Outline of Introductory Week Presentation**

---

1) Objectives:
  a) Mission Statement;
  b) Development of Gradaute Engineers;

2) "Forward thinking - why are you at College?":
  a) Increase students focus on themselves and their own learning styles: ie,

i) Where have I been;	Relevant prior learning
ii) Where am I now;	Present knowledge and skills
iii) Where do I want to get to:	Learning aims and objectives
iv) How am I going to get there:	Resource implications
v) How will I know that I have arrived:	Assessment scheme

  b) Changes/ differences between school etc and University study (ie "reading for a degree in ..."):

3) Resources available to aid learning:
  a) "Organising your Studies";
  b) "Making Learning Tools";
  c) "Lectures (How best to handle them)";
  d) "Tutorials (Getting the most from them)";
  e) Computer packages (eg CALM & CALMAT);
  f) Videos (eg Accounting, Maths, etc);

4) Reasons for carrying out feedback (*'Progress Evaluation'*):
  a) Part of Quality Assurance and Continuous Quality Improvement;
  b) Student developmental aspects;

6) Benefits to students of Progress Evaluation:
  a) Greater participation in education process;
  b) Focus on the students strengths and weaknesses;

7) What is expected of students (participation in process):
  a) The learning logbook;
  b) Questionnaires - module level,
  - course level;

  c) Review Meetings;

8) What is expected of staff (reporting back to students);

9) How the resulting information is fed through 'the system';

10) Common problems encountered by UG students in M & ES.

11) Timetable of Progress Evalaution events
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Appendix I

Outline Document for First Year Student Learning logs

Department of Manufacturing and Engineering Systems
Brunel University

Guide to *Learning Logs*

Introduction

One of the objectives of a University is to develop a capacity in you (as a student) to go on learning through life (for example, the concept of *Continuing Professional Development*). This, therefore, involves not only 'learning' the subject matter of your degree, but also 'learning-to-learn'. It is this ability and skill that will prove most useful to you when you embark on your industrial training and when you graduate, ie your ability to adapt to new situations quickly.

The Learning Log

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Purpose ---> Strategy ---> Outcome ---> Review

The objectives for each module you study can be found in the *"M & ES Scheme of Studies"*, a copy of which is held on the computer network on the 'gopher' electronic noticeboard .

The sheets should be attached to your log book (though the format is be no means prescriptive - what is important is that you record your approach to and progress on the modules you undertake). Those aiming for CEng should get into the habit now of routinely undertaking such exercises. You should also get into the habit of methodically keeping a log book (this is not the same as your lab book!), as you will have to do this for your industrial placement. **You should fill in 1 sheet per module per Semester.**

To access and save 'gopher' - after you have logged in (ie at the 'H:\' prompt) type **'use gopher'** then **'pcgopher'**. Then select (1) 'Faculty of Technology', (2) 'M & ES', (3) 'Scheme of Studies', (4) either 'BME' or 'SEP', and (5) the level that you are studying. These can be saved to disk by following the instructions.

To access and save 'e-mail' - after you have logged in (ie at the 'H:\' prompt) type **'nfsmail'**. Once you have re-entered your password, you are in your mailbox. Press the 'F9' key to get the menus (the '↓' key moves you down each menu, and the '→' moves you along the menus). The first menu is the one we want. The '+' and '-' keys allow you to move backwards and forwards between mail items. To save as a 'DOS text file' (that can be retrieved by *Word Perfect*) press the 'W' (for Write) key. Then enter the filename you want to save the mail item as (remember to put the disk drive letter first , eg A:\bmelvl1). Once you have exited your mailbox (by pressing the 'Esc' key), you can retrieve the document in *Wordperfect* and print it out on the line printers (for free!) in the Computer Centre (these printers should be prefixed by 'lp').

When filling in the formal feedback questionnaires (weeks 6-7), you should consult the log and use it to provide **CONSTRUCTIVE** feedback. Your personal tutor should discuss your progress on the course, and the log will provide a useful framework for this.

Any queries or comments , please don't hesitate to contact me. My telephone extension is 2940 and my e-mail address is **Simon.Chalkley@brunel.ac.uk**.

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Department of Manufacturing and Engineering Systems
Brunel University

Student 'Learning Log' ***pro forma***

Module title: ....

Date: ....

Objectives of module (ie learning goals):

Methods/ resources by which objectives will be met:

Methods/ resources actually used:

How successful were these methods in light of the objectives:

How would you change the way you went about fulfilling the objectives:

Please attach to log book.

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Appendix J

Examples of Student/Year Tutor Discussion Meeting Summary Sheets

Minutes of SEE Level 2 Review Meeting, Spring Semester 1995
held on Tuesday, 28 February 1995 at 12.00 in Room TA308

Present: [redacted]

The meeting began with an introduction to the review process, and its importance in maintaining effective levels of feedback and ensuring the quality of courses delivered. The following points are a summary of feelings expressed by students:

1. Level 2 in General

- The loading on the students seems to be greater than usual.

- Assignments are not spread out and due to increased number of contact hours, students do not have sufficient time for course work.

- Possibility of rescheduling course work and spreading it more evenly through the semester period should be explored with relevant lecturers.

  (Action PA)

- The ratio of Marks to effort on continuous assessment of some modules is not pitched at the right level. In particular, MN216S, Energy Com. and Conversion where the reports only carry 20% of total mark. A better ratio would be helpful.

- Final year options available are not as yet clear and with the view of meeting the 31 March 1995, it would be useful to arrange a meeting with Level 3 tutor as soon as possible.

  (Action IF)

- Students expressed concern over reports in Le Nurb that SEP & BME students only undertook eleven modules in Level 3. It was felt that this was unfair in comparison with 12 modules for SEE. Level 2 tutor to explore this point further.

  (Action PA)

- Some students felt that the direction of some of the lecture materials was unclear and seemed irrelevant to the course. An example of this was the Electronic Design Task in Environmental Engineering Design. Lecturers to be asked to outline the relevance of taught material to the SEE course.

- There is a feeling by some students that the course as a whole does not contain sufficient design elements. Others however, felt that this could be supplemented through right choice of options in the final year.

2. Particular Modules

These were discussed with students and level tutor will raise the relevant points of feedback with lecturers concerned.

Payman Adl
28.2.95

Minutes of SEE Year 1 Student Feedback/Course Review Meeting

Present: [redacted]

To: [redacted]
cc: Simon Chalkley
Date: 23 February, 1995
From: [redacted]

SEE year 1 student feedback meeting was held on Thursday the 23 Feb. 1995. Unfortunately, most students were not able to turn up because they went to an extra tutorial session on Maths. Issues discussed during the meeting are summarised here.

1. In general, the teaching in the first few weeks of Spring Semester has been fine for all modules. Particularly, it is felt that the pace of teaching is much more appropriate than Semester 1. Lecturers teaching analytic subjects explain clearly which helps the understanding. There is little complain about the work load.

2. General feelings towards individual modules are

> Env. Eng. Design & Practice: Students have to do a lot of private study to catch up the teaching. It was felt that too much materials were covered in the first few weeks (compared with design module in Semester 1). Time allowed for assignments is a bit tight.
>
> Materials: Students enjoyed the leactures. Good handouts and lecturing.
>
> Computing: Students have had a couple of lectures but still haven't had any chance to practice (the first lab will be next Monday). It was felt that teaching computing without computers does not help the understanding - It would be nice if they can have some hand-on experience on computer and programming during earlier stage.
>
> EEP II: There are some curiosity and confusion about why lecturing philosophy. They liked EEP in the Semester 1 more than the current EEP II.
>
> Dyn. & Thermo: Good lectures. Most students found the module (particularly, thermodynamics) difficult. Tutorial groups are smaller (than Semester 1), which do help. Some complaints about having Dyn. lectures on Friday afternoon (3:00-4:00 pm).
>
> Maths: New materials are now taught (not covered in A-level maths), no specific problems were reported.

3. Some SEE 1 students couldn't believe they have done so bad in the exams of Semester (for example, Maths). It is a bit worrying if they really don't know what needs to be rectified in these modules.

4. ZH encouraged students to work hard and to maintain their high motivation. ZH felt that SEE 1 students will need some extra help on all analytical subjects from lecturing staff.

Appendix K

Examples of Student Feedback Summary Sheets
sent to Staff and Staff Responses

Brunel University

Department of Manufacturing & Engineering Systems

Examples of Undergraduate Student Feedback Questionnaire Analysis (by Course and Level)

Semester 1
1994-95

Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: Dr [redacted] - Process Engineering (SEE)
Level: SEE Level 2
Response Rate: 10 forms (91%)
Feedback Mechanism: Questionnaire distributed and collected during lecture

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	3.11	0.74
Student interest in module subject	3.20	0.98
Module subject difficulty	2.30	1.00
Lecture usefulness	2.80	0.87
Student effort on module	3.05	0.65
Clarity of module objectives	3.40	0.92
Preparation of module materials	2.85	1.10
Clarity of lecturer explanations	2.80	0.87
Constructiveness of Feedback	4.00	1.41
Usefulness of recommended readings	3.30	1.10
Lecturer availability	2.00	0.76
Student attendance at lectures	1.44	0.50
Preparation of lab material	na	na
Usefulness of labs	na	na
Preparation of tutorial materials	na	na
Usefulness of tutorials	na	na

Comments on your module:

What 2 features of the module have you found most useful and interesting?
- good assignments on unit operations
- good to have a difficult theory lecture in a small group (ie not 100 plus students)

What 2 changes would you like to see made to this module?
- labs & more time
- more examples are required to give structure to the course, and enable better understanding

Do you have any other comments?
- I find it hard to see how the theory covered fitted in to the rest of the course

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Department of Manufacturing and Engineering Systems
Brunel University

Staff feedback form

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: Dr [redacted]

Module Taught: Process Engineering (SEE)

Comments on your student ratings/module comments:

The module average is good; the discrepancy in the constructiveness of feedback is due to the lack of assessed work before the questionnaire. The module objectives are not clearly defined in the scheme of studies

Any proposed action you will take in light of the feedback:

Carry on with the assignments in specific unit operations. Prepare examples-sheets to account for the limited time available

Comments on the actual feedback mechanism:

It produce 'easy to read' figures

Any questions/areas you would like the feedback mechanism to cover:

(Please use additional sheets if necessary) ?

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Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: Dr [redacted] - Environmental Engineering Design and Practice (SEE) MN111A
Level: SEE Level 1
Response Rate: 10 forms (56%)
Feedback Mechanism: Questionnaire distributed and collected during lecture.

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	2.20	0.75
Student interest in module subject	2.30	1.00
Module subject difficulty	4.75	0.75
Lecture usefulness	2.44	0.83
Student effort on module	2.70	0.90
Clarity of module objectives	1.50	0.50
Preparation of module materials	1.67	0.47
Clarity of lecturer explanations	1.70	0.64
Constructiveness of Feedback	2.83	1.46
Usefulness of recommended readings	2.00	0.82
Lecturer availability	2.56	0.96
Student attendance at lectures	1.40	0.92
Preparation of lab material	1.50	0.50
Usefulness of labs	1.60	0.49
Preparation of tutorial materials	na	na
Usefulness of tutorials	na	na

Comments on your module:

Please see separate sheet.

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Dr [redacted] - Environmental Engineering Design & Practice

SEE (Level 1)

What 2 features of the module have you found most useful and interesting?
- emphasis on group work and communication
- the fact that it covers many areas of manufacturing
- discussions with Brian
- freedom to choose own subject topic
- the chance to work in a group
- the fact that I obtained a greater understanding of manufacturing processes
- develops teamwork
- the project is a superb idea
- the project relies heavily on experiential learning, which is a good idea
- the freedom to choose our own object to study

What 2 changes would you like to see made to this module?
- less emphasis on the interim report
- more lab time please
- more feedback on the original work plan handed in
- more guidance on material study please (as we have not done much on materials)
- more labs
- more feedback on work plans and progress report

Do you have any other comments?
-more help for students please

Department of Manufacturing and Engineering Systems
Brunel University

Staff feedback form

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: [redacted]

Module Taught: SEF (Product Study)

Comments on your student ratings/module comments:

No real comments needed by me - all seems OK

Any proposed action you will take in light of the feedback:

If they all turned up we could continuously give feedback & do. This is one of the traps you'll fall into by only concentrating on those who fill in forms with an axe to grind! (only 5 forms back out of 20 !!!!)

Comments on the actual feedback mechanism:

No more lab time is available.

Any questions/areas you would like the feedback mechanism to cover:

(Please use additional sheets if necessary)
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Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: Dr [redacted] - Engineering Design (BME and SEE) MN101A
Level: SEE Level 1
Response Rate: 5 forms
Feedback Mechanism: Questionnaire distributed and collected during lecture.

