UNIVERSITY OF DERBY

AN ONLINE INTELLIGENT SYSTEM FOR TEACHING ENGINEERING DESIGN TECHNOLOGIES

BY

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Acknowledgements

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I must thank all my Family especially my husband Dr. Illias Oraifige who has been a constant source of encouragement. Finally I would like to dedicate this thesis to my father Yousef Nour Owies who inspires me to succeed.

"Lecturers are out there with a very difficult job, which they pursue with tireless dedication".

Chi McBride
Abstract

This study was based on a project, which was initiated by the author to respond to the needs of today’s market for the design and development of an online intelligent teaching system for engineering design technologies. The research project took place over the period of November 2005 to September 2010.

Engineering design is a knowledge intensive process that encompasses conceptual, detail analysis and evaluation, which involves various areas of knowledge and experience. The sharing between these tasks is critical to increase the capacity for new product development, while maintaining its quality. Engineering Design Technologies (EDT) describes the use of a wide range of computer-based tools to assist engineers in their activities. The rapid growth of such technologies in engineering design industry is considerable and it is important that education moves into this area of work. As this industry evolves, students in Higher Education (HE) seek to learn technologies that can best facilitate their future careers. Teaching EDT in the traditional way may involve standing in front of an audience and explaining instructions step by step. One of the main tasks of competent teaching is to provide a continuous training course with a wide diversity of problems and supporting activities.

This study presented the design, development, implementation and evaluation of an online system for teaching EDT to engineering students. The system was designed to guides them, according to their abilities and offers progression through an intelligent/individual learning plan that enabled them to access and navigates various engineering design tools and theoretical topics, supported by appropriate guidance remotely. The developed system incorporated a number of facilities to aid effective interaction and to promote experiential learning. Students were able to understand design concepts, perform different tasks, and therefore achieve the learning outcomes of individual modules. Their performance was continuously being evaluated and guided through appropriate assessment according to their learning styles, knowledge and needs. Results of different groups of students were analysed in details to determine the system’s effectiveness, this included change of pattern and level of students’ achievements. It determined the benefits and limitations of the operational procedures and the functions of the individual components.

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Glossary of Abbreviations

AI – Artificial Intelligence
ASP – Active Server Pages
BOM – Bills of Materials
CAA – Computer Aided Assisted
CAD – Computer Aided Design / Computer Aided Drafting
CADD – Computer Aided Design and Drafting
CAID – Computer Aided Industrial Design
EDT – Engineering Design Technologies
FA – Formative Assessment
GUI – Graphical User Interface
HE – Higher Education
HTML – Hypertext Markup Language
ICT – Information and Communication Technologies
IIS – Internet Information Services
ILP – Intelligent/Individual Learning Plan
ILS – Index of Learning Styles
IQ – Intelligence Quota
ITS – Intelligent Tutoring Systems
LS – Learning Styles
OS – Operating System
PBOL – Project Based Online Learning
PC – Personal Computer
PHP – Hypertext Preprocessor
PLA – Pre Learning Assessment
RLO – Reusable Learning Objects
SQL – Structured Query Language database
SW – Semantic Web
UDo – University of Derby Online Facility
VRML – Virtual Reality Modelling Language
WCS – World Co-ordinate System
1.0 Chapter 1 – Introduction

1.1 Introduction

Today, competitive pressures are increasing within the global market place demanding better designs in less time and at lower costs. Hence, industrial organizations seek to develop the optimum design, test it, implement it using state of the art technologies, and market it faster in a cost effective manner (Ye et al. 2004). Engineering design is a knowledge intensive process that encompasses conceptual, detail analysis and evaluation, which involves various areas of knowledge and experience. The sharing between these tasks is critical in increasing the capacity for new product development, while maintaining its quality. Engineering Design Technologies (EDT) describes the use of a wide range of computer-based tools to assist engineers in their activities.

The rapid growth of such technologies in the engineering design industries is considerable and they are looking to employ graduates with software knowledge and computer based competencies. Therefore Higher Education (HE) organisations are required to provide effective and responsive learning facilities within this field. They need to provide students with the knowledge and skills that are most practical and useful to them and allow practice of their design activities. Therefore, it is important that students have solid foundation in both theory and function of EDT that can best facilitate best their future careers (Folkestad and De Miranda 2002).

Teaching EDT in the traditional way can involve presenting in front of an audience and explaining instructions step-by-step. One of the main tasks is to provide continuous training sessions with a wide diversity of problems and activities. The lecturers' selection of examples steers the progress of learning, while the students are responsible for their personal time management. Permanent observation of the learning progress, evaluation of projects and examinations can ensure that most participants maximise their individual potential. However, as lecturers come from various areas of practice, portray diverse practical skills and theoretical knowledge, they may not sometimes recognise the difficulties students face and thereby make incorrect assumptions. Also students and lecturers are often of different age, social background and possess different general knowledge, thus both parties may
frequently have different approaches to problem solving and working processes. Consequently, the position and role of lecturers has to change (Asperl 2005).

Teaching forms part of the EDT education as well as in other subjects, however lecturers should not be the centre of activities; it is more effective to put individual students into the centre and allow them to engage with activities.

The teaching of such technologies is rapidly changing and is becoming an intensive part of the lecturers' responsibilities; hence demands that continue to increase in complexity having dependency on working software packages (Boettcher 1999, Hedberg 2000, Raval 2000). Many lecturers are familiar with the feeling of teaching a class only to find that the software will not function properly or co-operate. It is not uncommon to hear lecturers complain that a software application was not working or students remarks on how lecturers are not capable of using the software. Henceforth, many lecturers avoid teaching or demonstrating computer applications altogether (Zhao and Cziko 2001, Dawson 1996). Furthermore, students have their own pace of learning making it difficult to teach EDT in a stand-and-deliver format. Where some students excel and subsequently are waiting on the lecturers, others lag behind and may never grasp the intended learning objectives. Therefore, lecturers need quick and easy methods to use instructional technique for teaching EDT in order for students to be taught and communicated more effectively.

Online resources for teaching engineering students have grown significantly over the past few years. They can provide a new educational experience for teaching and learning that can open positive aspects of communication, collaboration and knowledge transfer. They can also offer educators a new medium to deliver teaching and learning material, which can bring new and exciting ways of learning and an alternative to traditional teaching techniques. They can potentially offer students many possibilities for enriching the learning process and promote multi-way knowledge transfers by having various interactive communication methods, techniques and activities (Kurubacak 2007). However careful research and analysis has proved that online education is far from achieving its main goal - reaching a wide distance with effective educational benefits. This is due to the fact that current online education systems are only being used as a depositary tools for uploading teaching material without the necessary interactive activities that would support individualised
learning processes. Online education should provide higher-level of services to its learners, it needs to accommodate flexible, independent, individual and personalised learning process. Students need to participate actively in their own learning and interact with the subject matter to enhance their understanding. However, the effectiveness of such systems is dependant on promoting the advancement of students' knowledge through gradual experiential learning rather than just the transfer of data. This will open possibilities that meet the learning needs of a diverse population to both students and educators on the web (Storey et al. 2002).

1.2 Aim
This research project aims to design, develop, implement and evaluate an online intelligent system that guides students according to their learning styles, abilities and progression through an intelligent/individual learning plan. It enables them to access and navigate various educational tools while their performance is continuously being evaluated through the appropriate assessment. The system incorporates a number of facilities to aid effective interaction and promote experiential learning. It aims to provide a wide distribution across the Internet and allow students to benefit from the available capabilities and achieve the desirable learning experience. It enables them to interact and explore this environment rapidly and directly, which can be utilised according to their own abilities through the use of menus and visual components.

1.3 Objectives
The proposed research project aim is achieved by the following objectives:

- Conduct a comprehensive literature review to fulfil the following and study the potential implications within their specifications:
  1. Research and investigation of existing educational methods and techniques such as, traditional, online and intelligent.
  2. Examine different factors that can enhance the learning experience such as learning styles, formative assessment and individual learning plans.

- Design and specify a novel framework with its comprehensive architectural operations that facilitates the desired outcome.
Creation of a fully operational system with all the necessary components as specified in the designed framework architecture.

Implementation and application of the developed system through a full educational experience to satisfy the adaptation and operations of its components' functions and features.

Evaluation and analysis of the results to promote new interactions in online education in order to establish the necessary recommendations for the envisioned benefits.

1.4 Methodology

Achieving the identified objectives within this research project requires a methodical approach that can satisfy all the necessary parameters and constraints within each objective. This methodology is based on using various methods and processes including data collection from various sources, this involves the collection and analysis of the necessary information and applying the appropriate interpretation relating to the research question, as shown in Figure 1.1.

Figure 1.1 Flow Diagram of the Implemented Methodological Process

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1.4.1 Literature Review
The literature survey includes a full investigation and analysis of the necessary and appropriate data to satisfy the following:

- Existing methods and techniques that are being used for the teaching of engineering design technologies such as, traditional, online and intelligent methods. This investigation focuses on the strengths and weakness of these methods in order to apply the most optimum method within the proposed system.
- Architecture and design of existing online intelligent systems used in HE institutions. Various systems have different requirements and support tools, this information can assist in the specification of the proposed in order to ensure it compatibility while providing maximum learning media in the most cost effective manner.
- Implications and specification of a practical problem (scenario) within using such systems. This provides exploration in further details the circumstances under which these systems can be evaluated in terms of resources and required support. This can feed into the development process in order to minimise potential implications and technical problems.
- Research works aiming to improve design education and investigation of different factors that can be added to enhance the learning experience such as learning styles, formative assessment and individual learning plans. These factors are being underutilised within current research work which leads to underperforming teaching systems. The outcome of this study can feed into the proposed system to maximise students' learning and ability to achieve to the best of their potential.

1.4.2 Framework Development
The framework development starts by outlining the main structure and the components of the proposed system. This investigates the architecture and the operational flow between these components and how each functions. It then develops an overall architecture that provides the skeleton structure of the proposed system with a functional flow diagram showing its operations including relevant input and output information, which applies a top-down bottom-up strategy. The author consults with students by means of questionnaire and interviews, while developing
the system to ensure that the appropriate facilities, functions and interface are provided. The author also implements what was already found through the literature review to ensure that the pedagogical ethos is also embedded within the developed system. Having finalised the overall architecture and tested that it positively provides the ultimate functional requirements; each sub section is designed to provide appropriate functional input/output activities that supports the achievement of the overall system.

1.4.3 System Development

- System components

Within the system development the main components is developed and integrated together to provide a fully functional system, these includes:

1. User Information <the basic access interface>: information regarding individual students that the system acquires on registration. Within this component the user is able to register and thereby securing a username and password which allows him/her to access the full system. At the same time this component starts the data collection process about individual students in order to track their performance over the period of using the system. It also uses the gathered information to provide useful and appropriate feedback to the individual students regarding their performance and the best way forward towards achieving their targets.

2. Learning Style <individual learning style information>: to provide students' preferences for their learning styles. Based on a specially designed questionnaire the system identifies the individual student's preferred learning style. This can be facilitated by providing the relevant material in the appropriate format that suits the student's learning style, e.g. visual. This helps the student in terms of the way he/she carries out the required tasks and activities.

3. Pre-Assessment and Learning Target setup <intelligent, adaptive target for learning>: this examines and records the students' knowledge of the subject or what they already know. As various students can have different background knowledge, this component uses this knowledge to identify the entry point that the students could start at, however students are always given the opportunity
to start from the beginning should they wish, such approach enhances their knowledge and confidence in using the system.

4. Intelligent/Individual Learning Plan <ILP-driven learning>: this contains an intelligent personal learning advice that records all students' interaction with the system and also guides them through achieving the learning outcomes of the taught subject. It serves as real time update of their performance and level of achievement. It also provides the lecturer of the status of students and hence identifying the level of support required at various stages of students' journey within the system.

5. Subject Database <subject knowledge material>: this includes the database that is concerned with the teaching/learning subjects and topics to be presented to the learner. It includes the teaching material as well as tutorials and activities that are required to support the learning process of individual topics. This material is available in various formats to suit all students with their various learning styles and needs.

6. Formative Assessment and feedback <effective evaluation>: this provides students with an effective evaluation and feedback of their knowledge regarding particular learnt topics. This component evaluates students' learning following each activity in order to identify areas of improvement that are required prior to proceeding to the next stage. It also provides students with accurate reflection of their performance in individual topics which highlights theirs strengths as well as areas where work still needs to be done. The overall aim of this component is to prepare students for their important summative assessment.

Components Integration

After the development of all the system components, they are integrated and linked together appropriately to provide a fully operational system. Such integration results in creating a dynamic specific links between these components to ensure successful relationships that satisfy the students' need and requirements. Individual components are tested as they are being integrated in order to minimise potential operational problems. Once these components are successfully integrated and tested, the overall system is tested to ensure full operational success. Any problem or issues are investigated and resolved.
User-Interface Development

This is one of the most important components as it provides the communication link between the system and the students. It includes an active dialogue that determines the most appropriate method of providing information to the students as well as interchanging and executing appropriate commands. This interface includes all mechanisms for data input and output of results from the system. It has graphic interface with icons and windows showing necessary data that is available in the system. Through this interface, students can control and interact with the data; review or print the results. The other part of this interface is between the system and the lecturer as it provides the lecturer with all the relevant information about individual students. Such information is critical in identifying students' needs and support. It also provides the lecturer with the opportunity to prepare appropriate teaching material and activities to suit various students' needs. This interface structure is suited to upload different teaching material to relevant subjects.

1.4.4 System Applications

At this stage the system is tested and analysed by using it as an educational tool to provide viable solution for a teaching experience. The system is used with a number of students with different level of learning to satisfy the operation of its components and the adaptation of the different knowledge and understanding of the taught subject. Once different groups of students have used the system, their results are analysed in details to determine its effectiveness. The analysis includes investigating the number of students that engaged with the system and level of achievement that have been secured, this should accurately reflect the level of learning that students are able to achieve over the period of using the system. The author then compares the summative results for the groups of students who used the developed system to results from previous years. Such analysis identifies the change in pattern and level of students' achievements. The outcome provides strong evidence whether using the developed system can be of a benefit to the students and thereby can lead to an overall improvement in students' performance.
1.4.5 Analysis and Evaluations
This stage comprises of evaluating the developed system through its use for the above applications. It determines the benefits and limitations of the operational procedures and the functions of the components. The evaluation encompasses compiling a constructive set of questions that is completed by the number of students that have used the system. The questions contain different topics to satisfy a complete evaluation of the system, such as:

- Access and ease of use.
- Operation of the system.
- Help and guidance.
- Benefits and limitations of using different functions.
- Efficiency of the system.

The results are then gathered and analysed using graphs and pie charts.

1.5 Thesis Structure
This thesis describes and discusses the work carried out for the development of a new methodology as well as outlining proposals for future developments. This thesis is organised in the following manner:

**Chapter One** presents an overview of the progression in teaching design technologies over the past decade leading to the demand for a new method that can satisfy the needs of today's industry. It highlights the necessity for producing more cost effective designs in less time in order to deal with the current global market demands, where success of achieving such targets depends on the education of current graduates in engineering design technologies. Therefore HE organisations are required to provide their graduates with effective and responsive learning facilities. The research aim and objectives are also outlined in details in this chapter including the methodology by which they are to be achieved.
Chapter Two covers a comprehensive literature review of the previous research work that was carried out in the field of teaching engineering design technologies such as traditional, online and intelligent methods. Research and study of existing intelligent systems used in HE, investigation of implications and factors that can be implemented to enhance the students' learning experience is also discussed. This chapter outlines the benefits gained from previous work as well as pointing out the shortcomings of such research. The outcome of this chapter verifies and justifies the theme of this research project and provides the author with the necessary pedagogical ethos that need to be considered in the development of the proposed system.

Chapter Three discusses the development of the proposed framework that outlines the structure of the system and its components. It also presents in details the proposed architecture and the operational flow for these components including facilitated functions for the input and output information. The outcome of this chapter grants a complete overall architecture with ultimate functional requirements for the proposed system.

Chapter Four describes the design and development of the overall system with all its components. Each individual component is designed, developed and tested prior to its integration to other components within the system. This integration includes the description of the specific relationships between these components and their dependency on each other in order to build the appropriate functionality for this learning experience. The operational and communication links between the system and the students that is provided through the development of a user interface includes the necessary active dialogue for the system's success. This design and development process is presented in details within this chapter including appropriate flow charts and program listing. The outcome of this chapter is an online link to the developed system that can be accessed by students.

Chapter Five reveals the system being used as an educational tool to provide a viable solution for a chosen teaching experience. Description of the selected module as well as the groups of students is discussed and analysed. Once the system has been tested by a number of students, their results are examined in detail to
determine its effectiveness. This analysis includes; firstly, an investigation of the system's use at many levels such as achievements, learning experience, success, etc. Secondly, a comparison between summative assessments results with previous years. The outcome of this chapter provides a strong indication whether there has been an improvement in students' learning and achievements.

Chapter Six describes the evaluation of the developed system by determining the benefits and limitations of its operational procedures and their effectiveness. This evaluation is the result of a specially designed questionnaire and interviews with students that have used the system. The results are compiled and analysed using graphs and charts. The outcome of this chapter presents the students' views and feedback about using the system and how it can be improved.

Chapter Seven discusses the outcome of the system being used as an educational tool for the second experience to provide a viable solution. Based on the lessons that can be learnt from the first experience in previous chapters, this chapter exhibits the appropriate plan and implementation to ensure using the system to its full potential. Description of the selected modules as well as the groups of students is discussed and analysed in this chapter. Once the system is used by a number of students, their results is studied in details to determine their effectiveness. The analysis includes firstly an investigation of the system's use at many levels such as achievements, learning experience and successes. Secondly, a comparison between summative assessments results with previous years. This outcome of this chapter provides a strong indication whether there has been an improvement to the first experience of the system and also the students' learning and achievements.

Chapter Eight outlines the evaluation of the developed system for the second group by determining the benefits and limitations of its operational procedures and their effectiveness. This evaluation is based on the similar specially designed questionnaire that was used for the previous group with the necessary modifications to cater for their feedback. Also interviews and informal discussions are carried out with the students that have used the system. The results are then compiled and analysed using graphs and charts. The outcome of this chapter reveals the students' views and feedback about using the system and how it can be improved further.

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Chapter Nine discusses the work carried out in the whole research program and identify a critical assessment of the results achieved. It shows how the developed system is applied by the HE to provide current engineering graduate with effective and responsive learning facilities. This chapter also demonstrate how the developed system is different and more applicable to today's industries compared with previously developed by other researchers. It outlines the proposed future developments to be carried out in order to enhance the system operations and functionalities.

1.6 Contribution to Knowledge

Although online education provides flexible and independent learning, it is still currently being used as a depositary tool for uploading teaching data with rigid transfer approaches. This opens the possibilities of new creations for individualised learning processes that facilitate the necessary interactive activities, which meets the learning needs of a diverse population to both students and educators. It should provide flexibility as well as higher level of interactions and exponential learning that is necessary for students to participate actively in their own learning and interact with the subject matter to enhance their understanding.

The main contribution to knowledge within this research project is the enhancement of students' learning experience by the creation of a new hypothesis that promotes on-line teaching material and methods to be adapted according to the individual student's experiences, learning style and performance. The planning and implementation of this research project is to design, develop, test, explore and evaluate this new hypothesis and its questions, which are evident in the creation of a novel system and using it as an educational tool for engineering design technologies. Students are able to understand design concepts, as well as learning to perform different tasks, and therefore achieving the learning outcomes of individual subjects. This is achieved while students' performance is continuously being evaluated and guided through appropriate assessment according to their learning styles, background knowledge and needs. This dynamic relationship between students and the system facilitates the educational goal for a particular student through providing links that can be hidden, while some additional links can be generated. In particular,
the system provides an intelligent personal learning plan that records all students' interaction with the system and also guides them through achieving the learning outcomes of the taught subject while monitoring their progress from a distance.

The prime contribution to knowledge can be summarised as follow:

- The creation of a novel and unique intelligent system for teaching engineering design technologies using a wide distribution across the Internet.
- The establishment of an operational exchange-of-information model between the students and lectures. This permits students to benefit from a wide range of functions and capabilities such as learning styles and formative assessment with feedback ensuring that desirable learning experience is well achieved.
- The investigation and formulation of a dynamic relationship between students and the system that facilitates the educational goal of a particular student according to his/her preferable learning style, background experience and performance.
- The invention of an ILP that instigates the appropriate intelligence to record student's interactions and thereby guiding him/her through the learning experience. Therefore achieving the learning outcomes of the taught subject while their progress is being monitored from a distance.
2.0 Chapter 2 – Literature Review

Engineering design is internationally recognised as a systematic intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints (Dym et al. 2005). Engineering Design Technologies (EDT) refer to the use of a wide range of computer-based tools to assist engineers in their design activities. They are geometry-authoring tools used within the Product Lifecycle Management process and involve both software and sometimes interfacing with special-purpose hardware. Current packages range from simple 2D vector based drafting systems to 3D parametric surface and solid design modellers (Garcia et al. 2007).

Such technologies are often referred to as CAD (Computer Aided Design) or (Computer Aided Drafting), CAA (Computer Aided Assisted), or a similar phrase. Also other related acronyms include; CADD, which stands for "Computer Aided Design and Drafting", CAID for Computer Aided Industrial Design. All these terms are essentially synonymous, but there are some subtle differences in meaning and application, for example Computer Aided Drafting only covers the drawing aspects of the design process, while Computer Aided Design also incorporates physical properties of the designed components/products.

These technologies are used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. They are also extensively used in the design of tools and machinery used in the manufacture of components. They are used throughout the engineering design process from conceptual design and layout (Aurasound Inc. 2010), as shown in Figure 2.2, through detailed engineering and analysis of components to definition of manufacturing methods.
The capabilities of EDT can include:

- Design creation features that expand from wire frame to 3D modelling and thereby the ability to produce drawing covering concepts to engineering drawings:
  - Wire frame geometry creation.
  - 3D parametric feature based modelling, solid modelling.
  - Freeform surface modelling.
  - Automated design of assemblies, which are collections of parts.
  - Create engineering drawings from the solid models.
  - Reuse of design components.
  - Ease of modification of design of model and the production of multiple versions.

- Design optimisation and creation of associated input/output files to facilitate the generation of complete designs with physical properties;
  - Automatic generation of standard components of the design.
Validation/verification of designs against specifications and design rules.

Simulation of designs without building a physical prototype.

Output of engineering documentation, such as manufacturing drawings, and Bills of Materials (BOM).

Import/Export routines to exchange data with other software packages.

Output of design data directly to manufacturing facilities.

Output directly to a Rapid Prototyping or Rapid Manufacture Machine for industrial prototypes.

Maintain libraries of parts and assemblies.

The use of the created design to analyse the individual parts as well as the full assembly in order to predict any possible problems, make the appropriate changes and hence prevent any potential problems;

Calculate mass properties of parts and assemblies to ensure correct fittings.

Aid visualisation with shading, rotating and hidden line removal.

Bi-directional parametric associatively (modification of any feature is reflected in all information relying on that feature; drawings, mass properties, assemblies, etc. and counter wise).

Kinematics, interference and clearance checking of assemblies sheet metal hose/cable routing

Electrical component packaging.

Inclusion of programming code in a model to control and relate desired attributes of the model

Programmable design studies and optimisation

Sophisticated visual analysis routines, for draft, curvature, curvature continuity...

Traditionally, the engineering design process has been at a distinct disadvantage due to a lack of sophisticated tools and models needed to describe such process from a development perspective (Poindexter et al. 1999). However, in the last few years with the advent of lower cost, more powerful networking and computing technologies, there has been an explosion in the use of modern technologies across the...
engineering design enterprise, ranging from physics-based material development processes and fabrication and assembly activities to advance cost and life-cycle modelling and high-level business process representation. Recently demonstrated advances in modern technological tools offer the potential to efficiently examine the impacts of many development scenarios and, thereby, reduce risk before costly investments in resources including tooling, materials, facilities and training programmes. However, even with these advances, the use of modern technologies across the enterprise is far below of what is needed to fully understand and describe the system represented by the design and its associated processes. Technologies applications such as modelling and simulation in the engineering design process are not considered to be critical-path activities, but rather are used as troubleshooting tools. Models of products, factory layout, equipment reorganisation and simulations of design processes are often created to help diagnose problems, but currently are infrequently used to create and optimise the engineering design process. This demonstrates that the prevalence and importance of computer applications within high-tech industry is undeniable, therefore it is vitally important that industrial technology graduates enter the workplace with a solid foundation in both theory and function. Companies are looking to hire individuals with software knowledge and computer-based competencies, therefore with the proliferation of new software, teaching these technologies is a rapidly changing and technology intensive part of the faculty member’s responsibilities; demands that continue to increase in complexity. This has required colleges and universities to provide maximum learning facilities within this field, students sought to obtain knowledge and skills that are most practical and useful to them while serving their future careers and practicing their design activities (Folkestad and De Miranda 2002).

The following sections provide a comprehensive literature review of the previous research work that was carried out in the field of teaching EDT. Investigations of the implications and factors that can be implemented to enhance the students' learning experience are also discussed.
2.1 Traditional Teaching

Colleges and universities are teaching EDT in different disciplines with different focuses, for example, in engineering disciplines such as aerospace, automobile, ship building and consumer product design, EDT may be taught as tools to assist their design drawing and drafting; or as part of engineering mathematics or graphics. However, as design industry evolves, students want to obtain the maximum value of learning such technologies so that it can best facilitate their future careers. They want to obtain knowledge and skills that are most practical and useful to them when they become engineers. On the other hand, lecturers also wish to provide their students with the maximum value of teaching EDT in related courses. Ye et al. (2004) conducted a survey on the importance of teaching EDT for students in colleges and universities. In the survey, the participants were asked what they think about the current status of EDT education in colleges and universities. From the 150 answers that were returned, only 8% of the participants thought that current EDT education is adequate. 18% of the participants thought that they have been taught too much, either in mathematics, computer science, or mechanical engineering. 74% of the participants thought they should have been taught more, in the order of, practical training, application development, computer science, mathematics, and mechanical engineering. They concluded that the current syllabus and training is not yet comprehensive and systematic.

Teaching EDT in the traditional way may involve presenting in front of an audience and explaining instructions step-by-step. According to Asperl (2005), lecturers should understand the difficulties of learning EDT and they should be able to counteract with these problems in various ways. Often, lecturers come from various areas of practice, obtain diverse practical skills and theoretical knowledge, but they sometimes do not realise the difficulties students face. Also students and lecturers are often of different age, social background and possess different general knowledge, thus both parties often have different approaches to problem solving and working processes. Students educated in a classical mathematical or scientific way start with thinking about the problem, where students with less scientific educational background tend to start with trying various possibilities. In most cases, students with classical mathematical background start to put their cognitive considerations into
action after about five minutes and they often fail. However, only by reflecting on their incorrect attempt, they begin to get the right answers and realise how to solve the problem. Asperl (2005) also argued that if lecturers are aware of this, they can easily try to adopt their teaching methods to the needs of their students. Good lecturers need to:

- Consider the challenges of the learning process of their students: Lessons with large parts of self-determined student work can provide lecturers a good opportunity to monitor the learning process of their students. Thus they will find out difficulties in the learning progress at a very early stage and can deal with these troubles by providing more exercise material, personal coaching or individual teaching support.

- Promotes autonomous learning by problem and process oriented sequences: one of the main tasks is to provide continuous training sessions with a wide diversity of problems and activities. The lecturers' selection of examples steers the progress of learning, while the students are responsible for their personal time and task management. Ongoing observation of the learning progress, evaluation of projects and examinations secure that most participants maximise their individual potential.

- Brings in a lot of enthusiasm and transfers this attitude to their students: students need to be encouraged by the spirit of their lecturers and therefore motivated to invest more time and power in their personal education.

Asperl (2005) concluded that as a consequence of this the role of lecturers have to change to adapt new teaching methods and techniques. Teaching should only be a small part in EDT education as well as in other subjects. Lecturers should not be the centre of activities; it is more effective to put individual students into the centre. A good EDT lecturer does not have to be the “most valuable” CAD player, but has to be the best coach and guide.

Teaching these technologies is a rapidly changing and is becoming an intensive part of the lecturers' responsibilities; demands that continue to increase in complexity (Boettcher 1999, Hedberg 2000, Raval and Vasant 2000). Evidence of these demands can be found throughout higher education. For example, many lecturers
are familiar with the feeling of teaching a class only to find that the software will not function properly. It is not uncommon to hear a lecturer complain that a software application was not working or a student remark on how a lecturer is not capable of using the software. Henceforth, many lecturers avoid teaching or demonstrating computer applications altogether (Zhao and Cziko 2001, Dawson 1996). The fact is that such education is not easy to learn; it not only requires computer skills but also mental capacity, spatial vision and physical coordination. This effort means that many students panic due to the initial difficulty and the need for continuous training because of the rapid obsolescence of the acquired knowledge (Garcia et al. 2007). Another example, software packages are changing and being upgraded so frequently that it is difficult for practitioners, let alone educators, to remain current and proficient in their use. This leads to a situation where lecturers are often learning the software just prior to providing in-class demonstrations. Furthermore, each student has their own pace of learning making it difficult to teach such related technologies in a stand-and-deliver format, where some students excel and subsequently are waiting on the lecturer; others lag behind and may never grasp the intended learning objectives. Lecturers need a quick and easy to use instructional technique for teaching EDT (Folkestad and De Miranda 2002).

Whilst traditional teaching methods, such as face-to-face lectures, tutorials, and mentoring, remain dominant in the educational sector, universities are investing heavily in learning technologies, to facilitate improvements with respect to the quality of learning. The implementation of such technologies, as an advanced flexible technology with its unique characteristics is one of the main new investments. Cancannon et al. (2005) stated that there is a trend in higher education to utilise the benefits of this implementation to improve the learning performance of students. As a result of this trend, many universities around the world are expanding their investment in adopting such technologies. However, several studies concentrated on barriers to using technology in education. Findings have shown that barriers included lack of lecturer time, limited access and high cost of equipment, lack of vision or rationale for technology use, lack of lecturer training and support, and current assessment practices that may not reflect what is learned with technology (Muir-Herzig 2004). Educational researchers such as Biggs (2005) and Ramsden (2005) have identified different approaches to learning that can be used to characterise the
ways in which students engage in learning tasks and their learning environment. Mahdizadeh et al. (2007) believed that before assessing the impact of technology on education, one should focus on how lecturers deliver lessons/lectures and how students learn. Race and Powell (2000) identified constructivist learning approach and instructional strategy as being important. Lowerison et al. (2006) also considered learning strategy and instructional technique as two effective factors of students’ perceived effectiveness of computer technology use.