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	2.80	0.75
Student interest in module subject	2.00	0.63
Module subject difficulty	4.20	0.98
Lecture usefulness	3.80	1.36
Student effort on module	2.40	0.49
Clarity of module objectives	1.70	0.40
Preparation of module materials	1.80	0.75
Clarity of lecturer explanations	2.50	0.89
Constructiveness of Feedback	3.00	0.00
Usefulness of recommended readings	2.00	0.71
Lecturer availability	2.25	1.25
Student attendance at lectures	1.20	0.40
Preparation of lab material	2.00	0.89
Usefulness of labs	2.67	0.94
Preparation of tutorial materials	2.67	1.25
Usefulness of tutorials	3.83	0.85

Comments on your module:

Please see separate sheet.

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Dr [redacted] - Engineering Design

SEE (Level 1)

What 2 features of the module have you found most useful and interesting?
- the project was hard but I enjoyed the challenge
- lecturer very helpful with regards to timetabling problems
- nothing needs changing

What 2 changes would you like to see made to this module?
- more time devoted to a 'practical lecture' on the use of drawing
- a beginners lesson on how to draw
- a timetabled slot each week for the set drawings where a member of staff is available to help
- more practical instruction on drawing

Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: Dr [redacted] - Engineering Design (BME and SEE) MN101A
Level: BME Level 1
Response Rate: 5 forms
Feedback Mechanism: Questionnaire distributed and collected during lecture.

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	4.00	1.26
Student interest in module subject	3.00	1.26
Module subject difficulty	3.60	1.50
Lecture usefulness	3.40	2.15
Student effort on module	3.00	1.10
Clarity of module objectives	3.00	1.26
Preparation of module materials	2.40	1.02
Clarity of lecturer explanations	3.40	1.62
Constructiveness of Feedback	3.00	0.00
Usefulness of recommended readings	4.20	1.60
Lecturer availability	2.00	1.00
Student attendance at lectures	1.40	0.49
Preparation of lab material	2.00	0.00
Usefulness of labs	2.50	0.50
Preparation of tutorial materials	3.00	0.00
Usefulness of tutorials	3.00	0.00

Comments on your module:

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Dr [redacted] - Engineering Design

BME (Level 1)

What 2 features of the module have you found most useful and interesting?
- the labs and the actual drawing

What 2 changes would you like to see made to this module?
- more teaching, as I've had no previous engineering drawing experience

Do you have any other comments?
- more lectures on designing (2 or 3 wasn't enough)
- the project requires a sound knowledge of geometrical drawing which most of us don't have yet. The 2 or 3 lectures we had did not really solve the problem
- the introduction to drawing was very brief. Please can we have a more detailed introduction.

Department of Manufacturing and Engineering Systems
Brunel University

Staff feedback form

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: [redacted]

Module Taught: Design & Drawing

Comments on your student ratings/module comments:

The 'design' & 'drawing' parts need separating with respect to assessment. I know about their bad comments re drawn & even anticipated them. This was because I had to arrange meetings (research, out Univ, in Univ etc etc) & had to cancel/rearrange miss etc. The students didn't miss out on lectures but certainly did on drawing office seminars & tutorials. Their com. are entirely justified but there was nothing I could do with all other commitments. I've discussed the problem with several & assured them th.
a) next yr the structure is changed & it shouldn't occur again in such a compressed way
b) timetabling should be known ages before
The 'design project' is the ball sorter & is continuing OK. Some problems but mainly due to studs non delivery.

Any proposed action you will take in light of the feedback:

None - see above.

Comments on the actual feedback mechanism:

Separate ~~[illegible]~~ 'drawing' & design' (project)

Any questions/areas you would like the feedback mechanism to cover:

Require feedback - there's 45~50 in the group & 5 back is totally insufficient.

(Please use additional sheets if necessary)
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Department of Manufacturing and Engineering Systems **Analysis and Reporting**
Brunel University

Module: Dr [redacted] - Thermodynamics (SEP and SEE) MN222A
Level: SEP Year 3 (& a few SEP Level 2)
Response Rate: 23 forms (59%)
Feedback Mechanism: Questionnaire distributed and collected during lecture

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	2.61	0.64
Student interest in module subject	3.57	0.97
Module subject difficulty	2.35	1.05
Lecture usefulness	2.13	0.99
Student effort on module	3.13	1.03
Clarity of module objectives	3.09	1.25
Preparation of module materials	1.61	0.71
Clarity of lecturer explanations	2.67	1.08
Constructiveness of Feedback	na	na
Usefulness of recommended readings	2.00	0.66
Lecturer availability	1.46	0.63
Student attendance at lectures	1.35	0.70
Preparation of lab material	2.17	0.69
Usefulness of labs	1.83	0.83
Preparation of tutorial materials	2.23	0.67
Usefulness of tutorials	2.36	1.02

Comments on your module:

Please see separate sheet.

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Dr [redacted] - Thermodynamics

SEP Year 3 (& a few Year 2)

What 2 features of the module have you found most useful and interesting?
- tutorials and practice questions
- tutorials related theory to questions well
- liked heat transfer and reacting mixtures
- heat transfer through solids
- chemical heat exchanges
- exhaust gas analysis
- very competent lecturer
- structuring of sections was very useful (ie 1.1, 1.1.1, etc)
- excellent notes (more of them please!)

What 2 changes would you like to see made to this module?
- clearer tutorials
- none, its fine
- often were trying to write things down from the board whilst the lecturer was explaining things (ie missed what he was saying). Therefore, more printed notes would be helpful (also more detailed notes).
- much of the material was covered too quickly (ie should concentrate on the fundamentals)
- more examples relating to real life engineering situations (ie not so academic)
- overhead transparencies were often too small
- give time to copy notes from board/OHP before discussing them
- could increase understanding if lecturer could summarise a topic/explain key areas before the indepth lecturing on the subject (eg give out a summary sheet that would allow students to see a brief description of the goals of teaching).
- have an introduction/ overview of the course at the beginning
- have continuous assessment
- course was a bit rushed so examples weren't always fully explained
- lecture speed was too fast

Do you have any other comments?
- Course was covered too quickly given its complexity
- lecturers notes made topic more understandable
- have covered most of the syllabus before (ie physics A-level)
- module is a little disjointed (ie more a collection of facts, not a coherent body of thought)

Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: Dr [redacted]- Thermodynamics (SEP and SEE)
Level: SEE Level 2
Response Rate: 7 forms (64%)
Feedback Mechanism: Questionnaire distributed and collected during lecture

MN223A

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	3.00	0.53
Student interest in module subject	2.64	0.58
Module subject difficulty	2.29	0.70
Lecture usefulness	3.14	0.83
Student effort on module	2.86	0.64
Clarity of module objectives	3.86	0.64
Preparation of module materials	2.71	1.03
Clarity of lecturer explanations	3.64	0.44
Constructiveness of Feedback	na	na
Usefulness of recommended readings	2.64	0.44
Lecturer availability	2.60	1.20
Student attendance at lectures	1.14	0.35
Preparation of lab material	3.00	0.00
Usefulness of labs	na	na
Preparation of tutorial materials	2.29	0.70
Usefulness of tutorials	2.57	1.05

Comments on your module:

Please see separate sheet.

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Dr [redacted] - Thermodynamics

SEE Level 2

What 2 features of the module have you found most useful and interesting?
- Good course overall
- Appreciated supply of worked solutions to tutorial questions
- liked combustion chamber/ exhaust gas analysis
- liked reacting gas mixtures

What 2 changes would you like to see made to this module?
- More examples/ application of theory
- More practicals
- Make clear in lectures which formulae are important
- Labs should be at the same time (*I think they mean the same week - STC*) as lectures (thereby increasing understanding)
- Did not understand 'heat transfer' part of course
- Should be run alongside 'Process Engineering'
- More worked solutions to tutorials
- clear identification of important derived formulae
- Need more time to explain the contents of the module/ felt that the material was rushed

Department of Manufacturing and Engineering Systems
Brunel University

Staff feedback form

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: [redacted]

Module Taught: Level 2 Thermodynamics + Final year I.C. Engines

Comments on your student ratings/module comments:

The ratings are generally realistic and ~~p~~ representative.

The reason for not giving sufficient handout is due to the cost of photocopy.

Any proposed action you will take in light of the feedback:

Regarding to the handout, the problem is common for most lecturers. There should be a departmental policy for this. It does increase the load for all the lecturers if the photoc cost has to be collected individually by the lecturer involved.

Comments on the actual feedback mechanism:

Very useful

Any questions/areas you would like the feedback mechanism to cover:

(Please use additional sheets if necessary)
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Department of Manufacturing and Engineering Systems
Brunel University

Analysis and Reporting

Module: D[redacted] - Electrical Engineering Principles (BME and BEST)
Level: BEST Level 1
Response Rate: 28 forms
Feedback Mechanism: Questionnaire distributed and collected during lecture.

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	2.80	1.11
Student interest in module subject	3.06	1.34
Module subject difficulty	3.18	1.20
Lecture usefulness	2.45	0.79
Student effort on module	3.18	0.93
Clarity of module objectives	3.30	1.19
Preparation of module materials	2.05	0.85
Clarity of lecturer explanations	1.88	0.70
Constructiveness of Feedback	3.37	1.34
Usefulness of recommended readings	2.18	1.00
Lecturer availability	2.05	0.92
Student attendance at lectures	1.64	0.97
Preparation of lab material	2.50	1.15
Usefulness of labs	2.39	1.11
Preparation of tutorial materials	3.02	0.95
Usefulness of tutorials	2.71	1.28

Comments on your module:

Please see separate sheet.

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[redacted] - Electrical Engineering

BEST (Level 1)

If you did not consistently attend these lectures, why? How did you cover the subject matter?
- covered most of the material before
- read around the subject and do the tutorial sheets
- miss lectures because of timetabling (ie only one in the morning)

What 2 features of the module have you found most useful and interesting?
- lab sessions back up lecture material well
- labs are very helpful
- practicals are very useful in improving understanding
- good style of lecturing
- being able to ask Chris questions without being put down
- good lecturing and notes
- the lab work and the excellent attitude of the lecturer

What 2 changes would you like to see made to this module?
- more examples done during the lecture
- have a tutorial sheet assessment half way through the semester to see if we have learnt anything
- make lecture notes available before the lecture
- labs write ups are tedious
- compulsory tutorial questions each week to get students working
- subject material is dull
- Chris should be available for seminars
- give out notes before the lecture
- lecture notes should not be given out as a reward for attending lectures
- tutorials are very confusing
- less theory and maths
- more help in labs
- more examples and more help in labs
- slow down the pace of lectures
- please give out a syllabus for the module

Do you have any other comments?
- teaching staff are very approachable
- style of lecturing is very easy to follow
- don't need to change the module at all
- students who turn up late are annoying
- Dick Nimmo's tutorials are very confusing

Department of Manufacturing and Engineering Systems **Analysis and Reporting**
Brunel University

Module: Dr [redacted] - Electrical Engineering Principles (BME and BEST) MN133A
Level: BME Level 1
Response Rate: 26 forms (49%)
Feedback Mechanism: Questionnaire distributed and collected during lecture.

Rating Scale:

High 1 2 3 4 5 6 Low

Factor	Your Module Avg	Your Module Stnd Dev
Amount learnt from module	2.96	1.26
Student interest in module subject	3.08	1.11
Module subject difficulty	2.79	1.23
Lecture usefulness	2.62	1.00
Student effort on module	3.19	1.00
Clarity of module objectives	3.23	1.28
Preparation of module materials	2.81	1.14
Clarity of lecturer explanations	2.46	1.13
Constructiveness of Feedback	3.33	1.15
Usefulness of recommended readings	1.92	0.69
Lecturer availability	2.39	1.15
Student attendance at lectures	1.77	1.31
Preparation of lab material	3.23	1.34
Usefulness of labs	2.81	1.36
Preparation of tutorial materials	3.16	1.60
Usefulness of tutorials	2.50	1.12

<u>**Comments on your module:**</u>

Please see separate sheet.

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[redacted] - Electrical Engineering

BME (Level 1)

If you did not consistently attend these lectures, why? How did you cover the subject matter?
- covered the module content at A-level

What 2 features of the module have you found most useful and interesting?
- pace of lectures is OK
- useful notes and a good, clear lecturer
- labs are good once they get going
- labs were very good

What 2 changes would you like to see made to this module?
- BME haven't got a tutorial for this module
- bad timetabling led to low attendance
- unclear structure and objectives of module
- boring as I've covered this on BTEC (could BTEC have a separate group?)
- make lecture notes available before hand
- prepare lecture notes beforehand
- more tutorials and lab sessions
- give out lecture notes so we can concentrate on understanding and not writing
- lecture notes should not be 2 to 3 weeks late
- more tutorials (i in 2 months is not enough)
- a copy of the syllabus please
- more info on the labs (ie 'how to do them')
- apply more to real life cases
- more seminars
- more direct reference to the text book
- more work sheets and some compulsory questions
- labs seem to be too long (ie can't finish them in time allocated)
- a prep lab on basic lab equipment would be good)ie oscilloscope)
- more tutorials
- course text was a waste of money (ie Smith)

Do you have any other comments?
- labs are poorly organised compare to other modules (eg statics, fluids, etc)
- copies of past exam papers please
- lectures are useful, informative and fun!

MSWT

Do you have any other comments?
- progress on course hindered by no tutorials being available. Chris has been of great help, but it would be good to know how everyone else was coping and what standard they were at (ie need seminars and tutorials).

Department of Manufacturing and Engineering Systems
Brunel University

Staff feedback form

Please return to: Simon Chalkley, Department of Manufacturing and Engineering Systems.

Name: [redacted]

Module Taught: Elec. Eng. Princ. BEST/BMcE 1

Comments on your student ratings/module comments:

Scores indicate general satisfaction although SD especially of BMcE indicates a spread of views. The only problem I can see with taking them too seriously is that only ½ BMcE and BEST attend the lectures! It w. be interesting to find out why the others don't turn up.

Any proposed action you will take in light of the feedback:

* Try to get notes out (overhead copies) in advance of lectures - of course the little darlings don't appreciate that they're only written the night before which makes this difficult!
* I will identify the mass of question that they have had acc to in future as 'tutorial' questions and give out answers more promptly.
* I won't give in to their requests for any 'compulsion' for answering questions - we are still a University!

Comments on the actual feedback mechanism:

Great idea + execution.
I'm all for it - I hope that you can set up a system which is workable by someone after you become Dr Simon!

Any questions/areas you would like the feedback mechanism to cover:

(Please use additional sheets if necessary)
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Appendix L

Paper Presented at the European Society for Engineering Education (SEFI) Annual Conference, September 1995

DEVELOPMENTAL ASPECTS OF STUDENT-BASED QUALITY SYSTEMS IN UNDERGRADUATE MANUFACTURING ENGINEERING HIGHER EDUCATION

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ABSTRACT

It has been argued that current engineering higher education is not producing 'quality' graduates, as they are not equipped for continuing lifelong learning. The reason is seen to lie in the fact that engineering education focuses on learning (the quantitative product) rather than learning-to-learn (the qualitative process). This approach does not support the development of deeper and 'lifelong' learning in engineering students. By focusing education on the developmental aspects of learning, a more effective educational and quality system can result. Such systems work along the lines of 'continuous improvement'. It was found that barriers that exist to such systems are mostly 'culture' dependent. Therefore, attempts to change the culture should be the main focus of an educational quality system.

1 INTRODUCTION

The entrants into engineering degree courses in Britain are reflecting increasingly varying patterns of previous learning. As the demand for engineers increases and the supply falls, educational institutions have to look at non-traditional sources for students. At the same time, there has been increasing criticism [1,7] of the 'quality' of graduate engineers that universities are producing. It has been suggested [7, 11, 15] that a new kind of graduate engineer is now required - one with a broader knowledge base, a team orientation, the versatility and flexibility to adapt to change, and a continuous ability to learn. This change in 'inputs' and 'outputs' has implications for the higher education system (*see figure 1*).

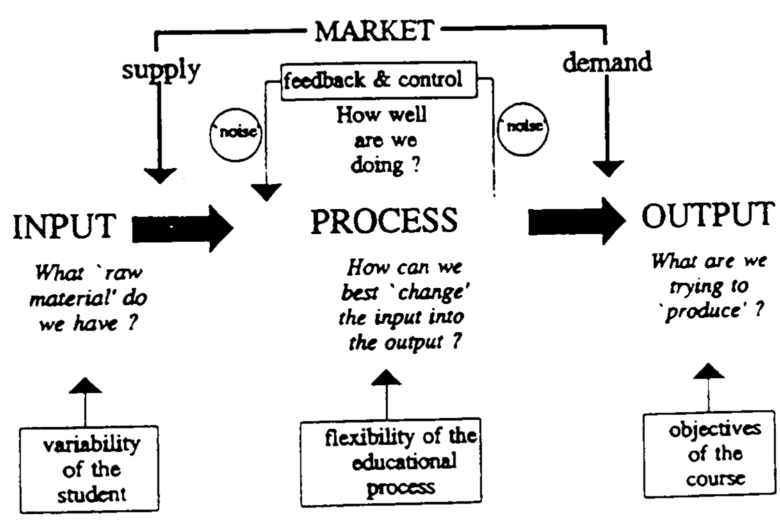

Figure 1: A simple model of a higher education system

Engineering education has been criticised for dealing with only purely technical subjects, with an over-emphasis on factual knowledge, and neglecting such areas as understanding concepts, management, communication, and teamwork, as well as *inter* and *intra* personal abilities [3, 10, 14, 20]. This change in demands has resulted in a rethink as to the purpose of higher education, from *university centred* [1] and *economic centred* [4, 24, 25] models, to *student centred* models [6, 12, 17, 18, 19]. The purpose of these student centred models is to increase the students' capacity to learn in periods of great change Engineering education should, therefore, be as much about 'learning-to-learn' (i.e. the qualitative 'process' of education) as it is about 'learning' (i.e. the quantitative 'product' of education) [3].

How does this learning manifest itself, i.e. how can we use new approaches to learning to develop the required graduate engineers? To promote this 'learning-to-learn' we must give students the opportunity to reflect [8, 16] on what they have done and how they went about it. To do this, it is argued [21] that there is a need to move away from passive, surface learning toward more active, deeper learning. To this end, greater emphasis must be placed on the formative side of education, where the taught curriculum is enhanced by promoting an environment that encourages initiative and independent decision making [22] Engineering educators need to establish ways of facilitating this. Built into this new approach should be a mechanism [3] that ensures that the educational system is transforming the input into the required output, i.e. a quality system. Such student-centred approaches are made more difficult by:-

1) the complexity of the students role in the educational system - are they the customer, consumer, stake-holder, partner, product or participant? [3] The answer to this question has implications for the students' role in quality [9] and learning;

2) the 'fact explosion' in engineering, where the factual content is becoming excessive [21, 26], leading to rote learning and insufficient understanding of fundamental principles. It has been said that engineers only use 15% of the knowledge they learn on their degree course [10]. This 'scientific' approach to engineering [20] has lead to a shortage of creative, skilled engineers [13];

3) the educators (ie lecturers), who have been educated in traditional system, might not be equipped for the required changes in educational delivery. These lecturers often rely on traditional educational methods, involving heavily fact-based lecture courses that encourage a passive, surface approach. As a result students only concentrate their attention on short-term goals (e.g. passing exams). The focus is often on the content of course (i.e. product) rather than the way the content is presented (i.e. the process) Education has traditionally been dominated by such teacher-centred courses, where the learning situation is inactive.

Therefore, the system is required to: (a) encourage and develop these *intra-personal* abilities of 'learning-to-learn' and deep learning (i.e. *educational*) [18, 21], and (b) ensure that what was intended is produced (i.e. *quality*) [3, 5]. Quality systems already established in engineering education range from simple inspection based models (e.g. setting end of year exams that students must pass), to complex continuous improvement models (e.g. encouraging and developing the ability to learn and learning for life) [3]. Based on research, engineering educators must strive towards the latter [18]. According to W. Edwards Deming:-

> *"Cease dependence on mass inspection. Instead build quality in at every step of the process.. Inspection to improve quality is too late, ineffective and costly.... Inspection, scrap, downgrading, and rework are not corrective action on the process".*

Traditionally such educational and quality systems work above, rather than with, the student [3]. By adopting a student-centred approach to teaching and learning, where the *process* of learning is developed, it is possible to develop more effective education [6, 18] and quality systems (where quality is built into every step of the process) [5]. To support the learning process, students should be encouraged to discuss and review the courses they undertake. As they review their learning, a more active, deeper approach to learning is fostered and a move toward a true quality system is developed [3]. The proposed models of deep learning, for example 'Plan-Do-Reflect-Conceptualise' [16] and 'Purpose-Strategy-Outcome-Review' [8], mirror closely the 'Plan-Do-Check-Action' models of quality management [5] (*see figure 2*). The important aspect of these models, as far as this paper is concerned, is the 'reflection/review' stage.

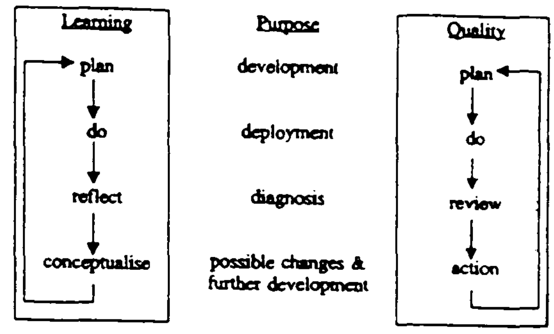

Figure 2: Mapping learning onto quality (adapted from [5] and [16])

2 THE STUDY

2.1 Background

The Department of Manufacturing and Engineering Systems (henceforth called *'the Department'*) is a broad-based, multi-disciplinary department. It was formed in 1986, by the merger of the Department of Production Technology and the Department of Engineering and Management Systems. The Department runs three distinct undergraduate courses: broad-based programmes in Manufacturing Engineering (49 first year students) and Environmental Engineering (18 first year students), and an 'enhanced' Special Engineering Programme (33 first year students). Each undergraduate course has its own identity and objectives. Much of the study was carried out with the students from the Manufacturing Engineering course (henceforth called *'the Manufacturing Course'*), though work was later done with students from the other two courses. The Manufacturing Course is four years in duration, with most students spending around a quarter of that time on industrial placements. Changes have been observed within the Manufacturing Course, for example an increased instances of student 'rework'(*see figure 3*), and a rise in the number of students with vocational qualifications (e.g. Higher National Diploma, Foundation of Engineering, Access, etc.), from 25% of first year intake in 1986, to 51% of first year intake in 1994. There has also been a rise in student numbers, from 35 first year students in 1986, to 49 first year students in 1994.

The Department has always placed an emphasis on some form of student feedback, so as to gain an insight into students' perceptions of the modules and courses they undertake. An earlier feedback system in the Department was based on an end of year questionnaire, with only two questions for each subject/module studied (students were asked to rate 'Course Organisation' and 'Amount Learned on Course'). It gave little insight into why students responded as they did, and what could be done to change this. It also did little to promote the development necessary for student reflection and review. Because of this, it was felt necessary to develop a system that would move from this 'quality audit' mode into a 'quality development

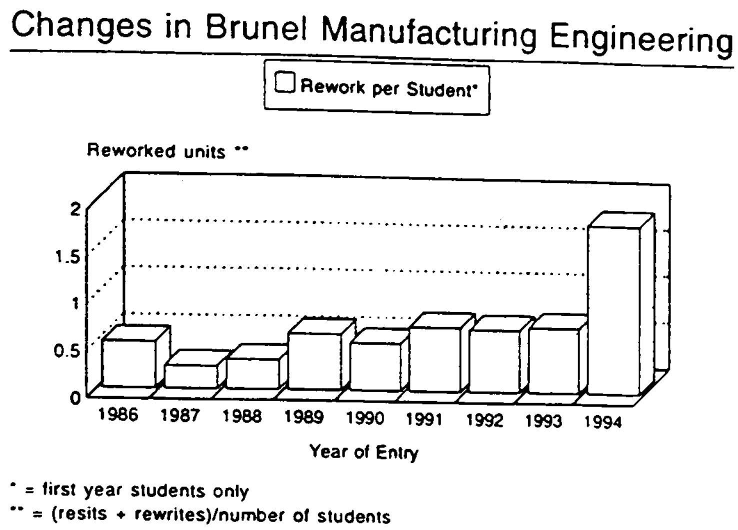

Figure 3: Rework by 1st year students on the Manufacturing Course

and enhancement' mode. To this end, the Department undertook to research, review and formalise its quality system, i.e. collecting, analyzing and responding to student feedback [2].

2.2 From Inspection to Continuous Improvement

A pilot study was carried out in 1992/1993 with third year students (28 in total) on the Manufacturing Course. This initially involved small group interviews, 'brainstorming' sessions, and 'cause and effect' analyses. This helped to define parameters for the proposed quality system, in terms of the type and scope of feedback mechanisms and data collection methods, as well as giving information on the value of such a system. Students felt that the earlier quality system in the Department was not effective as:- (a) the results of such feedback activities were never communicated to them; and (b) the format (ie questionnaire based) did not allow any student involvement or allow students to expand on what they thought (in terms of problem identification, analysis, and solution). Examples of students' criticisms included:-

> *"I fill these (feedback) forms in, but never find out what happens to them"; "Whenever we complain we're told that students make the same complaints every year. Nobody seems to listen to what we say".*

A corresponding meetings was held with lecturing staff, year tutors and course directors, to gather their views on the scope, style and value of such a quality system.

The study experimented with questionnaire delivery and collection methods, including: anonymous questionnaires left in the undergraduate office (around 28% response rate); named questionnaires put in student departmental pigeon holes (around 35% response rate), and questionnaires given out and collected by the lecturer during the lecture (around 70% response rate). However, the student pilot group reported that the questionnaires were only effective if there was a forum for them to discuss the results of such a mechanism. They felt that group meetings between the year tutor and students would fulfil this need.