To address the widespread inefficient teaching of EDT applications, Bhavnani et al. (2001) identified a set of efficient and general strategies for teaching such applications effectively. They formulated a general instructional framework explicitly in combination with command knowledge. Furthermore, they implemented this framework within a university course for students and carried out a controlled experiment in which they compared their approach to the traditional approach. This approach provided a promising alternative to traditional training, especially that its implementation was not appreciably more complex, and it did not require excessive time. The experiment revealed that some strategies may be automatically acquired just by learning commands. On the other hand, it also showed that other important strategies are not that easily acquired but can be learned as a result of explicit instruction.

Didactical principles and difficulties in EDT traditional education have been discussed; learning EDT is a hard task for all those students about to take their first steps in the field of computational graphics, and it is no less difficult for lecturers who face a multitude of software packages and options with which to transmit their knowledge (Garcia al. 2007). However, it is evident from current research (Asperl 2005) that there still exist a lot of yet fully understood interactions between lecturer, students and EDT, which have to be investigated further. Knowing exactly how the knowledge transfer is happening and what type of teaching support fits best, will surely lead to a further improvement of EDT education.


2.2 Online Learning

The Industrial society is rapidly becoming more technologically complex. Consequently, students need to be taught and communicated more effectively than they have been in the past. Universities must prepare students to become active members of this changing society to adapt to these transformations as they occur. Also, universities must build rich online programs that facilitate and promote multi-way knowledge transfers by having various interactive communication methods, techniques and activities. Kurubacak (2007) research work focused on exploring the main characteristics of Project-Based Online Learning (PBOL) to promote students' critical learning skills through Reusable Learning Objects (RLO) from global online resources. This was a qualitative case study that utilised both qualitative and quantitative data to provide detailed information for data collection. The study used this data for both summative and formative evaluation methods to assess the students’ critical thinking developments and their RLO based tasks during the course. The formative assessment addressed the learners’ self and group tasks that have been accomplished or not accomplished during the course (Process) whereas the summative assessment addressed the learners’ self and group tasks that have been accomplished or not accomplished at the end of the course (Production). Through this data analysis, this research addressed the diverse questions and concerns toward higher-order think skills, which were very crucial for students to build democratic and multicultural communities via RLO. Their work provided a constructivist-based PBOL approach to improve student critical thinking skills successfully by exploring different practices and various experiences from the real-life situations. To sum up, this study discussed pedagogical knowledge and design guidelines that would be comprehensively required for the communication-oriented designs of digital reusable learning resources.

Online technologies appear to offer many advantages over conventional formats including economies in cost, greater levels of access to students, more flexible teaching and learning approaches and enhanced educational opportunities. But the literature suggests that many of these assumed goals are often not being met in practice. Foremost among these unmet outcomes is the frequent failure of online learning environments to create enhanced learning processes and learning
outcomes. Oliver (1999) explored design strategies for online learning, suggested and demonstrated ways in which online technologies can be used to enhance the learning processes. This research also explored the ways in which lecturers using online learning environments can gain added value from the available technologies by implementing them in various ways. It described a framework which identified and distinguished between three critical elements in the design of online learning: the content of the course, the learning activities and the learning supports. Each of these elements can be manipulated in deliberate ways to influence learning outcomes and each can play a significant role in the quality of the learning achieved. Examples were used to demonstrate ways in which learning activities can be designed to take advantage of online opportunities as communication, collaboration, and information access with storage. This research concluded that there is need for lecturers to look critically at online education. There is a growing body of evidence guiding them towards best practice in the design of effective learning environments. They need to carefully consider how well their online courses can add value to the learning processes. They can do this by considering different ways in which they can use such technologies to provide access to appropriate content and resources, to engage and motivate the students and to support them in their learning activities.

Mahdizadeh et al. (2007) conducted a study to identify factors in using online learning. The main purpose of this study was to investigate lecturers' use of online learning environments as teaching and learning tools in higher education. A questionnaire was completed by 178 lecturers from a wide variety of departments at Wageningen University in the Netherlands. Results concluded that lecturers' perceived added value of online learning environments as part of their general attitude and opinion about computers and the web. However, they also concluded that while computers and the web have a direct impact on the perceived added value of online learning environments, it was not possible to explain the impact of instructional and pedagogical aspects of those environments. Thereby, further studies are needed to shed light on the unexplained part of the variance of lecturers' use of online learning environments. Most of the positive experiences show that web-based education works well for well-prepared, well-motivated students in reasonably homogeneous virtual classrooms. It is thought that one of the difficulties with web-based education is the teaching methods, which currently comes in various forms -
lectures, tutorials, examples, quizzes, and assignments, is still implicitly oriented for a traditional on-campus audience. A web-based course, which is designed with a particular class of students in mind, who may have very different goals, backgrounds, knowledge levels, and learning capabilities, may not suit other students. The only way to enhance it is to make the course material richer and more flexible so that different students can get personalised content and order of presentation.

Brusilovsky et al. (1998) proposed to develop web-based courses, which can adapt to students with different backgrounds, prior knowledge of the subject and learning goals. For example, students with specific goals could access many parts of the course in more detail, students with some knowledge of the subject would not be taught the known material again, and less prepared students would get more examples and more problems, starting from the very simple. It consisted of three levels or steps of increasing complexity on the way to a flexible and adaptive courseware. They claim that all three steps up to the level of adaptive guidance must be made to turn web-based education into a way to maximise educational opportunity for the majority types of students. The major problem with such system is that its development would be time consuming, and the end result will not be suitable for EDT teaching. Students who have never worked with complex information systems simply cannot cope with advanced hyperspaces offered by modern web-based applications. They will rarely be able to find a relevant learning path to suit their knowledge, background and goals.

While many research studies report substantial success with web-based education, a careful analysis of the situation and informal discussions with lecturers show that web-based education is quite far from achieving its main goal - reaching a wide distance audience in a cost effective and educationally sound manner (Brusilovsky et al. 1998). There appears to be a need for lecturers to look critically at the online teaching and learning methods with careful consideration of how well these methods are adding value to their learning programmes (Oliver 1999). They can do this by considering the ways in which they use the new technologies to provide access to appropriate content and resources, to engage and motivate their students and to support them in their learning activities. Bourne et al (2005) recommended that engineering establishments should explore, implement, and extend blended learning and partnership activities with continuation to implement online technology that
increase the quality of their courses, improve the ability to scale to larger populations and the breadth of coverage. The collection of data and distribution of knowledge about successes and failures will permit successful operation across the spectrum of colleges and universities engaged in online engineering education over the upcoming decade.

2.3 Intelligent Learning Systems

An intelligent learning system can be defined as “an interactive computer program that can solve problems, make decisions, analyse, design, diagnose, and interpret, like an expert, within the context of specifically defined domains, by drawing upon the factual and heuristic information that can be stored in their knowledge bases in relation to these domains” (Beerel 1987). Such systems have been developed to handle problems that cannot be solved by traditional computational-based systems. They are embedded with a wealth of design rules and heuristics (Cheok and Nee 1997). In addition, they have features such as symbolic, programming, objects, rules manipulation and tracing. They are such a large and varied field, which encompasses any computer programme that contains some intelligence and can be used in learning (Freedman 2000). Therefore, in order to increase the degree of objectivity, it is essential to rely on the research of specialists and institutions working in this field. They defined intelligent learning systems in various definitions (Kaklauskas et al. 2006) such as:

- Learning technology that dynamically adapts learning content to objectives, needs, and preferences of a student by making use of his expertise in instructional methods and the subject to be taught.
- Software that aims to communicate the knowledge of a domain (mathematics, language, etc.) to its user. Such system is named "intelligent" mainly if it can adapt the interactions to the student. Therefore, it must have, among other things, some information about the user.
- Software program, which provides instructions to students with guidance and insight in the way lecturers would guide. In its' program the knowledge of "how to teach" is distinct from that which is to be taught and from that which the student knows. Each of these areas of knowledge may be captured in a
knowledge base or at least some form of an abstraction, which the program operates upon to control its execution.

- Educational tools containing an intelligence component. The software tracks students' work, tailoring feedback and hints along the way. By collecting information on a particular student's performance, the software can make inferences about strengths and weaknesses, and can suggest additional work.

- System that is capable of emulating a lecturer's behaviour in all aspects relating to supporting students as they acquire knowledge (Koutsojannis et al. 2001). It offers course units covering the needs of users with different knowledge levels and personal characteristics. It tailors the presentation of the educational material to the users' diverse needs by using AI (Artificial Intelligence) techniques to specify each user's model as well as to make pedagogical decisions. The system tailors the presentation of the teaching material to the diverse needs of its users. To some degree, the users can intervene in the teaching process.

- Hypermedia courses that adapt to each individual user by means of: control of the learning level, control of course navigation, adaptation to available information, adaptation of the teaching methodology, explanation of errors, answers to the student's questions, advice and help. In other words, it is a model which enables a student to be evaluated through the taught subject and also for the education to be adapted to the student's performance (Negnevitsky 1998).

- Computer-based learning systems which attempt to adapt to the needs of the students and provide precise and explicit forms of educational, psychological and social knowledge which are often left implicit (Samuelis 2007). They provide individualised tutoring or instruction and have the following four models or software components (Zhou 1996):
  - Knowledge of the domain (i.e. knowledge of the domain expert, refers to the topic or curriculum being taught).
  - Knowledge of the student, which can be general, personal, technical or professional (e.g., what they know, what they have done, how they learn).
  - Knowledge of lecturer strategies or pedagogical issues i.e. how to teach, in what order, typical mistakes and remediation, typical
questions a student might ask, hints one might offer a student who is stuck).

- User interface and accessibility (i.e. interactive environment interface).

There has been a vast amount of research to identify the relationship between different students' learning traits and different teaching strategies (Jonassen and Grabowski 1993). If a student's learning traits are known, an intelligent system can adapt its behaviour to use the most effective teaching strategy. For example, the intelligent system adapts its behaviour to different levels of IQ (Intelligence Quota) (Shute 1995). Another important learning trait that can be identified and used by the system is a student's cognitive ability, as defined by Piaget's theory of cognitive development (Piaget 1953). The cognitive abilities that Piaget described are important when teaching young students, as they help determine how much and in what way students can begin to understand the topics being taught. In the realm of the system, knowing a student's individual cognitive ability, can greatly improve its effectiveness.

Numerous research and studies show that the web-based intelligent learning is becoming more effective. Due to the rapid growth in the use of computers in education, a large number of web-based educational applications have been developed and implemented. However, very few of them are pedagogically intelligent and responsive for learning purposes. Although educationalists are fascinated by the applications of intelligent web-based techniques in various courseware developments, McArthur et al (1990) reported that the application of such tools in education has somewhat diversified and the approaches are more fractured. Their research work in intelligent and expert systems in education proposes important opportunities to the educational developers and experts so as to investigate important challenges, issues and developments of these applications in teaching/learning for various levels of courses in classroom based as well as web-based educational system. Recent developments in web technologies and using AI techniques support efforts in making the web more intuitive and provide higher-level services to its students; this has opened the door to building the Semantic Web. It's about explicitly declaring the knowledge embedded in many web-based applications, integrating information in an intelligent way and extracting information from texts.
Devedzic (2004) conducted a study on the basics of the Semantic Web (SW) and discussed its importance in future web-based educational applications. This study concluded that the development of Semantic Web in general, and in its use in education in particular, is only at the beginning. The most likely explanation for this fact is that the web is huge, and not smart enough to easily integrate adaptivity and intelligence into its content. Contreras et al. (2006) examined the design and development of an online intelligent learning system consisting of two types of components: administrative and educational. The administrative component included consulting teaching material, enrolling students on courses. The educational component, on the other hand, aimed to replicate the lecturer's behaviour and so an intelligent system has been developed to cover two types of education: distance learning (where the student is not present) and individualised instruction (one-on-one guidance for student education). Their system provided a flexible, independent, individual and personalised online learning process for each student. (Arroyo et al. 2001) presented an independent, adaptive, easy to integrate web-based component to evaluate a student's cognitive development. This component can be used as the pre-test of an adaptive system. The result is a flexible and reusable adaptive component that works over the web. It can be easily plugged-in as a front end to any adaptive web based system that needs a quick cognitive diagnosis of the user. The advantages of this architecture are three-fold. Given that the component allows for high interactivity, it is possible to overcome the limitations of traditional multiple-choice evaluations. The test can be done in minimal time, thus allowing more time to be spent on the actual instruction. Finally this component can be used by any system that needs to establish a student's cognitive ability. They also presented the idea of adaptive testing as a tool to help the system make a quick diagnosis of student's traits, to then adapt its pedagogical and student models to these differences. Authors intend to create other computer-based tests with the final goal of making intelligent systems sensitive to student individual differences, not only with respect to cognitive abilities, but also for the diagnosis of learning styles and emotional traits (Jonassen and Grabowski 1993).

It has been concluded that in higher education (Sener 1991), knowledge has usually been provided through traditional, non-interactive methods. The need to present an ever-increasing amount of material in courses of limited time duration has lead to...
lessened opportunity for student participation and interaction with the subject matter. Within this traditional mode of delivery there is scope for automating certain parts of education, as increasingly attempted by computer-aided intelligent learning packages. It is claimed that such programs enable students to participate actively in their own learning, also interact with the subject matter to enhance their understanding. However, unless the emphasis is explicitly on promoting the advancement of students' knowledge through gradual experiential learning rather than the transfer of data, the development and use of such systems may not be as effective (Day and Suri 1999). There have been relatively few evaluations of intelligent learning systems tools. This is in part because the tools have numerous features and it is difficult to measure the effect of individual features and difficult to create control situations against which to compare the results (Murray 1999). Also, it could be argued that it is sufficient to demonstrate that a variety of authors have successfully developed such tools that were actually used by students. However, only few tools have been used significantly as an "existence proof" for change of supporting technologies (Murray 1993).

2.4 Learning Styles

In higher education, lecturers are required to adopt changes within their teaching methods to accommodate for a wide diversity of students; they can no longer assume that students will learn by being taught in a particular way, they have to adopt new methods and techniques within their teaching, which is greatly aided by the existence of different learning styles. Learning styles are the methods students use to learn and include the ways in which they approach knowledge and utilise information. This can be achieved through many ways, such as: visualising, hearing, reflecting, acting, analysing and modelling. The most important aspect on how students learn in a class depends on the match between their learning preferences and the lecturer teaching styles. Understanding how learning and teaching styles influence learning is becoming increasingly significant. Using a good relationship between teaching and learning styles, can be a strong factor in the success of a topic or a course. Felder and Spurlin (2005) suggested that students have different levels of motivation, different attitudes towards learning, and different responses to specific classroom environments and instructional practices. The more thoroughly lecturers
understand the differences, the better chance they have of meeting the diverse learning needs of all of their students. Learning is a process which combines action and reflection. There are many things that students can do in order to become better students. It is important that students gain a good understanding of how they learn so that they can maximise their strengths, then adapt existing strategies and develop new ones for more beneficial and enjoyable learning experience. At the same time, some students may be conscious of their deficiencies but may not realise that they also have strengths, since traditional teaching does not address those strengths and seldom call on students to exercise them. Learning what those strengths are can be empowering and even transformative (Felder 1990).

Teaching methods vary, some lecturers lecture, others demonstrate or discuss; some focus on principles and others on applications; some emphasise memory and others understanding (Felder and Silverman 1988). Based on this definition, mainly within traditional teaching approaches, this individual providing learning is called “lecturer”, hence he/she is accepted as knowledge provider and the students are knowledge receivers. However this unidirectional relationship hinders, if not eliminates, the feedback channels from the students to the lecturers and only addresses short-term learning objectives (Erhan 2004). This relationship can lack the learning opportunities through pair, group, or corporative-collaboration due to the limited interaction between the students. Critical thinking opportunities are also missed due to “authoritative” environment.

The traditional teaching pattern has to be broken and implement proven-to-be-effective instructional strategies to help students become long-term knowledge acquirers. These motivate higher-order thinking, e.g. analysis, synthesis, evaluation (Bonwell and Eison 1991). Therefore, the responsibility of lecturers stretches from possessing knowledge of subject matter to the knowledge of how students learn and how to transform them into active students (Garvin and Sweet 1991). Johnson et al. (1991) argued that students should be engaged in more activities like dialog, debate, writing, and problem solving than just listening, which will encourage active and corporative learning. (Felder et al. 2002) discussed the effectiveness of these methods in different platforms, which was demonstrated by educational experiments. Erhan (2004) argued that in conjunction to active learning, reinterpreted version of
conventional can be used with skill-gaining strategies; such as apprenticeship that emphasises the selection and use of strategic knowledge for accomplishing a given task or solving a problem. These two approaches taken together with the incorporation of the learning styles (psychological models of how students learn) form an educational framework that students can effectively acquire facts, concepts, and principles. Also lecturers can facilitate learning with examples, practice, and feedback.

Montgomery and Groat (1998) believed that there are many reasons to incorporate an understanding of learning styles within teaching styles:

1. **Making teaching and learning a dialogue:** Students are like empty vessels, and it is the role of lecturers to fill them with knowledge (Tiberius 1986). Once a shift from the empty vessel model to a dialogic and communal one, old habits in teaching begin to shift.

2. **Responding to a more diverse student body:** It is axiomatic to point out that student bodies are increasingly diverse, not only in terms of ethnicity and gender, but also in terms of age, nationality, and cultural background (Knowles 1998).

3. **Communicating intended message:** Lecturers tend to be passionately committed to their discipline/profession and are anxious to convey its significance and knowledge base to their students.

4. **Ensuring the Future of current Disciplines:** An undisputed assumption in career counselling is that any individual will be better suited to some tasks, subject areas, and careers and others, as a function of personality, talents, and cognitive styles.

Educational theorist Kolb (1981) observed that over time selection and socialisation pressures combined to produce an increasingly impermeable and homogenous disciplinary culture and correspondingly specialised orientations to learning, and thereby in order to ensure the long term viability of given field it is essential that such diversity of learning styles are welcomed and encouraged to:

- Motivate learning as much as possible and relate the material being presented to the course.
- Provide a balance of concrete information and abstract concepts.
Provide explicit illustrations of intuitive and sensing patterns and thereby encourage all students to exercise both patterns.

Assign some drill exercises to provide practice in the basic methods applied.

Discuss learning styles with students and advise them that finding academic difficulties may not be due to personal inadequacies.

Learning styles and teaching mismatch leads students to perform very poorly resulting in being discouraged from learning which could lead to dropping out of education (Felder and Brent 2005). Grasha (1996) argued that the problem is not the mismatch between teaching and learning, but rather it is the failure to acknowledge and work out the potential conflicts and misunderstanding that undermine student learning. Indeed, acknowledgement can be empowering for students if they can be made aware of their preferred learning style(s) and assisted in stretching their capabilities to accommodate greater variety (Randall et al. 1995). As Grasha (1996) suggested, any attempts to modify one's teaching style needs to be framed within this boarder of conceptual context. Moreover, matching teaching style to learning style is not a panacea that solves all classroom conflicts. Other factors such as classroom climate, previous background, motivation, gender and multicultural issues will greatly influence that amount and quality of learning that takes place (Mckeachie 1995). Clay and Orwig (1999) suggested that learning style can affect how a student perceives, gathers, and process learning materials. They greatly affect the learning process, and therefore the outcome (Carver et al. 1999, Vincent and Ross 2001). Numerous learning style theories have been applied in educational practices by various research groups including:

- Kolb’s learning style theory (Kolb and Fry 1975, Kolb 1984).
- Gardner’s Multiple Intelligences Theory (Gardner 1993).
- Felder-Silverman Learning Style Theory (Felder and Silverman 1988, Felder 1993).

2.4.1 Learning Styles in Engineering Education

Felder and Brent (2005) discussed three categories of diversity that have been shown to have important implications for teaching and learning are differences in students' learning styles, approaches to learning and intellectual development levels. They also highlighted that if it is pointless to consider tailoring instruction to each
individual student; it is equally misguided to imagine that a single one-size fits all. Unfortunately, a single approach has dominated engineering education since its inception: the lectures and the students attempt to absorb the lecture content and reproduce it in examinations. Their research output concluded that it’s important to understand and be aware of the different attitudes students have toward learning, the different ways they approach it, and how lecturers can influence both their attitudes and approaches.

Litzinger et al. (2007) conducted a study on the Felder-Soloman Index of Learning Styles (ILS) to assess reliability, factor structure, and construct validity. Factor analysis revealed that multiple factors were present within three of the learning style scales, which correspond to known aspects of the scale definitions. The factor analysis and direct feedback from students on whether they felt their scores accurately represented their learning preferences provide evidence of construct validity for the ILS. The results showed that the original version of the ILS generates data with acceptable levels of internal consistency reliability, and that evidence for its construct validity from both factor analysis and student feedback is strong. On the other hand, neither the construct validity nor the factor structure of the instrument was strengthened by the modification of the response format.

Factors affecting engineering students’ performance in a course are related to how their learning preferences fit with the teaching style(s) provided for them (Kuri 1998). Felder and Spurlin’s (2005) used ILS and found the majority of students to be Active, Sensing, Visual, and Sequential students. Thus, it may be beneficial for the long term educational experience of engineering subjects to adjust teaching styles to match student learning styles whenever possible. According to Gilbert and Han (1999), this is an important factor for the students’ success on the course. They state: The learning style theory implies that how much individuals learn has more to do with whether the educational experience is geared toward their particular style learning.

Cagiltay (2008) suggested if the lecturer’s style of instruction is conductive with the majority of the student’s learning style, then the class as a whole will perform well. According to Felder and Silverman (1988), the level of student’s learning in class is governed in part by that student’s native ability and prior preparation but also by the
compatibility of both learning and teaching styles. Zualkernan et al. (2006) discussed methods that focus on the improvement of students' learning process, and particularly the use of learning styles in engineering. It has recently been recognised (Holvikivi 2007) that engineering students represent different types of students; each student has his/her own special abilities, skills and capabilities. Standardised education cannot respond to all individual needs, a student who is aware of his/her own studying habits and particular strengths and weaknesses is well-equipped to improve the learning process. Price (2004) and Holvikivi (2007) explored learning style theory within their engineering education programmes. Their research outcome shows that being aware of learning styles may provide benefits to improve the educational performance and to retain a diverse population.

Arslan and Aksu (2005) believed that awareness of the learning style would provide better engineering educational experiences for students and may help lecturers to better understand their students. Guven and Ozbek (2007) argued that determining the individual characteristics students have and representing appropriate teaching activities for them, institutions can provide equal opportunity in education as well as improve their success. Similarly, McShannon and Derlin (1999) suggested that lecturers should consider the interactive learning styles of the various student groups when designing engineering programmes, which will retain diverse populations. For example, Fallan (2006) has shown that the student's personality type effect both the most effective mode of learning and even the student's selection of subject areas of study. Jones et al. (2003) found that students' learning style preferences varied by academic performance and their preferences across disciplines. Bostrom et al. (1990) also showed through their research work that learning style is an important predictor to determine the learning performance. The researcher believes that when it is used as a tool to guide both the student and the lecturer, learning styles theory potentially can improve the learning performance and provide benefits for both the students and the educational organisations.

In today's engineering climate that has technological advances to speed up design solutions and reduce product lead times, engineers, especially project engineers and team leaders, need to adopt more global learning style characteristics. Learning styles describe the attitudes and behaviours that determine the preferred way of
learning of an individual; this may vary not just in their learning skills but also in their learning styles (Felder 1996). The objectives of this investigation were to answer the following:

- Do design engineers have different learning characteristics than the rest of the professional population, and if so what are their preferred styles of learning?
- Does the present CAD training available satisfy the engineers' learning style preferences?
- Do design engineers have different learning characteristics than managerial engineers, such as project engineers and team leaders?

The evidence presented by the authors resulted in recommending the following research outcomes:

- Engineers in the design environment have a very visual preferred style of learning. For all but the visual learning style, there is not a significant difference between the engineers at the company and the professional population.
- The present CAD training in the company does satisfy the engineers' learning style preferences, as it incorporates visual techniques and graphically represents the design.
- There is not a significant difference in the learning style preferences design engineers or managerial engineers such as project engineers and team leaders. Hence, there is no need to have different training and learning techniques for them.

Gordon and Bal (2001) used a company to research into engineers' learning style preferences. All the engineers at this company utilise CAD software for 3D design, development, optimisation, data management, and detailing. Traditional lecturer-led courses were adequate for teaching general skills. However, there was a need to develop customised training material that can be accessed when the engineer needs to learn new skills, and not wait until the next lecturer-led classroom course. As the responsibility was put on all engineers at the company to keep updated and refreshed with engineering knowledge and skills, what techniques could be used to make their learning more effective were investigated. In order to examine the objectives, primary data was collected using questionnaires in order to investigate
the engineers' various learning style preferences. There were two questionnaires selected; one was an established questionnaire devised by (Honey and Mumford 1992). The other was a prototype version, developed by Felder (1996). For all but the visual learning style, there was not a significant difference between the means for all the engineers at the company and the population. Engineers due to their nature would automatically cycle through all the learning styles and adopt their characteristics.

2.4.2 Learning Styles and E-Learning

E-learning has opened possibilities that meet the learning needs of a diverse student population. Online content items provide a diversified learning environment both to students and educators on the Web. The purpose of these items is to improve face-to-face teaching and to enable to teach fully online courses (Storey et al. 2002). Different types of content items can use several types of knowledge representations, thus appealing to different students and different learning styles. Nevertheless, while Information and Communication Technologies (ICT) can provide such a variety of ways for adapting learning environments to learning styles, they are not often used to their full potential (Dimitrova et al. 2003).

Kinshuk (2004) explored how to improve learning process by adapting course content presentation to student learning styles in multi-platform environments such as Personal Computer (PC). A framework was developed to comprehensively model student's learning styles and present the appropriate subject matter, including the content, format and media type to suit individual student. The framework uses traditional web-based intelligent tutorial architecture, with two additional components: 'learning style analysis module' and 'access device analysis module'.

Mitchell et al. (2005) concluded as a result of their study that it is possible that online instruction does not suit students with certain learning styles; however, online instructional environments should be designed to meet the needs of students whose learning styles are neglected by traditional pedagogy. Their study examined aspects of student diversity in a web-based learning environment aiming to:

1. Explore and characterise the patterns of students' Web usage of content items.
2. Identify students' learning style preferences.
3. Assess the relationship between web usage patterns and learning styles.

Results from their research showed variance among students in viewing the content items and in asynchronous discourse. Similar usage patterns were described by Nachmias and Segev (2003), and Peled and Rashty (1999) who found that most students viewed only a small percentage of the available items, whilst few students viewed all of them. Similarly, Carver et al. (1999) have reported that, in a web-based course, by tailoring the presentation of material to the student's learning style, students learned more efficiently and effectively. Another study shows (Osborn and Nag 2002) that, with a clearer understanding of learning and teaching differences and developing support network within and outside of the university, the task of undergraduate first year engineering education has become a positive experience for all involved. Environments of web-based learning are adaptable and therefore allow many different ways of learning. The results of this literature review suggest that when developing an online environment, one should consider the diversity in individual learning styles and use different content items and communication means in order to suit students' different personal learning styles and preferences (Leiba and Nachmias 2006).

2.5 Assessment for Learning

Angelo (1998) defined assessment as an ongoing process aimed at understanding and improving student learning. It involves making learning expectations explicit and public; setting appropriate criteria and high standards for learning quality; systematically gathering, analysing, and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain, and improve performance. When it is embedded effectively within larger institutional systems, assessment can help to focus collective attention, examine assumptions, and create a shared academic culture dedicated to assuring and improving the quality of higher education. Ewell (2004) also defined assessment as a process that focuses on student learning, a process that involves reviewing and reflecting on student performance—what students can do—and
focuses on curriculum and group performances in a planned, deliberate, and careful way. Spurlin (2006) outlined the key facets of assessment:

- A focus on student learning;
- The collection, analysis, and interpretation of information; and
- Application for the purpose of improvement.

Assessment provides students with opportunities to discover whether or not they understand, if they are able to perform competently and demonstrate what they have learnt in their studies. Also the feedback and grades that assessors communicate to students serve to teach and motivate them (Thorpe 1998). Whether discussed as a measure of student learning, cost-effectiveness, administrative efficiency, or the value of technology, assessment is on the minds of many groups. Assessment has different meanings and measures depending on its use (Ewell 2002). Furthermore, opportunities to explore new assessment methods and styles are now afforded by, for example: timed online exams, group projects and peer/self assessment (O'Reilly and Newton 2002).

2.5.1 Online Assessment

Online environments offer educators a new medium to deliver teaching and learning material with different assessments methods. They can bring new and exciting ways of learning and can potentially offer students many possibilities for enriching the-learning process, compared to traditional learning strategies. According to French et al (1999), students can use online environments for more communication possibilities, collaboration, opportunities, interaction with their lecturers/classmates and access to a wider range of learning resources. Graff (2003) outlined that there are numerous clear theoretical advantages of online instructional methods: firstly, they provide flexible-learning, meaning that students can progress at their own pace; secondly, they provide facility for students-centred learning, making them responsible for their own learning. Finally, material can be made available on demand from anywhere at any time provided that the student has the facility for taking advantage of such system. These new techniques can provide solutions to the demands of a changing environment, allowing flexibility for learning from home or work, and the ability to cope with a widening variety of backgrounds and qualifications. However, according to Allen (1998), the difficulty comes in finding ways to apply the new
technologies to a learning process with a proven educational benefit. Carmean (2004) argued that online technology can help establish effective learning environments by bringing real-world problems into the classroom; allowing students to participate in complex learning, providing them feedback on how to improve reasoning skills and expanding opportunities for their learning.

"Sharing understanding and supporting each other in an open unstructured forum suggests that deeper social and learning communication networks are developing among students" (O'Reilly and Newton 2002).

"In order to stimulate motivation, e-learning should be accessible and involve high levels of interaction between students and resources, students and lecturers as well as students and students" (Graham et al 2000).