The final developed feedback system comprised of two parts. *Part (1)* was a mid-semester module questionnaire, consisting of 16 closed and 4 open response questions, which was aimed at gathering a number of 'performance indicators'. *Part (2)* was a discussion session run twice a semester (at the beginning and towards the end). It gathered more detailed information as to the background of part (1). The meetings encouraged students to review and reflect on what they had done on their undergraduate degree courses, (eg what went well?, what did not go so well?, how could it be done better?, how could the students do better?). These normally informal meetings attracted eight to twelve students, with the year tutor acting as a facilitator. Students were able and keen to discuss, consider and analyze the educational experience they had participated in. Results were communicated to relevant staff, and any reaction reported back to students - thereby closing the 'feedback loop'. At each stage, staff and students were also given the opportunity to comment on the actual quality system and how it could be improved. Early on in the research it became clear that the system had to be 'transparent' (i.e. every one could see what was going on and what needed to be done), and that a 'third party' was necessary to participate in the feedback system. Students often colluded with tutors [23] and did not tell them their problems or views, but seemed more inclined to tell an 'independent' party. It also became clear that some staff were unused to, and uncomfortable with, running such sessions.

As the research progressed it became increasingly clear that students found the bi-semester meetings most useful, as they had a chance to discuss and interact with fellow students, year tutors, and the independent party. Indeed, some student groups ran their own feedback meetings, and communicated the minutes back to staff. The focus of the quality system was changed to promoting student learning rather than just checking that students felt that such learning was taking place. The quality system, therefore, aims to take the 'measurements' from the questionnaires and use these to formalise students' and lecturers' thoughts, ideas, etc., for improvement. Through these small feedback loops the learning and quality process can be improved. A well supported quality system can then be used as a vehicle for change, i.e. to get students to be more proactive, to reflect and analyze on what they have done, and to suggest strategies for improvement. What this quality system is trying to do is move from a situation of inspection and control, to one of continuous improvement of quality (*see figure 4*).

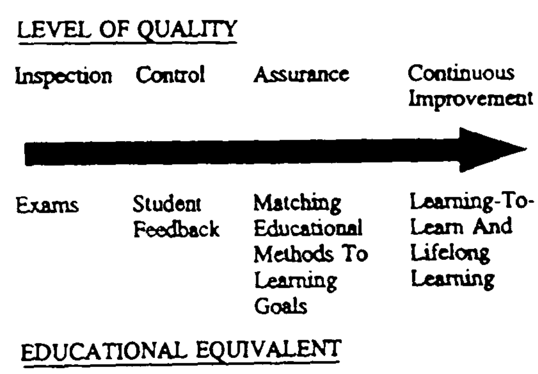

Figure 4: A progression of quality systems in higher education

2.3 The Emphasis on Development

The quality system implemented in the Department aims to encourage a more mature and active approach to learning, and to help students and staff focus on the learners attitudes and the educational process. It developed as a formative rather than summative approach, via a progression of small iterations from the feedback process. The system also aimed to discover how students perceived what they were learning and whether teaching methods were effective. Issues determined included how clear course objectives were, and how clearly was learning material presented. From the quality system it became clear that lecturers were focusing on improvements in the educational product, whereas the students' emphasis was on improvements in the educational process. For example:-

> staff - a meeting to discuss problems with undergraduate engineers mathematical ability might focus wholly on what should be taught rather than the way it was taught;
>
> students - typical comments from students include: *"I have passed the exams but still don't really know or understand the subject", "We learn in spite of what is taught us, not because of it", "I don't see the point of why we are learning this - I can't relate it to anything!"*.

To have an impact on the 'reflection/review' activities, students suggested that the quality system would be more effective if developed in the early stages of the Manufacturing Course. They felt that any quality system needed to be heavily promoted and resourced, should aim to motivate students, should support them as independent learners, and encourage team-working skills. The study found that real developmental benefits did not emerge until the final years of a course, when students were more able, and willing, to examine critically what they had achieved and suggest ways for any improvements. Students felt that reflecting on outcomes of actions helped the students extend their understanding of how they went about learning (ie intra-personal abilities), improved communications skills, and developed inter-personal abilities. However, they reported that time-constraints and work-load on the Manufacturing Course forced them to adopt a *'plan-do'* approach, with little emphasis on *'reflection/review'* activities.

3 CONCLUSIONS

The research study involved three years research in to student-based quality systems. There has been mixed success, dependent on the degree course and module culture, with some staff members not being fully supportive. Problems were encountered with: (a) staff resistance, possibly from the distinction between *change* (internally directed) and *being changed* (externally imposed), as well as staff seeing themselves as engineers rather than engineering *educators*; and (b) an unreceptive departmental culture, where the first year was aimed to run 'cheaply' and more emphasis was placed on specialisation in the final year and research activities. To overcome this, a policy of staff support and development, would be required, with its feedback culture more integrated into course philosophies.

The focus of the quality system is on development and enhancement rather than audit. It has been shown during the project that, to achieve quality, we must emphasise 'learning-to-learn' and not just learning, therefore the system cannot work solely with traditional educational methods or attitudes (ie passive learning). This involves the students reflecting upon their own learning, ie *student centred learning* rather than *student delegated learning*. The key is changing behaviour and attitudes of lecturers and students via motivation, persuasion and education. In systems involving student feedback, it is vital that the feedback loop is closed (ie any action taken or not taken, or decisions made, should be reported back to students)

To achieve this there needs to be a change in attitude within engineering higher education. Departments have to overcome the difficulties in progressing towards a learning organisation, where teaching is determined by the needs of the learner as well as the needs of the lecturer. It is important to ensure that those actually responsible for teaching and for learning, (i.e. lecturers and students), have the encouragement and information to enable them to secure continuous quality improvement. The quality system described is still being development, as part of the ethos of continuous improvement, but shows promise in helping to move departments towards this goal.

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Appendix M

Paper Presented at the European Society for Engineering Education (SEFI) Curriculum Development Group Annual Conference, November 1995

Student-Based Quality Systems As An Example Of Active And Productive Learning In Undergraduate Manufacturing Engineering Higher Education

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Abstract

It is argued that engineering higher education in United Kingdom has a number of purposes. Changes in the environment in which this engineering education functions have lead to a reappraisal of these purposes, including a move towards more student-centred education models. This shift in focus has implications for the type of quality systems that are inherent in such educational models. This paper argues that there is a need to move away from passive, quantitative quality systems that focus on the 'product' of learning, and move towards more qualitative, active and dynamic quality systems that focus on the developmental 'process'. It reports on the attempts within one university manufacturing engineering department to introduce such a system.

1 Introduction

Higher education in the United Kingdom has a number of objectives or *purposes* (Mulgan, 1993; Sparkes, 1993). The emphasis and priority placed on each purpose depends on the particular institution, discipline area, degree course, etc., and is seen to change over time and circumstances. Engineering is seen as an essentially vocational discipline (Life and Wild, 1981; Parnaby and Donovan, 1987; Sobol, 1990) and, based on this premise, the needs of prospective employers (Bryce, 1993) and professional institutions (Kelly, 1988) have traditionally directed the purpose of engineering education[1] (*see figure 1*).

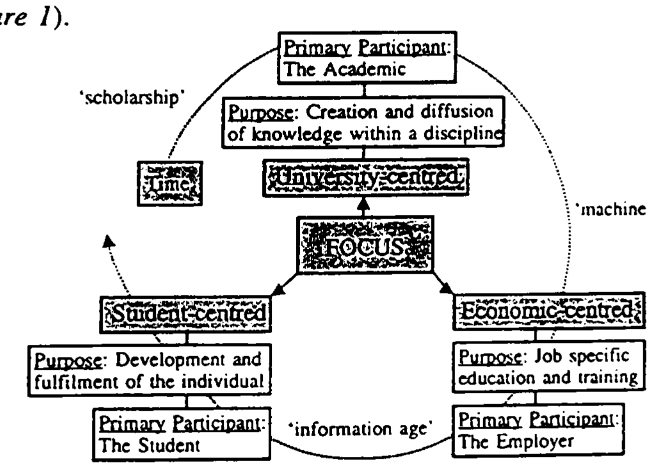

Figure 1: The dynamic focus and purpose of engineering higher education

[1]'Engineering education' in this paper refers to undergraduate engineering degree programmes in the United Kingdom higher education system.

This economic-centred focus has resulted in higher education institutions 'training' graduates for specific jobs. However, changes in the environment in which engineering education functions, have resulted in a reappraisal of the purpose of engineering education. Such changes include:

- the structure of employment and the broadening of job descriptions (Goodman, 1993; Leake, 1993; Parnaby and Donovan, 1987);
- the nature of society, where there is a move from the 'machine age' towards the 'information age' (Daily et al, 1992; McMaster, 1992; Sobol, 1990; Vasilca, 1994); and
- the engineering profession itself, where there is a move away from the significance of factual knowledge (Chisholm, 1990; Sparkes, 1992) towards an increased emphasis on Continuing Professional Development (Farmer, 1994; The Engineering Council, 1995).

These changes have increased pressure for engineering education to move toward more student-centred models. This involves shifting the educational emphasis from the 'product' of learning (i.e. what students learn) to the 'process' of learning (i.e. how students learn). The purpose is, therefore, to prepare students for 'lifelong' learning (Partington, 1995). Traditional educational methods can act as a barrier to this shift (Chalkley et al, 1995b). Such methods are often teacher-centred (Bhattacharya and Mandke, 1992), involve heavily fact-based courses that encourage a passive, surface approach to learning (Kuo, 1992; Sparkes, 1992), and are seen to discourage student initiative or adaption (McMaster, 1992). In effect, they mirror the approach taken by Scientific Management to manufacturing, to quote F.W. Taylor (in McMaster, 1992, p. 249):

> *"Under our system, a worker is told just what he has to do and how he has to do it. Any improvement he makes upon the orders given to him are fatal to success".*

Educational objectives and methods (and their inherent quality systems) are, therefore, still based in the 'machine age' (Daily et al, 1992; Kelly, 1988; Murr, 1988). These seem to concentrate on factors that are quantifiable, easily measured and highly visible. The issues of purpose and quality are interlinked, as quality cannot be defined without purpose (Chalkley et al, 1995a; Mulgan, 1993; Sparkes, 1995; THES, 1994). Defining this purpose is important as it is this that allows us to improve the quality[2] of higher education (*see figure 2*).

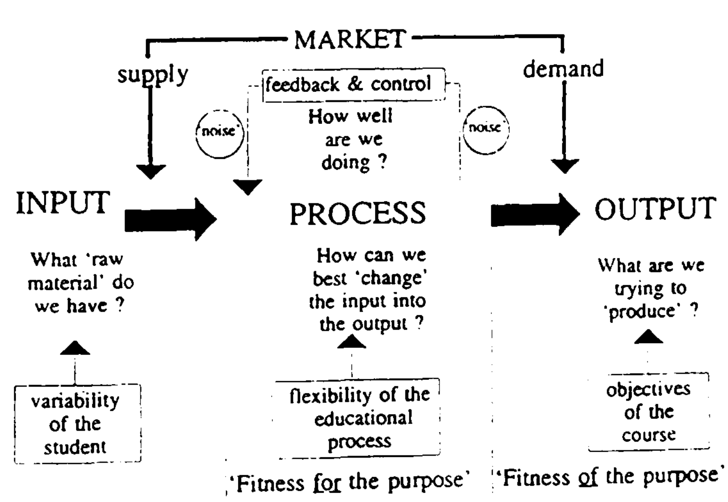

Figure 2: A simple model of a higher education system

[2]'Quality' in this paper is defined as "fitness for purpose".

Therefore, there are two stages of this quality process :

1) Deciding what the objectives of an engineering degree course are (i.e. fitness of the purpose); and
2) Instigating ways of meeting these objectives (i.e. fitness for the purpose).

The quality process should, therefore, be examining the questions of "are we doing things right?" (through internal quality systems) and "are we doing the right things?" (through external quality systems). The debate about quality in the United Kingdom Higher Education Sector has concentrated on assessment and audit (BSI, 1992; HEFCE, 1994; HEQC, 1994). Both approaches have been criticised by a number of authors (Fitzgerald, 1994; Sanders, 1994a; Weitzman, 1993) and it has been argued (Chalkley et al, 1995b) that such approaches do little for the development of students' abilities - the proposed main purpose of engineering education. It has also been observed (Hedberg and Riis, 1994) that student input into such quality systems is often neglected and overlooked, for example (Hill, 1994, p. 11):

> *"One is struck by how 'producer centred' the common elements of the (quality) criteria are. There is no mention of sampling views of students.... much less of consultation with the representatives of such groups".*

Therefore, we should be trying to develop quality systems that are integrated into, and complement, the objectives of the educational system. This involves enabling and encouraging students <u>and</u> staff to participate in critical reviews of their own performance and the performance of the modules and courses in which they participate. It has been shown (Chalkley et al, 1995b) that quality theory maps well onto learning theory (*see figure 3*), in terms of the stages that encourage improvement in both. By encouraging and developing learning we are, by definition, encouraging and developing quality. The key is to foster a system that provides the information, culture and impetus necessary to promote and encourage reflection and review. By doing this (Chalkley et al, 1995b) we are not only moving towards a 'true' quality system (i.e. continuous quality improvement), but we are also developing the effectiveness of students' and staff's ability in 'learning-to-learn' and lifelong learning (EPC/UCoSDA, 1994; Partington, 1995), for example:

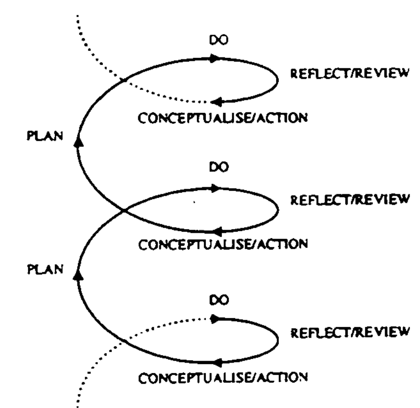

Figure 3: The learning/quality helix

> *"Changes in technology are happening at such a rate that knowledge now dates quickly. The individuals capacity to continue to learn, revealed in effective action, will remain of permanent value".*
>
> (Bolton, 1994, p. 24)

Therefore, we would argue that aspects of quality systems, that are based on developments in manufacturing industries, can be used in educational systems as a means of having a positive impact on effective student learning. Based on this proposition, we will now describe one approach to student-based quality systems taken by Brunel University's Department of Manufacturing and Engineering Systems.