Some studies (Twigg 2004) have shown that students prefer courses taught using computers, and some research indicates that incorporating technology into a course results in greater learning. Other studies have shown that technology-enriched courses positively affect students' personal and intellectual development (Kuh and Hu 2001). Few have determined (Nelson and Kuh 2005) whether technology has a positive effect on how well students learn. Spurlin (2006) argued that assessment programs should include an understanding of how the relationships among students, learning principles, and learning technologies affect student learning. They envisaged on how to incorporate the best-known principles about teaching and learning and using technology as a tool for innovation. A report published by the Association of American Colleges and Universities, articulated the principle of empowering students to become better problem solvers, to work well in teams and how to use, interpret data and increase their understanding. This also can have a positive effect in terms of students' awareness of collusion and how it can be avoided.

However, using online technology with assessment can exacerbate some confusion, the answers are not simple. The challenges begin with the definition of assessment but are compounded by the complexities of different types of students, technology, and educational organisations. Spurlin (2006) suggested that online assessment should take into account the intentions behind assessment, the unit of analysis, and...
the interaction of technology with other variables. Assessment, which focuses on students’ learning, is not a solitary activity but a cycle that can lead to improvement. The ultimate goal of assessment is the informed, purposeful improvement of the quality of student learning. Although assessment is not easy, the goal makes it well worth the effort.

2.5.2 Online Formative Assessment
Online formative assessment has many advantages over traditional classroom assessment. Zakrzewski and Bull (1999) stated that students can take the assessment at any time, they can take it repeatedly, and it can provide instant feedback that helps remedy weaknesses in their learning abilities. They also indicated that student anxiety could be reduced if they take the formative assessment before summative tests. According to Buchanan (2000), a web-based formative assessment strategy is able to improve students’ learning interest and students’ scores. Formative assessment allows students to assess their own progress and understanding. Clariana (1997) noted that formative assessment designs should be able to engage student attention, engender student commitment to self-evaluation and enhance-learning effectiveness. Bransford et al. (2000) argued that online formative assessment creates new learning environments, which need to be assessed carefully, including:

- How their use can facilitate learning,
- The types of assistance that lecturers need in order to incorporate the tools into their classroom practices,
- The changes in classroom organisation that are necessary for using technologies, and
- The cognitive, social, and learning consequences of using these new tools.

Wang et al (2006) referred to studies made by Federico (2000), Kraus et al. (2001), Buchanan (1998) and Terrell (2002), when looking at improvement of the effectiveness of e-learning, and developed an e-learning environment that integrated formative assessment strategy. The purpose was to discover whether the benefit of e-learning environments varies among students with different learning styles. Three questions were explored in their research; Firstly, do learning styles and formative assessment strategy affect student-learning achievement? Secondly, what kind of
formative assessment strategy can be built into the e-learning environment to facilitate student learning? Finally, what kind of learning style best suits the e-learning environment? The results of this study indicated that both learning style and formative assessment strategy significantly affect students' achievement in e-learning. This suggested that both formative assessment strategy and learning styles should be taken into account in the design of e-learning environments. They also suggested that successful lecturers tend to be those who are able to use a range of teaching strategies and a range of interaction styles, rather than a single, rigid approach to teaching and learning. Research studies have discussed evaluations of what types of formative assessment strategies would work best. Buchanan (2000) argued that 'repeat the test' is an important design of web-based formative assessment strategy. However, he noted, this strategy design must be implemented in conjunction with the functions of 'provide with no answer' and 'instant feedback' so that the web-based formative assessment will be more effective. Graham et al (2000) emphasised that the planning process is one of the most important stages in implementing any e-learning strategy; it saves time by identifying problems before they arise. These can be best approached as a series of considerations that will help in developing a clearer image of the parameters.

To help focus on identifying a specific technology and focus on a learning situation, Spurlin (2006) demonstrated an example in engineering professionals. Years ago they used to sketch ideas using pencil and paper. Today, CAD programs extend students' ability to accurately manipulate a creative reality of the problem. The question is: When using CAD technology for modelling in a laboratory setting, are students able to think more deeply about an issue or have a broader understanding? CAD technology allows for nonlinear thinking—thinking in more than two dimensions—which lets an engineer creatively engage more ideas and variations without worrying about the technical skill of sketching (Rohrback et al. 2004). Clarifying the student-learning portion, the question above can be modified as follows: When using CAD technology for modelling in a laboratory setting, how are the students' critical thinking and multidimensional problem-solving skills transformed? Su et al (2005) focused in their study on both quantitative and qualitative data to investigate how lecturers and students perceive the importance of online interactions. They discussed various ways of interactions including: Student-
Lecturer, Student-Student, Student-Content, Student-Interface, Student-Self Interaction, and Vicarious Interaction. They pointed out that there is a need to understand which instructional techniques and activities can promote interaction in online education, including summarising key points, giving feedback, and lecturer participation in class discussion. Such activities indicate using the lecturer-student interactions; they help students' reflective thinking. Students need to work together to solve problems and also get involved in class discussions to critique each other, which helps to establish a rich interaction between them, that indicates using the student-student interactions. Students need to be asked to explore and then analyse the content of the online learning in order to achieve the required results, it is also necessary to interlink contents between online learning, as they are dependant on each other. This helps students to interact with the content of the taught subject, which indicates using student-content interactions. Their study concluded that students generally perceive interaction as an effective means of learning, which varies with respect to differences in personality or learning style, as well as the level of online interactions. Based on these findings, the implementation of e-learning strategies for formative assessment would be enhanced by providing online access to information and training through tutorials and instructions based on the widest possible range of learning interactions.

To conclude, according to Thorpe (1998), there is a need to understand the ways students use the online learning and also the factors that can enhance or hinder their learning. This will help to initiate and continue improvements in interactive online teaching and learning environments. Jolliffe et al (2001) argued that for any process to be successful it is important to analyse its context as one of both improvement and effectiveness, depending upon the level being carried out. The evaluation process should consider all features of the learning events that may promote or hinder progress. Graham et al (2000) stated that students must not feel that e-learning is just afterthought but on and therefore strong links with the subject aims must be evident. In the same contrast, by building a formal assessment element into the e-learning task, all students will seriously engage with these tasks and not only the interested ones.
2.6 Chapter Summary

The outcome of this literature review has shown that the quality of teaching and learning have a powerful impact on the way education works, whether it takes place in a classroom or over the internet. The relationship between educators, students, and the study material is greatly influenced by the development of efficient courses. These courses need to be assessed and evaluated effectively, with respect to learning outcomes, student satisfaction, retention and achievement. In addition, levels of learning, such as critical and reflective thinking, are a priority (Garrison and Kanuka 2004). It has also shown that learning, knowledge and education are major themes of this century, where solutions are required for fast learning and successful retention of knowledge for the wide range of education professions. Based on these findings, the author constructed a Venn diagram as shown in Figure 2.3, which identifies and summaries the main goals and potentials for this research project.

![Venn diagram showing the main outcomes of the literature review](image)

**Figure 2.3 Main Outcomes Summary within Literature**
Higher technical institutions with engineering courses need to set themselves the goal of making such education ever more efficient as the demand for EDT education will continue to grow rapidly (Ye et al. 2004). This is a great challenge for educators, they should use the many different instructional methods available and not just stick to what is familiar as no one method is perfect. "A combination of main instructional methods is the most effective approach for the teaching and training of students to aid effective interaction and to promote experiential learning" (Magoha 2002).

Based on the summarised findings, the main goal of this thesis is the design, development, implementation and evaluation of an online intelligent system for teaching EDT. The developed system aims to provide a wide distribution across the Internet and allows students to benefit from the available capabilities and achieve the desirable learning experience. They are able to utilise it according to their own abilities through the use of menus and visual components and to enable them to access and navigate various engineering design tools and theoretical topics, supported by appropriate guidance remotely. The developed system incorporates a number of facilities to aid effective interaction and to promote experiential learning. Students are able to understand design concepts, as well as learning to perform different tasks, and therefore achieving the learning outcomes of individual subjects. This is achieved while students' performance is continuously being evaluated and guided through appropriate assessment according to their learning styles, previous knowledge and needs. This dynamic relationship between students and the system facilitates the educational goal for a particular student through providing links that can be hidden, while some additional links can be generated. In particular, the system provides an intelligent personal learning advice that records all students' interaction with the system and also guides them through achieving the learning outcomes of the taught subject while monitoring their progress from a distance. The system is tested and analysed by using it as an educational tool to provide viable solution for a teaching experience. Results of different groups of students is analysed in details to determine its effectiveness, this includes change of pattern and level of students' achievements. It determines the benefits and limitations of the operational procedures and the functions of the components.
3.0 Chapter 3 – Framework Development

An interactive learning environment refers to the use of various tools in conjunction with integrated communication systems, to provide visualisation and simulation through an educational interface. Such an environment and the demand for its use in the education sector are growing rapidly due to the dramatic achievements in low cost, high-speed computing and communication hardware, which increasingly continues to reduce the cost of such facilities and its applications. Thus, there is a requirement for developing a framework that enables students to interact and explore its environment rapidly and directly on the Internet. Based on this and the outcome of the literature review, this chapter aims to develop a framework that provides a wide distribution across the Internet and allows students to benefit from the available capabilities and achieve the desirable learning experience. They are able to utilise its environment to learn about EDT according to their own abilities and learning styles through the use of menus and visual components. This is achieved by the development and integration of the required components in order to provide a cost effective and widely distributed format for their learning. Such framework development enables students to access and navigate through various methods and applications, supported by appropriate guidance remotely.

3.1 Main Layout

This Framework allows students to access an adequate level of information, communication, learning, collaboration and management. Its structure encompasses a web browser and a secured server integrated via an intelligent system to provide Internet remote access via unique usernames and passwords, as shown in Figure 3.4. It relies on the Internet as the primary medium to create a shared environment for its distribution. Using standard web browsers as an execution engine for the environment, it enables multiple students to remotely access, navigate, and interact with appropriate components, such as learning styles, intelligent/individual learning plan, on-line tutorials and formative assessment that can be carried out in class or remotely.
The developed framework focuses on incorporating a number of facilities, including:

- Sharing learning data and information using the Internet.
- Providing engineering students with an interactive environment for learning design technologies based on their learning styles.
- Supporting and guiding students according to their abilities and performance through an intelligent/individual learning plan.
- Achieving learning outcomes of individual components by performing appropriate tutorials and tasks followed by a formative assessment.
- Providing a comprehensive feedback based on their performance.

![Figure 3.4 Main Framework Layout](Image)

### 3.2 Intelligent System Architecture

The structure of the intelligent system is based on an extensive body of knowledge about the specific area involving the learning process for the taught subject. This knowledge is extracted from the subject database and the students' interactions within the system. It accumulates by uploading the relevant material for the taught subject and also from the students' results and performances within the system. Characteristically this knowledge is organised as a number of components as shown in Figure 3.5, with a collection of rules, which allows the system to collect and draw
conclusions from the given data or premises. This section discusses each of these components and identifies its exact role and how it operates within the developed framework.

![Intelligent System Components](image)

**Figure 3.5 Intelligent System Components**

### 3.2.1 Student Information

The Student Information component is used to accumulate information about students including their name and registration details such as username and password. It gathers all the information from study needs, training schedule and results of previous tests. Thus it accumulates information about the whole learning history of the student for the purpose of the intelligent learning plan component. It stores data, which is specific to each individual student; that can be explicit or tacit.

Explicit knowledge is data that is widely used in information technologies such as name, date of birth, etc. Tacit knowledge is data comprised of informal and non-registered practice and skills such as knowledge that was gained through experiential learning. This knowledge is vitally important because it defines the abilities and experience of students (Kaklauskas 2006). The students need to register their details for the first time in order for the system to create the student’s information file. This identifies what needs to be done and what actions are to be taken by both the
students and the system. Upon this, students are able to access the system by using a Username and a Password; Figure 3.6 shows the diagram of this component.

Figure 3.6 Students Information Diagram

3.2.2 Learning Styles

Learning styles component identifies the students' preferable learning styles and upon this scores and details of their learning styles is provided. There are many types of quizzes and questionnaires to help students analyse their learning styles. They can identify that a particular student has a main strong preference; others can have a mixture of two or, less commonly, three styles. There is no right or wrong learning style, the point is that there are preferred learning styles for different students and that lecturers need to address a variety of learning styles within their teaching plan. They need to make students aware of the various learning styles and encourage them to consider their preferred style to maximise their learning within their studies. There are many different theories relating to learning styles, the learning styles system that are considered within this study are based on the VAK (Visual, Auditory, and Kinaesthetic) system. This was selected based on its merits of offering relatively simple and accessible methods to understand and explain students' preferred ways to learn and develop. Students can be one single style or a mixture of styles and preferences, this system provides a responsive perspective for understanding and explaining a student's preferred or dominant thinking and learning style with related strengths. This selection is also supported by the findings of Amal Oraifige
Gordon and Bal (2001) that engineering students' learning is more effective by using diagrams, sketches, photographs, schematics, flow charts, pictures, videos, computer graphics. The VAK system is described below (Duckett and Tatarkowski 2002):

1. **Visual**
   Students with visual style of learning can learn more effectively when they observe or read. They prefer written handouts, graphs, charts, diagrams, etc... They also prefer colour coding and highlighting text, using bullets to separate ideas, watching films and observing others to demonstrate first. Students with this type of learning style are provided with written tutorials that have visual examples and step-by-step instructions, which they can read and follow.

2. **Auditory**
   Students with auditory style of learning generally prefer the transfer of information through listening. They learn best by listening to verbal instructions or information presented in a lecture. They also prefer discussions or audio recordings, reading text aloud, study with a friend, recite information to help them to remember and tape study notes. All written tutorials are also available in audio format which includes visual demonstrations that are supported by audio instructions.

3. **Kinaesthetic**
   Students with kinaesthetic style of learning are also called tactile. They prefer using physical experience and they mostly learn by using whole body movements, such as touching, feeling, holding and practicing hand-on experience. They prefer to be totally involved and can benefit from making models, breaking information into steps, exercising while studying, using rhythms and storylines to help them remember information and making cards to record notes. Students with this type of learning style are provided with interactive tutorials that support such learning techniques including appropriate quizzes and puzzles; Figure 3.7 shows the overall diagram for this component.
3.2.3 Pre-Assessment

Pre-Assessment component assesses the students' knowledge or prior experience of the taught subjects by using appropriate assessment methods including multiple choice questions. It uses this data to create a progression profile of the students; this is inputted into the intelligent learning plan component in order to decide on the topics that are to be learnt. It stores data that is specific to each individual student, this knowledge is vitally important as it defines the abilities and experience of students. This component records the student's current knowledge and support the transition to a new knowledge state. This means that if a student answers a set of questions correctly, the system presents the student with the necessary topics to be learnt within a specified subject. However, if the student answers incorrectly, the teaching plan is updated and alternative topics to be learnt is presented. The pre-assessment component helps first-time users to setup their individual learning targets according to their existing and previous experience regarding the taught subject; Figure 3.8 shows the diagram for this component.
Questions based on the topics to be learnt within a taught subject

Results and Scores for individual topics

Figure 3.8 Pre-Assessment Diagram

3.2.4 Intelligent/Individual Learning Plan (ILP)

An Individual learning plan (ILP) is an effective form of planning how students get from their starting point on a learning journey to the desired end point. It can be described as the heart of assessment, learning, support and achievement, as it can help students to become an active, motivated partner in learning (QIA 2008). It should be individual for each student to reflect aspirations, aptitude and needs. The author summarised these as follow:

- A flexible path to guide students through their learning experience.
- A dynamic working plan, owned and used by the students, supported by lecturers.
A record of learning goals and progression status, initial and diagnostic assessment information, learning targets and achievements within different contexts for learning.

A communication tool between students and lecturers who support the learning process in various contexts.

A way of making and reinforcing links and connections between topics, subject and personal, learning and thinking skills.

The students' learning experience is dynamic and not confined to a simple loop. They will pass through several cycles of learning and reviews. A proposed ILP needs to:

> Create a climate in which students can contribute to their own learning plans.
> Use teaching approaches that make learning skills explicit.
> Provide constructive feedback and support for students as they develop reflection skills.
> Share learning objectives and success criteria with students in a language that they will be able to understand. Students need to know and understand their targets if the ILP is to be an effective tool.
> Create bite-sized, personal learning targets with outcomes and timescales.
> Provide details of the resources, support and guidance to the students.
> Provide details of where and how the learning will take place.
> View every assessment as a learning opportunity and to plan for the next steps in learning.

The benefits of such ILPs can be summarised as follow:

Students can use ILPs to:

> Take ownership of their own learning
> Recognise the value of prior experiences
> Make sense of new experiences and understand how they learn
> Identify and understand barriers to learning, and where they can find support to remove them
> Measure their success.
Lecturers can use ILPs to:

- Listen to students' feedback, review performance and respond to their needs.
- Integrate processes around the students: initial and diagnostic assessment, action planning, additional support needs, tutorial records, students' performance, progression options and exit information.
- Match teaching and learning to students' strengths and needs, and ensure that they are on the right topics and achieving according to expectations.
- Plan opportunities for progression to further learning.

The Pedagogical Domain within ILPs

ILP models the student's current knowledge and support the transition to a new knowledge state. This can require alternating between diagnostic and didactic support (Wenger 1987). Diagnosis means that the ILP infers information about the student's state on three levels:

- Behavioural level, ignoring the student's knowledge and focusing only on the observable behaviour.
- Epistemic level, dealing with the student's knowledge state and attempting to infer that state based on observed behaviour.
- Individual level, covering such areas as the student's personality, motivational style, self-concept in relation to the domain in question.

Gathering diagnostic information presents a challenge for intelligent systems' designers. The only data readily available are the outcomes of individual tasks or problems presented and some fine-grained interface data, such as keystrokes and the amount of time between the keystrokes or mouse movements, therefore the developed ILP within this framework focuses on the Didactic support. It is concerned with the delivery aspect of teaching and learning. Wenger (1987) suggested that didactics could be organised around four principles:

1. Plans of action: "mini curricula" that are used to lead the student and provide the context for diagnostic operations.
2. Strategic contexts: in which the plans of action are implemented. Generally, these are planned (intended by the lecturer) or opportunistic (the student completes a task that provides this opportunity for learning).

3. Decision base: rules or guidelines for allocating the system resources in the context of constraints.

4. Target level and style of the student model: students can select the level and style at which the learning takes place.

The ILP component within this framework allows students to be in charge of their learning and at the centre of their activities, while also being monitored by their lecturer. This component is linked to all the components within the system. It contains and updates all relevant data about students' information, learning styles and pre-assessment. ILP also contains an intelligent personal learning advice that records all students' interaction with the system and also guides them through achieving the learning outcomes of the taught topics within a particular subject. This component offers a personal learning target that provides:

- Students' information.
- Preferable learning styles with results and reflections.
- Review of current knowledge through Pre-Assessment to identify the needs assessment.
- Target topics to be learnt through the Subject Knowledge.
- Review of gained knowledge and achievements through the formative assessment to identify the skills assessment.
- Successfully completed topics.
- Outstanding topics with deadlines.
- Attendance to individual topics and formative assessment; Figure 3.9 shows the overall diagram for this component.
3.2.5 Subject Knowledge

The Subject Knowledge component includes the database that is concerned with the teaching and learning topics that are going to be presented to the student. This is the most important since without it; there is nothing to teach the student. This includes different teaching models that contain a selection of tutorials, presentations, interactive quizzes and assessment. These models are presented in different formats to suit different learning styles; this can be in text, images, screen shots, diagrams and audio. It is also interactive so students can input some data and find out how they did instantly, this helps to enhance their understanding of the taught topic. Students also are able to follow instructions based on step by step tasks. Each topic to be learnt has the following sections:

- Main tutorial: this includes information about individual topics to be learnt in different learning styles presentation. It also includes presentations with text, images, diagrams, screen shots and also audio sound. It is interactive so students can input data and receive instant response in order to enhance their understanding of the taught topic.
- Tutorial in action: this helps students to follow instructions of the steps required in order to complete a task.
A Quiz or a puzzle: this includes a form of a game that is based on a particular topic. Students are able to play, interact and keep trying till they succeed. This helps them to understand the subject in a different format and gives them extra motivation to practice on a particular exercise; Figure 3.10 provides the diagram of this component.

![Subject Knowledge Diagram](image)

**Figure 3.10 Subject Knowledge Diagram**

### 3.2.6 Formative Assessment

The Formative Assessment component evaluates students' learning experience; it records the students' gained knowledge and support the transition to a new knowledge state. If the student answers a set of test questions correctly, through this component, the information is inputted to the ILP and thereby the system records and presents the results to the student, this provides the student the direction to move into the next teaching topic within the specified subject. If the student answers
incorrectly, again the ILP updates and provides students with the correct directions to repeat topic to be able to gain the understanding and achieve the desired learning outcome. This can be in a form of multiple choice questions or a quiz depending on the topics taught. Upon submission, they are presented with a comprehensive feedback and guidance based on their performance, which is instantly updated within their ILP. Figure 3.11 shows the diagram of this component.

Figure 3.11 Formative Assessment Diagram
3.2.7 Student Interface
This framework provides guidance and support through its interface to prevent the student from foundering or missing important aspects of the domain. Through the Student Interface, students can have an active dialogue with a computer by determining how the information is provided and how the commands are interchanged. Without a suitable interface, students cannot have full advantage of the system's features. It includes all mechanisms for data input and output of results from the system. Various interface types is used such as commands, menus, and graphics, also icons in windows opened in the computer screen showing data, models and other objects available in the system. Through this interface, the student can control data; subsystems and knowledge then review or print the results. Figure 3.12 shows the diagram of this component.
3.3 Operational Flow

The development of the proposed framework consists of integrating all of its specified components into a fully operational system, as shown in Figure 3.13. It combines the operating procedures to create dynamic specific links between the components to ensure successful relationships that satisfy the students' need and requirements. A web browser and a server are integrated within the system to provide online remote access, which enables students to interact and explore the environment directly. The structure encompasses the Internet as the primary medium to create a shared environment for its distribution. Using standard web browsers as an execution engine for the environment enables multiple students to remotely access, navigate, and interact with the developed system. The following sections cover the integration of all the proposed components, database and functions together into the framework, in order to provide a fully operational system.

![Figure 3.13 Framework Components Operational Flow Diagram]

3.3.1 Introduction

Upon accessing the online system, students are given a brief introduction about it, which includes information regarding content, benefits, capabilities and applications. They can access further details regarding the system if they require, as shown in Figure 3.14, which ends by number 1 that leads into the next operation (new registration).
3.3.2 Registration and Learning Styles

Student Information component enables first-time students to create an account with their information such as student number and name. Based on this information, the system builds students' profile and progression. This leads them into the learning style component to verify their preferable learning styles. Upon submission, scores and details of their learning styles are provided, as shown in Figure 3.15, which ends with a number 3 that leads into the pre-assessment operation. It also has an exit point number 2, which leads into the existing registration operation. Registered students are able to access the system using an individual username and a password as shown in Figure 3.16. This displays and updates their achieved results within the ILP, this ends with number 7, which feeds into the formative assessment operation.
Figure 3.15 New Registration Operational Flow

1. New Student?
   - Yes: Enter Student's Details, including: Name and Number
     - Create Student's File
     - Create Student's Username and Password
     - Go through the VAK Learning Style Evaluation Process
   - No: Output Message: Ask him/her to Log on again

2. Log on the System Username Password
   - Log on Details Correct?
     - Yes: Upload Student's ILP showing Achieved Results
     - No: Log on to System Username Password

Figure 3.16 Existing Registration Operational Flow
3.3.3 Pre-Assessment

After identifying their preferable learning styles, students are able to access the pre-assessment component to help first-time users to setup their individual learning targets according to their existing and previous experience regarding the taught subject. The results of this component are highlighted to the students and then guide them into their ILP, as shown in Figure 3.17, which ends with number 4 and leads into the ILP operation.

![Pre-Assessment Operational Flow](image_url)
3.3.4 Main Functions through ILP

ILP is linked to all the components within the system, contains and updates all relevant data about students' information, learning styles and pre-assessment. It records and updates all the students' interaction within the system to help them achieve the learning outcomes of the taught subject; it offers individual learning targets that allow students to be in charge of their learning and at the centre of their activities, while also being monitored by their lecturer. From the ILP, students are able to access the subject knowledge component, as shown in Figure 3.18. This includes the topics to be taught in different formats to suit different learning styles. This can be in text, images, screen shots, diagrams, audio etc... It also can be interactive so students can input some data to enhance their understanding of the taught topic. Students can also follow instructions in the form of step by step task or tutorial. This operation has number 5 as the exit point, which leads into the formative assessment operation. It also has feedback point from the formative assessment through entry point number 6.

![Figure 3.18 Functions of ILP Operational Flow](image-url)
3.3.5 Formative Assessment and Feedback

Within the subject knowledge, students are able to access the formative assessment component; this evaluates the students' learning experience within the taught topic. Upon submission, they are given a comprehensive feedback and guidance based on their performance, which is instantly updated within their ILP, as shown in Figure 3.19, this operation ends through the exist point. A complete flowchart with all the components integrated together is given in Figure 3.20.

![Formative Assessment Operational Flow](image)

Figure 3.19 Formative Assessment Operational Flow
Figure 3.20 Overall Framework Operational Flow
3.4 Chapter Summary
A good dynamic educational environment should provide the necessary functions to explore a particular learning experience in a consistent style. It has to dynamically resolve problems according to all given parameters and constraints, and provides students with an effective and interactive capability in order to shorten the gap between them and their teaching tools. This section presented the proposed system framework and its operational flow. This consisted of investigating and outlining the flowchart of each of the proposed system’s components. The overall framework consisted of compiling information regarding individual students and providing appropriate teaching methods to suit their learning styles and abilities. It provided students a door to access an ILP on the Internet, and thereby provided them with the knowledge and guidance through a learning process to teach them a particular subject. The development of this framework would be critical to the achievements of successful educational environments for many institutions, as it could appreciate changes in their teaching models and their targets.
4.0 Chapter 4 – System Development

This chapter describes the development of the overall system; this includes the development and integration of the required system components, which have been identified within the previous Chapter (Framework Development). Each individual component is discussed in terms of its functionality, operation, programming as well as achieved outcomes. It is designed, developed and tested prior to its integration to other components within the system. This integration of all the system's components requires the identification of the specific relationships between them in order to facilitate the appropriate functionality for the system's operations. Finally, an appropriate interface is developed to provide the operational and communication links between the system and the students, this facilitates the necessary active dialogue for the system's success. The outcome of this chapter is an online link to the developed system that can be accessed by students.

In order to provide a full picture of how this system operates and show the exact functions, the author has decided to demonstrate the database on teaching CAD. The system also is developed in modular format; thereby it is possible for the lecturer to upload different taught subjects.

4.1 Development Plan

In order to provide a fully functional and operational system with all its required components, a development plan is compiled and summarised as shown in Table 4.1. The execution of this plan and the identification of all the necessary actions for this development ensure the success of the proposed system. The first stage focuses on selecting the appropriate tools that can enable the development of this system and ensure the success of its operations. The second and third stages focus on applying these tools in the development of the main components and followed by their integration in order to develop a fully operational system. The final stage involves the main testing of the developed functions and operations, while this is also integrated within each stage to ensure the success of the final outcome and to minimise potential failures and problems.
### Table 4.1 System’s Development Plan detailing the Progression Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Development Tools</th>
</tr>
</thead>
</table>
| 1     | • Programming Language  
|       | • Web Browser  
|       | • Hosting Server |

<table>
<thead>
<tr>
<th>Stage</th>
<th>System’s Components</th>
<th>Actions</th>
</tr>
</thead>
</table>
| 2     | • System Information  
|       | • Students’ Registration  
|       | • Learning Styles  
|       | • Pre-Assessment  
|       | • Intelligent/individual Learning Plan (ILP)  
|       | • Subject Knowledge  
|       | • Formative Assessment and Feedback  
|       | • Suitable Students’ Interface | • Structure  
|       |                           | • Functionality  
|       |                           | • Programming / Coding  
|       |                           | • Outcome |

### Integration of Components

<table>
<thead>
<tr>
<th>Stage</th>
<th>Integration of Components</th>
</tr>
</thead>
</table>
| 3     | • Structure  
|       | • Functionality  
|       | • Programming / Coding  
|       | • Testing and Outcome |

### Testing of Developed System

<table>
<thead>
<tr>
<th>Stage</th>
<th>Testing of Developed System</th>
</tr>
</thead>
</table>
| 4     | • Components’ Operations  
|       | • Integration Operations  
|       | • Interface Operations  
|       | • System’s Overall Operations |

### 4.2 Development Tools

The main structure of the developed system encompasses a web browser and a secured server to provide Internet remote access via unique usernames and passwords. It relies on the Internet as the primary medium to create a shared environment for its distribution. Using standard web browsers within Windows environment as an execution engine provides users with an easy and common access to the system. Based on this, the author carried out a research into the appropriate tools that ensures the successful development of this system and provides the required solution for its functionalities. This research focused on two main programming languages, which were PHP and ASP.
4.2.1 PHP and SQL

PHP (Hypertext Preprocessor) is a widely used open-source server-side scripting language that was designed for web development to produce dynamic web pages that users can only access customised information. Its code is embedded into the HTML (Hypertext Markup Language) source document and interpreted by a web server with a PHP processor module, which generates the web page document. This language is used mainly in server-side scripting, but can be used from a command line interface or in standalone graphical applications. It generally runs on a web server, taking PHP code as the input and creating web pages as the output, however it is also popular for command-line scripting and GUI (Graphical User Interface) applications. It can be deployed on most web servers and on almost every OS (Operating System) platform (Indiana University 1999). It can also be used to create dynamic web pages that are generated from SQL (Structured Query Language database). SQL is the standard language for interacting with relational databases as supported by MySQL, which is a database server that can be ideal for both small and large applications. PHP combined with MySQL are cross-platform that can be developed in Windows and serve on a UNIX platform. This can also run on different platforms and is compatible with almost all servers used today (Apache, Internet Information Services IIS). However, in order to get access to a web server with PHP support, it is essential to install Apache (or IIS) on the user's own server with PHP, and MySQL or the alternative is to find a web hosting plan with PHP and MySQL support (W3schools 1999).