2) The study

a) Background

The Department of Manufacturing and Engineering Systems (henceforth called *'the Department'*) is a broad-based, multi-disciplinary department. It was formed in 1986, by the merger of the Department of Production Technology and the Department of Engineering and Management Systems. The Department runs three distinct undergraduate courses, each with a reputation for innovation in teaching: broad-based programmes in Manufacturing Engineering (Griffiths, 1988) and Environmental Engineering (van der Vorst, 1993), and an 'enhanced' Special Engineering Programme (Clark et al, 1985; Life and Wild, 1981). Each undergraduate course has its own identity and objectives. Much of the study was carried out with the students from the Manufacturing Engineering course (henceforth called *'the Manufacturing Course'*), though work was later done with students from the other two courses. The Manufacturing Course is four years in duration, with most students spending around a quarter of that time on industrial placements.

The Department has always placed an emphasis on some form of student feedback, so as to gain an insight into students' perceptions of the modules and courses they undertake. An earlier feedback system in the Department was based on an end of year questionnaire, with only two questions for each subject/module studied (students were asked to rate 'Course Organisation' and 'Amount Learned on Course'). It gave little insight into why students responded as they did, and what could be done to change this. It also did little to promote the development necessary for staff and student reflection and review. Such purely questionnaire-based approaches have been criticised, from both a learning and quality perspective (HEQC, 1994; Hill, 1994; Sanders, 1994b). Because of this, it was felt necessary by some in the department to develop a system that would move from this 'quality audit' mode into a 'quality development and enhancement' mode. To this end, the Department undertook to research, review and formalise its quality system, i.e. encouraging, collecting, analyzing and responding to student feedback (Chalkley and Butler, 1994).

b) The new system

A pilot study was carried out in 1992/1993 with third year students (28 in total) on the Manufacturing Course. This initially involved small group interviews, 'brainstorming' sessions, and 'cause and effect' analyses. This helped to define parameters for the proposed quality system, in terms of the type and scope of feedback mechanisms and data collection methods, as well as giving information on the value of such a system. Students felt that the earlier quality system in the Department was not effective as:- (a) the results of such feedback activities were never communicated to them; (b) the timing of the feedback collection was such that it had no impact on the modules that the students had taken; and (c) the format (ie questionnaire based) did not allow any student involvement or allow students to expand on what they thought (in terms of problem identification, analysis, and solution). Examples of students' criticisms included:-

> *"I fill these (feedback) forms in, but never find out what happens to them"; "Whenever we complain we're told that students make the same complaints every year. Nobody seems to listen to what we say"; "It would be interesting to know if anything is done in light of what we've said"; "As the feedback is at the end of the year, it has no effect on the modules I've done, so what's in it for me!".*

A corresponding meeting was held with lecturing staff, year tutors and course directors, to gather their views on the scope, style and value of such a quality system. Staff views were mixed, with roughly

50% of attending staff supporting a rationalised and coherent approach to staff/student feedback. There was a significant minority (around 20%) that were not too bothered about the exact details of a feedback, as long as the department was 'seen' to be doing something. A typical comment from such a staff member was:-

"What is the minimum we have to do to keep the university happy?"

The study experimented with questionnaire delivery and collection methods, ranging from anonymous questionnaires left in the undergraduate office (around 28% response rate) to questionnaires given out and collected by the lecturer during the lecture (around 70% response rate). However, the student pilot group reported that the questionnaires were only effective if there was a forum for them to discuss the results of such a mechanism. They felt that group meetings between the year tutor and all students in that year would fulfil this need. It was agreed at a subsequent staff meeting that the delivery and collection of feedback questionnaires should be carried out by the relevant member of staff concerned, i.e. to retain ownership of the process. It was also agreed that the system would only cover those modules taught directly by the Department, so as (a) to avoid imposing the Departments 'culture' on another department, and (b) restrict coverage to those modules that the Department had direct control over.

The developed feedback system comprised of three stages (*see figure 4*). Stage (1) was an initial feedback and discussion session between the students and the relevant year tutor, held in the first few weeks of the semester. Its purpose was to raise students' awareness of what the quality system involved and what their role was (i.e. what was expected of them). It also gathered information on students' impressions of their first few weeks on the course. Stage (2) was a mid-semester module questionnaire, consisting of 16 closed and 4 open response questions, which was aimed at gathering a number of 'performance indicators'. The questionnaires were analysed by a third party, and the results were communicated to the relevant member of teaching staff and to the year tutor. There was a requirement that teaching staff would inform both the students and the year tutor of any action they proposed to take in light of the feedback. However, these indicators were not used as an end in themselves (i.e. summative), but rather they provided 'sign posts' for further investigation and action (i.e. formative). To this end, Part (3) was a further discussion session run towards the end of the semester. It gathered more detailed information as to the background of Part (2) and checked on how effective students felt the proposed remedies had been. During the academic year, each course team (eg. the Manufacturing Course) and subject team (eg. Mechanical Engineering) in the department would also hold review meetings to discuss the results from the quality system and decide on any general action to be taken.

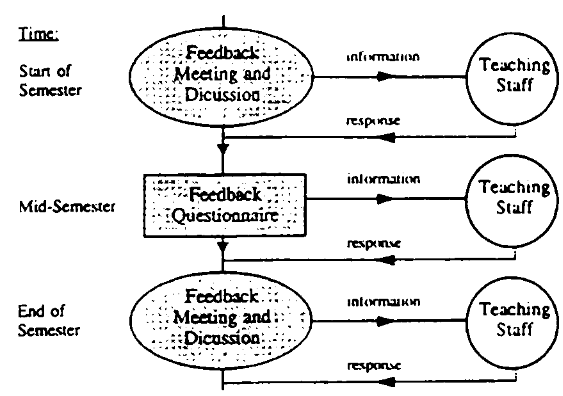

Figure 4: Simple schematic of the Department quality system

These discussion meetings aimed to encourage students to review and reflect on what they had done on their undergraduate degree courses, (eg. what went well?, what did not go so well?, how could it be done better?, how could the students do better?). They were normally informal and attracted eight to twelve students (around 30-40%, depending on the year of the course), with the year tutor acting as a facilitator. Students were able and keen to discuss, consider and analyze the educational experience they had participated in. By requiring staff to communicate to students and year tutors on any action taken or not taken, it was hoped to close the 'feedback loop'. At each stage, staff and students were also given the opportunity to comment on the actual quality system and how it could be improved. It became clear that some staff were unused to, and uncomfortable with, running such sessions, and that students often felt 'intimidated' by the staff running the sessions. To overcome this, an 'independent' party helped run the sessions. The course/subject team meetings allowed staff to take a broad view of all the modules taken by a particular year or all students taking a particular module, and spot any common areas of concern or best practice. They also provided a supportive forum in which staff could discuss particular ideas or problems.

As the research progressed it became increasingly clear that students found the bi-semester meetings most useful, as they had a chance to discuss and interact with fellow students, year tutors, and the independent party. Indeed, some student groups ran their own feedback meetings, and communicated the minutes back to staff. The focus of the quality system was changing to promoting student learning rather than just checking that students felt that such learning was taking place. The quality system, therefore, was taking 'measurements' from the questionnaires and using these to formalise students' and lecturers' thoughts, ideas, etc., for improvement. Through these small feedback loops it was hoped that the learning and quality process was being improved. If this were the case, then a well supported quality system could be used as a vehicle for change, i.e. to get students to be more proactive, to reflect and analyze on what they have done, and to suggest strategies for improvement. In quality terms, what the system was trying to do was move from a situation of inspection and control, to one of continuous improvement of quality (Chalkley et al, 1995b; Dale, 1994), where quality was disseminated amongst all learning activities (rather than concentrated in a separate one).

c) Review of the Department quality system

The quality system implemented in the Department aimed to encourage a more mature and active approach to learning, and to help students and staff focus on the learners attitudes and the educational process. It developed as a formative rather than summative approach, via a progression of small iterations from the feedback process. The system also aimed to discover how students perceived what they were learning and whether teaching methods were effective. Issues determined included how clear course objectives were, and how clearly was learning material presented.

From the quality system it became clear that lecturers were focusing on improvements in the educational product, whereas the students' emphasis was on improvements in the educational process. For example:-

> staff - a meeting to discuss problems with undergraduate engineers mathematical ability might focus wholly on what should be taught rather than the way it was taught;
>
> students - typical comments from students include: *"I have passed the exams but still don't really know or understand the subject", "We learn in spite of what is taught us, not because of it", "I don't see the point of why we are learning this - I can't relate it to anything!"*.

To have an impact on the 'reflection/review' activities, students suggested that the quality system would be more effective if developed in the early stages of the Manufacturing Course. They felt that any quality system needed to be heavily promoted and resourced, should aim to motivate students, should support them as independent learners, and encourage team-working skills. The study found that real developmental benefits did not emerge until the final years of a course, when students were more able, and willing, to examine critically what they had achieved and suggest ways for any improvements. Students felt that reflecting on outcomes of actions helped the students extend their understanding of how they went about learning (ie intra-personal abilities), improved communications skills, and developed inter-personal abilities - the transferable skills that are seen as important (Goodman, 1993; Leake, 1993). However, they reported that time-constraints and work-load on the Manufacturing Course still forced them to adopt a *'plan-do'* approach, with little emphasis on *'reflection/review'* activities.

A formal discussion and review of the implemented quality system was carried out in July 1995 by the year tutors and course convenors of the Manufacturing Course and the Special Engineering programme. Staff on the Environmental Engineering course had provided constructive comments and suggestions throughout the project, and it was felt that such a meeting was unnecessary. It was felt by some staff that the system was still too heavily questionnaire-based, and that staff at certain levels of the course were not following the agreed procedure (*see figure 5*). It was found, from the discussions with staff and students, that other forms of feedback were seen to be more appropriate to modules in later years. This was because: (a) group sizes were reduced (due to the range of options available to students), therefore facilitating more open discussion; and (b) as students progressed through the relevant courses, they become more confident and able to discuss any problems they had directly with the member of staff concerned or with their peers. Some participating staff viewed the questionnaires as a useful means of gathering formative feedback, and that students comments correlated well with exam performance. Some staff still felt, however, that students used the feedback forum maliciously, for example:-

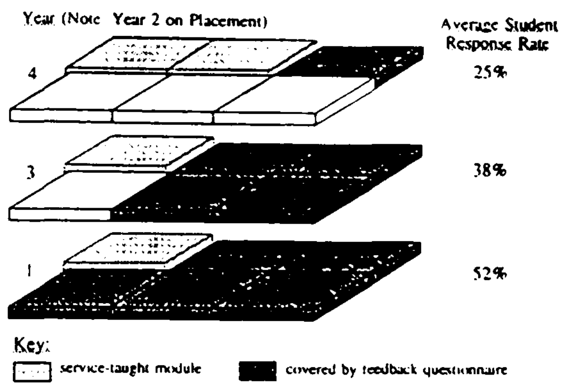

Figure 5: Semester 1 (1994-95) feedback questionnaire coverage on the Manufacturing Course

> *"This is what happens when you get a few students with an axe to grind"; "How can students comment on my module, when they've never been to my lectures!".*

Some staff resisted the suggestion that such information should be used in formal annual appraisals (i.e. summative judgements), with many stating that they would boycott such a system. Others felt that they should be given credit for being proactive and receptive to the ethos of Continuing Professional Development.