4.2.2 ASP

ASP (Active Server Pages) is a technology that enables the creation of dynamic and interactive web pages. It uses server-side scripting to dynamically produce web pages that are not affected by the type of browser used. The default scripting language used for writing ASP is VBScript, although other scripting languages can be used such as Microsoft's version of JavaScript. ASP pages have the extension .asp instead of .htm, when a page with the extension .asp is requested by a browser the web server interprets any ASP contained within the web page before sending the HTML produced to the browser. ASP was first introduced by Microsoft on it's web server, IIS, which allows it to run on all versions of Windows from NT4, including Windows 7, Vista, XP Pro, Windows 2000, 2003, 2008 (Web Wiz 2001). ASP can
dynamically edit, change, or add any content of a web page and respond to user queries or data submitted from HTML forms. It also can access any data or databases and return the results to a browser. Web pages can be customised to make them more useful for individual users. The advantages of using ASP are those of simplicity and speed, provide security - since ASP code cannot be viewed from the browser, minimise the network traffic, the browser that displays the ASP file does not need to support scripting at all as the ASP scripts are executed on the server (W3schools 1999).

Based on this, the author has decided to use the ASP based codes in conjunction with Microsoft Access to develop the system as it is widely recognisable, easy to use and adequate for the purpose. This provided the means of querying and updating a database, in particular, the Microsoft Access database to integrate to the online application. Firstly, the database was built based on the development of tables with associated information. Each table was a simulated library database, with the information about its members. The member-id was the primary key and it linked the member information such as last name, first name, as shown in Figure 4.21.

Figure 4.21 Microsoft Access Tables Database with Relevant Member IDs
Secondly, based on these tables' information and required actions, queries were created using the ASP language. These queries and associated actions were responsible for the communication and interaction between the user interface and the database as shown in Figure 4.22.

![Figure 4.22 The System Main Development Operations](image)

### 4.3 Development of System's Components

This section introduces the main development of each component within the proposed system in accordance with the development plan as shown in Table 4.1. The initial stages consisted of identifying each component with the system and based on its functions, a full detailed operational chart was developed. The appropriate tools were used to build and test each component, screenshots of the components in operation and the outcome results are also provided.
4.3.1 System Information

The system's information component introduces the students to this developed online interactive teaching environment for design technologies to suit their various learning styles using various means including menus and visual components. It introduces them to the aspect of using an individual learning plan through which learning outcomes of individual taught topics can be achieved by performing appropriate tutorials and tasks followed by a formative assessment. It also emphasises that this system provides them with a comprehensive feedback based on their performance. This component provides students with information and guidelines on how to navigate thorough the system in order for them to access an adequate level of information, communication, learning, collaboration and management of tasks including on-line tutorials, CAD tools and formative assessment. Firstly the students are given a brief introduction about the system's functionalities and capabilities:

"An online interactive teaching environment for learning CAD to suit various learning styles. Through an individual learning plan, students will be able to achieve learning outcomes of individual modules by performing appropriate tutorials and tasks followed by a formative assessment. Comprehensive feedback will be provided based on their performance."

If students still require further information and details, the system outputs the following:

"Students can utilise this environment to learn about CAD according to their own learning style through the use of menus and visual components. This provides an extremely inexpensive and widely distributed format for teaching CAD, and hence enable students to access and navigate various design tools and applications, supported by appropriate guidance, remotely. It allows students to access an adequate level of information, communication, learning, collaboration and management. It enables multiple students to remotely access, navigate, and interact with appropriate tasks, such as on-line tutorials, CAD tools and formative assessment. It focuses on three aspects which are:

- Providing students with an interactive environment for learning CAD based on their learning styles.
- Sharing learning data and information using the Internet.
- Supporting and guiding students according to their abilities and performance through an individual learning plan."

Amal Oraifige
Furthermore, the system outputs user's guide information if required under the following headings as shown in Table 4.2

<table>
<thead>
<tr>
<th>Registration</th>
<th>First-time users are asked by the system to register with username and password that are unique for those individuals.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Styles</td>
<td>Once users have registered on the system, a learning style test is used to help them to identify and utilise their own learning style in an aid to effective and efficient learning.</td>
</tr>
<tr>
<td>Pre-Assessment</td>
<td>A prior knowledge assessment is used to help first-time users to setup their individual learning targets according to their existing and previous experience.</td>
</tr>
<tr>
<td>ILP</td>
<td>The Individual Learning Plan (ILP) is the main gateway for users to check their individual personal details, learning states, learning progress, and access to the learning contents provided.</td>
</tr>
<tr>
<td>Subject Knowledge</td>
<td>The learning contents for each Topic comprise of: E-Lecture/Tutorial for conceptual explanation E-game and demo to reinforce the understanding of individual concepts Formative assessment to review the learning achievement.</td>
</tr>
</tbody>
</table>

The full operation of this component is shown in Figure 4.23.
Based on the above chart, using the ASP programming language, the appropriate programming code was written; the results of the designed template for the system information component are shown in Figure 4.24.
Online intelligent system for Teaching CAD
ITS for CAD

An online interactive teaching environment for learning CAD to suit various learning styles. Through an individual learning plan, students will be able to achieve learning outcomes of individual modules by performing appropriate tutorials and tasks followed by a formative assessment. Comprehensive feedback will be provided based on their performance.

Students can utilise this environment to learn about CAD according to their own learning style through the use of menus and visual components.

This provides an extremely inexpensive and widely distributed format for teaching CAD, and hence enable students to access and navigate various design tools and applications, supported by appropriate guidance, remotely.

It allows students to access an adequate level of information, communication, learning, collaboration and management. It enables multiple students to remotely access, navigate, and interact with appropriate tasks, such as on-line tutorials, CAD tools and formative assessment.

It focuses on three aspects which are:

• Providing students with an interactive environment for learning CAD based on their learning styles.

• Sharing learning data and information using the Internet.

• Supporting and guiding students according to their abilities and performance through an individual learning plan.

Figure 4.24 System Information Component Design Template
The program was then tested to ensure its successful operation; Figure 4.25 shows the initial message output from the system information component. Together with the message, three options were given, to enter the system and start using it, be given further details and information about the system or go into the help file which contains the user’s guide.

**Figure 4.25 System Information initial Message Output**

The further details option would provide more information about the systems as shown in Figure 4.26.

**Figure 4.26 System Information Further Details**
However, if the help option was selected, the user's guide message would be displayed, as shown in Figure 4.27. This contained more specific details about the system and how to it could be used. This would be very useful to verify further help and guidance on how to use the system or a general overall view about its components.

![User Guide](image)

**Registration:**

First-time users will be asked by the system to register with "username" and "password" that will be unique for those individuals.

**Learning Styles:**

Once users have registered on the system, a learning style test is used to help them to identify and utilise their own learning style in an aid to effective and efficient learning.

**Assessment of Prior Knowledge:**

A prior knowledge assessment will be used to help first-time users to setup their individual learning targets according to their existing and previous experience.

**Individual Learning Plan (ILP):**

The Individual Learning Plan (ILP) is the main gateway for users to check their individual personal details, learning states, learning progress, and access to the learning contents provided.

**Modules:**

The learning contents for each module will comprise of:

- E-Lecture/Tutorial for conceptual explanation
- E-game and demo to reinforce the understanding of individual concepts
- Formative assessment to review the learning achievement

![Close](image)

**Figure 4.27 System Information Users Guide**
4.3.2 Students' Registration

The system uses this component to compile information regarding individual students that the system acquires for registration. Within this component registration is essential for securing usernames and passwords, which allows access to the system. At the same time this component starts the data collection process about individual students in order to track their performance over the period of using the system. It also uses the gathered information to provide useful and appropriate feedback to the individual students regarding their performance and the best way forward towards achieving their targets; the full operation of this component is shown in Figure 4.28.

Figure 4.28 Student Registration Full Operation Chart
Based on the above chart, the appropriate programming code was then written to satisfy the required operations for this component. Figure 4.29 shows the initial designed template for the Student Registration component.

![Figure 4.29 Student Login and Registration Initial Designed Template](image)

**Figure 4.29** Student Login and Registration Initial Designed Template
The program was then tested to ensure its successful operation. Details regarding registration were needed for the first time in order for the system to create the students' information file. First-time students had to create an account with information such as first name, last name, username and password. Upon this students could access the system by using a username and password. Figure 4.30 shows the initial registration dialogue window which included the required basic students' information highlighted with the red star.

* - Required field

Back to login page

Figure 4.30 Student Registration Dialog Box

Once students registered their information, the system creates the appropriate files including the students' profile. Upon this registration, students were allowed to log onto the system by submitting a login request as shown in Figure 4.31.

Figure 4.31 Student Login Dialog Box
4.3.3 Learning Style

This component identifies students' preferences for their learning styles. Based on a specially designed questionnaire the system is able to identify the individual student's preferred learning style. This is achieved using multiple choice questions to verify the student preferable learning styles, which can be Visual, Auditory and Kinaesthetic. Upon submission, scores and details of their learning styles are provided. This questionnaire was designed by the author based on the VAK theory; Table 4.3 provides a list of these questions.

Table 4.3 Learning Styles Designed Questions

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>When using new computer software, do you like?</td>
</tr>
<tr>
<td></td>
<td>a) Reading from a written tutorial on screen.</td>
</tr>
<tr>
<td></td>
<td>b) Listen to verbal instructions from lecturer.</td>
</tr>
<tr>
<td></td>
<td>c) Have a go as you can figure it out as you use it.</td>
</tr>
<tr>
<td>2</td>
<td>When thinking of a new design idea, do you prefer to?</td>
</tr>
<tr>
<td></td>
<td>a) Write and sketch features.</td>
</tr>
<tr>
<td></td>
<td>b) Discuss it with others.</td>
</tr>
<tr>
<td></td>
<td>c) Build a mock up model.</td>
</tr>
<tr>
<td>3</td>
<td>When you are asked to explain a practical topic, do you?</td>
</tr>
<tr>
<td></td>
<td>a) Use pictures and diagrams.</td>
</tr>
<tr>
<td></td>
<td>b) Give verbal explanations.</td>
</tr>
<tr>
<td></td>
<td>c) Demonstrate how it works and let them have a go.</td>
</tr>
<tr>
<td>4</td>
<td>In your spare time, do you like?</td>
</tr>
<tr>
<td></td>
<td>a) Visit exhibitions, galleries, museums, etc.</td>
</tr>
<tr>
<td></td>
<td>b) Listen to Music.</td>
</tr>
<tr>
<td></td>
<td>c) Engage in sport activities, painting, making things, etc.</td>
</tr>
<tr>
<td>5</td>
<td>If you are buying new equipment, do you?</td>
</tr>
<tr>
<td></td>
<td>a) Read lots of information in catalogues or use web sources.</td>
</tr>
<tr>
<td></td>
<td>b) Ask others about it.</td>
</tr>
<tr>
<td></td>
<td>c) Go round the shops and have a look.</td>
</tr>
<tr>
<td>6</td>
<td>When you are taught a new task, do you normally remember?</td>
</tr>
<tr>
<td></td>
<td>a) Visual illustrations presented.</td>
</tr>
<tr>
<td></td>
<td>b) Lecturer's discussion.</td>
</tr>
<tr>
<td></td>
<td>c) Doing the task.</td>
</tr>
<tr>
<td>7</td>
<td>When trying to solve a problem in the class, you tend to?</td>
</tr>
<tr>
<td></td>
<td>a) Focus on the words, illustrations or images.</td>
</tr>
<tr>
<td></td>
<td>b) Discuss it within a group.</td>
</tr>
<tr>
<td></td>
<td>c) Build models to demonstrate solutions.</td>
</tr>
</tbody>
</table>
8. If you see a new car design, do you like to?
   a) Read about new features in magazines/web.
   b) Call dealers to enquire about it.
   c) Visit dealers and test drive.

9. When you are explaining a new procedure, do you?
   a) Present lots of pictures and diagrams.
   b) Telling it verbally.
   c) Demonstrate it for others to follow.

10. When you are asked to do a computer based practical task, do you find useful?
    a) Visual prompts.
    b) Bleeps and sound.
    c) Trial and error approach.

11. When you are asked to find information about a place, do you prefer to?
    a) Use books or Internet sources.
    b) Discuss it with colleagues.
    c) Go out and find the place.

12. When you are trying to remember how to spell a word, do you?
    a) Try to visualise the word in your mind.
    b) Repeat it in your head or out loud.
    c) Write it down and see if it feels right.

13. When receiving an appraise/thank you, do you like to?
    a) Get a written note.
    b) Hear it said to you.
    c) Public demonstration in front of colleagues.

14. When you are concentrating, do you become distracted by?
    a) Untidiness.
    b) Sounds and noise.
    c) Activities around you.

15. When you meet people again, do you remember?
    a) Faces and places where you met before.
    b) The way they sound and speak.
    c) Events occur.

16. When you are learning a new task, do you prefer to?
    a) Watch the lecturer do it first.
    b) Listen to a verbal explanation from the lecturer.
    c) Have a go at doing it yourself.

17. When you are asked to work in groups, do you prefer?
    a) Taking a leading role.
    b) Follow others in the group.
    c) Share activities together.
18. When you are presenting a topic, do you prefer?
   a) Using slides with text and images.
   b) Verbally discussing it.
   c) Demonstrating physical models

19. When you have a problem with your computer, do you?
   a) Look at the help guide.
   b) Call the help desk.
   c) Fix it yourself.

20. When you asked to learn something new, do you prefer to?
   a) Read the text and look at the images and screen shots.
   b) Listen to an audio tutorial or the lecturer.
   c) Hands on procedures.

There are a total of 20 questions covering the three possible learning styles. Based on the students' responses to these questions, the system provides the students with their preferable learning styles. Students can be prominently:

- Visual
- Audio
- Kinaesthetic
- Visual and Audio
- Visual and Kinaesthetic
- Audio and Kinaesthetic
- Audio, Visual and Kinaesthetic.
- None of the above in the case where students submit blank responses to all questions and thereby no conclusions could be made.

Table 4.4 shows all the probabilities of students' preferable styles.

<table>
<thead>
<tr>
<th>Visual</th>
<th>Audio</th>
<th>Kinaesthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>-</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
The previous table is then presented in terms of percentage of individual possibilities of students being of such learning style. The scores shown in Figure 4.32 identify that students can have a main strong preference; or can have a mixture of two or, less commonly, three styles. There is no right or wrong learning style, the point is that there are preferred learning styles for different students.

![Learning Styles Probabilities](image)

**Figure 4.32 Learning Styles Probabilities Distribution**

The learning materials are provided in all three versions to suit all types of learning styles. Students are encouraged in the first instant to use the learning material that matches their preferable learning style; however it might be beneficial for some students to use other types of learning materials. This becomes apparent to students and lecturers once students start to engage with the system and using the learning materials; the full operation of this component is shown in Figure 4.33.
Figure 4.33 Learning Styles Full Operation Chart with Input/Output

Based on the above chart, the appropriate programming code was written using ASP coding. Figure 4.34 shows the designed template for the learning style component as the initial results decipher.
Learning Style Test Result

It's very important that learners recognise their own learning style and preferences, so they can maximise their strengths in their preferable learning styles and also adapt new strategies to work on their weaknesses in other learning styles.

The score below identifies that learners can have a main strong preference; or can have a mixture of two or, less commonly, three styles. There is no right or wrong learning style, the point is that there are preferred learning styles for different learners.

<table>
<thead>
<tr>
<th>Your Visual Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your Auditory Score</td>
</tr>
<tr>
<td>Your Kinaesthetic Score</td>
</tr>
<tr>
<td>Your Preferable Learning Style is</td>
</tr>
</tbody>
</table>

1. Visual

Learners with visual style of learning can learn more effectively when they observed or read. They prefer written handouts, graphs, charts, diagrams, etc… They also prefer colour coding and highlighting text, using bullets to separate ideas, watching films and observing others to demonstrate first.

2. Auditory

Learners with auditory style of learning generally prefer the transfer of information through listening. They learn best by listening to verbal instructions or information presented in a lecture. They also prefer discussions or audio recordings, reading text aloud, study with a friend, recite information to help them to remember and tape study notes.

3. Kinaesthetic

Learners with kinaesthetic style of learning are also called tactile. They prefer using physical experience and they mostly learn by using whole body movements, such as touching, feeling, holding and practicing hand-on experience. They prefer to be totally involved and can benefit from making models, breaking information into steps, exercising while studying, using rhythms and storylines to help them remember information and making card to record notes.

Figure 4.34 Learning Styles Results Decipher Template

The program was then tested to ensure its successful operation. Figure 4.35 shows a screenshot of an example of the designed questions as they were displayed to the students.
<table>
<thead>
<tr>
<th></th>
<th>When using new computer software, do you like?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Reading from a written tutorial on screen</td>
</tr>
<tr>
<td></td>
<td>○ Listen to verbal instructions from lecturer</td>
</tr>
<tr>
<td></td>
<td>○ Have a go as you can figure it out as you use it</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>When thinking of a new solution, do you prefer to?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Write and sketch features</td>
</tr>
<tr>
<td></td>
<td>○ Discuss it with others</td>
</tr>
<tr>
<td></td>
<td>○ Build a mock up model</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>When you are asked to explain a practical topic, do you?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Use pictures and diagrams</td>
</tr>
<tr>
<td></td>
<td>○ Give verbal explanations</td>
</tr>
<tr>
<td></td>
<td>○ Demonstrate how it works</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>In your spare time, do you like to?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Visit exhibitions, galleries, museums, etc</td>
</tr>
<tr>
<td></td>
<td>○ Listen to Music</td>
</tr>
<tr>
<td></td>
<td>○ Engage in sport activities, sing, dance, paint, make things, etc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>If you are buying new equipment, do you?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Read lots of information in catalogues or use web sources</td>
</tr>
<tr>
<td></td>
<td>○ Ask others about it</td>
</tr>
<tr>
<td></td>
<td>○ Go round the shops and have a look</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>When you are taught a new task, do you normally remember?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○ Visual illustrations presented</td>
</tr>
</tbody>
</table>

**Figure 4.35 Learning Styles Component Operation Output**

Following the submission by students, the system provided a summary of the results including their preferable learning styles; **Figure 4.36** shows an example of a results' decipher.
Learning Style Test Result

It's very important that learners recognise their own learning style and preferences, so they can maximise their strengths in their preferable learning styles and also adapt new strategies to work on their weaknesses in other learning styles.

The score below identifies that learners can have a main strong preference; or can have a mixture of two or, less commonly, three styles. There is no right or wrong learning style, the point is that there are preferred learning styles for different learners.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Your Visual Score</td>
</tr>
<tr>
<td>2</td>
<td>Your Auditory Score</td>
</tr>
<tr>
<td>13</td>
<td>Your Kinaesthetic Score</td>
</tr>
<tr>
<td>13</td>
<td>Your Preferable Learning Style is Kinaesthetic</td>
</tr>
</tbody>
</table>

1. Visual
Learners with visual style of learning can learn more effectively when they observed or read. They prefer written handouts, graphs, charts, diagrams, etc. They also prefer colour coding and highlighting text, using bullets to separate ideas, watching films and observing others to demonstrate first.

2. Auditory
Learners with auditory style of learning generally prefer the transfer of information through listening. They learn best by listening to verbal instructions or information presented in a lecture. They also prefer discussions or audio recordings, reading text aloud, study with a friend, recite information to help them to remember and tape study notes.

3. Kinaesthetic
Learners with kinaesthetic style of learning are also called tactile. They prefer using physical experience and they mostly learn by using whole body movements, such as touching, feeling, holding and practicing hand-on experience. They prefer to be totally involved and can benefit from making models, breaking information into steps, exercising while studying, using rhythms and storylines to help them remember information and making card to record notes.

Figure 4.36 Learning Styles Results Decipher

4.3.4 Pre-Assessment
The operation of this component is mainly to examine and record the students' prior knowledge of the taught subject. Their result from this component is used to create an appropriate progression profile that is fed into the ILP component, which decides on topics that are required to be learnt. It stores data, which is specific to each individual student, this knowledge is vitally important as it defines the abilities and experience of students. As various students have different background knowledge, this component uses the results to identify the entry point that the students can start at, however students are always given the opportunity to start from the beginning should they wish, such approach can enhance their knowledge and confidence in using the system.

Questions Design
Blows Taxonomy (Bloom 1956) is a classification of learning objectives within education to identify forms and levels of learning. It identifies domains of learning, as shown in Figure 4.37, which is organised as a series of levels or pre-requisites refers
to knowledge structures starting from the bottom level. It can be viewed as a sequence of progressive contextualisation of the material.

Anderson and Krathwohl (2001) have made some changes to include the renaming and reordering of the taxonomy, as shown in Figure 4.38.
The Bloom revised method is applied by the author to construct the assessment questions for the taught subject. The model questions in Table 4.5 forms the guidelines for developing the appropriate set of multiple choice questions that relates to each individual topic.

<table>
<thead>
<tr>
<th>Key Word</th>
<th>Model Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understand</strong></td>
<td>What are the facts? What does this mean? Is this the same as? Give an example. Select the best definition. Condense this paragraph. What would happen if? State in one word. Explain what is happening. What part doesn't fit? Explain what is meant. What expectations are there? Read the graph (table). What are they saying? This represents. What seems to be? Is it valid that? What seems likely?</td>
</tr>
<tr>
<td><strong>Apply</strong></td>
<td>Predict what would happen if? Choose the best statements that apply. Explore the effects. What would result? Identify what would happen. How much change there would be? Identify the results of?</td>
</tr>
<tr>
<td><strong>Evaluate</strong></td>
<td>What fallacies, consistencies, inconsistencies appear? Which is more important? Find the errors.</td>
</tr>
<tr>
<td><strong>Create</strong></td>
<td>How would you test? Propose an alternative. Solve the following. How else would you? State a rule.</td>
</tr>
</tbody>
</table>

Upon this, a total of 20 multiple choice questions, as shown in Table 4.6, covering the taught topics within the selected subject are compiled and designed according to the chosen subject for this project, which is the fundamental of 2D AutoCAD. The individual topics within this subject are: Coordinates, Layers, Blocks and PaperSpace including Units and Scale.
### Table 4.6 Pre-Assessment Questions

1. **What is a co-ordinate?**
   - a) A point on a grid where 2 grid-lines cross or where 2 object lines intersect
   - b) An undefined point in a drawing
   - c) A line
   - d) A series of points linked together

2. **How is the WCS identified on screen in 2D CAD?**
   - a) An arrow
   - b) A cross
   - c) the X Y icon
   - d) It is not shown on screen

3. **In CAD, where are the co-ordinates for the cursor displayed?**
   - a) Upper left corner of the screen
   - b) Lower left corner of the screen
   - c) Lower right corner of the screen
   - d) They are not shown on screen

4. **What is the correct format for entering Absolute Co-ordinates in CAD?**
   - a) 10-5
   - b) 10,5
   - c) 10 5
   - d) 10/5

5. **What is the correct format for entering Relative Polar co-ordinates in CAD?**
   - a) 10<5
   - b) <10,5
   - c) @10,5
   - d) @10<5

6. **When drawing, every thing is drawn on which layer?**
   - a) Default layer
   - b) Current layer
   - c) Layer 0
   - d) Drawing layer

7. **Using layer, you can control the layout of the drawing. Which answer below is INCORRECT?**
   - a) Control the visibility of objects on the same layer
   - b) Control the style of text on the same layer
   - c) Control the colour of objects on the same layer
   - d) Control the line type of objects on the same layer

8. **In AutoCAD, which operation can NOT be done to a layer?**
   - a) Open / Close
   - b) Lock / Unlock
   - c) On / Off
   - d) Freeze / Thaw
9. In the Layer Manager window, if you want to set a layer to be the current Layer, which button should you click on? – Images are Provided
   a) 1
   b) 2
   c) 3
   d) 4

10. If you want to change the colour of a group of objects by changing their layer colour, the colour property of the objects must be set to:
    a) Be the same colour
    b) By Layer
    c) Red colour
    d) Layer colour

11. What does a block mean, in general, in the AutoCAD system?
    a) A large building divided into separate units
    b) An obstacle
    c) A group of simple entities to represent a more complex entity
    d) A solid piece of a hard substance

12. In terms of a library of blocks, which statement below is incorrect?
    a) Can be accessed through network
    b) It is a building built with blocks
    c) Consists of the blocks you use regularly
    d) Can be put into different folder

13. Once you change a block and re-define it in a CAD drawing, which Statement below is correct?
    a) All the instances or copies of this block in the drawing will have the same changes
    b) It will change the similar blocks within the same layer only
    c) It will only change the objects within that one block
    d) It won’t affect other blocks that were duplicated from this block

14. If you want to create a block and save it as a file to be used in any CAD Drawing, which command should you use in AutoCAD?
    a) Bmake
    b) Blockwrite
    c) Wblock
    d) Block

15. To modify a group of blocks, make sure you define the new block to?
    a) Its original name
    b) Its original insert point
    c) Its original layer
    d) Its original scale

16. In terms of the drawing units in a CAD system, which statement below is incorrect?
    a) Everything you draw within CAD should in centimetre
    b) There is no general measurement reference in CAD
    c) Drawing units include linear units and angular units
    d) Drawing unit in CAD can represent any measurement units in real life
17. In terms of using paper space in AutoCAD, which statement below is incorrect?
   a) Paper space is used to simulate the drawing process on real paper
   b) Paper space is used to scale the drawing onto standard paper sizes
   c) Paper space is used to put different parts of the drawing in model space onto the same piece of paper
   d) Paper space is used to plot or print the drawing created in model space

18. Which statement below about the paper scale and plot scale is incorrect?
   a) Different drawing units will affect the plot scale even when producing drawings under the same paper scale
   b) Paper scale is used in measuring the dimensions represented on paper
   c) Plot scale is always equal to paper scale
   d) Plot scale is a calculation related to drawing units and paper scale

19. According to the golden rules in setting scale and unit, which one below is incorrect?
   a) Drawing everything in full size 1:1
   b) Draw everything in model space
   c) Always set the plot scale to 1:100
   d) Print or plot only in paper space

20. In terms of defining multi-viewports, which statement below is incorrect?
   a) You can only use rectangle to create viewports
   b) You can treat the viewport as a general object to modify their shape
   c) You can use Mview command to create multi-viewports
   d) You can hide the border of a viewport by putting them into a layer that is switched off or frozen

The full operation of this component is shown in Figure 4.39.

![Diagram of Pre-Assessment Full Operation Chart]

Figure 4.39 Pre-Assessment Full Operation Chart
Based on the above chart, the appropriate programming code was written; Figure 4.40 shows the initial decipher template design for this component.

![Pre-learning Assessment Result](image)

**Figure 4.40 Pre-Assessment Results Decipher Template**

The program was then tested to ensure its successful operation; Figure 4.41 shows a screenshot of an example of the designed questions as they were displayed to students.
1. **What is a co-ordinate?**

   - A point on a grid where 2 grid-lines cross or where 2 object lines intersect
   - An undefined point in a drawing
   - A line
   - A series of points linked together

2. **How is the WCS identified on screen in 2D CAD?**

   - An arrow
   - A cross
   - the XY icon
   - It is not shown on screen

3. **In CAD, where are the co-ordinates for the cursor displayed?**

   - Upper left corner of the screen
   - Lower left corner of the screen
   - Lower right corner of the screen
   - They are not shown on screen

4. **What is the correct format for entering Absolute Co-ordinates in CAD?**

   - 10-5

---

**Figure 4.41 Pre-Assessment Questions Output Operation**

Following the submission by students, the system provided a summary of their results to this component; **Figure 4.42** shows an example of such results.
4.3.5 Intelligent Learning Plan

This component is linked to all the other components within the system. It contains and updates all relevant data about students' information, learning styles and pre-assessment. ILP also contains an intelligent personal learning advice that records all students' interaction with the system and also guides them through achieving the learning outcomes of the taught subjects, as shown in Table 4.7.

Table 4.7 ILP Functions within Student's Profile

<table>
<thead>
<tr>
<th>Student's Information</th>
<th>Student's Personal Learning Targets</th>
<th>Student's Personal Learning Advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student's Name (s).</td>
<td>Topic Numbers and Topic Titles.</td>
<td>Preferable learning style.</td>
</tr>
<tr>
<td></td>
<td>Pre-Assessment scores per topic.</td>
<td>Topics with prior knowledge.</td>
</tr>
<tr>
<td>Student's Score in all Learning Styles with link to further information.</td>
<td>Deadline for completion per topic.</td>
<td>Successfully completed topics.</td>
</tr>
<tr>
<td></td>
<td>Attendance of topics and their assessments.</td>
<td>Topics not attended.</td>
</tr>
<tr>
<td></td>
<td>Assessment status per topic.</td>
<td>Topics not completed within deadline.</td>
</tr>
<tr>
<td></td>
<td>Current topics status.</td>
<td></td>
</tr>
</tbody>
</table>

The full operation of this component is shown in Figure 4.43.
Based on the above chart, the appropriate programming code was written; Figure 4.44 shows an example of the initial designed template for the ILP component.
The program was then tested to ensure its successful operation; **Figure 4.45** shows a screenshot of an example of a typical ILP. Within this example, topic one was passed through the pre-assessment component and therefore it was not included within the learning targets for this ILP. However, topic one can still be accessed through the learning contents link if required as shown in **Figure 4.46**.
4.3.6 Subject Knowledge

This component includes the database that is concerned with the teaching and learning models that is going to be presented to the students. This includes different teaching models that contain a selection of tutorials, presentations, assessment, case studies and documents to enhance further reading. The author selected appropriate material for the development of this component based on a level 4-module titled Computer Aided Design. This subject provides students with an introduction to the skills and knowledge required to use appropriate computer software such as AutoCAD as an aid to design for the engineering industry. It consists of using CAD tools for the production of two-dimensional drawings of engineering components and assemblies. Industry standard layer convention and libraries of standard symbols along with system procedures and functions are used to speed up the design process. A three dimensional model is utilised to produce elevations and various views and perspectives of the project. Text insertion and automatic dimensioning to a drawing are investigated. Upon successful completion of this subject, students are able to:

- Demonstrate the knowledge and ability to save, retrieve and printout to scale a drawing file using industry standard CAD software.
- Use industry standard CAD software to produce dimensioned component drawings.
- Demonstrate the knowledge ability to utilise the CAD system's commands to produce an assembly drawing of an engineering product.

All the appropriate subject material was developed, which had a total of 14 tutorials as well as appropriate exercises, these tutorials for each topic were then developed by the author to cover the following different learning models; examples are available in Appendix A:

- Main tutorial: included information about individual topics to be learnt in different learning styles presentation. The tutorial included presentations with text, images, screen shots, demonstrations and audio sound. It also incorporated an interactive medium, which enabled students to input data and receive immediate feedback to enhance their understanding of the taught topic.
Tutorials in action: this type of tutorials was designed and developed to help students to follow instructions of the steps required in order to complete a task or a tutorial, they included audio, visual and kinaesthetic support.

A Quiz or a puzzle: this included a form of a game that was based on a particular topic such as co-ordinates. Students were able to play, interact and keep trying till they succeeded. This helped them to understand the subject in a different format and provided them with extra motivation to practice on a particular exercise.

The full operation of this component is shown in Figure 4.47.
Based on the above chart, the appropriate programming code was written; Figure 4.48 shows the initial designed template for this component.

Figure 4.48 Initial Design Template Example for Subject Knowledge

The program was then tested to ensure its successful operation; Figures 4.49 - 4.55 provide samples of a range of tutorials in different learning styles.
PAGE/PAGES EXCLUDED UNDER INSTRUCTION FROM UNIVERSITY
Figure 4.51 Subject Knowledge Demonstration Tutorials
Figure 4.52 Subject Knowledge Presentation Tutorials
Essential CAD Concept Series 1

USING CO-ORDINATES

Figure 4.53 Subject Knowledge Presentation Tutorials
C

The CARTESIAN co-ordinate and POLAR co-ordinate systems both use 2 methods of entering co-ordinates. These are:

**CARTESIAN**

- **Relative Entry**: co-ordinate entry uses a value for the 'X' and 'Y' axis, compared to the Origin Point or 0,0 (the Origin Point is where the 'X' and 'Y' line cross), e.g. (2,5).

- **Absolute Entry**: co-ordinate entry uses a value for the 'X' and 'Y' axis COMPARSED to the Last co-ordinate entry that was made, or one that is Selected by using the @ symbol before the co-ordinate, e.g. (2,3).

We'll look at CARTESIAN co-ordinates and POLAR co-ordinates in sequence and see how relative and absolute co-ordinate entry is used.

**Cartesian Co-ordinates - Relative Entry**

Relative co-ordinate entry uses a value for the 'X' and 'Y' axis COMPARSED to the Last co-ordinate entry that was made, or one that is Selected by using the @ symbol before the co-ordinate, e.g. (2,3).

**Cartesian Co-ordinates - Relative Entry**

OK, you've seen the theory and examples again, now it's time for YOU to enter some co-ordinates!

For a tip, move the cursor over the co-ordinate entry box.
To clear your entry use the backspace key.
If you enter 3 incorrect co-ordinates you'll be taken back to the previous explanatory slide.

Starting from 0,0 what is the relative co-ordinate for Point 1?

Figure 4.54 Subject Knowledge Interactive Tutorials
Figure 4.55 Subject Knowledge Interactive and Quizzes Tutorials
4.3.7 Formative Assessment
This component assesses and records the students' current knowledge and supports the transition to a new knowledge state. If students answer a set of test questions correctly, through this component, this information is inputted into the ILP component and thereby the system presents the next teaching topic in accordance with the specified learning targets. If students answer incorrectly, again the rest of teaching plan is updated and alternative teaching blocks is presented. This component has 15 multiple choice questions per topic to evaluate the learning experience that the student has gained by going through the subject's knowledge component. These questions are designed using the Bloom Taxonomy method; full details are discussed in section 4.3.4. The student needs to achieve 12 out of 15 (80%) and above to pass this assessment in order to proceed to the next topic. Table 4.8 shows the formative assessment questions for the Co-ordinates topic as an example from the selected subject knowledge. Upon submission, students are given the results of the assessment together with a comprehensive feedback and guidance based on their performance within this component as shown in Table 4.9, this is an example based on Topic 1.

Table 4.8 Formative Assessment Questions

<table>
<thead>
<tr>
<th>1. What is a co-ordinate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. A series of points linked together</td>
</tr>
<tr>
<td>b. A point on a grid where 2 grid-lines cross or where 2 object lines intersect</td>
</tr>
<tr>
<td>c. An undefined point in a drawing</td>
</tr>
<tr>
<td>d. A line</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Why are co-ordinates important when working in CAD?</th>
</tr>
</thead>
<tbody>
<tr>
<td>e. They identify areas of the drawing</td>
</tr>
<tr>
<td>f. They are not important; they do not need to be used</td>
</tr>
<tr>
<td>g. They identify the location of any point within the drawing</td>
</tr>
<tr>
<td>h. They help with printing the drawing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. What does WCS stand for in CAD?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Web CAD System</td>
</tr>
<tr>
<td>b. World-stand Co-ordinate System</td>
</tr>
<tr>
<td>c. Worldwide Co-ordinate System</td>
</tr>
<tr>
<td>d. World Co-ordinate System</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. How is the WCS identified on screen in 2D CAD?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. A cross</td>
</tr>
<tr>
<td>b. An arrow</td>
</tr>
<tr>
<td>c. the X Y icon</td>
</tr>
<tr>
<td>d. It is not shown on screen</td>
</tr>
</tbody>
</table>
5. What is the Origin Point in CAD?
   a. The point where the X-axis and Y-axis cross at 0 units on each axis
   b. The point where you start your drawing
   c. A random position within the drawing
   d. The lower left corner of the screen

6. When entering co-ordinates, the value for which axis should be entered first?
   a. X
   b. Y
   c. Z
   d. It doesn't matter, the computer will work it out

7. In CAD, where are the co-ordinates for the cursor displayed?
   a. They are not shown on screen
   b. Upper left corner of the screen
   c. Lower left corner of the screen
   d. Lower right corner of the screen

8. When moving across the CAD screen to the right and up, in terms of co-ordinate entry, in which direction are you moving?
   a. Negative direction to the right; Positive direction upwards
   b. Positive direction
   c. Positive direction to the right; negative direction upwards
   d. Negative direction

9. Absolute co-ordinates use which point as their reference point?
   a. The lower left point of the screen
   b. The Origin Point 0,0
   c. The point that is selected by the user
   d. The first point of the first line drawn

10. What is the correct format for entering Absolute Co-ordinates in CAD?
    a. 10-May
    b. 10,5
    c. 10-May
    d. 10 5

11. Relative Co-ordinates use which point as their starting point?
    a. Any point on the screen
    b. The last defined point or a point that is selected
    c. The lower left corner of the screen
    d. The Origin Point 0,0

12. What is the correct format for entering Relative Co-ordinates in CAD?
    a. @10/5
    b. @10-5
    c. @10,5
    d. 10,5

13. From which direction does CAD start measuring angles for Polar co-ordinates?
    a. 6 o'clock
    b. 3 o'clock
    c. 9 o'clock
    d. 12 o'clock
14. When entering Polar co-ordinates, is entering 270 degrees the same as entering -90 degrees?
   a. Sometimes
   b. No
   c. Yes
   d. It depends which point you select the drawing

15. What is the correct format for entering Relative Polar co-ordinates in CAD?
   a. @10<5
   b. <10,5
   c. @10,5
   d. 10<5

<table>
<thead>
<tr>
<th>Score</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>There was no serious attempt made to answer the questions. This shows a serious lack of understanding, which indicates that you have failed to follow the tutorial correctly. You must go through the tutorial again and it would be advisable to go through it step-by-step to ensure that you fully understand the actions that you are following. If you still achieve same level of outcome, then you are advised to seek help and guidance from the lecturer.</td>
</tr>
</tbody>
</table>
| 1-5   | This is a very poor performance with well below the expected level to achieve a pass. There is no evidence of serious engagement with the tutorial. Your answers show evidence of confusion and incoherence with serious misunderstanding leading to errors. You have failed to demonstrate or show evidence of learning the main objectives including:
   - Defining co-ordinates
   - Understanding benefits of using co-ordinates
   - Using Absolute, relative and polar co-ordinates
   - Understanding the World Co-ordinate System
As your performance was well short of the pass standard, you must repeat the tutorial. It would be advisable to try and follow instructions more carefully and at a slower pace to allow you to absorb instructions. It may be beneficial to try a different learning style to enhance your understanding and therefore achieve a better score. |
### Score | Feedback
--- | ---
6-12 | You overall performance was unsatisfactory. There was some evidence of good learning but that was followed by evidence of weakness and inadequate level of deep learning. Some aspects of the tutorial were fully understood, this was shown by providing clear coherent answers to some areas, where other areas were clearly misunderstood as incorrect answers have shown such phenomena. In order to achieve an overall satisfactory performance, you must show evidence of learning in all field of study including:
- Defining co-ordinates
- Understanding benefits of using co-ordinates
- Using Absolute, relative and polar co-ordinates
- Understanding the World Co-ordinate System
You must repeat the tutorial in order to achieve better score; extra effort and maybe trying a different learning style can be beneficial to ensure success.

13-14 | Congratulations, you have passed this assessment. Very good level of understanding, which was evident by the coherent answers that you have provided across the covered topic, including:
- Defining co-ordinates
- Understanding benefits of using co-ordinates
- Using Absolute, relative and polar co-ordinates
- Understanding the World Co-ordinate System
Your answers show clear evidence of clarity in thinking and sense of coherence with minor errors. There is still possibility for improvement; this can be done by repeating the tutorial or by trying to use different learning style, which might strengthen your understanding. Well Done!

15 | Congratulations, you have passed with outstanding result. This shows an exceptional level of learning with clarity of ideas, excellent coherence and logic. Achieving this commendable score shows that you have understood the learning objectives fully. It also shows that this could be your suitable learning style in this particular field. Very Well Done!

The full operation of this component is shown in **Figure 4.56**.
Based on the above chart, the appropriate programming code was written and then tested to ensure its successful operation; Figure 4.57 shows screenshots of the formative assessment component questions in operation and Figure 4.58 shows two typical examples of the feedback performance as an outcome of this component.
1. What is a co-ordinate?
- A series of points linked together
- A point on a grid where 2 grid-lines cross or where 2 object lines intersect
- An undefined point in a drawing
- A line

2. Why are co-ordinates important when working in CAD?
- They identify areas of the drawing
- They are not important; they do not need to be used
- They identify the location of any point within the drawing
- They help with printing the drawing

3. What does WCS stand for in CAD?
- Web CAD System
- World-stand Co-ordinate System
- Worldwide Co-ordinate System
- World Co-ordinate System

9. In the Layer Manager window, if you want to create a new layer, which button should you click on?
- 1
- 2
- 3
- 4

Figure 4.57 Formative Assessment Questions Operation Output
You scored 7/15 and failed the Formative Assessment

You overall performance was unsatisfactory. There was some evidence of good learning but that was followed by evidence of weakness and inadequate level of deep learning:

Some aspects of the tutorial were fully understood, this was shown by providing clear coherent answers to some areas, where other areas were clearly misunderstood as incorrect answers have shown such phenomena.

In order to achieve an overall satisfactory performance, you must show evidence of learning in all field of study including:

- Defining co-ordinates
- Understanding benefits of using co-ordinates
- Using Absolute, relative and polar co-ordinates
- Understanding the World Co-ordinate System

You must repeat the tutorial in order to achieve better score; extra effort and maybe trying a different learning style can be beneficial to ensure success.

Go Through the Learning Module Again?

Yes  No

Congratulation!

You scored 13/15

You have passed this assessment. Very good level of understanding, which was evident by the coherent answers that you have provided across the covered topic, including:

- Defining co-ordinates
- Understanding benefits of using co-ordinates
- Using Absolute, relative and polar co-ordinates
- Understanding the World Co-ordinate System

Your answers show clear evidence of clarity in thinking and sense of coherence with minor errors. There is still possibility for improvement; this can be done by repeating the tutorial or by trying to use different learning style, which might strengthen your understanding.

Well Done!
4.3.8 Performance and Lecturer’s Role
This system is specially designed and developed so that individual students are put into the centre as this has been already proved through out the literature to be more effective for experiential learning. Good EDT lecturers do not have to be the “most valuable” CAD players, but have to be the best coaches. Therefore, the system has also considered the role of the lecturers and is designed to ensure that they can play the important role of remotely guiding and helping students to meet the desired learning outcomes and thereby achieve best and successful results throughout using the system. This role facilitates lecturers with the ability to view individual student(s)’ progress and then act if guidance, help, advice is required. To access this role, a lecturer has to login as an admin on the system, he/she is given a special username and password that leads them into an appropriate interface, which is specially designed to fulfil this role. Figure 4.59 shows the initial dialog box that can be expanded to access further details.

Figure 4.59 Lecturers Role – Initial Dialog Box
Upon expansion, a list of the main components and students’ users, as shown in Figure 4.60, can be accessed for further actions.

Figure 4.60 Lecturers Role – Main Expanded List
Selecting the "Student' Users" option provides a full list of students together with their details and records of their achievement status as shown in Figure 4.61.

![Figure 4.61 Lecturers Role – Main Students’ Users Dialog Box](image)

This option provides a number of possible global actions including; Logout, Advance search, Export results, Printer friendly version, Print all pages and Import as shown in Figure 4.62.

![Figure 4.62 Lecturers Role – Global Actions](image)

Selecting the Logout action button exit the lecturer from the system and take him/her back to the login dialog box as shown in Figure 4.63.

![Figure 4.63 Lecturers Role – Logout Action](image)
Selecting the Advanced search enable the lecturer to search for individual students using various key words such as ID, Username or achieved results, as shown in Figure 4.64.

![Advanced Search Interface](image)

**Figure 4.64 Lecturers Role – Advanced Search**

Export results action button enable the lecturer to export the results of the group of students in various formats such as Word and Excel as shown in Figure 4.65.

![Export Action Interface](image)

**Figure 4.65 Lecturers Role – Export Action**
The print action results in producing a printer friendly version of the students' records that is easily listed and read through as shown in Figure 4.66.

Figure 4.66 Lecturers Role – Print Actions

The import function allows the lecturer to upload individual file concerning groups of students in various appropriate formats such as Word and Excel as shown in Figure 4.67.

**Import**

Browse to the comma-separated (.csv) or to the Excel (.xls) file that you wish to import. The first line in the file should contain the field names.

![Image of import function](image)

Figure 4.67 Lecturers Role – Import Function

Within the system there are also more specific local functions that relate to a specifically selected component from the main expanded list shown in Figure 4.60. Within the students' users' record component, as shown in Figure 4.68, the available functions are; Add new, Inline Add, Edit selected, Delete selected, Export selected and Print selected.

![Image of local functions](image)

Figure 4.68 Lecturers Role – Local Functions
The Add new function, either using a dialog box or inline, enable the lecturer to add a new student user to the database by entering relevant information such as Username and Password as shown in Figure 4.69. This function can also be useful to re-create an existing record for a specific student user in case of data loss or corruption.

![Image of Add New Record dialog box]

**Figure 4.69 Lecturers Role – Add New Record**

The Edit function, either using a dialog box or inline, enables the lecturer to modify selected student’s record. The inline function within the edit enables the lecture to edit more than one record at a time as shown in Figure 4.70, while the dialog box edit only enables the editing of individual records as shown in Figure 4.71.

![Image of Edit Inline]

**Figure 4.70 Lecturers Role – Edit Inline**

Amal Oraifige
The Delete function erases selected records. The export function exports selected records in various appropriate formats such as Word and Excel as shown in Figure 4.72, while the print function prints details of selected records as shown in Figure 4.73.

![Figure 4.71 Lecturers Role – Edit Dialog Box](image)

Figure 4.71 Lecturers Role – Edit Dialog Box

![Figure 4.72 Lecturers Role – Export Selected Records in Excel Format](image)

Figure 4.72 Lecturers Role – Export Selected Records in Excel Format

![Figure 4.73 Lecturers Role – Print Selected Records](image)

Figure 4.73 Lecturers Role – Print Selected Records
Within the main records, all the results of students are available in a format of a table; each student has an individual row containing all his/her interactions with the system. This also can be viewed by selecting the View action button as shown in Figure 4.74.

![Figure 4.74 Lecturers Role – Student Record View Function](image)

The ILP of individual students can also be viewed Inline within the row, or through a dialog box. This function allows the lecturer to access students’ progression within the subject knowledge and formative assessment components, which can support providing the best possible guidance and advice if required; an example of this is shown in Figure 4.75.

![Figure 4.75 Lecturers Role – Inline View of an ILP](image)

If the lecturer selects the ILP component within the main list, this provides details regarding all the topics within the subject knowledge. Each row provides the name of the topic against a unique ID number for the individual student and his/her ILP as
shown in Figure 4.76. This can inform the lecturer with the latest status of all students' progress against all topics within the subject knowledge. The list also shows the number of learning and assessment attempts as well as the status of achievements. Each individual record results can also be viewed as a dialog box as shown in Figure 4.77. This component also has the facility for the local functions, as discussed previously, such as Edit, Delete, Export and Print.
Within the Modules component, existing topics can be Edited, Deleted, Exported and Printed. It is also possible to add and upload new topics, as shown in Figure 4.78.

The LST (Learning Styles) component contains a list of the questions that were designed by the author for the learning style test. The lecturer has the ability to upload new questions as well as add to existing ones or either edit, export and print; this is shown in Figure 4.79. Each row provides the question with the possible answers that students are able to select from. Editing can be performed multiply either within the table provided as shown in Figure 4.80 or individually for each question in a dialog box as shown in Figure 4.81.
Figure 4.79 Lecturers Role – LST Module

Figure 4.80 Lecturers Role – LST Inline Edit Function

Figure 4.81 Lecturers Role – LST Edit Individual Record Function
The PLA (Pre Learning Assessment) component contains a list of the questions that was designed by the author for the pre-assessment test. The lecturer has the ability to upload new questions as well as Add to existing ones or either Edit, Export and Print; this is shown in Figure 4.82. Each row provides the question with the possible answers that students are able to select from, it also provides a box to enter the correct answer number so that the system will be able to calculate whether the student has selected the wrong or the right answer. Images, diagrams and charts can also be uploaded in the box provided as part of the answers. Editing can be preformed multiply within the table provided as shown in Figure 4.83 or either individually for each question in a dialog box as shown in Figure 4.84.

![Figure 4.82 Lecturers Role – PLA Component](image)

![Figure 4.83 Lecturers Role – PLA Inline Edit Function](image)
The formative assessment component is designed in the same way as shown previously with the pre-assessment component. Each topic questions are listed within the appropriate FM component. For example to access the questions for topic one, this is listed under M01FA; Figure 4.85 shows an example of the possible functions and actions that can be preformed by the lecturer depending on the desired or required outcomes to satisfy the need.

<table>
<thead>
<tr>
<th>PLA Q</th>
<th>What is a co-ordinate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLA Qpic</td>
<td></td>
</tr>
<tr>
<td>PLA A</td>
<td>A point on a grid where</td>
</tr>
<tr>
<td>PLA Apic</td>
<td></td>
</tr>
<tr>
<td>PLA B</td>
<td>An undefined point in a</td>
</tr>
<tr>
<td>PLA Bpic</td>
<td></td>
</tr>
<tr>
<td>PLA C</td>
<td>A line</td>
</tr>
<tr>
<td>PLA Cpic</td>
<td></td>
</tr>
<tr>
<td>PLA D</td>
<td>A series of points linke</td>
</tr>
<tr>
<td>PLA Dpic</td>
<td></td>
</tr>
<tr>
<td>PLA CA</td>
<td>1</td>
</tr>
<tr>
<td>PLA LTI</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 4.84 Lecturers Role – PLA Individual Edit Function
4.3.9 Interface

As discussed and shown previously within this chapter, the interface was designed to provide guidance and support for the students and also to prevent them from foundering or missing important aspects of the domain, at the same time preventing them from tampering with the system. Through this Interface, students can have an active dialogue with a computer by determining how the information is provided and how the commands are interchanged. It has been designed so that students and lecturer can have full advantage of the system's features. It includes all mechanisms for data input and output of results from the system. Various interface types are used such as commands, menus, and graphics, also icons in windows opened in the computer screen showing data, models and other objects available in the system. Through this interface, students and lecturers can control data; subsystems and knowledge then review or print the results, a summary of the system interface functions are shown in Figure 4.86.
Log in

Username:
Password:
Remember Password:

Submit

Login

Cartesian Co-ordinates - Relative Entry

For a tip, move the cursor over the co-ordinate entry box. To clear your entry use the backspace key.

If you enter 3 incorrect co-ordinates you will be taken back to the previous explanatory slide.

Starting from 0.0, what is the relative co-ordinate for Point 2?

The Cartesian co-ordinate and Polar co-ordinate systems both use 2 methods of entering co-ordinates. These are:

- Cartesian
- Polar

- Cartesian: co-ordinate entry uses a value for the X and Y axis compared to the Origin Point or 0,0 (the Origin Point is where the X and Y lines cross), e.g. 120,34

- Polar: co-ordinate entry uses a value for the X and Y axis COMPARED to the Last co-ordinate entry that was made, or one that is Selected by using the @ symbol before the co-ordinate, e.g. 120

We’ll look at Cartesian co-ordinates and Polar co-ordinates separately and see how @Cartesian and @Polar co-ordinate entry is used.

Figure 4.86 Examples of System Interface Outputs to Students and Lecturers
4.4 Integration of Developed Components

Following the development of all the system components, it was necessary to build appropriate and specific links between all components in order to provide a fully operational system. Such integration resulted in creating dynamic as well as specific links between these components which ensured successful relationships that satisfies the students' need and requirements. The individual components were tested as they were being integrated in order to minimise potential operational problems. Once these components were successfully integrated and tested, the overall system was tested to ensure full operational success. Any problems or issues were investigated and resolved throughout this development. The main links for these components were between the ILP and the rest of components namely; Students' Information, Learning Styles, Pre-Assessment, Subject Knowledge and Formative Assessment as shown in Figure 4.87.

The students would only go through the learning styles and pre-assessment for the first time they register and log into the system unless they fail to answer any questions. Their results are then recorded and updated within their individual ILP. The subject knowledge and formative assessment interactions are recorded and
updated throughout using the system. These links have been designed and tested, Figures 4.88 - 4.90 show examples of the programming code used to ensure their successful operations.

![Figure 4.88 Student Information Links Operations with ILP](image)

![Figure 4.89 Learning Styles Links Operations with ILP](image)
Figure 4.90 Further Sample Interactions with ILP and other Components
4.5 Chapter Summary

This chapter discussed the development of the proposed system for this research project, this consisted of the design, development and testing of each individual component in order to ensure successful operational functions throughout. The integration was developed by building specific links between these components to provide a fully operational system. Throughout this development the system was tested online to ensure the appropriate operations by the interface and that was suitable to be used by the students and lecturers.

This system was designed and developed to provide an online environment that can be used by the students and lecturers to meet the learning outcomes of individual modules and thereby achieve successful results. The students will be able to follow a well structured systematic approach by firstly going through the learning styles to ensure that they are aware of the different learning methods that they can use, secondly they will go through the pre-assessment to ensure that their background knowledge and experience are being considered and can be taken into account while they are learning. This will lead them into a personal learning plan that provides targets to be achieved; they will be able to access different topics and learn them through many different methods to ensure effective and successful results. They can verify their understanding through the formative assessment for each given topic. Students will be able to reflect on their results and they may wish to re-learn individual topics through using different learning styles as this can increase their understanding of the taught topic and thereby achieve better results. Lecturers will be able to access the system through an admin account which enables them to monitor the students' progress from a distance; this will help them to offer guidance, support and/or advice if and when required.
5.0 Chapter 5 – Application of the Developed System (Group One)

This chapter discusses the developed system used for a teaching experience within a selected module. This module had a number of students with different levels and backgrounds of learning to satisfy the operation of the system's components and the adaptation of the different knowledge and understanding of the taught subject. The group's results were then gathered and analysed to provide the effectiveness of the system operations and functionalities. This analysis included the investigation of how the system was used by the students and reflections on the level of learning that could be achieved. It provides particular results for the students' learning styles, participation within individual topics and assessments' achievements. As an outcome, it will include an overall view of students' participation and engagement.

5.1 Selected Module Information

The Computer Aided Design for Motorsport is a 15 credit level-4 (Year one) module that is normally taught to a class of 40-50 students at the University of Derby within the engineering subject area (Motorsport). In this particular year (2009/2010) there were 43 students enrolled on this module with various backgrounds. This module provided the students with the necessary skills and knowledge using appropriate computer software for Motorsport design applications. This module focused on using CAD tools for the production of 2/3-Dimensional drawings of engineering components and assemblies. Industry standard layer convention and libraries of standard symbols along with system procedures and functions are used to speed up the drawing process. A three-dimensional model was utilised to produce elevations and various views and perspectives of the component. Text insertion and dimensioning to a drawing were also investigated. On successful completion of this module students were be able to:

- Demonstrate a knowledge and understanding of the AutoCAD software's tools and fundamentals.
- Apply and use AutoCAD software to produce 2D engineering dimensioned component drawings.
- Develop and apply CAD system knowledge to produce a fully detailed 3D assembly drawing for a Motorsport application.
The understanding and practise of this subject were very crucial to the students, as they had to complete the required summative assessment to pass this module, full details of these assessment briefs are provided in Appendix B. This assessment comprised of two coursework components worth 50% each:

- In the first assessment, students were required to create a two-dimensional Third Angle Projection orthographic engineering drawing to BS 8888 standard using Motorsport based component. Students were assessed based on: presentation, design representation, use of layer, line-type, dimensioning, blocks, utilising paper-space, and other features such as producing a cross section view with hatching.

- In the second assessment, students were required to create a 3D CAD assembly model for a Motorsport component, such as suspension model, brake system or an engine. The 3D model consisted of the main assembly made from several parts. Students were assessed based on: design layout and features, accuracy and scale of models, innovation, design intent and exploded parts with the use of layers.

The delivery of this module consisted of a two-hour weekly lecture, which included PowerPoint presentations, class discussions and tutorial exercises. The module was always taught in the traditional way, which involved a lecturer presenting in front of the students and explaining instructions step-by-step. Students often committed on this delivery as being bland and they did not always remember what they needed to achieve, especially after the lectures. The way to solve this was to provide continuous training sessions with a wide diversity of problems and tasks. However, for this to be effective, this required the lecturer to select the examples and steer the progress of learning. The lecturer needed to be able to permanently observe the learning progress of the students, evaluation of projects and tasks, which maximised the students' individual potential. Also another problem was highlighted that lecturers and students often had different backgrounds, practical skills and theoretical knowledge, which sometimes resulted in lecturers not realising the difficulties that students could face. Furthermore, it was noted that there was a difficulty to accommodate a balanced pace of delivery that would suit all types of students.
5.2 Planning and Implementation

The planning process is one of the most important stages in implementing any online learning strategy; it saves time by identifying problems before they can arise by having interventions in place to solve them. Graham et al (2000) emphasised the important factors that are needed to be considered during the planning stage. These can be best approached as a series of considerations that help in developing a clearer image of the parameters. Based on these considerations, the author has constructed Table 5.10 using number of considerations and implications applied to the subject, student and learning to include all the necessary planning and delivery data for the taught subject. Using this table, the online system (its4cad.com) was implemented within the delivery of the selected module (Computer Aided Design for Motorsport).

Table 5.10 Planning and Delivery of the Developed System

<table>
<thead>
<tr>
<th>Considerations</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>Understanding and applying: Coordinates, Layers, Blocks, Scale and Units, Paper-Space.</td>
</tr>
<tr>
<td>Subject</td>
<td>The coordinates' system, Layers, Blocks, Scale and Units, Paper-Space.</td>
</tr>
<tr>
<td>Medium</td>
<td>Use of AutoCAD Software. Access Internet (space, cost, licence, copyrights)</td>
</tr>
<tr>
<td></td>
<td>Link to system website.</td>
</tr>
<tr>
<td>Stage</td>
<td>43 Level-4 (year 1) Motorsport students within the Engineering subject group. No background in using AutoCAD tools.</td>
</tr>
<tr>
<td>Access</td>
<td>Some will access the material from home, some from the library, but most from the University computing rooms. AutoCAD is available at various CAD Labs. Some home computers are below required specifications; hence students may not be able to complete all the tasks at home.</td>
</tr>
<tr>
<td>IT skills</td>
<td>Mixed abilities of students. Identifying extra tutorial sessions by permanent observations.</td>
</tr>
<tr>
<td>Learning</td>
<td>Mixed learning styles are available. A range of material and activities</td>
</tr>
<tr>
<td>Considerations</td>
<td>Implications</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Styles</td>
<td>to suite different styles and approaches.</td>
</tr>
<tr>
<td>Learning</td>
<td>Tutorial material was developed and uploaded onto the system website at the appropriate time ready for students to use and complete. User guide is available for instructions.</td>
</tr>
<tr>
<td>Relation to Module</td>
<td>ITS4CAD will be used during the last four weeks of the module. Students are required to complete one topic per week.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>Outline learning outcomes section within the online topics. Include methods for students to measure their progress through the formative assessment. Provide means for students to follow their progress through feedback and reflection. Lecturer can monitor students’ progress and achievements.</td>
</tr>
<tr>
<td>Summative Assessment</td>
<td>Comprises of 2 coursework components worth 50% each. Successful completion underpins the learning outcomes and support students to achieve the best possible results in the required assessment.</td>
</tr>
<tr>
<td>Resources</td>
<td>The use of system is to support the delivery of this module. The use of AutoCAD software package to practise. The system can be accessed anywhere and anytime. Normal spec computers with an internet access can be sufficient. Autodesk are offering free educational licence for students to download AutoCAD.</td>
</tr>
<tr>
<td>Development</td>
<td>Depending on students’ feedback, future learning material may vary.</td>
</tr>
</tbody>
</table>
The system link (www.its4cad.com) was uploaded onto UDo (University of Derby Online Facility) for students to use and complete in their own time. Students were encouraged to reflect on their experience and provide feedback at the next face-to-face lecture. Any encountered problems were then discussed and resolved prior to students' engagements with the next topic. The system contained an interactive teaching environment for learning and practising 2D AutoCAD to suit various learning styles. Through the ILP, students were able to achieve learning outcomes of individual topics by performing appropriate tutorials and tasks followed by a formative assessment. Comprehensive feedback was provided based on their performance. The formative assessment had no contribution to the marking criteria. The system was developed to enhance and consolidate students' learning and understanding of the subject to be able to achieve the best results in their summative assessment; the learning outcomes of the selected topics are presented in Table 5.11.