Both staff and students felt that the meetings between the year tutor and relevant student year were seen as a particular strength of the system, and one that should be retained and encouraged. These meetings were seen to be more effective than year tutor/student year representative meetings, as they reduced the filtering of information, and allowed all students a chance to join in the discussion. However, it was felt that these should be reduced to once a semester. Staff generally felt that the questionnaires, though useful on an ad hoc basis, took too long to fill in and were not always an appropriate mechanism for the method of teaching adopted (eg. some teaching staff used group project work rather than lectures - clearly a different questionnaire would be needed for each case). A major concern was the feeling that the Department still did not have a student-centred focus (i.e preparing students for 'lifelong' learning), and that any initiatives designed to move towards this purpose were not adequately supported. It also became clear that students were suffering from a certain amount of 'feedback fatigue'.

With these comments in mind, the quality system was developed further (under the ethos of continuous improvement). The main focus of the system was now the student/year tutor meetings (*see figure 6*). These meetings would be the main mechanism for identifying and reporting areas of concern. If more information on these identified areas was needed, a questionnaire would be issued. The information gathered form these meetings would be circulated to the relevant staff as before, as would any relevant action taken by the staff concerned. Therefore, the Department still had a means of eliciting student and staff reaction and views on the modules they undertook, but had shifted the focus from exhaustive use of questionnaires, to more interactive review and analysis:

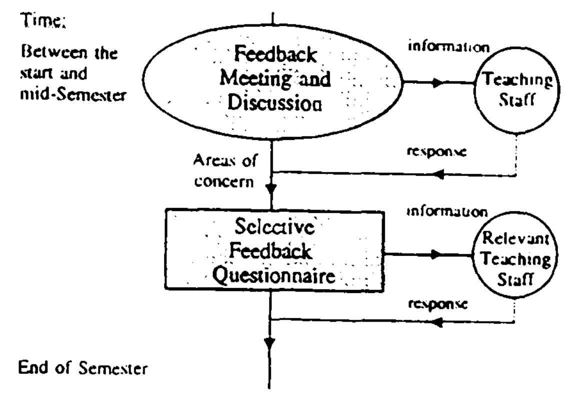

Figure 6: Revised quality system within The Department

(a) between the year tutor and students, and within the group of students themselves i.e. inter-personal); and

(b) within the student (intra-personal).

Some concern has been expressed over the increased information 'lead time', i.e. the time taken between problem identification, analysis, solution and implementation has potentially increased. It has been argued (Chalkley et al, 1995b) that delays in closing the feedback/quality loop, result in deterioration in the participation rates and effectiveness of such systems.

3) <u>Conclusions</u>

It has been shown that engineering education has not been "doing the right things" (Goodman, 1993; Sparkes, 1995). Much of the students traditional engineering education experience encourages passive behaviour and serialist, surface-level learning, with little development of the capacity for 'lifelong' learning. Therefore, we need to stimulate and encourage effective learning (EPC/UCoSDA, 1994). As educators, we need to encourage students to develop as 'lifelong' learners by changing the way we both teach and ensure quality, ie encourage participation, discussion, review, and reflection. The quality system described goes part of the way to achieving this.

A number of problems were identified, namely:

- indifference from some staff to student led initiatives and their own continuing professional development;
- apathy from some students to the quality system and concept of 'lifelong' learning ;
- some staff viewing themselves as 'engineers' rather than 'educators';
- a general lack of familiarity, amongst staff and students, with the research on how students learn and how what they do impinges on this;
- an unreceptive department culture that was perceived to still focus on economic-centred models and training students for specific employment areas;
- the lack of full integration of the quality system into the undergraduate courses, possibly due to the above; and
- students confusion as to their role in the quality system, owing to conflicting messages from senior staff.

The quality system developed allows students to take a more active part in their education, by encouraging them to review and reflect on what they have experienced. This review and reflection activity should also make them more productive as lifelong learners (i.e. more effective). The research has found, therefore, that it is necessary to make explicit what was assumed to be implicit. If we agree that education should be preparing students for the 'information age', then we should adjust the focus and purpose of our education systems (and inherent quality systems) accordingly. We, therefore, have to move towards more student-centred models, where the emphasis is as much on context and 'process', as on content and 'product'.

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Appendix N

Paper Presented at the European Foundation For Quality Management (EFQM) Annual Conference, April 1996

Student-Centred Quality Systems

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Abstract It is argued that engineering higher education in United Kingdom has a number of purposes. Changes in the environment in which this engineering education functions have led to a reappraisal of these purposes, including a move towards more student-centred education models. These models emphasise the 'transformational' aspects of education, including development of the full range of cognitive abilities with a view to lifelong learning. This shift in focus has implications for the type of quality systems that are inherent in such educational models. This paper argues that there is a need to move away from passive, post-process quality systems that focus on the 'product' of learning, and move towards active, in-process quality systems that focus on the developmental 'process'. It reports on research within a university manufacturing engineering department aimed at introducing such systems, and the implications this has on organisational culture.

1 Introduction

Higher education in the United Kingdom has a number of objectives or *purposes* (Mulgan, 1993). The emphasis and priority placed on each purpose varies, depending of factors such as the institution mission, the discipline area, and the degree course. This purpose can be seen to change over time and circumstances. Engineering is seen as an essentially vocational discipline (Life and Wild, 1981; Parnaby and Donovan, 1987) and, based on this premise, the needs of prospective employers (Bryce, 1993) and professional institutions (Kelly, 1988) have traditionally directed the purpose of engineering education[1] (see Figure 1).

This economic-centred focus has resulted in higher education institutions 'training' graduates for specific jobs. However, changes in the environment in which engineering education functions, have resulted in a reappraisal of the purpose of engineering education. Such changes include:

- the structure of employment and the broadening of job descriptions (Goodman, 1993; Parnaby and Donovan, 1987);

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[1]'Engineering education' in this paper refers to undergraduate engineering degree programmes in the United Kingdom higher education system.

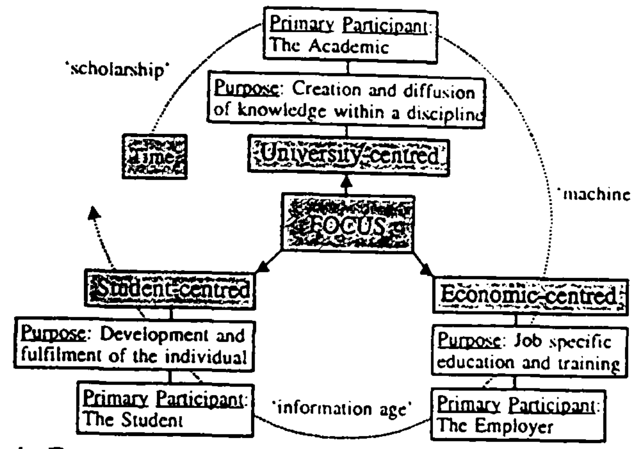

Figure 1: The Dynamic Focus and Purpose of Engineering Higher Education.

- the nature of society, where there is a move from the 'machine age' towards the 'information age' (McMaster, 1992; Vasilca, 1994);
- the engineering profession itself, where there is a move away from the significance of factual knowledge (Sparkes, 1992) towards an increased emphasis on Continuing Professional Development (Farmer, 1994; The Engineering Council, 1995).

These changes have increased pressure for engineering education to move toward more student-centred models. This involves shifting the educational emphasis from the 'product' of learning (i.e. what students learn) to the 'process' of learning (i.e. how students learn). The purpose is, therefore, to prepare students for 'lifelong' learning (Partington, 1995). Traditional educational methods can act as a barrier to this shift (Chalkley et al, 1995). Such methods are often teacher-centred (Bhattacharya and Mandke, 1992), involve heavily fact-based courses that encourage a passive, surface approach to learning (Sparkes, 1992), and are seen to discourage student initiative (McMaster, 1992). In effect, they mirror the approach taken by Scientific Management to manufacturing, to quote F.W. Taylor (in McMaster, 1992, p. 249):

> *"Under our system, a worker is told just what he has to do and how he has to do it. Any improvement he makes upon the orders given to him are fatal to success".*

Educational objectives and methods (and their inherent quality systems) are, therefore, still based in the 'machine age' (Kelly, 1988; Murr, 1988). These appear to concentrate on factors that are quantifiable, easily measured and highly visible. The issues of purpose and quality are interlinked, as quality cannot be defined without purpose (Chalkley et al, 1995; Mulgan, 1993; Sparkes, 1995). Defining this purpose is important as it is this that allows us to improve the quality[2] of higher education. Therefore, there are two stages of this quality process: firstly, deciding what the objectives of an engineering degree course are (i.e. fitness of the purpose); and secondly, implementing ways of meeting these objectives (i.e. fitness for the purpose).

The quality process should, therefore, be examining the questions of "are we doing things right?" (through internal quality systems) and "are we doing the right things?" (through

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[2]'Quality' in this paper is defined as "fitness for purpose".

external quality systems). The debate about quality in the United Kingdom Higher Education Sector has concentrated on assessment and audit (BSI, 1992; HEFCE, 1994; HEQC, 1994). Such approaches have been criticised by a number of authors (Fitzgerald, 1994; Weitzman, 1993) and it has been argued (Chalkley et al, 1995) that such approaches do little for the development of students' abilities - the proposed main purpose of engineering education. An overview of the various quality initiatives is given in Figure 2.

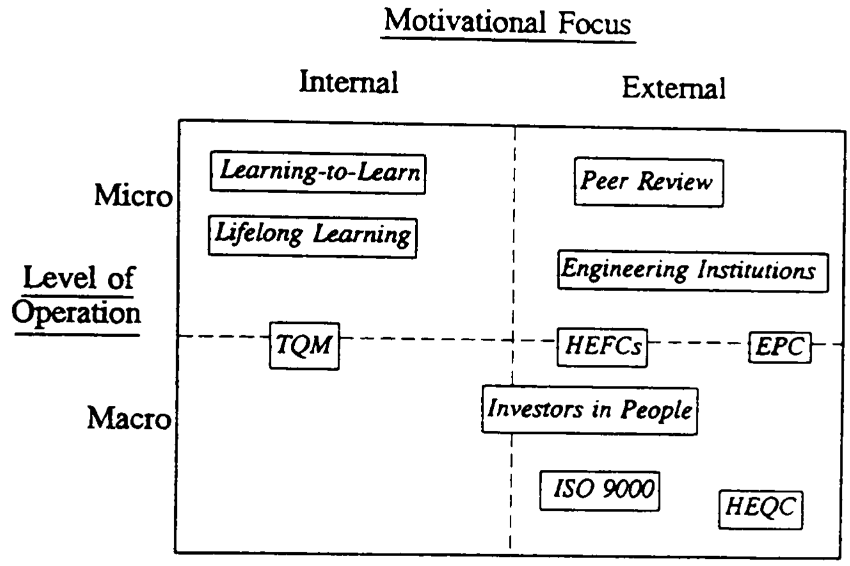

Figure 2: Quality Initiatives in Engineering Higher Education.

It has been observed (Hedberg and Riis, 1994) that student input into higher education quality systems is often neglected and overlooked, for example (Hill, 1994, p. 11):

> *"One is struck by how 'producer centred' the common elements of the (quality) criteria are. There is no mention of sampling views of students.... much less of consultation with the representatives of such groups".*

Therefore, we should be trying to develop quality systems that are integrated into, and complement, the objectives of the educational system. This involves enabling and encouraging students and staff to participate in critical reviews of their own performance and the performance of the modules and courses in which they participate. This requires action on the learning process. By referring to Figure 2, it can be seen that many of the quality initiatives work above this individual (i.e. internal/micro) level.

2 The Learning Process

We have argued that the purpose of engineering higher education is to develop the students' ability to learn and to continue to learn. This requires the development of the full range of cognitive abilities (Beard, 1968; Matthew and Hughes, 1994; Sparkes, 1992), and this cognitive domain is shown in Table 1.

Therefore, higher education should develop learning and other transferable skills within a body of knowledge (eg. engineering). The higher cognitive abilities require the learner to

<table>
<tr><th rowspan="2">Level of Cognitive Ability</th><th colspan="3">Model</th></tr>
<tr><th>Bloom</th><th>Sparkes</th><th>Beard</th></tr>
<tr><td>Low</td><td>1 Knowledge</td><td>Knowledge</td><td rowspan="3">Mechanical and Manual Skills</td></tr>
<tr><td></td><td>2 Comprehension</td><td rowspan="2">Know-how and Measurable Skills</td></tr>
<tr><td></td><td>3 Application</td></tr>
<tr><td>Medium</td><td>4 Analysis</td><td rowspan="3">Understanding and Complex Skills</td><td rowspan="3">Higher Mental Skills</td></tr>
<tr><td></td><td>5 Synthesis</td></tr>
<tr><td>High</td><td>6 Evaluation</td></tr>
</table>

Table 1: Comparison of Taxonomies of Learning.

'internalise' learning cycles (eg. Kolb's learning cycle). These cycles involve an individual carrying out continuous planning, executing, reflecting and conceptualising in the cognitive domain.

3 Quality in Higher Education

Traditional internal systems for addressing quality and learning in higher education institutions can be seen to focus on inspection (eg. end of year exams) and rudimentary control mechanisms (eg. quantitative rating of lecturers by students). These methods are often post-process and reactive, with the feedback loop often not closed, i.e. corrective action, when identified, is not initiated (Chalkley et al, 1995). Such approaches add very little to the purpose and process of higher education, i.e. "*enabling students to achieve worthwhile learning goals*" (Sparkes, 1995). This is because there is an overemphasis on evaluation and not enough emphasis on self-reflection and review, personal goal setting, enhancement and development of transferable skills, and general preparation for 'lifelong learning'. A robust approach to quality lies in the use of quality cycles (Dale, 1994), where there is a more structured approach to the planning, implementing, reviewing and improving of activities. To be successful, such cycles must be adopted on an organisation-wide basis. From this, it can be argued that successful organisation-wide continuous quality improvement initiatives lie in:

- the cognitive domain, as it requires giving people the personal tools to improve themselves and the processes they are involved in;
- the affective domain, as it requires changing peoples attitudes, motivations and behaviours to develop and use these cognitive tools;
- the organisational culture, as it requires systems that support the developments in the cognitive and affective domains.

4 Matching Learning to Quality

From the above, it can be argued that quality theory maps well onto learning theory (see Figure 3), in terms of the stages that encourage improvement in both. By encouraging and developing learning we are, by definition, encouraging and developing quality. The key is to foster a system that provides the information, culture and impetus necessary to promote and encourage reflection and review. By doing this (Chalkley et al, 1995) we are not only moving towards a 'true' quality system (i.e. continuous quality improvement), but we are also developing the effectiveness of students' and staff's ability in 'learning-to-learn' and lifelong learning (EPC/UCoSDA, 1994; Partington, 1995).

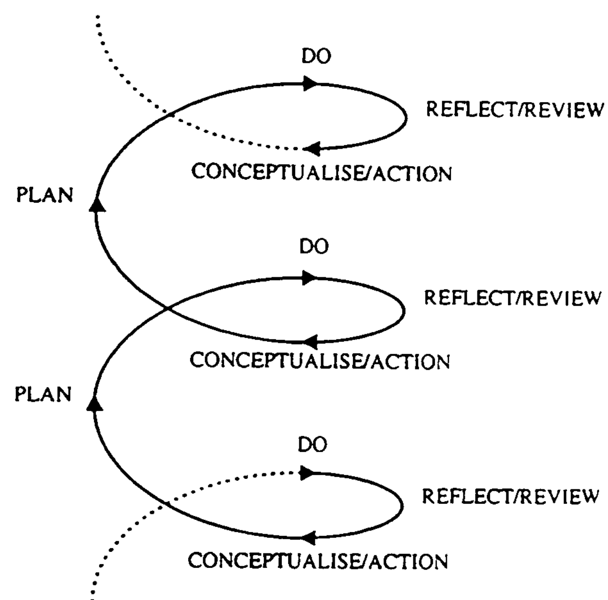

Figure 3: The Learning/Quality Helix (Chalkley et al, 1995).

To implement such systems requires action at the internal/micro level (as shown in Figure 2), as it is here that learning (in both the cognitive and affective domains) is developed. By developing and encouraging this personal continuous improvement, the result should be organisation-wide continuous quality improvement.

Therefore, it can be argued that aspects of quality systems, that are based on developments in manufacturing industries, can be used in educational systems as a means to create a culture that engenders effective student learning. Based on this proposition, the paper will now describe one approach to student-centred quality systems taken by Brunel University's Department of Manufacturing and Engineering Systems.

5 The Research Study

The Department of Manufacturing and Engineering Systems (Henceforth called '*the Department*') is a broad-based, multi-disciplinary general engineering department. It was formed in 1986, by the merger of the Department of Production Technology and the Department of Engineering and Management Systems. The Department runs three distinct undergraduate courses: broad-based programmes in Manufacturing Engineering (around 45 first year students) and Environmental Engineering (around 18 first year students), and an 'enhanced' Special Engineering Programme (around 35 first year students). Each course has its own identity and objectives. Much of the study was carried out with the students from the Manufacturing Engineering course (henceforth called *'the Manufacturing Course'*), though work was later done with students from the other two courses.

Over the period of the research project, the number of teaching staff in the Department fell by six (from a total of around 30); there was increased external pressure from the HEFCE Research Selectivity exercise, and from Engineering Institution Accreditation visits (i.e. the IEE and the IMechE); as well as internal pressure from the university 'centre' to increase student numbers.

5.1 The Existing System

Each course had its own management structure, consisting of a Course Director aided by Year Tutors for each cohort of students (eg. Manufacturing Engineering Year 1 Tutor, Special Engineering Year 1 Tutor, etc.). There were also Departmental Subject Panels, which consisted of inter-course groups of staff who oversaw the teaching of particular disciplines (eg. Mechanical Engineering, Electrical Engineering, Management, etc.). These various bodies fed into the Departmental Board of Studies. This structure is shown in Figure 4.

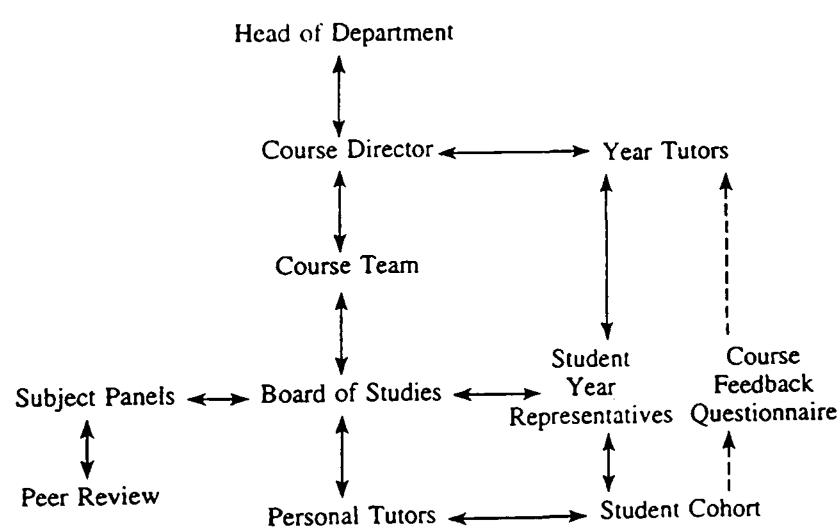

Figure 4: Schematic of the Internal Quality System of the Department.

The Department has always placed an emphasis on some form of student feedback, so as to gain an insight into students' perceptions of the modules and courses they undertook. The feedback system in the Department, prior to the research project, was based on an anonymous end of year questionnaire, with two questions for each subject/module studied. Students were asked to rate '*Course Organisation*' and '*Amount Learned on Course*'. There was space on the form for the students to rate each of the twelve modules that they had undertaken that year. The results of the feedback were not circulated to students and no check was made of staff action based on the feedback.

5.2 Pilot Study

A pilot study was carried out in 1992/1993 with third year students (28 in total) on the Manufacturing Course. The rest of the students in the Department followed the existing system (i.e. an end of year questionnaire). The pilot study initially involved small group interviews, 'brainstorming' sessions, and 'cause and effect' analyses. This helped to define parameters for the proposed quality system, in terms of the type and scope of feedback mechanisms and data collection methods, as well as giving information on the value of such a system. Students felt that the earlier quality system in the Department was not effective as:

- the results of such feedback activities were never communicated to them
- the timing of the feedback collection was such that it had no impact on the modules that the students had taken
- the format (i.e. questionnaire based) did not allow any student involvement or allow students to expand on what they thought (in terms of problem identification, analysis, and solution)

Examples of students' comments include:

> *"I fill these (feedback) forms in, but never find out what happens to them"; "Whenever we complain we're told that students make the same complaints every year. Nobody seems to listen to what we say"; "It would be interesting to know if anything is done in light of what we've said"; "As the feedback is at the end of the year, it has no effect on the modules I've done, so what's in it for me!".*

A corresponding meeting was held with lecturing staff, year tutors and course directors, to gather their views on the scope, style and value of such a quality system. Staff views were mixed, with roughly 50% of attending staff supporting a rationalised and coherent approach to staff/student feedback. There was a significant minority (around 20%) that were not too bothered about the exact details of a feedback, as long as the department was 'seen' to be doing something. A typical comment from such a staff member was:

> *"What is the minimum we have to do to keep the university happy?"*

The student pilot group reported that the questionnaires were only effective if there was a forum for them to discuss the results of such a mechanism. They felt that group meetings between the year tutor and all students in that year would fulfil this need. It was agreed at a subsequent staff meeting that the delivery and collection of feedback questionnaires should be carried out by the relevant member of staff concerned, i.e. to retain ownership of the process. It was also agreed that the system would only cover those modules taught directly by the Department, so as to avoid imposing the Departments 'culture' on another department, and restrict coverage to those modules that the Department had direct control over.

It was decided to attempt to introduce a system that would move the learning and quality culture from 'post-process, passive' to 'in-process, active'. Rather than try to execute this shift in one manoeuvre, it was decided to adopt a more gradual and phased introduction of the quality system. An outline of the proposed strategy is given in Figure 4. The rationale behind this is summed up by Keith Noble:

"To improve in traditional Higher Education institutions, small reforms must be implemented, small reforms that nurtured over time can succeed. Not excessive and forced reforms that will be resisted and circumvented" (Noble, 1994, p. 71).

It was decided not to focus solely on the feedback questions asked, but rather to engender a system where learners were encouraged to plan, enact, review, reflect and improve on their approach to learning. The study was, therefore, taking a holistic approach to the whole system, rather than only focusing on one part of that system.

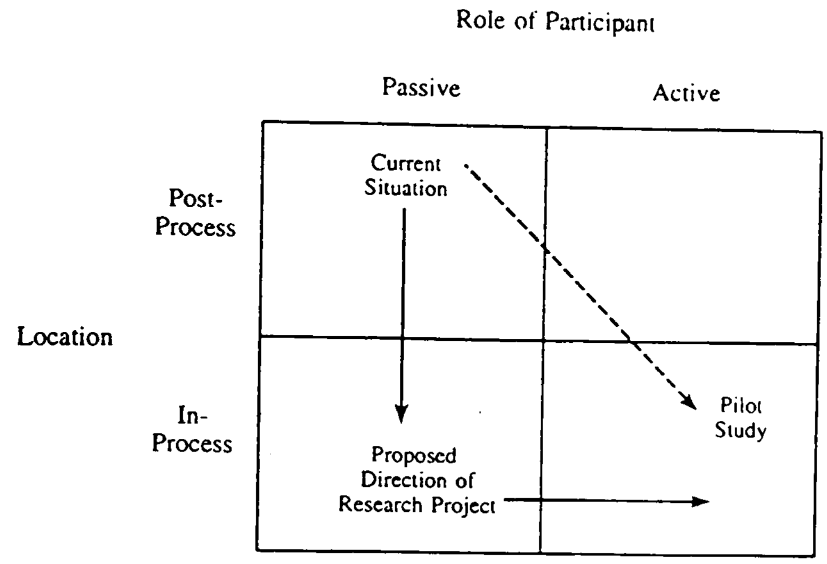

Figure 5: Strategy for the Research Project.

5.3 The New System

Over the next two years, the quality system was moved from the existing post-process, passive state, to a more in-process, active state. The developed feedback system now comprised of six stages (see fig Figure 6):

- Stage (1) was an initial feedback and discussion session between the students and the relevant year tutor, held in the first few weeks of the semester. Its purpose was to raise students' awareness of what the quality system involved and what their role was (i.e. what was expected of them). It also gathered information on students' impressions of their first few weeks on the course. Staff running such sessions had to submit a single-sided sheet of A4 summarising the main issues raised at the meeting;
- Stage (2) was a mid-semester module questionnaire, consisting of 16 closed and 4 open response questions, which was aimed at gathering a number of 'performance indicators'. The questionnaires were analyzed by a third party, and the results were communicated to the relevant member of teaching staff and to the year tutor. There was a requirement that teaching staff would inform both the students and the year tutor of any action they proposed to take in light of the feedback. However, these indicators were not used as an end in themselves (i.e. summative), but rather they provided 'sign posts' for further investigation and action (i.e. formative);

- Stage (3) was a further discussion session run towards the end of the semester. It gathered more detailed information as to the background of Stage (2) and checked on how effective students felt the proposed remedies had been. During the academic year, each course team (eg. the Manufacturing Course) and subject team (eg. Mechanical Engineering) in the department would also hold review meetings to discuss the results from the quality system and decide on any general action to be taken;
- Stage (4) was the personal review and analysis carried out by the relevant student cohort;
- Stage (5) was the personal review and analysis carried out by the relevant member of staff on the feedback from the relevant student cohort. This was to be supported by the relevant course and subject panels;
- Stage (6) was an end of year course level questionnaire, aimed at gathering information on students' perceptions of the general running and management of the course, as well as the other Departmental and university systems;

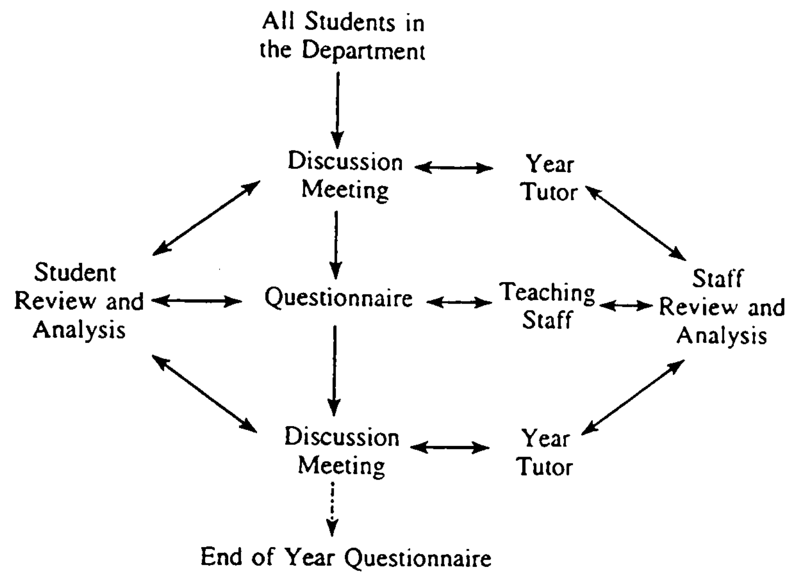

Figure 6: Third Run of the Departmental Quality System (1994-1995).