Table 5.11 Learning Outcomes of the Selected Topics

<table>
<thead>
<tr>
<th>Topic 1</th>
<th>Overall Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Defining co-ordinates.</td>
</tr>
<tr>
<td></td>
<td>Understanding benefits of using co-ordinates.</td>
</tr>
<tr>
<td></td>
<td>Understanding the World Co-ordinate System.</td>
</tr>
<tr>
<td></td>
<td>Using Absolute, relative and polar co-ordinates.</td>
</tr>
<tr>
<td>Topic 2</td>
<td>Defining and creating layers.</td>
</tr>
<tr>
<td></td>
<td>Setting the current layer.</td>
</tr>
<tr>
<td></td>
<td>Changing layer settings.</td>
</tr>
<tr>
<td></td>
<td>Overriding Properties Set BYLAYER such as, colour, linetype and lineweight.</td>
</tr>
<tr>
<td>Topic 3</td>
<td>Understanding benefits of using blocks.</td>
</tr>
<tr>
<td></td>
<td>Defining and storing new blocks.</td>
</tr>
<tr>
<td></td>
<td>Inserting blocks.</td>
</tr>
<tr>
<td></td>
<td>Modifying blocks.</td>
</tr>
<tr>
<td>Topic 4</td>
<td>Understanding units and drawing scale.</td>
</tr>
<tr>
<td></td>
<td>Defining and using paper space.</td>
</tr>
<tr>
<td></td>
<td>Creating different view-ports in paper space.</td>
</tr>
<tr>
<td></td>
<td>Understanding printing and plotting scale.</td>
</tr>
</tbody>
</table>
5.3 Students Analysis

This section presents and discusses the results of the first group of students who took part in a pilot run on using the developed system. However, prior to going through the results and interpreting their meanings, the author would like to clarify the following points:

- Students had already six weeks of traditional teaching on 2D AutoCAD.
- The decision to ask this group of students to use the system was taken without prior planning on how it was to be integrated within this module.
- Students were not under obligation to use the system as it was not part of the initial module delivery plan.
- Using the system coincided with other activities that students needed to be involved with, which were part of the summative assessment for this module.

The implications and lessons learnt from the above factors is also discussed at the end of this chapter.

To evaluate the effectiveness of the implemented online system on the students' learning, Su et al (2005) pointed out that there was a need to understand which instructional techniques and activities that could promote interaction in online education. Summarising key points, giving feedback, and lecturer participation in class discussion were widely used within the teaching of this module; such activities indicated using the lecturer-learner interactions. These activities helped improve students' reflective thinking skills. Students were working together to solve problems and also were involved in class discussions to critique each other, which helped to establish a rich interaction between them, that indicated using the learner-learner interactions. Students were asked to explore and then analyse the content of the online intelligent system in order to achieve the required results, it was also necessary to interlink contents between the online tutorials and tasks, which they were also connected to the individual plan and dependant on each other. This helped students to interact with the content of the taught subject, which indicated using learner-content interactions. As a result of this pilot run, 36 out of the 43 group of engineering students studying the Computer Aided Design for Motorsport module had utilised the developed system. All students started by going through an assessment module that was designed to identify students' preferred learning style.
This provided students with indication of the appropriate format of tutorial and tasks to follow, however the system also encouraged students to try out other learning styles’ based tutorials in order to enhance their learning (Examples of generated ILPs are available in Appendix C). The results shown in Figure 5.91 demonstrate that most of the students were found to be of a combination of Visual and Kinaesthetic learning styles with: 61% Kinaesthetic; 22% Visual; 3% Auditory and 14% No Particular Style. This was found to be common in design engineering environments (Gordon and Bal 2001).

![Preferred Learning Style Results](image)

**Figure 5.91 Details of Students Preferable Learning Styles Results**

The No Particular style means that students scored evenly in two or more learning styles as shown in Table 5.12. In this particular experience, 60% of these were again a combination of Visual and Kinaesthetic learning style (highlighted in red).

**Table 5.12 Details of Students with No Particular Learning Styles Results**

<table>
<thead>
<tr>
<th>Student</th>
<th>V</th>
<th>A</th>
<th>K</th>
<th>Preferred Learning Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>No Particular</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>No Particular</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>No Particular</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>No Particular</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>No Particular</td>
</tr>
</tbody>
</table>

Total “No Particular Style Students” = 5
Following this part of using the system, students went through a pre-assessment session in order to identify their prior knowledge of individual topics taught; the results in Table 5.13 show that 8 students passed various topics.

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Number of Students Passed Pre-Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Those students who passed the pre-assessment of a particular topic were given the choice of not going through it, thereby would not have to study it or go through its formative assessment either. This could indicate that students would have enough background knowledge about this topic and they would be able to meet its learning outcomes. However, on this occasion these students were asked to go through the passed topic followed by the formative assessment to verify the effectiveness of the pre-assessment function. The results were very encouraging as all students passed the formative assessment for these topics as shown in Table 5.14.

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Number of Students Passed Pre-Assessment</th>
<th>Number of Students Passed its Formative Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Therefore the overall results of this pre-assessment versus formative assessment was summarised in Table 5.15.

<table>
<thead>
<tr>
<th>No of Students Passed Pre-Assessment</th>
<th>No of Topics Passed</th>
<th>No of Same students who passed same topics through formative Assessment</th>
<th>%age of Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
<td>100</td>
</tr>
</tbody>
</table>
Based on these results the following graph was constructed as shown in Figure 5.92.

![Pre-Assessment Analysis Graph](image)

**Figure 5.92 Pre-Assessment versus Formative Assessment**

The results achieved by the auditory group (1 student) are shown in Table 5.16 and Figure 5.93.

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Number of Topics attempted</th>
<th>Total Number of Topics Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

![Auditory Group Achievement Table](image)

**Table 5.16 Auditory Group Achievement List**

![Auditory Style Results Summary Graph](image)

**Figure 5.93 Auditory Group Summary Results**
Similarly the results of the visual group (8 students) were summarised in Table 5.17. Figure 5.94 shows that the 8 visual learning style students attempted a total 21 topics, of which they passed 14 topics.

Table 5.17 Visual Group Achievement List

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Number of Topics attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>8</td>
<td>14</td>
<td>21</td>
</tr>
</tbody>
</table>

Figure 5.94 Visual Group Summary Results

The 22 Kinaesthetic learning style students attempted a total number of 63 topics, which they passed a total of 44 topics; these results are shown in Table 5.18 and summarised in the graph as shown in Figure 5.95.

Table 5.18 Kinaesthetic Group Achievement List

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Total Number of Assessment Attempts</th>
<th>Number of Topics attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinaesthetic</td>
<td>22</td>
<td>44</td>
<td>292</td>
<td>63</td>
</tr>
</tbody>
</table>
The no particular learning style group (5 students) achieved results are shown in Table 5.19.

Table 5.19 No Particular Group Achievement List

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Number of Topics attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Particular Style</td>
<td>5</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

The above shows that this group of students attempted a total of 11 topics, of which they passed a total of 10 topics; these results showed an overall pass rate of 91%, as shown in Figure 5.96.
In summary, the overall results of all the groups are given in Table 5.20 and Figure 5.97.

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Number of Topics attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visual</td>
<td>8</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Kinaesthetic</td>
<td>22</td>
<td>44</td>
<td>63</td>
</tr>
<tr>
<td>No Particular Style</td>
<td>5</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

**Overall Analysis of Results Achieved**

![Graph showing the comparison of students' preferred learning styles, total topics passed, number of topics attempted, and pass rate. Auditory, Visual, Kinaesthetic, and No Particular Style are represented by different colors.](image)

**Figure 5.97 Complete Group Summary Results**
As it was explained at the start of this section, due to a number of reasons that the
author has noticed through this pilot run experience, not all the students attempted all
four topics; Table 5.21 and Figure 5.98 show the number of students who attempted
each topic.

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Number of Students attempted this topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

Figure 5.98 Summary of Topics Attempted
6.0 Chapter 6 – Group One Evaluation and Analysis of Results

There is a need to understand the way students used the online system and the factors that enhanced/hindered their learning. The purpose of obtaining students’ feedback is to gain information that help to initiate and continue improvements in interactive online teaching and learning (Thorpe 1998). The system was evaluated using a designed questionnaire by the author following attending questionnaire design workshops and using other relevant sources (Galloway 1997). The evaluation process also involved informal meetings/interviews with students in order to verify their feedback and comments on using the system for their learning. The aim was to gather feedback from students on their perceptions of features that were aiding/distracting their learning in using the environment, more specifically the relevance of learning styles, tutorials and formative assessment in preparation for the summative assessment. Their summative results were compared to last year’s group to identify patterns and levels of students’ achievements. The outcome provided an overall view of the system capabilities, benefits and limitations as well as whether it could provide improvement to the students’ learning. It highlighted the possible changes or improvements that could be implemented as a result of this experience.

6.1 Analysis of Feedback Results

As a result of this questionnaire, 36 (84%) out of 43 engaged with the system, 31 (86%) completed the feedback questionnaire. The majority of students (96.8%) expressed that the system was beneficial to learn about AutoCAD fundamentals. One student informally commented “Using the online system was very easy way in increasing my knowledge in AutoCAD”. Students found that it was necessary to relate lectures and was asked from them via the online system. It made them rely on their analysis knowledge and skills rather than just copying notes, this was facilitated by the way these tutorials were designed, and by the fact that they were being able to assess their performance immediately. They were able to reflect on their learning and how it could be enhanced with the lecturer’s help and advice. The questionnaire also included other aspects regarding the development, delivery and support of the tutorials. The overall feedback was quite positive, as students gave strong comments about the benefits they gained from using this system as summarised in Table 6.22.
Table 6.22 Summary of Responses to Questionnaire

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Partially Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Not Sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Knowing your particular learning style through the system was useful</td>
<td>3</td>
<td>20</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Learning style results reflected well on your true learning style</td>
<td>4</td>
<td>19</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Pre-assessment was good reflection of your prior knowledge on individual topics</td>
<td>4</td>
<td>19</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Tutorials and tasks were enjoyable and easy to follow</td>
<td>9</td>
<td>14</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>Tutorials included different learning styles were beneficial for your learning</td>
<td>7</td>
<td>21</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>Intelligent Individual Learning Plan was useful to keep up with your progress</td>
<td>5</td>
<td>18</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>G</td>
<td>Individual Learning Plan was a good guide of your performance</td>
<td>2</td>
<td>21</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>H</td>
<td>Formative Assessment questions to assess your knowledge of individual topics were useful</td>
<td>6</td>
<td>13</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>I</td>
<td>Formative assessment feedback and results reflected on your true performance</td>
<td>5</td>
<td>11</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>J</td>
<td>Minimum time needed to learn about the system itself and its functions</td>
<td>5</td>
<td>15</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>K</td>
<td>ITS4CAD benefited you to learn about AutoCAD fundamentals</td>
<td>13</td>
<td>11</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>L</td>
<td>One hour with ITS4CAD is more valuable than one hour of lectures or labs</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>16</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>M</td>
<td>Learning with ITS4CAD was enjoyable</td>
<td>2</td>
<td>11</td>
<td>14</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>Interface was easy to use</td>
<td>5</td>
<td>17</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>O</td>
<td>Display of the schema was understandable</td>
<td>3</td>
<td>19</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>Accessing and using the system from anywhere at anytime was useful</td>
<td>9</td>
<td>18</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Q</td>
<td>System experience was encouraging to learn about different topics</td>
<td>0</td>
<td>21</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>R</td>
<td>You would use ITS4CAD again</td>
<td>6</td>
<td>19</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S</td>
<td>You would recommend ITS4CAD to other students</td>
<td>7</td>
<td>19</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
More detailed analysis of the questionnaire results were carried out in order to evaluate the response of the students to using the online system.

For question A, Figure 6.99 shows that 97% of the students found that knowing their learning styles were useful and beneficial to their learning.

![Figure 6.99 Question A (Learning Styles) Response](image-url)
Following from that, within question B, students were asked whether what the system suggested as their preferable learning style was accurate reflection of their true learning styles. The results of students' response showed that again 97% of students found that the system's suggestion was accurate reflection. This showed true confidence in the system's analysis and thereby prediction of students' preferable learning style, which would then provide appropriate learning materials for students to use and thereby enhance their potential of achieving the learning outcomes; Figure 6.100 shows these results.

Figure 6.100 Question B (Learning Styles Reflections) Response
In order to maximise the utilisation of the system by students, they had to complete a pre-assessment section. It provided students with the option to skip a topic in case of past knowledge; students had to score the full mark in a topic to pass this assessment, which was then updated within students' ILPs. In question C, students were asked whether the results of the pre-assessment reflected well on their prior knowledge of these topics. The response to this question showed that 91% of students agreed with the outcome. 3% of students disagreed with the outcome and 6% were not sure. To ensure the effectiveness of such activity, and to endorse this positive feedback, the author experimented by asking some students to carry out the formative assessment for the tutorials that they had passed their pre-assessment. In all cases students passed the formative assessment taken, which showed that the level and appropriateness of the questions within the pre-assessment section was accurate and fit for purpose; Figure 6.101 shows the results for this question in more details.

Figure 6.101 Question C (Pre-Assessment) Response
It was then necessary to evaluate how students felt about using the system in terms of content and ease of use. Therefore, in question D, students were asked whether they found the tutorials enjoyable and easy to follow. The responses to this question were very encouraging with 94% agreeing that it was enjoyable and easy to follow. There were 3% students who disagreed and 3% who were not sure. This was not surprising considering that students had various backgrounds and various levels of competence in using such technology, and thereby the author felt confident with such responses as true reflection of students' experience when they used this system; Figure 6.102 shows a detailed breakdown of the responses to this question.

![Bar Graph](image1)

**Figure 6.102 Question D (Topics and Tasks) Response**
Each tutorial was offered to students in various formats, these included the three learning styles: Auditory; Visual and Kinaesthetic. Such approach provided students with wider choice of selection and the opportunity to follow different learning style than what was suggested by the system as their particular learning style. This approach provided students with the opportunity to not only verify their learning style but also the opportunity to enhance their learning capabilities by applying various learning styles throughout different tasks and tutorials. It was therefore important to gather the reflection of the students themselves with regards to whether such assumption is correct through question E. The responses given by students to the question "Tutorials included different learning styles were beneficial for your learning" supported the author’s assumption in a very positive manner. 96% of students agreed, 3% disagreed and 3% were not sure; Figure 6.103 shows the detailed breakdown of results.

![Bar Chart]

**Figure 6.103 Question E (Subject Knowledge Formats) Response**
As students progressed through the tutorials and passed their formative assessment, their individual learning plan was updated through the ILP Component. There were three main reasons for such a feature within the system. Firstly, it kept the students informed and updated of their progress. Secondly, it provided them with positive encouragement and motivation to continue progressing successfully through this experience. Thirdly, this function provided the students with indications of areas where they might need to work harder. At the same time, it informed the lecturer of students' ongoing performance and thereby identified students who may need extra tutorial support. It was important to find out whether students benefits tangible and thereby they were asked within question F: "Intelligent Individual Learning Plan was useful to keep up with your progress". Their response showed that 90% found such approach was beneficial, and 10% were not sure but did not disagree. Such response is considered by the author to be very encouraging; detailed breakdown of results are shown in Figure 6.104.

![Figure 6.104 Question F (ILP) Response](image)
It was also very important to find out if the ILPs were providing an accurate guidance to students of their performance; thereby, within question G, students were asked if "Individual Learning Plan was a good guide of your performance". The majority of students with 91% found that ILP provided them with good guide to their performance, however, 3% of students disagreed and 6% were not sure. Again this provided a good reflection of the mixture of students who took part in this exercise, especially that 69% completely agreed with this approach; Figure 6.105 provides full results of responses to this question.

![Individual Learning Plan was a good guide of your performance](image)

![Individual Learning Plan was a good guide of your performance](image)

**Figure 6.105 Question G (ILP Support and Guidance) Response**
The system used formative assessment to assess the knowledge gained by students and thereby helped them with their summative assessment at a later stage. Therefore, it was important to find out if such an approach was effective and if students had benefited from such an activity. This was assessed by relating the question to the students' gained knowledge, and thereby, within question H, they were asked "Formative Assessment questions to assess your knowledge of individual topics were useful". Students responded positively with 87% identifying a positive benefit in the overall outcome of such experience. Only 3% disagreed with such assumption and 10% were not sure. Such a response is quite acceptable and encouraging especially that not all students have completed their summative assessment by the time they completed this questionnaire, and these are most likely to be the ones that they were unsure; Figure 6.106 shows the full results of responses to the question.

Figure 6.106 Question H (Formative Assessment) Response
In order to make the formative assessment beneficial to students, feedback was essential. The feedback was designed to reflect on the performance of individual students, otherwise any benefit of such assessment would be very limited. Once students have received this instant feedback, they were able to address any issues that were emphasised by the feedback in order to improve their achievements, and thereby maximising their learning abilities. At the same time the feedback needed to reflect an accurate account of students' performance in order to build students' confidence in both the formative assessment and the given feedback. From question I, response from students was again very positive with 90% seeing a true reflection of their performance in the feedback that was given. There were no students disagreeing with such reflection but 10% were not entirely sure. Such a response showed a true confidence in the system in terms of providing a true learning experience that led to an enhanced learning by students; Figure 6.107 shows full details of response results.

![Formative assessment feedback and results reflected on your true performance](image1)

![Formative assessment feedback and results reflected on your true performance](image2)

**Figure 6.107 Question I (Feedback) Response**
Once the system was evaluated and proved to be providing appropriate tools, which enhanced students' learning whilst supporting them in achieving sought learning outcomes, the intention is to role it out and start using it on an ongoing basis for teaching students on CAD modules. Therefore, learning and using such technology should be seamless and effortless; hence it was essential to find out how students felt about learning and using the system. Within question J, they were then asked "Minimum time needed to learn about the system itself and its functions". Once again the results to this question were very positive with 94% of students found the system easy to learn and use, only 6% were not sure while not disagreeing. Such results strongly supported the user-friendly feature of the system and thereby had built the confidence in future use of the system; Figure 6.108 shows full details of responses to this critical question.

![Figure 6.108 Question J (System Functions) Response](image-url)
Having identified that the students had agreed that the developed system was beneficial and reflected true resemblance to their learning styles and performance, it was time to evaluate whether students have learnt the fundamentals of CAD by using this system. In order to start this evaluation, within question K, students were asked “ITS4CAD benefited you to learn about AutoCAD fundamentals”. The results showed that 97% responded by feeling that they had learnt CAD fundamentals by using the system. The remaining 3% did not respond negatively, however they were not entirely sure. This pattern of response had been noticed with a small number of students that seemed to struggle, and thereby were not being able to achieve the full benefits of the system. This would be due to the background of these students and their limited experience on such technology. The use of such system would help the lecturer to identify such group of students and provide extra support in order to ensure their learning achievements; detailed results are given in Figure 6.109.

![Graph showing IT S4CAD benefits](image)

**Figure 6.109 Question K (System Benefits) Response**
Having established that students believed that they had achieved the required learning outcomes, and that they had learnt the fundamentals of CAD by using this system, it was essential to find out whether students would prefer this system as a replacement to the traditional teaching methods. Within question L, students were then asked "One hour with ITS4CAD is more valuable than one hour of lectures or labs". Not surprisingly, students responded by expressing their views that they would not want traditional teaching to be given up completely, but be supported by the use of the such systems. Only 32% felt that using the developed system would be more beneficial if used for the same time period of traditional teaching, while 55% disagreed and 13% were not sure; Figure 6.110 shows such breakdown in the students' response.

These results suggested that students might prefer to learn using both methods (traditional and online), i.e. blended learning. A recent study by Means et al. (2009) compared performance of groups of students taught using online and face-to-face. The results has shown that of 51 studies carried out, eleven were significantly positive favouring online or blended learning strategies, and only two favoured traditional face-to-face strategies. They concluded from the overall finding of their studies that classes using online learning (whether taught completely online or blended) on average produce stronger student learning outcomes than those classes with solely face-to-face learning.

Another study by Dell et al. (2010) reported that students, in both face-to-face (traditional) and online teaching, were able to learn the course content, actively engage with the content through analysis, observation, or experimentation, and participate in active discussion with peers regarding ideas and understandings of the content. Higher level thinking skills were required to participate in discussions of analysis, and group facilitators in the online graduate section were engaged in providing guidance to a group of students actively engaged in analysis and reflection. Instructional platforms formats differ, but evidence strongly suggests that either type can be effectively designed and taught, leading to equally strong student learning outcomes. They suggested that there are few pedagogical variables that can have an influence including: (1) the use of problem-based learning strategies, (2) the opportunity for students to engage in mediated communication with the lecturer, (3)

Amal Oraifige
course and content information provided to students prior to class starting, and (4) the use of video provided to students by the lecturer.

Figure 6.110 Question L (System versus Traditional) Response
It was time to reflect on the students' experience in using the system. Within question M, the author started by asking them "Learning with ITS4CAD was enjoyable". The results to the question as shown in Figure 6.111 were very encouraging, 90% of the group found it very enjoyable, while only 3% found it less enjoyable and the remaining 7% were not sure.

![Learning with ITS4CAD was enjoyable](image1)

![Learning with ITS4CAD was enjoyable](image2)

**Figure 6.111 Question M (System Enjoyment) Response**
In order to identify the ease use of the developed system, within question N, the students were then asked "Interface was easy to use". Results were extremely positive with 94% of the students found the interface easy to use, and 6% found the system's either difficult or were not sure. Overall, such results provided confidence in the developed system that it provided students not only with beneficial learning environment but also an enjoyable one too, together with user friendly interface; Figure 6.112 provides the full results to this question.

![Bar Graph](image1)

![Pie Chart](image2)

**Figure 6.112 Question N (System Interface) Response**
Within question 0, students were then asked "Display of the schema was understandable" in order to identify any possible improvements in the display of information. The results were that 91% of the students found it very understandable and only 3% struggled while again 6% were not sure as shown in Figure 6.113. Such profile of results showed that there was maybe some room for minimal improvement, which any system developer would expect, and carry out as normal procedure.

![Bar chart showing the distribution of responses to the question: Display of the schema was understandable.](image1)

![Pie chart showing the distribution of responses to the question: Display of the schema was understandable.](image2)

**Figure 6.113 Question O (Schema) Response**
Following on with the matter of accessing the developed system, it was interesting to find out the view of the students regarding using the system away from the university facilities. Within question P, they were then asked "Accessing and using the system from anywhere at anytime was useful". The results to this question supported one of the author's main objectives of developing such system, which was to provide learning capabilities from anywhere outside the university premises including homes. The results were that 94% of the students found accessing it from outside university was very useful while 6% were still unsure; Figure 6.114 shows these results.

Figure 6.114 Question P (System Accessibility) Response
As the developed system included a number of topics within AutoCAD, it was interesting to find whether the students found it useful to have such variety of topics, and thereby, within question Q, they were asked "System experience was encouraging to learn about different topics". The results as shown in Figure 6.115 were again very positive with 94% finding such material was useful and encouraged them to learn further and increase their knowledge. Only 3% did not find it encouraging and the remaining 3% were still unsure.

![System experience was encouraging to learn about different topics](image)

![System experience was encouraging to learn about different topics](image)

**Figure 6.115 Question Q (System Experience) Response**
Having found the system encouraging and supportive in achieving the learning outcomes, within question R, students were then asked "You would use ITS4CAD again". Unsurprisingly, 94% said that they would use it again while 3% would prefer not to use it and remaining 3% unsure; Figure 6.116 shows these results in more details.

Figure 6.116 Question R (System Usage) Response
Finally, within question S, the students were asked "You would recommend ITS4CAD to other students". The purpose of this question was to identify future potential of using the developed system by other users. The results, as shown in Figure 6.117, were very positive with 97% saying that they would recommend it to other, and the remaining 3% not disagreeing but still unsure.

![Bar chart showing student responses to recommending ITS4CAD to others.](image)

![Pie chart showing student responses to recommending ITS4CAD to others.](image)

Figure 6.117 Question S (System Recommendations) Response
The overall summary of this questionnaire results was very positive with major support by the students for the developed system. They had found it very useful, beneficial, and easy to use and managed to get true reflections of their learning style, performance and progress. This feedback also has shown that students prefer a mixture of teaching methods and not just one particular approach, which was reflected within question L feedback results, further details were provided within individual questions evaluation; Figure 6.118 shows summary of the total agrees responses to the questionnaire.

![Summary of Total Agree Responses](image)

![Percentage of Agree Responses](image)

Figure 6.118 Summary of the Overall Questionnaire Responses
Students were then encouraged to add any comments that they could give about the system, some of these responses are given below:

"It has helped me to see which parts of AutoCAD was my strongest and also my weakest points I need to concentrate on"

"A very good interface, which makes it easy to use, the information is very useful but I still feel that lecturers are needed so that there is a lecturer to help. Using the site is a very easy way to increase my knowledge of AutoCAD"

"Its good as it gives visual examples of how a certain function works in AutoCAD"

Students were then asked to fill in their recommendations of what can be done to improve such facility; some of their responses are given below:

"To include larger variety of topics to be tested on"

"To improve the pause button on slides"

"To add other links to other web pages on AutoCAD"

"To add more interactive activities"

The responses for these parts were quite low in comparison with the number of students who completed the feedback questionnaire, so in order to achieve a clearer image of the system use and capabilities, it was necessary to carry out informal interviews and discussions with the students. These were carried out as an informal meeting between the lecturer (author) and a small group of students at each time; there were five meetings in total. Students were very happy to participate and provided constructive feedback. The overall outcome was quite positive and students clearly stated that the overall system was well designed and easy to use. It helped them to understand and evaluate the taught topics as well as highlighting the weak areas that they needed to work on. Students also suggested that such systems could be implemented prior to the start of the module, maybe within the holiday periods as that could be used as a tool for background information, preparations and practice.
Following the summative assessment, students' results were then analysed and compared against last year's results. In summary, it has shown that there was an overall improvement in their performance. The overall mean grade was improved by 29%; however the most encouraging improvement was the significant reduction in failure rates. This was reduced from 11% to 3%, which clearly showed that students' performance has shifted towards the mean grades. These improvements clearly reflected good progress with the students' achievements; however the argument could be that these improvements may be the result of other factors such as the level of this cohort of students could have been higher than last year's cohort. But based on the author's experience with both cohorts, together with the evidence obtained through the students' feedback, it was evident that this system had provided extra support and help for both the students and lecturer within the taught subject.

6.2 Chapter Summary
The system was used as an educational tool with the first group of students that were studying a CAD based module, using AutoCAD software. Students' data using the system and the survey results were gathered, analysed and evaluated. The overall outcome was positive, however there were few challenges and difficulties that the lecturer was faced with; most significantly were students' incentives to engage with the learning process. This resulted in not fully utilising the learning environment and its functions, which limited the benefits that they could have gained. This created an additional pressure on the lecturer to continuously keep encouraging and motivating students to take part. Therefore, changes to the planning and implementation of the system were made to ensure students' participation and utilisation of the system at its full potential, this included:

- The integration of the system into the indicative content of the module itself.
- The module delivery plan is to include using the system as part of the weekly tasks.
- System introduction to be part of the module delivery tools.
- Better timing and planning of the summative assessment so that the system's experience will be beneficial for students in their preparation for such assessment.
Chapter 7 - Application of the Developed System (Group Two)

Based on the lessons learnt from the first experience using the system that was described in Chapters 5 and 6, appropriate planning and implementation process were developed to ensure using the system to its full potential. The learning experience was analysed in a similar manner to the method applied in Chapter 5, this included:

- Description of the selected module and the group of students.
- Students' results analysis that verified the system effectiveness at many levels such as achievements, learning experience and successes throughout the delivery of this particular subject.

The outcome provided an indication whether there was an improvement in this group's participation and engagement in comparison to the previous group.

7.1 Selected Module Information

Computer Aided Design is a 15 credit level-4 (year 1) module that is normally taught to a class of 15-20 students at the University of Derby within the engineering subject area (Mechanical Engineering). In this particular year (2009/2010) there were 13 students enrolled on this module with various backgrounds, however they had very little knowledge in AutoCAD. This module provided the students with the necessary skills and knowledge using appropriate computer software such as AutoCAD for design applications. This module provided an introduction to the skills and knowledge required to use appropriate CAD tools as an aid to design for the mechanical engineering design industry. The difference in approach between manual and CAD was explained. The production of 2D drawings to introduce basic system commands was investigated. This module concentrated on using CAD tools for the production of 2D models of engineering components and assemblies in mechanical applications. Industry standard layer convention and libraries of standard symbols along with system procedures and functions were also used to speed up the drawing process. The 3D model was utilized to produce elevations and various views and perspectives of the project, text insertion and automatic dimensioning to a drawing were also investigated.
On successful completion of this module students were be able to:

- Demonstrate the knowledge and ability to save, retrieve and printout to scale a drawing file using industry standard CAD software.
- Use industry standard CAD software to produce dimensioned component drawings.
- Demonstrate the knowledge ability to utilise the CAD system's commands to produce an assembly drawing of an engineering product.

The understanding and practise of this subject were very crucial to the students, as they had to complete the required summative assessment to pass this module. This assessment comprises of one coursework to produce industry standard component drawings and an assembly drawing using an appropriate CAD package. Students were given a 3D sketch and they were required to detail it up as full orthographic 2D engineering drawings with complete detailing such as layers and dimensions. The delivery of this module is normally consisted of using similar methods to the previous selected module; please refer to Chapter 5, Section 5.1.

7.2 Planning and Implementation

From the previous group experience, it was noted that students' participation and engagement within the system needed to be improved, this was identified for a number of reasons:

- The lecturer introduced the system in the sixth week of the module, which meant that students had already been taught in the traditional way for that period and needed to adjust to the new plan of delivery.
- The integration of the system within the module was planned well; however prior planning was needed on how it was going to be integrated within the full initial delivery of the module.
- Lecturer introduced the system in quite relaxed manner, in which students were not under any obligation that they had to experiment with it.
- The timing of this integration coincided with other activities that had higher priorities such as the summative assessment.
Based on these findings, a number of planning factors needed to be implemented before the system could be used for the next cohort of students, these included:

- The lecturer needed to integrate the system into the indicative content of the module itself by introducing it within the initial plan of delivery.
- This integration needed to include using the system as part of the weekly tasks for the module selected and the module delivery tools.
- Appropriate timing and planning of the summative assessment to ensure full beneficial gain by students in their preparation for it.