The objective of the research project was to move from a quality system that emphasised measurement to one that emphasised development. Therefore, this system attempted to shift the focus of staff and students from simple evaluation towards the developmental action taken after that evaluation. Such a system involved a move from simple monitoring and feedback to a system that implicitly encouraged the application of learning theories using critical and constructive reflection, dialogue and feedback. This required a system that allowed a reappraisal and clarification of purpose, input from all participants, and increased focus on continuous improvement. This aspect of the system in the research project became difficult to control, once ownership was given to individual lecturers. However, this was essential if the system was to operate once the researcher had left.

The discussion meetings aimed to encourage students to review and reflect on what they had done on their undergraduate degree courses, (eg. what went well?, what did not go so well?, how could it be done better?, how could the students do better?). They were normally informal and attracted eight to twelve students (around 30-40%, depending on the year of the course), with the year tutor acting as a facilitator. Students were able and keen to discuss, consider and analyze the educational experience they had participated in. By requiring staff to communicate to students and year tutors on any action taken or not taken, it was hoped to close the 'feedback loop'. At each stage, staff and students were also given the opportunity to comment on the actual quality system and how it could be improved. It became clear that some staff were unused to, and uncomfortable with, running such sessions, and that students often felt 'intimidated' by the staff running the sessions. To overcome this, an 'independent' party helped run the sessions. The course/subject team meetings allowed staff to take a broad view of all the modules taken by a particular year or all students taking a particular module, and spot any common areas of concern or best practice. They also provided a supportive forum in which staff could discuss particular ideas or problems.

As the research progressed it became increasingly clear that students found the bi-semester meetings most useful, as they had a chance to discuss and interact with fellow students, year tutors, and the independent party. Indeed, some student groups ran their own feedback meetings, and communicated the minutes back to staff. The focus of the quality system was changing to promoting student learning rather than just checking that students felt that such learning was taking place. The quality system, therefore, was taking 'measurements' from the questionnaires and using these to formalise students' and lecturers' thoughts, ideas, etc., for improvement. Through these small feedback loops it was hoped that the learning and quality process was being improved. If this were the case, then a well supported quality system could be used as a vehicle for change, i.e. to get students to be more proactive, to reflect and analyze on what they have done, and to suggest strategies for improvement. In quality terms, what the system was trying to do was move from a situation of inspection and control, to one of continuous improvement of quality, where quality was disseminated amongst all learning activities (rather than concentrated in a separate one).

5.4 Review of the Quality System

The quality system implemented in the Department aimed to encourage a more mature and active approach to learning, and to help students and staff focus on the learners attitudes and the educational process. It developed as a formative rather than summative approach, via a progression of small iterations from the feedback process. The system also aimed to discover how students perceived what they were learning and whether teaching methods were effective. To have an impact on the 'reflection/review' activities, students suggested that the quality system would be more effective if developed in the early stages of the Manufacturing Course. They felt that any quality system needed to be heavily promoted and resourced, should aim to motivate students, should support them as independent learners, and encourage team-working skills. Students felt that reflecting on outcomes of actions helped the students extend their understanding of how they went about learning (i.e. intra-personal abilities), improved communications skills, and developed inter-personal abilities. However, they reported that time-constraints and work-load on their courses still forced them to adopt a 'plan-do' approach, with little emphasis on 'reflection/review' activities.

A formal discussion and review of the implemented quality system was carried out in July 1995 by the year tutors and course convenors. It was felt by some staff that the system was still too heavily questionnaire-based, and that staff at certain levels of the course were not following the agreed procedure. Some participating staff viewed the questionnaires as a useful means of gathering formative feedback, and that students comments correlated well with exam performance. Some staff still felt, however, that students used the feedback forum maliciously, for example:

"This is what happens when you get a few students with an axe to grind"; "How can students comment on my module, when they've never been to my lectures!".

Some staff resisted the suggestion that such information should be used in formal annual appraisals (i.e. summative judgements), with many stating that they would boycott such a system. Others felt that they should be given credit for being proactive and receptive to the ethos of continuing professional development (CPD).

Both staff and students felt that the meetings between the year tutor and relevant student year were seen as a particular strength of the system, and one that should be retained and encouraged. These meetings were seen to be more effective than year tutor/student year representative meetings, as they reduced the filtering of information, and allowed all students a chance to join in the discussion. However, it was felt that these should be reduced to once a semester. Staff generally felt that the questionnaires, though useful on an ad hoc basis, took too long to fill in and were not always an appropriate mechanism for the method of teaching adopted (eg. some teaching staff used group project work rather than lectures - clearly a different questionnaire would be needed for each case).

A major concern of the researcher was the feeling that the Department still did not have a student-centred focus (i.e preparing students for 'lifelong' learning), and that any initiatives designed to move towards this purpose were not adequately supported. It also became clear that students were suffering from a certain amount of 'feedback fatigue'.

With these comments in mind, the quality system was developed further (under the ethos of continuous improvement). The main focus of the system was now the student/year tutor meetings (see Figure 7). These meetings would be the main mechanism for identifying and reporting areas of concern. If more information on these identified areas was needed, a questionnaire would be issued. The information gathered form these meetings would be circulated to the relevant staff as before, as would any relevant action taken by the staff concerned. Therefore, the Department still had a means of eliciting student and staff reaction and views on the modules they undertook, but had shifted the focus from exhaustive use of questionnaires, to more interactive review and analysis:

- between the year tutor and students, and within the group of students themselves (i.e. inter-personal);
- within the student (i.e. intra-personal).

Some concern has been expressed over the increased information 'lead time', i.e. the time taken between problem identification, analysis, solution and implementation has potentially increased. It has been argued (Chalkley et al, 1995) that delays in closing the feedback/quality loop, result in deterioration in the participation rates and effectiveness of such systems.

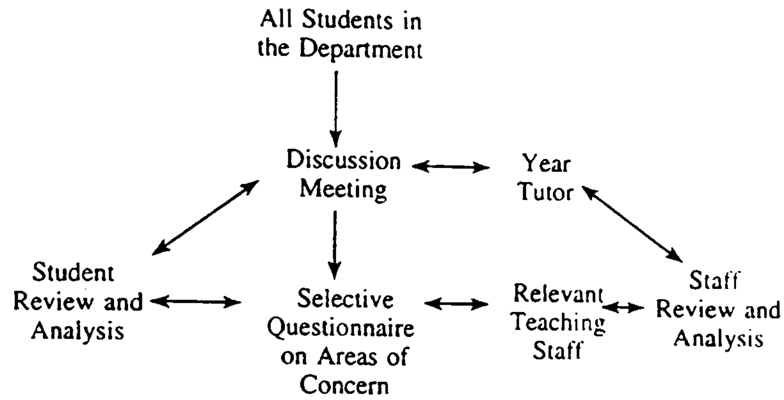

Figure 7: The Final Run of The Quality System.

6 Conclusions

It has been shown that engineering education has not been "doing the right things" (Goodman, 1993; Sparkes, 1995). Much of the students traditional engineering education experience encourages passive behaviour and serialist, surface-level learning, with little development of the capacity for 'lifelong' learning. Therefore, we need to stimulate and encourage effective learning (EPC/UCoSDA, 1994). As educators, we need to encourage students to develop as 'lifelong' learners by changing the way we both teach and ensure quality, ie encourage participation, discussion, review, and reflection. The quality system described goes part of the way to achieving this.

The research project found that developmental benefits did not emerge unless students were encouraged, and able, to examine critically what they had achieved and suggest ways for any improvements. If we refer to Figure 1, it can be seen that the system in the research project attempted to develop a student-centred process, where 'feedback and control' is personal and internal. By emphasising the move towards development and enhancement, it was hoped to encourage a transformational approach to engineering education. However, the culture within the Department was still geared to a vocational orientation. This resulted in the quality system being at odds with the culture of the Department and the majority of the Departments systems (eg. students seen as passive entities; employers viewed as 'the customers', etc.).

The three and a half year research project achieved mixed success, depending on the degree course and module culture, with some staff members not being fully supportive. Problems were encountered with:

- indifference from some staff to student led initiatives and their own continuing professional development;
- apathy from some students to the quality system and concept of 'lifelong' learning ;

- a general lack of familiarity, amongst staff and students, with the research on how students learn and how what they do impinges on this;
- the lack of full integration of the quality system into the undergraduate courses, possibly due to the above
- students confusion as to their role in the quality system, owing to conflicting messages from senior staff
- some staff resistance, possibly from the distinction between *change* (internally directed) and *being changed* (externally imposed)
- some staff seeing themselves as engineers rather than engineering *educators*, where the focus was on the content of what was taught rather than the way it was taught

To overcome this, a policy of staff support and development would be required, with its feedback culture more integrated into course philosophies and more emphasis on CPD and continuous self-improvement. Therefore, engineering education needs to stimulate and encourage effective learning (EPC/UCoSDA, 1994). Engineering educators need to encourage students to develop as 'lifelong' learners by changing the way they both teach and ensure quality, ie encourage participation, discussion, review, and reflection. The quality system described goes part of the way to achieving this, but such initiatives cannot survive without Department wide support (i.e. a meeting of 'top-down and 'bottom-up').

After promising initial results with the experimental group, problems were encountered when the system was opened up to a wider community of staff and students. This wider exposure found that the quality system was at odds with the prevailing culture. It can argued that the external-micro and external-macro initiatives identified in Figure 2 (eg. HEQC, HEFCE), aim to change the culture within a department so that it becomes more receptive to such systems. The objective, therefore, is to influence the participants in higher education at the internal/micro level (eg. cognitive and affective domains). These two forces meet to form a particular culture and set of systems (see Figure 8). However, if there is a mismatch between these internal and external pressure, as in the case of the research project, then the result can be confusion, contradiction and 'tokenism'.

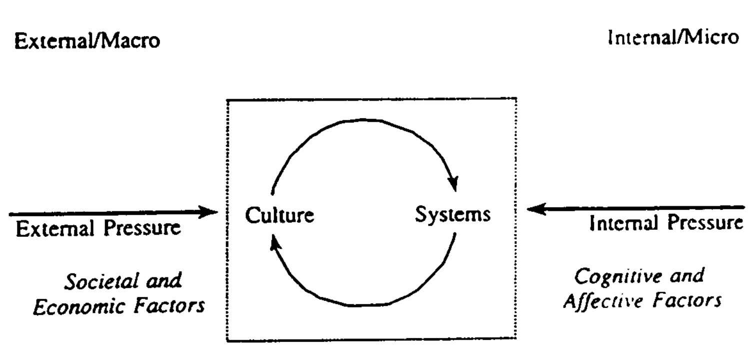

Figure 8: Pressure on Departmental Culture and Systems.

Based on this research project, it must be questioned how effective external/macro systems will be in actually changing the behaviour and attitudes of the participants in engineering higher education, i.e. whether such systems are actually reflected at a 'grass roots' level. It must be remembered that differing universities have differing cultures, therefore there is no universal procedure. The required change in attitude and behaviour that such external pressure aims to engender are not attained, as the participants do not fully internalise the required mechanisms and systems.

Looking back, the quality system was not sufficiently integrated into the mechanisms and culture of the Department and its courses. For such systems to succeed they need to be linked to larger, organisation-wide programmes. This requires a more holistic view of quality systems and culture, and how they impact and impinge on each other, rather than the isolated approach the research study was required to take, i.e. it was examining one aspect of the Departments culture and systems. In attempting to bring around the required cultural change, the project may have been too ambitious, given the short time frame (i.e. three years), the sensitivity of the research area (i.e. staff and student relationships and interactions), and the developments in the external environment (i.e. increased participation rates and accountability). The pressure to introduce a quality system in such a short period of time meant that a more gradual and subtle introduction was not possible. The task is now to find progressive systems that match the cultures of the host departments.

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