Taking all the above into consideration, the full plan delivery was developed and implemented within the second selected module; **Table 7.23** shows an example of a session planner that was delivered to the students at the first session of the module.

**Table 7.23 Session Planner**

<table>
<thead>
<tr>
<th>Timing</th>
<th>Lecturer Activity</th>
<th>Student Learning Activity</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 min.</td>
<td>Welcoming the students. Define objectives and learning outcomes of this Module. Introduce the delivery plan of the module.</td>
<td>Listening and Discussions about the module and previous experiences within the subject area</td>
<td>Module Handbook Delivery Plan Verbal Communication</td>
</tr>
<tr>
<td>5 min.</td>
<td>Discuss this session learning outcomes Introduce resources used</td>
<td>Listening and Discussions</td>
<td>AutoCAD System Link Verbal Communication</td>
</tr>
<tr>
<td>30 min.</td>
<td>Presentation and Discussion on of WCS and Co-ordinates in AutoCAD</td>
<td>Listening, Discussions, asking questions and watching exercises to create and define co-ordinates</td>
<td>PowerPoint Slides White Board AutoCAD</td>
</tr>
<tr>
<td>5 min.</td>
<td>System introduction</td>
<td>Access to system link</td>
<td>UDo</td>
</tr>
<tr>
<td>10 min.</td>
<td><strong>BREAK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 min.</td>
<td>Help and guide students going through the system Create an account with the system Go through learning styles and pre-assessment Access the ILP and carry out tutorials and tasks Go through formative assessment</td>
<td></td>
<td>AutoCAD its4cad system UDo</td>
</tr>
</tbody>
</table>
7.3 Students Analysis

All students started by going through the assessment section that was designed to identify students' preferred learning style. This provided students with indication of the appropriate format of tutorial to follow, however the system also encouraged students to try out other learning styles' based tutorials as that might enhance their learning. The results of this section, as shown in Figure 7.119, presented that there were only two types of learners; Kinaesthetic and Visual: 54% Kinaesthetic and 46% Visual. These resulted showed a similar pattern to the results obtained from group one, please refer to Chapter 5. This supports the findings from the literature review that engineering students are mostly a combination of Visual and Kinaesthetic learners.

![Preferred Learning Style Results](image)

Figure 7.119 Details of Students Preferable Learning Styles Results

Following this part of using the system, students went through the pre-assessment session in order to identify their prior knowledge of individual topics to be taught. The results showed that 7 students passed one topic out of the four as given in Table 7.24. This proved the effectiveness of the system as the passed topic by the most students was regarding the co-ordinates subject, which students had studied this topic before hand.
Table 7.24 Students Pre-Assessment Results

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Number of Students Passed Pre-Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

Some of the students that passed this topic chose to go through this topic again and its formative assessment, they passed it from the first attempt which again consolidates the effectiveness of this component; the results achieved by the visual group (6 students) are shown in Table 7.25 and Figure 7.120. (Examples of generated ILPs are available in Appendix C)

Table 7.25 Visual Group Achievement List

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed out of a total of 24 Topics</th>
<th>Total Number of Assessment Attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>6</td>
<td>24</td>
<td>34</td>
</tr>
</tbody>
</table>

![Visual Learning Style Chart]

Figure 7.120 Visual Group Summary Results
The 7 Kinaesthetic learning style students attempted a total number of 27 topics out of the possible total of 28, of which they passed a total of 27 topics; these results are shown in Table 7.26 and Figure 7.121.

**Table 7.26 Kinaesthetic Group Achievement List**

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Total Number of Assessment Attempts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinaesthetic</td>
<td>7</td>
<td>27</td>
<td>40</td>
</tr>
</tbody>
</table>

**Figure 7.121 Kinaesthetic Group Summary Results**
In summary, the overall results of the entire group are given in Table 7.27 and Figure 7.122. These results had shown a significant improvement in the students’ achievement in comparison with the previous group. The author believes that this was due to the careful planning and implementation changes that were made to the initial delivery plan of the module.

<table>
<thead>
<tr>
<th>Preferred Learning Style</th>
<th>Number of Students</th>
<th>Total Number of Topics Passed</th>
<th>Number of Topics attempted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>6</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Kinaesthetic</td>
<td>7</td>
<td>27</td>
<td>28</td>
</tr>
</tbody>
</table>

Figure 7.122 Complete Group Summary Results
As the planning of delivery was integrated into the initial module plan, the number of students who attempted the four topics improved significantly from the first group, which means their participation and engagement with the system had improved to 98%. Only one student did not complete the final topic due to withdrawing from the course at an early stage; Table 7.28 shows the number of students who attempted each topic, this was also summarised in Figure 7.123.

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Number of Students attempted this topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 7.28 List of Topics Attempted

![Number of Topics Attempted](image)

Figure 7.123 Summary of Topics Attempted
Chapter 8 – Group Two Evaluation and Analysis of Results

The evaluation of the developed system for the second group was focused on using similar methods that were used in Chapter 6, which consisted mainly of identifying the system's benefits and limitations and its operational procedures and their effectiveness. This evaluation was based on using a similar designed questionnaire that was used for the previous group with the necessary modifications to cater for their feedback. Students from the previous group clearly identified that they would prefer a mixture of the two methods (traditional and online) of learning. The main difference was that this questionnaire did not have question L, which was “One hour with ITS4CAD is more valuable than one hour of lectures or labs”. Again informal discussions with the students were followed to ensure the gathering of constructive feedback. These results were then compiled and analysed using the appropriate graphs and charts in order to present the students' views and feedback about using the system.

8.1 Analysis of Feedback Results

After the period of using the system within the module delivery plan, students were given the questionnaire to fill it in and hand it back to the lecturer. As a result of this, 13 (100%) out of 13 engaged with the online system, 12 (92%) completed the feedback questionnaire, this was due to the one student who was withdrawn from the course at an early stage. Based on the overall results from the completed feedback sheets, as shown in Table 8.29, the majority of the students (92%) expressed that the online system was beneficial to learn about AutoCAD fundamentals. The following tables, graphs and charts were developed to present the complete results of the individual feedback responses to the questionnaire and to evaluate the response of students on using the online system. These results were then compared to the ones from the previous group to verify any changes or improvements occurred.
Table 8.29 Results of Responses to Questionnaire

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Partially Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Not Sure</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Knowing your particular learning style through the system was useful</td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>B</td>
<td>Learning style results reflected well on your true learning style</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>Pre-assessment was good reflection of your prior knowledge on individual topics</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>Tutorials and tasks were enjoyable and easy to follow</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>E</td>
<td>Tutorials included different learning styles were beneficial for your learning</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>F</td>
<td>Intelligent Individual Learning Plan was useful to keep up with your progress</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>G</td>
<td>Individual Learning Plan was a good guide of your performance</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>H</td>
<td>Formative Assessment questions to assess your knowledge of individual topics were useful</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>I</td>
<td>Formative assessment feedback and results reflected on your true performance</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>J</td>
<td>Minimum time needed to learn about the system itself and its functions</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>K</td>
<td>ITS4CAD benefited you to learn about AutoCAD fundamentals</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>M</td>
<td>Learning with ITS4CAD was enjoyable</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>N</td>
<td>Interface was easy to use</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>O</td>
<td>Display of the schema was understandable</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>P</td>
<td>Accessing and using the system from anywhere at anytime was useful</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Q</td>
<td>System experience was encouraging to learn about different topics</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>R</td>
<td>You would use ITS4CAD again</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>S</td>
<td>You would recommend ITS4CAD to other students</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>
For question A, Figure 8.124 shows that 100% of the students found that knowing their learning style was useful and beneficial to their learning. These results were very positive and would support the finding within literature regarding the importance of the learning styles. These were quite similar results to the first group.

![Bar Chart](chart1.png)

**Figure 8.124 Question A (Learning Styles) Response**
Following from that, within question B, students were asked whether the system's suggestion of their preferable learning style(s) was an accurate reflection of their true one(s). The results of students' response showed that 100% of students found that the system's suggestion was accurate. This showed full confidence in the system's analysis and thereby prediction of students' preferable learning style(s), which then provided appropriate learning materials for students to use and thereby enhancing their potential of achieving the learning outcomes. This was an improvement from the last group of which 97% agreed with the system's suggestion; Figure 8.125 shows the results for this group.

![Learning style results reflected well on your true learning style](image)

![Learning style results reflected well on your true learning style](image)

**Figure 8.125 Question B (Learning Styles Reflections) Response**
In order to maximise the utilisation of the system by students, they had to complete a pre-assessment section. It provided them with the option to skip a topic in case of previous knowledge; students had to score the full mark in a topic order to pass it, which then was updated within students' ILP. Within question C, students were asked whether the results of the pre-assessment reflected well on their prior knowledge of these topics. The response to this question showed that 100% of students agreed with this outcome. This was a great improvement from the last group of which 91% agreed to this question; Figure 8.126 shows the results for this question in more details.

![Bar Chart](image1)

**Figure 8.126 Question C (Pre-Assessment) Response**

![Pie Chart](image2)
The next stage was to evaluate how students felt about using the system in terms of content and ease of use. Therefore, within question D, students were asked whether they found the tutorials enjoyable and easy to follow. The responses to this question were extremely encouraging with a complete 100% students’ agreement that it was enjoyable and easy to follow. Again there was an improvement from the previous group to this question by 3%; Figure 8.127 shows a detailed breakdown of the responses to this question.

![Bar Graph](image1)

**Figure 8.127 Question D (Topics and Tasks) Response**
Inline with students' preferred learning styles, each tutorial was offered to them in various formats. Such approach provided students with wider choice of selection and the opportunity to follow different learning style than what was suggested by the system as their particular learning style. It was then necessary to find out if students found such approach beneficial? From question E, the responses given by students to the question "Tutorials included different learning styles were beneficial for your learning" supported the author's assumption in a very positive manner as 100% of students agreed to this question; this strongly would endorse the theory of learning styles. Again there was an improvement from the previous group to this question by 4%; Figure 8.128 shows the detailed breakdown of results.

![Figure 8.128 Question E (Subject Knowledge Formats) Response](image_url)
Students' progression through the tutorials and assessment was updated regularly within their ILP. This provided students with keeping up with their progress, encouragement and motivation as well as indications of areas where they might need to work harder. At the same time, it informed the lecturer of students' ongoing performance and thereby identified who may need extra help and support. It was important to find out whether students' benefit was tangible and thereby, within question F, they were asked “Intelligent Individual Learning Plan was useful to keep up with your progress”. Their response showed complete support for such theory with 100% finding such approach very beneficial. Such response is considered by the author to be extremely encouraging. There was a significant improvement from the previous group to this question by 10%; detailed breakdown of results are shown in the Figure 8.129.

![Figure 8.129 Question F (ILP) Response](image-url)
It was also very important to find out if the individual learning plans were providing an accurate guidance to students of their performance; thereby, within question G, students were asked if "Individual Learning Plan was a good guide of your performance". Again, all the students (100%) found that ILP provided them with good guide to their performance. There was an improvement of 9% from the previous group to this question; **Figure 8.130** provides full results of responses to this question.

![Bar Chart]

**Figure 8.130 Question G (ILP Support and Guidance) Response**
The formative assessment component was designed to assess the knowledge was gained by the students and thereby help them with their summative assessment at a later stage. Therefore, it was important to find out if such approach was effective and if students had benefited from such activity. This was assessed by relating the question to the students' gained knowledge, and thereby, within question H, they were asked "Formative Assessment questions to assess your knowledge of individual topics were useful". Students responded very positively with 100% identified a positive benefit in the overall outcome of such experience. Such response is again very encouraging and significantly improved from previous group by 10%. This was evident to support the author's proposal and assumptions; Figure 8.131 shows the full results of responses to the question.

![Formative Assessment questions to assess your knowledge of individual topics were useful](image1)

![Formative Assessment questions to assess your knowledge of individual topics were useful](image2)

Figure 8.131 Question H (Formative Assessment) Response
Following the formative assessment, students were given feedback to reflect on the performance with individual topics, otherwise any benefit of such assessment would be very limited. This could help students to address any issues that were emphasised in order to improve their achievements, and thereby maximise their learning abilities. Question I was designed to verify their account on such method. The response from students was again very positive with 100% seeing a true reflection of their performance in the feedback that was given. Such response shows full confidence in the system in terms of providing a true feedback based on the individual students' performance. This response was also higher than the previous group by 10%; Figure 8.132 shows full details of response results.

![Formative assessment feedback and results reflected on your true performance](image)

![Formative assessment feedback and results reflected on your true performance](image)

**Figure 8.132 Question I (Feedback) Response**
This system was designed to enhance students' learning whilst supporting them in achieving sought learning outcomes. Therefore learning and using such system should be seamless and effortless, hence it was essential to find out how the students felt about learning and using the system. Within question J, they were then asked "Minimum time needed to learn about the system itself and its functions". Once again the results to this question were very positive with 100% of students finding the system easy to learn and use. Such results strongly supported the user-friendly feature of the system and thereby build confidence in future use of the system. There was an improvement of 6% from the previous group; **Figure 8.133** shows full details of responses to this critical question.

**Figure 8.133 Question J (System Functions) Response**

![Bar chart](image)

![Pie chart](image)
So far it was evident that students had found the system to be beneficial and reflected true resemblance to their learning styles and performance. Next, it was necessary to evaluate whether students had learnt the fundamentals of AutoCAD by using the system. In order to start this evaluation, within question K, students were asked "ITS4CAD benefited you to learn about AutoCAD fundamentals". The results showed that 92% agreed to this question and that they had learnt CAD fundamentals by using the system. This result might indicate that there was a particular student who was struggling with the taught subject or using such technology. Further details were gained from the discussions that were carried out with the students and are covered later on. This result was similar to the previous group as there was one student who was unsure about this question; results are given in Figure 8.134.

![Figure 8.134 Question K (System Benefits) Response](image-url)
The students' experience in using the system was reflected on by using question M, this was "Learning with ITS4CAD was enjoyable". The results to the question were again extremely encouraging; all students (100%) found it very enjoyable. There was an improvement of 10% in comparison with group one's results; Figure 8.135 shows the breakdown of results.

![Bar Graph](image1)

![Pie Chart](image2)

**Figure 8.135 Question M (System Enjoyment) Response**
To reflect on the design of the interface within the developed system, question N asked the students “Interface was easy to use”. Results were extremely positive with 100% of the students finding the interface easy to use. Such results provided full confidence in the developed system and that it provided students not only with a beneficial learning environment and an enjoyable one, also with a user-friendly interface. Again the improvement was 6% in comparison to the previous group; Figure 8.136 provides the full results to this question.

![Bar chart showing interface ease of use](image1)

![Pie chart showing interface ease of use](image2)

*Figure 8.136 Question N (System Interface) Response*
In order to identify any possible improvements in the display of information, within question 0, students were then asked "Display of the schema was understandable". 92% of the students found it very understandable and only 8% were not sure. These were of similar results to the previous group, which indicated that there might be some room for improving the display of such data within the system; Figure 8.137 shows these results.

![Bar Chart](image)

**Figure 8.137 Question 0 (Schema) Response**
The benefits of being able to use the system away from anywhere and at anytime was reflected on within question P. Students were asked "Accessing and using the system from anywhere at anytime was useful". The results to this question were evident to support one of the main objectives to developing such systems. These included that 100% of the students found that accessing the system from anytime and anywhere was very useful. The results included 50% of the students strongly agreeing with such assumption and the other 50% agreeing. This had shown an improvement of 6% in comparison with the previous group; Figure 8.138 shows these results.

![Graph showing the results of the question](image)

**Figure 8.138 Question P (System Accessibility) Response**
The system incorporated a number of topics within the taught subject, it was interesting to find whether the students found it useful to have such variety of topics, and thereby, within question Q, they were asked “System experience was encouraging to learn about different topics”. The results were again very positive with 100% found such material very useful and thereby encouraged them to learn more. An improvement of 6% from the previous group was achieved; Figure 8.139 shows these results.

![System experience was encouraging to learn about different topics](image)

**Figure 8.139 Question Q (System Experience) Response**

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Amal Oraifige
To verify the system's effect on students' participation and define if it had encouraged them in achieving the learning outcomes, within question R, students were asked "You would use ITS4CAD again". Unsurprisingly, 100% said that they would use it again. Again of a similar improvement of 6% to the previous group; Figure 8.140 shows these results in more details.

![Bar Chart](chart1.png)

![Pie Chart](chart2.png)

**Figure 8.140 Question R (System Usage) Response**
Finally, the future potential of using the system by the students was analysed through question S, the students were asked "You would recommend ITS4CAD to other students". The results again were quite positive with 100% support as all students said that they would recommend it to others. These were marginally improved to the results obtained from the previous group (97%); Figure 8.141 shows these responses.

Figure 8.141 Question S (System Recommendations) Response
To conclude, the overall results obtained by this group were extremely positive and provided full and complete support for the developed system. They have found it very useful, beneficial and easy to use and had true reflection of their learning styles and performance. As an overall summary, they had shown an improvement to the previous group in most categories. This was quite evident that planning, implementation and timing of such technologies were very beneficial to ensure their success and effectiveness to provide experiential learning. However, the author still believes that there is always a room for improvement in such systems, which some are included within the future development section within Chapter 9.

Table 8.30 shows a summary of the total agrees responses to the feedback questionnaire, this was then summarised in Figure 8.142.

<table>
<thead>
<tr>
<th>Number</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Partially Agree</th>
<th>Total Agree</th>
<th>%age</th>
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<tbody>
<tr>
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<td>1</td>
<td>12</td>
<td>100</td>
</tr>
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<td>B</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>100</td>
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<tr>
<td>D</td>
<td>8</td>
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<tr>
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<td>4</td>
<td>3</td>
<td>12</td>
<td>100</td>
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<tr>
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<td>6</td>
<td>5</td>
<td>1</td>
<td>12</td>
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<tr>
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<td>3</td>
<td>7</td>
<td>2</td>
<td>12</td>
<td>100</td>
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<tr>
<td>J</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
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<tr>
<td>O</td>
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<td>S</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>
For this evaluation, students were then asked to complete two areas, which included the following two questions:

**Question 1:** “What did you find useful about “ITS4CAD.com”?"

**Responses:**

“Seeing my knowledge on CAD”

“The formative assessment questions”

“Memory jogging”

“Very simple to use and also assessments to assess progress”

“By using this I was able to find the areas that I needed to improve, this was helped by the tutorial. It also showed my strengths in AutoCAD”

“Having a look at the slides, then the in action tasks, then go for the assessment and see what I have learnt”

“ITS4CAD made it easy to assess your prior knowledge and the progress you are making as you progress through the tutorials”

“The videos which are before the questions and the drawing images next to the questions”

“Enjoyed it”

“Good for learning”
Question 2: “How can “ITS4CAD.com” improved for you?”

Responses:

“The way the questions read”
“Making it part of other modules”
“Reducing the time of videos”

This feedback was very positive with supportive and complementary comments regarding the system capabilities. Students also provided useful comments regarding further possible improvements, which were considered to be very beneficial. The author considered the responses to these parts as being quite high in comparison with the number of students completed the feedback questionnaire. Further on, informal meetings were arranged with the students for the purpose of discussing: firstly their comments and reflections on using the system together with traditional approaches and secondly to provide reflections on the overall delivery of the module.

Only two meetings took place; the first meeting was carried out with the larger number of the group and the second meeting was carried out as one-to-one with a specific student. The first meeting resulted in achieving good feedback and reflections from the students. Furthermore, they were very happy with the overall delivery of this module especially that they could relate to different methods and strategies, which helped them to identify and practice various learning approaches. They found that the tutorials were very well and cleverly designed to promote their learning, they commented very positively regarding the interactive medium type and games. They also highlighted some further improvements that could be done to enhance the step-by-step tutorials, such as the timing and pace of some videos.

The second meeting was carried out as one-to-one with a student that found using such technology could be quite overwhelming. The student generally found such subjects (CAD based) hard to learn and most of the times found it difficult to grasp or achieve the learning outcomes. Reflecting on this, the lecturer arranged some extra supporting one-to-one sessions with this particular student and provided further help throughout this module. This resulted in the student passing the module with satisfactory grades.
Following the summative assessment, students' grades were then gathered and analysed. Unfortunately these grades could not be compared to similar group results from previous years as this module was taught at the university for the first time. Therefore students' grades results were compared to other groups that studied similar modules in the university; these grades are presented in Table 8.31.

<table>
<thead>
<tr>
<th>Assignment 1</th>
<th>Assignment 2</th>
<th>Overall Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A-</td>
<td>A</td>
</tr>
<tr>
<td>A-</td>
<td>B+</td>
<td>A-</td>
</tr>
<tr>
<td>B</td>
<td>C+</td>
<td>B-</td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>B-</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>B</td>
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<tr>
<td>B</td>
<td>A-</td>
<td>B+</td>
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<tr>
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<td>B+</td>
</tr>
<tr>
<td>B+</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>C</td>
<td>C-</td>
<td>C</td>
</tr>
<tr>
<td>C-</td>
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<td>D</td>
</tr>
<tr>
<td>C+</td>
<td>C</td>
<td>C+</td>
</tr>
<tr>
<td>D+</td>
<td>C</td>
<td>C-</td>
</tr>
</tbody>
</table>

In summary, these achievements had shown overall improvements on students' submissions and mean grades. The comparison showed that all the students using the system participated with the summative assessment and all of them submitted the required work on time, which meant there were no failures or late submission. When this was compared to other groups studied who similar modules, it showed improvement by at least 15%; some modules had approximately 18% failures or no submissions. These results were quite positive and would support that students enjoyed their learning and were more confident with the subject taught. As for the overall mean grade, an improvement of approximately 19% was achieved by the students, which is regarded as a successful outcome.

8.2 Chapter Summary

The developed system was used as an educational tool for the second group of students that were studying a CAD based module, using AutoCAD software. Students' data using the system and the survey results were gathered, analysed and evaluated. The results of this experience were extremely positive with further improved results from the first group especially with students' participation and
engagement with the system. This resulted in further understanding of the taught subject and better overall achievements within the system and the summative assessment.

In reflection, the author believes that there will always be students who may struggle with using technology for learning and practicing their subjects, let alone having to use technology to learn about technology. However, the moral of the story is that if lecturers do not just stick to one strategy of teaching and apply a combination of different strategies, such as traditional and online, they will ensure catering for most students' needs within their classes. Furthermore, using various approaches within these teaching strategies such as consideration of background experiences, learning styles and formative assessment, will help to promote experiential learning and high level of achievements. Most importantly it will aid to increase students' confidence with the subject taught that can elicit enjoyment of learning leading to better success stories. However, in order to create more effective learning experiences and increase access with flexibility, lecturers need to take advantages of the strengths of each strategy and avoid their weaknesses. They might need to make decisions whether to use one or the other or both strategies to meet the desirable learning experience.

To conclude, it is very important to continue identifying successful models of learning at HE institutions, these can be transformed in a consistent manner by mitigating the fiscal and pedagogical challenges and deficiencies that currently challenging the quality of the classroom experience. These models need to be assessed and evaluated effectively, with respect to learning outcomes, student satisfaction, retention and achievement. In addition, levels of learning, such as critical and reflective thinking, are a priority. Therefore it's essential to continue exploring the impact of such models in achieving meaningful learning experiences. Recent studies by (Bonk et al. 2009 and Ateş et al. 2008) indicated that traditional face to face learning environments is indispensable for social aspect of teaching and learning, however online technologies can provide students more flexible and interactive learning environments independent from time and space. They can enhance interaction between students and lecturers, which may provide further motivation for learning.
9.0 Chapter 9 – Discussions, Conclusion and Further Developments

This chapter discusses the conclusions of this research project; it will also reiterate the contributions that were made to the field of online learning and teaching environment through the design, development, implementation and evaluation of an online intelligent system for teaching engineering design technologies. The achievements of this research project, aim and objectives are also be appraised for their completion, strengths and weaknesses. It will also discuss the proposed potential future developments for the developed online teaching environment and thereby highlight any possible improvements. It will aim to summarise the key questions upon which this research project was based, these are as follow:

- What were the needs and aim of this research?
- What was the solution and why?
- How were the research’s objectives met?
- What were the strengths and weaknesses of this research project?
- What were the major original contributions made to the research field?
- What are the possible future developments that can be made to enhance the functionality of the developed solution?

9.1 Research Aim

It is becoming evident that competition within the global market is continuously increasing, which is leading to demands to deliver cost effective designs to the market in less time and effort. Hence, industrial organisations, using state of the art technologies, seek to develop, test and implement optimum designs into the market faster and in a cost effective manner (Ye et al. 2004). Engineering Design Technologies (EDT), describe the use of a wide range of computer-based tools to assist engineers and designers in their activities. The rapid growth of such technologies in the engineering design industries is considerable and therefore new employee graduates are expected to have high level of software knowledge and computer based competencies. In order to respond to such requirements, Higher Education (HE) organisations need to provide effective and responsive learning
facilities within this field, which can provide students with the appropriate practical, useful knowledge and skills that are suitable for their design activities.

Traditionally, teaching EDT may involve step-by-step instruction given by the lecturers presenting in front of their audience. This may require implementing a wide diversity of problems and activities. The lecturers' selection of examples steers the progress of learning, while the students are responsible for their personal time management. However, due to the diversity of students' and lecturers' age, social background and general knowledge, both parties frequently have different approaches to problem solving and working processes. Also, the teaching of such technologies continues to increase in complexity and have higher dependency on working software packages (Boettcher 1999) (Hedberg 2000) (Raval 2000). It is not uncommon to hear lecturers complain that a software application was not working or students remarks on how lecturers are not capable of using the software. Furthermore, students have their own pace of learning making it difficult to teach EDT in a stand-and-deliver format. Where some students excel and subsequently are waiting on the lecturers, others lag behind and may never grasp the intended learning objectives. Therefore, a quick and easy instructional technique for teaching EDT is needed, this will allow students to be taught and communicated more efficiently than they have been in the past. Consequently, the position and role of lecturers have to change, the lecturers need no longer to be the centre of activities; it is more effective to put individual students into the centre and allow them to engage with relevant activities.

Online resources for teaching engineering students have grown significantly over the past few years. They provide a new educational experience for teaching and learning and can offer educators a new medium to deliver teaching and learning material. They can potentially offer students many possibilities for enriching the learning process and promote multi-way knowledge transfers by having various interactive communication methods, techniques and activities (Kurubacak 2007). However research work has shown that online education is quite far from achieving its main goal - reaching a wide distance with effective educational benefits. It still needs to provide flexible, independent, individual and personalised learning process for students.
These needs formed the basis of this research project in order to allow students to participate actively in their own learning and interact with the subject matter that can enhance their understanding and achieve the learning outcomes for individual modules. Upon this, the aim of this research project was to:

"Design, develop, implement and evaluate an online intelligent system for teaching engineering design technologies."

The developed system aimed to provide the appropriate learning environment across a wide distribution medium using the Internet and thereby allowing students to benefit from the available capabilities and hence achieve their desirable learning expectations. The successfully developed system enabled students to interact and explore an online environment rapidly and directly on the Internet. They were able to utilise it according to their own abilities through the use of menus and visual components. It allowed them to access and navigate various engineering design tools and theoretical topics, supported by appropriate guidance remotely. The developed system incorporated a number of facilities to aid effective interaction and to promote experiential learning, including:

- Sharing learning data and information using the Internet with high level of reliability and security.
- Providing engineering students with an interactive environment for learning EDT based on their individual learning styles.
- Supporting and guiding students according to their abilities and performance through an intelligent individual learning plan. Hosting all the relevant material including tutorials and students' profiles within its database.
- Achieving learning outcomes of individual modules by performing appropriate tutorials and tasks. Providing formative assessment in preparation for the summative assessment that students have to undertake at the end of the taught module.
- Providing a comprehensive feedback based on their performance.
9.2 Research Objectives

The proposed research project aim was met by achieving the following objectives:

1. **Conduct a comprehensive literature review to fulfil the following and study the potential implications within their specifications:**
   - Research and investigation of existing educational methods and techniques such as, traditional, online and intelligent.
   - Examine different factors that can enhance the learning experience such as learning styles, formative assessment and individual learning plans.

The literature review for this research project has covered a comprehensive study on the field of teaching for EDT. This started by investigating the various methods such as; traditional, online and intelligent or a combination of these. The author has concluded that for any of these methods to provide an effective teaching experience and to be able to accommodate for the different types of students, other strategies needed to be considered and investigated. This led the author to carry out an in-depth research into learning styles and formative assessment and whether they would enhance the learning and teaching experience. The results strongly indicated that both strategies significantly affect students' achievements through increasing and promoting their interactions and motivations. This has suggested that both strategies should be taken into account in the design of teaching online environments. Please refer to Chapter 2 – Literature Review.

The outcome of this literature review has shown that the quality of teaching and learning have a powerful impact on the way education works, whether it takes place in a classroom or over the internet. It has also shown that the demand for EDT education will continue to grow rapidly, which requires solutions for fast learning and successful retention of knowledge for the wide range of education professions. Learning, knowledge and education are major themes of this century where higher technical institutions with engineering courses need to set themselves the goal of making such education ever more efficient. Therefore, the relationship between educators, students, and the study material will be greatly influenced by the
development of efficient courses. Upon this, the author strongly believes that this is a great challenge for educators; they need to use many different instructional methods available that can be enhanced with different learning strategies and therefore should not just stick to what is familiar as no one method is perfect. In conclusion, this study has suggested that successful lecturers tend to be those who are able to use a range of teaching strategies and a range of interaction styles, rather than a single, rigid approach to teaching and learning.

Based on these findings, the author designed, developed, implemented and evaluated an online intelligent system for teaching EDT. The developed system incorporated a number of facilities and strategies to aid effective interaction and to promote experiential learning. In particular, the system provided an intelligent personal learning advice that recorded all students' interaction within the system and also guided them through achieving the learning outcomes of the taught subject while monitoring their progress from a distance.

2. Design and specify a novel framework with its comprehensive architectural operations that facilitates the desired outcome.

Within this objective, the author created a novel framework that provided the initial structure and operational functions for the proposed system. The author started the initial design of the system by identifying the main components that formed the overall system. The design of each component was then discussed in detail through the use of flowcharts and operational flow diagrams. This was then followed by a complete integration of all these components to form the overall design and architecture of the proposed system. Please refer to Chapter 3 - Framework Development.

The author has concluded that by the development of such framework, students would be able to utilise the proposed system environment to learn about EDT according to their own abilities and learning styles through the use of menus and visual components. This framework was necessary for the successful development of the operational system, which would enable students to access and navigates
through various methods and applications, supported by appropriate guidance remotely.

3. **Creation of a fully operational system with all the necessary components as specified in the designed framework architecture, including:**
   - **User Information >the basic access interface>**.
   - **Learning Style >individual learning style information>**.
   - **Pre-Assessment & Learning Target setup >Intelligent, adaptive target for learning>**.
   - **Intelligent Learning Plan >ILP-driven Learning>**.
   - **Subject Database >Subject Knowledge Material>**.
   - **Formative Assessment and Feedback >effective evaluation>**.

Within this objective, the author designed and developed the overall system; which included the development and integration of all components that were identified within the framework development objectives. Using further comprehensive operational flow diagrams, the author identified in detail the design and operation of each component. Furthermore, based on the developed operational charts, ASP programming language was used to build each component, these were then tested to ensure successful operation and function. This was supported by an appropriate subject knowledge database; teaching the fundamentals of 2D AutoCAD. The system was also designed and developed in modular format so that teaching material could be easily uploaded by lecturers to suit different taught subjects. The final overall integration was developed by building specific links between these components to provide a fully operational system. Throughout this development the system was tested online to ensure the appropriate operations by the interface and that it was suitable to be used by the students and lecturers.

To provide an overall summary of how the system performed, students were able to follow a well-structured systematic approach by firstly going through the learning styles to ensure that they were aware of the different learning methods that they could use, secondly they went through the pre-assessment to ensure that their background knowledge and experience was being considered and could be taken into account while they were learning. This led them into a personal learning plan that
provided targets to be achieved; they accessed different topics and learnt them through many different methods to ensure effective and successful results. Then they verified their understanding through the formative assessment for each given topic. Students were able to reflect on their results and re-learn individual topics through using different learning styles as this could increase their understanding of the taught topic and thereby achieve better results. Lecturers were able to access the system through an admin account, which allowed them to upload, add or edit the subject database as well as being able to monitor the students' progress from a distance; this helped them to offer guidance, support and/or advice if and when required.

The author was fully satisfied with the outcome of this objective leading to the extremely successful achievements of developing the fully operational modular system with all its associated components. The success of achieving this outcome was also challenging and time consuming, however, in ideal situations, HE organisations in collaboration with software development teams would be responsible for developing such systems and lecturers would only require training sessions to be able to upload their teaching material onto the subject knowledge database.

The outcome of this objective awarded the opportunity for the author to test, analyse and evaluate the developed system by using it as an educational tool to provide viable solution for a teaching experience.

4. Implementation and application of the developed system through a full educational experience to satisfy the adaptation and operations of its components' functions and features.

5. Evaluation and analysis of the results to promote new interactions in online education in order to establish the necessary recommendations for the envisioned benefits.

Within these two objectives, the author necessitated to trial the system by using it as an educational tool to satisfy a selected teaching experience within an appropriate module. The author then analysed and evaluated this experience in order to determine the effectiveness of using such system. The system was utilised with a number of students with different levels of learning and backgrounds, in order to
satisfy the operation of its components and the adaptation of the different knowledge and understanding of the taught subject. This started with the planning process, the author has emphasised that this was an important stage in implementing any e-learning strategy; it saved time by identifying problems before they could arise by having interventions in place to solve them. Therefore this was constructed using a table based on (Graham et al 2000) theory by identifying a series of considerations that helped in developing a clearer image of the parameters. This has resulted in having high level of confidence in the system being ready to be implemented within a module, which then was selected and described. Firstly, the system was used by a group of 43 students who were studying 2D AutoCAD for Motorsport Module. The author decided to use the system within the sixth week of the module; students happily participated and enjoyed the experience. Their results were analysed in detail to determine the system’s effectiveness. This analysis included an investigation into their learning styles, levels of achievements, participations in specific topics and formative assessment, previous learning experience and successes. The overall results were investigated to accurately reflect the level of learning that students were able to achieve over the period of using the system. They were good and satisfactory but there was a room for improvement especially regarding the level of participation and specifically within the last topic of the module.

To verify and evaluate this experience, the students were given a specially designed questionnaire about the system. This has determined the benefits and limitations of the operational procedures and the functions of the components. The questions were designed to cover different aspects about the system including: access and ease of use, benefits and limitations of using different functions and efficiency of the system. The results were then compiled and explored using graphs and charts. The outcome presented the students' views and feedback about using the system and how it could be improved. This has concluded that the experience of using the system was enjoyed by the students and it was beneficial, it was easy to use from anywhere and at anytime as well as provided extra help with their learning. However they have felt that it would have been more beneficial if the system was introduced at an earlier stage of the module as they needed the time to work on their summative assessment towards the end.
One major outcome of this evaluation was found when students were asked whether they felt that such systems could replace the traditional teaching methods (lectures and labs using PowerPoint presentations and demonstrations) within this field. The results were conclusive as most of the students (55%) clearly disagreed with such a statement and responded by expressing their views that they do not acquiesce with traditional teaching to be resigned completely, but to be supported by the use of such systems. This was not surprising and supported the author's findings that educators should use a combination of different teaching methods, strategies and a range of interaction styles, rather than a single, rigid approach to teaching and learning.

Following the questionnaire, it was necessary to carry out interviews and discussions with the students to reflect on their views regarding the system. The overall outcome was positive and students clearly stated that this system was well designed and easy to use. It helped them to understand and evaluate the taught topics as well as highlighting the weak areas that they needed to work on. Few students suggested that such systems could also be used as a tool for background information, preparations and practice. Following the summative assessment, students' results were examined and compared against last year's. In summary, it has shown that there was an overall improvement on their performance. The overall mean grade was improved by 29%; however the most encouraging improvement was the significant reduction in failure rates. This was reduced from 11% to 3%, which clearly showed that students' performance has shifted towards the mean grades.

The main outcome of this experience was to confirm that there was a constructive plan that could help to improve the engagement of the next cohort of students. This needed to ensure fully utilising the system to its extensive potential. Therefore, the author developed a comprehensive planning process for the overall delivery of the second selected module; this inherited the following changes:

- The integration of the system into the indicative content of the module itself,
- The module delivery plan is to include using the system as part of the weekly tasks and the system introduction to be a part of the module delivery tools,
- Better timing and planning of the summative assessment so that the system's experience will be beneficial for students in their preparation for such assessment.
The outcome of this has shown even better success with using the system and provided strong evidence that using the developed system was of a benefit to the students and thereby led to an overall improvement in the students' performance within the summative assessment. Please refer to Chapter 5 – Application of the Developed System (Group One), Chapter 6 – Group One Evaluation and Analysis of Results, Chapter 7 – Application of the Developed System (Group Two) and Chapter 8 – Group Two Evaluation and Analysis of Results.

9.3 Research Summary

Engineering design is a knowledge intensive process that encompasses conceptual, detail analysis and evaluation, which involves various areas of knowledge and experience. The sharing between these tasks is critical to increase the capacity for new product development, while maintaining its quality. EDT describes the use of a wide range of computer-based tools to assist engineers in their activities. Teaching EDT in the traditional way can involve presenting in front of an audience and explaining instructions step-by-step. One of the main tasks is to provide continuous support with a wide diversity of problems and activities. The lecturers’ selection of examples steers the progress of learning, while the students are responsible for their personal time management. However, as lecturers come from various areas of practice, portray diverse practical skills and theoretical knowledge, they may not sometimes realise the difficulties students face. Also students and lecturers are often of different age, social background and possess different general knowledge, thus both parties frequently have different approaches to problem solving and working processes. The teaching of such technologies is rapidly changing and is becoming an intensive part of the lecturers’ responsibilities; hence demands that continue to increase in complexity having dependency on working software packages.

Furthermore, students have their own pace of learning making it difficult to teach EDT in a stand-and-deliver format. Where some students excel in the skill and subsequently are waiting on the lecturers, others lag behind and may never grasp the intended learning objectives. Kurubacak (2007) stressed that lecturers need to prepare students to become active members of this changing society to adapt to these transformations as they occur. They must build rich online programs that
facilitate and promote multi-way knowledge transfers by having various interactive communication methods, techniques and activities.

Online technologies offer educators a new medium to deliver teaching and learning material – one, which can bring new and exciting ways of learning, and an alternative to traditional teaching techniques. These environments can potentially offer students many possibilities for enriching the-learning process, compared to traditional learning strategies. Mahdizadeh et al. (2007) believed that before assessing the impact of online technology on education, one should focus on how lecturers deliver and how students learn. Lowerison et al. (2006) also considered learning strategy and instructional technique as two effective factors of students' perceived effectiveness of online learning. Mahdizadeh et al. (2007) concluded that while online environments have a direct impact on the students' learning, it was not possible to explain the impact of instructional and pedagogical aspects of such environments. Dym et al. (2005) stated after a careful analysis of the situation and informal discussions with lecturers, that online education is quite far from achieving its main goal - reaching a wide distance with an effective educational benefits. Recent developments on online education are supporting efforts in making it more intelligent and provide higher-level services to its learners. Contreras et al. (2006) examined the design and development of an online intelligent system that aimed to replicate lecturers' behaviour and provide a flexible, independent, individual and personalised learning process for students. It is claimed that such programs enable students to participate actively in their own learning and interact with the subject matter to enhance their understanding. However, the effectiveness of such systems is dependant on promoting the advancement of students' knowledge through gradual experiential learning rather than the transfer of data.

The integration of learning styles within online education was investigated and was found that while they can provide such a variety of methods for adapting learning environments, they are often not used to their full potential. The most important aspect is that students need to recognise their own learning style and preferences, so that they can maximise their strengths and also adapt new strategies to work on their weaknesses. At the same time, lecturers need to adopt new approaches to their
teaching to enable students with different learning styles to learn effectively, reaching to the wider audience of students.

Another strategy that was also investigated within online education was formative assessment; it has many advantages over traditional classroom assessment. Web-based formative assessment strategy is able to improve students' learning interest and students' scores. They allow students to assess their own progress and understanding. However, it's important to understand how such technologies can facilitate learning and offer technical and pedagogical support. Wang et al. (2006) stated that successful lecturers tend to be those who are able to use a range of teaching strategies and a range of interaction styles, rather than a single, rigid approach to teaching and learning.

This research project focused on the development, implementation and evaluation of an online intelligent system for teaching EDT to engineering students. The developed system enabled students to interact and explore an online environment rapidly and directly on the Internet. They were able to utilise it according to their own abilities through the use of menus and visual components. It enabled them to access; navigate various engineering design tools and theoretical topics, supported by appropriate guidance, remotely. The developed system incorporated a number of facilities to aid effective interaction and to promote experiential learning including; sharing information, interactive environment, support and guidance, formative assessment, comprehensive feedback and Intelligent/individual learning plan. The structure of the developed system encompassed a web browser and a server integrated via an intelligent system to provide Internet remote access. Using standard web browsers as an execution engine, multiple students were able to remotely access, navigate, and interact with the online environment.

The structure of the intelligent system was based on an extensive body of knowledge involving the learning process for the taught subject. This was organised as a number of components as shown in Figure 9.143, with a collection of rules, which allowed the system to collect and draw conclusions from the given data or premises.
The user information component enabled first-time students to create an account with their information, which then allowed them to access the system using a username and a password. This then led them to the learning style component, which offered multiple choice questions, based on the VAK system (Visual, Auditory, and Kinaesthetic), which verified the students' preferable learning styles (Duckett and Tatarkowski 2002). Upon submission, scores and details of their learning styles were provided. After identifying their preferable learning styles, students were able to access the pre-assessment component, which again offered multiple choice questions (depending on the topics taught) to help setup their individual learning targets according to their existing and previous experience. The results of this component were highlighted to the students, which then guided them to their ILP. The ILP was linked to all the components within the system, contained and updated all relevant data about students' information, learning styles and pre-assessment. It recorded and updated all the students' interaction within the system to help them achieve the learning outcomes of the taught subject; it offered individual learning targets that allowed students to be in charge of their learning and at the centre of their activities, while also being monitored by their lecturer. Subject knowledge component included the topics to be taught in different formats to suit different learning styles. This could be in text, images, screen shots, diagrams, and Audio. It was also interactive in order to provide students with the ability to input data as required which then helped to enhance their understanding of the taught topic. Students followed instructions of step by step task or tutorial, formative assessment was provided within the subject knowledge component, which had multiple choice.
questions (depending on the topics taught) to evaluate the students' learning experience. Upon submission, they were given a comprehensive feedback and guidance based on their performance, which was instantly updated within their ILP.

The implementation and evaluation of the developed system utilised a module (Computer Aided Design for Motorsport) that was taught to year one students with a class of 40-50 engineering students. This module provided students with the necessary skills and knowledge using appropriate computer software for engineering design applications. It focused on using AutoCAD software for the production of 2/3-dimensional drawings of engineering components and assemblies. The understanding and practice of this subject was very crucial to the students, as they had to complete the required summative assessment to pass this module. The delivery of this module normally consisted of a two-hour weekly lecture, which includes PowerPoint presentations, class discussions and tutorials. The module was always taught in the traditional way, which involved a lecturer presenting in front of the students and explaining the topic followed by class demonstrations. Students often commented on this delivery as being bland and that found it difficult to remember what they were supposed to achieve, especially after the lectures. Furthermore, it was difficult to accommodate a pace of delivery that was going to suit all types of students as some were lagging behind, while some were excelling. To maximise students' individual potential, the developed online system was implemented within the delivery of this module. In order to include all the necessary planning and delivery data, a comprehensive planning process was constructed using to ensure the successful delivery of the module.

Upon planning, the subject's material for this subject was developed and implemented within the online system. This was presented in different formats to suit different learning styles. The interactive tutorials included text, images, screen shots and audio. Such approach provided students with a wider selection and the opportunity to follow different learning style than their preferable one, which helped to widen their knowledge and enhanced their learning experience. Students relied on their analysis knowledge and skills to continue with their learning. This was facilitated by the fact that they were being able to assess their performance immediately and reflect on what they have missed and seek advice if needed. The ILP updated their
progress remotely, this helped in three ways: firstly, keeping them informed and updated with their progress; secondly, providing them with positive encouragement and motivation to continue progressing successfully; thirdly, providing indications of areas where they might need to work harder or seek advice. At the same time, the lecturer (author) was informed of students’ ongoing performance and thereby identified required extra support or advice. Students were encouraged to reflect on their experience and also provide feedback at the next face-to-face lecture. Any encountered problems were then discussed and resolved prior to students’ engagements with the next task. By completing the required topics and tasks students were able to demonstrate that they could: Define and understand coordinates: absolute, relative and polar; Define, create, set and modify layers; Define, insert, modify and store blocks; Define and create view-ports within PaperSpace; Understand units, drawing scale and plotting. This therefore satisfied the learning outcomes of the intended taught subject.

To evaluate the effectiveness of the implemented online system on students’ learning, Su et al. (2005) pointed out that there is a need to understand which instructional techniques and activities can promote interaction in online education. Summarising key points, giving feedback, and lecturer participation in system interactions followed by class discussion indicated using the lecturer-learner interactions. These activities helped students’ reflective thinking. Students were working together to solve problems and discuss their action plan, which helped to establish a rich interaction between them, that indicated using the learner-learner interactions. Students were asked to explore, interact and then analyse the taught topics, which they were connected to their ILP and dependant on each other. This helped students to interact with the content of the taught subject, which indicated using learner-content interactions. As a result, 36 out of 43 students (84%) took part using the online system. They started by going through the learning style module that was designed to identify their preferred learning style. This provided students with indication of the appropriate format of tutorial and tasks to follow, however the system also encouraged students to try out other learning styles’ based tutorials in order to enhance their learning. The results demonstrated that most of the students were found to be of a combination of Visual and Kinaesthetic learning styles with: 61% Kinaesthetic; 22% Visual; 3% Auditory and 14% No Particular Style. The No
Particular style means that students scored evenly in two or more learning styles. In this particular pilot, 60% of these were again a combination of Visual and Kinaesthetic learning style. These results can be common in engineering design environments (Gordon and Bal 2001). Also from the results it was found that the 8 visual learning style students attempted 21 topics and passed 14. The 22 kinaesthetic learning style students attempted 63 topics and passed 44. Finally, the 5 students with no particular learning style attempted 11 topics and passed 10; this is shown in Figure 9.144.

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Number of Students</th>
<th>Total Number of topics attempted</th>
<th>Number of topics passed</th>
<th>Pass Rate (%age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>8</td>
<td>14</td>
<td>21</td>
<td>67</td>
</tr>
<tr>
<td>Kinaesthetic</td>
<td>22</td>
<td>63</td>
<td>44</td>
<td>70</td>
</tr>
<tr>
<td>No Particular Style</td>
<td>5</td>
<td>11</td>
<td>10</td>
<td>91</td>
</tr>
</tbody>
</table>

Figure 9.144 Preferred Learning Styles Summary Results

A questionnaire was conducted to gather feedback from students on their perceptions of features that were aiding or distracting their learning by using the system. It was also necessary to gain information that helped to initiate and continue improvements on the system. As a result, 31 students out of 36 (86%) completed the feedback questionnaire and the majority (96.8%) expressed that the online system was beneficial to learn about AutoCAD fundamentals in preparation for their summative assessment. Also 97% of students agreed that the learning style module helped them to identify their preferable learning styles and gave them indications of different ways of learning. It was then necessary to evaluate how students felt about using the system in terms of content and ease of use. The responses to this question were very encouraging with 94% agreeing that it was enjoyable and easy to follow, as one student said "Using the online system was an easy and enjoyable way in increasing my knowledge in AutoCAD". Students were then asked a series of questions to highlight the effectiveness of different approaches within the system such as: formative assessment and ILP. Students' comments were very positively. The average response showed that about 90% found such approaches were beneficial, and 10% were not sure but did not disagree. This response was
considered by the authors to be very encouraging; **Figure 9.145** shows examples of this feedback that was given by students.

![Pie charts showing feedback](image)

**Figure 9.145** Various Students Feedback

In order to achieve a clearer image of the system use and capabilities, it was necessary to carry out interviews and discussions with the students. The overall outcome was positive and students clearly stated that the system was well designed and easy to use. It helped them to understand and evaluate the taught topics as well as highlighting their weak areas to improve on. A few students suggested that such systems could also be implemented prior to the start of the module by highlighting that it can be used as a tool for background information, preparations and practice.

Following the summative assessment, students' results were compiled and compared against last year's. In summary, it has shown that there was an overall improvement on their performance. The overall mean grade was improved by 29%; however the most encouraging improvement was the significant reduction in failure rates. This was reduced from 11% to 3%, which clearly showed that students' performance has shifted towards the mean grades.

The author reflected on the feedback that was given by students and then implemented all the necessary changes prior to conducting another application and evaluation of the developed system using the second group of students, the results of the second experience exercised very positive and supportive findings. Full details
of this can be found in the thesis in Chapter 7 – Application of the Developed System (Group Two) and Chapter 8 – Group Two Evaluation and Analysis of Results.

9.4 Strengths and Weaknesses

Leitch and Warren (2008) identified through reviewing of literature pertaining to systems’ analysis and design for online teaching and learning that there are some “gaps” and they argued that there is a need for more specialised and specific methods for the design of such systems. They conducted a research (from focus group sessions, questionnaire feedback, and analysis) to collect information to assist in the filling of such gaps of the systems analysis and design knowledge within Australia. They concluded with a number of changes to online teaching and learning systems, these should focus on providing more useful information resources that include audio, visual, and interactive mediums.

The author of this thesis, based on the appropriate research that was carried out within the fields of education, has combined different strategies to develop a system that enhanced the students’ learning experience and provided different means for their progression and motivation. The author believes that such systems, based on the students' results and feedback, are an important development within the field of technology education. Throughout this development and for the purpose of evaluating different aspects of this system and identifying how it can affect the quality of learning through its individual components, the author of this thesis has presented and published one journal and two conference papers; Full copies of these papers are provided in Appendix D.

The planning, development, implementation and evaluation of this new hypothesis were evident in the outcomes that were achieved following using the system as an educational tool for teaching engineering design technologies. In summary the strengths of this system are as follow:

- The system's flexibility as students can access the system from anywhere and at anytime.
Students' performance is continuously being evaluated and guided through appropriate assessment according to their learning styles, knowledge and needs.

The system provides an intelligent personal learning advice that records all students’ interaction within the system and also guides them through achieving the learning outcomes of the taught subject while monitoring their progress from a distance.

Students are able to understand design concepts, as well as learning to perform different tasks, and therefore achieving the learning outcomes of individual topics within a taught subject.

Ongoing progress evaluation by the formative assessment and comprehensive feedback.

Throughout this study, the author has also faced some challenges and identified the weaknesses that affected both the lecturer and students. The following summarises these factors and highlights their effectiveness with possible solutions.

"The time and effort that was required for the development of the subject knowledge in appropriate format that was required to support the system's functions and features."

To accommodate for different learning styles, teaching materials needed to be developed in various appropriate formats including: text, images, screenshots, diagrams, slides, audio, animations, interactive tasks, quizzes and games as well as step by step instructions. Based on these, the author then had to extract appropriate details in order to build the assessment questions, these were specially designed to provide a comprehensive evaluation of the students' knowledge and understanding of the taught subject. These were time and effort consuming; however the author believes that their positive effectiveness on students' learning and the important fact that they accommodated for different types of students was worth this time and effort. This was quite evident within this experience as students commented on many occasions on the quality and usefulness of these teaching materials. It is also apparent that specialist software packages are constantly being developed and upgraded to aid such processes and thereby reducing the time and effort needed.
"Students' participation and motivation to use the system"
In some ways, lecturers can face a problem that students have no incentive to engage with such systems. They may not fully utilise this learning environment and its functions, which can limit the benefits that they can gain. This can create an additional pressure on lecturers to continuously keep encouraging and motivating students to take part. Within this study, the author has experienced such challenge especially within the first group application. Some students were not very enthusiastic to use the system and experience its functions, the author felt that they did not have enough motivation to take part. The system was implemented within the sixth week of the module, which affected the timing and planning of the summative assessment and it was not introduced as part of the formal module delivery. Therefore, this was taken into account into group two application and changes to the planning and implementation of the system were made to ensure students' participation and utilisation of the system to its full potential. Please refer to the detailed plan in Chapter 7.

"The ongoing upgrade to higher versions of software packages that are used for the applications of engineering design"
This is a general and ongoing problem that can affect the education of EDT as a whole regardless of the method or format that is being delivered. Within the author's experience, these versions are constantly being upgraded to include changes within the interface or operations in either a major or minor format. Lecturers have to adapt to these new versions and update their teaching materials to respond to such changes, which ultimately affect the overall development time and effort. From a positive prospective, these upgrades can enhance the functions and operations of these software packages as they add values and benefits to the overall interface to make it more users' friendly and easier to use. Software providers support users by providing considerable help and guidance to assist them in adapting to these changes.

"Students' ability to access the appropriate software packages and the Internet from outside HE organisations"
The teaching of such subjects relies heavily on the access to the appropriate software package required. In order for students to achieve their optimum learning...
potential, they will require to use and practice on these software packages outside their lecture time. They also will be expected to complete other tasks including coursework, exercises and summative assessment within their allocated self directed study time. The access to such packages can be challenging as students might not be able to purchase individual licences, or even have the specialist hardware to accommodate for such high capacity requirements. However, HE organisations such as University of Derby have recognised these challenges and began to address them with some viable solutions. They extended the opening times of their specialist labs into seven days a week and late evenings, they also offered a scheme which would allow students to borrow specialist laptops when necessary. On the other hand, software providers offered educational versions to students at very low discounted prices which students were able to afford.

9.5 Conclusion

In conclusion, the author believes that it is important for lecturers to facilitate higher level thinking skills, reflection, and promote problem solving through interactive, problem-based activities. The design of such environment should include tools to help students with time management, pacing their work load, deadlines that facilitate the completion of their assignments, and appropriate learning strategies. These activities scaffold learners' self-regulation and lead to their sense of self-efficacy for online learning. Norton and Hathaway (2008) stressed that providing self-regulating activities are essential for effective online teaching. They provided guidance for online lecturers, explaining that they should be skilled in online instruction, understand the learning process, and be able to build learning communities within the class.

The prime aim of this research project was to design, develop, implement and evaluate a dynamic educational environment that should provide the necessary functions to explore a particular learning experience in a consistent style. The developed environment within the system has dynamically resolved problems according to all given parameters and constraints, and provided students with an effective and interactive capability in order to shorten the gap between them and their learning tools. This thesis has presented the planning, development, implementation
and evaluation of an online intelligent system for teaching EDT to engineering students. This consisted of compiling information regarding individual students and providing appropriate teaching methods to suit their abilities and learning styles. Students’ reflections and feedback were compiled during their learning experience and then analysed to fully understand the impact of such methods on their learning. The overall results had provided support for the argument that such online systems for students’ teaching, learning and evaluation can be reliably implemented. However, careful planning and analysis is necessary to gain the full envisioned potential benefits. The author strongly believes that the development of such systems is critical to the achievements of successful educational environments for many higher education institutions, as it appreciate changes in their teaching delivery models and can lead to overall improvement in their students’ learning and progression.

9.6 Further Developments

During this study, a number of factors have been identified for further investigations and developments to enhance the developed system in terms of its functionalities, processes and performance. These factors were identified based on the author conclusions and observations during the period of application and evaluation of the system. In order to present such factors in a well and structured manner, they are discussed in the following sections in relation to individual components.

9.6.1 Learning Styles

Within this component, further investigations and developments can be carried out to include further different learning styles, including the currently used VAK (Duckett and Tatarkowski 2002), theories such as:

- Kolb’s learning style theory (Kolb and Fry 1975, Kolb 1984).
- Gardner’s Multiple Intelligences Theory (Gardner 1993).
- Felder-Silverman Learning Style Theory (Felder and Silverman 1988, Felder 1993).
This option can be useful for both lecturers and students. Lecturers will be able to advise students on the best theory to use according to their styles and the subject taught. Students can also select or go through more than one theory if they needed to further verify their preferable learning style(s).

The author also suggests that this component can be further developed through the evaluation purposes of the results. Currently within the developed system, students are given the results according to simple calculation of how many points they score within each category. This can be further enhanced using a more complex calculation theory such adding a matrix to verify the exact percentage of each score according the overall number of categories rather than just the maximum. This can be demonstrated by the following example:

If a student scores the following:

- Visual: 7
- Auditory: 5
- Kinaesthetic: 8

Then the current calculation will display that the student preferable learning style is Kinaesthetic as this is the highest score; the proposed method will calculate this as a percentage and will provide an overall score taking into consideration the contribution of the three values together in relation to the overall score of 20. An algorithm will have to be developed using theories and tools such as Fuzzy Logic to achieve the required.

9.6.2 ILP

The author believes that this component can be further investigated and developed by increasing the number of features and records for the benefit of both students and lecturers. Currently this component provides details regarding the student information, personal learning advice and personal learning targets; these are shown in Figure 9.146. The proposed investigations and developments are to expand the scope of information to include further diagnostic information regarding the students' interactions and outcomes while using the system. These can include the time taken to complete tasks, tutorials and assessments; this can provide indications of the different levels of learning and pace, which can help lecturers to trigger a help support plan if needed. The author also suggests that this component can be further
enhanced by integrating an intelligent help plan that students will be able to trigger if required. This may require further investigation into using AI in order to determine appropriate conclusions to provide the correct support plan according to the students' performance within the system.

Figure 9.146 Current ILP Functions

Finally the author suggests investigations to further develop the overall system by providing a more complex modular selection system that will be able to accommodate various modules within the education sector. This investigation requires developing the main interface to include the newly identified modules together with their associated topics and assessments. The database sections will need to be developed and expanded to include the information covering the new modules, this will need to develop and re-allocate the links within the system to accommodate for the addition of this new information. For example, each module will have its own: pre-assessment questions; formative questions, relevant feedback and subject knowledge. Once the student selects the module to be learnt, the system will automatically guide him/her through the relevant areas within the system including his/her ILP. By investigating this further and taking into consideration the variation in the nature of modules, students maybe able to study number of modules while being facilitated with individual records of their performance together with the appropriate guidance and support.
References


Amal Oraifige

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Appendices
Appendix A – Subject Material

All the appropriate subject material was developed, which had a total of 14 tutorials as well as appropriate exercises. Tutorials for each topic were developed by the author to cover the different learning models, including:

- Main tutorial: included information about individual topics to be learnt in different learning styles presentation. The tutorial included presentations with text, images, screen shots, demonstrations and audio sound. It also incorporated an interactive medium, which enabled students to input data and receive immediate feedback to enhance their understanding of the taught topic.

- Tutorials in action: this type of tutorials was designed and developed to help students to follow instructions of the steps required in order to complete a task or a tutorial, they included audio, visual and kinaesthetic support.

A Quiz or a puzzle: this included a form of a game that was based on a particular topic such as co-ordinates. Students were able to play, interact and keep trying till they succeeded. This helped them to understand the subject in a different format and provided them with extra motivation to practice on a particular exercise.
Written Tutorials

2D AUTOCAD TUTORIALS

PAPERSPACE

There are two drawing areas within an AutoCAD drawing:

- **Model-Space** where the main drawing area in AutoCAD; all modelling is drawn in the Model-Space.

- **PaperSpace** is the area to plot or print the drawing created in ModelSpace. Paper space can be deemed to be a blank sheet of paper, where separate and different views of the model can be created.

  - As paper space can be set to the exact print area of CAD drawings, it can be defined to standard paper sizes.

  - Within PaperSpace, **Viewports** can be created. Let’s imagine PaperSpace as a piece of paper with holes cut away where different parts of the drawing to be shown. These holes are the Viewports. The model can be moved closer or further away from the hole. It can also be moved or ‘panned’ around. The view of the model in one viewport is totally independent from the view in another viewport. Zooming into one viewport will not affect the view of other Viewports within the paper space.
PLOTTING SCALE

- Plot scale in CAD is used for converting drawing units to paper units. The basic paper or layout unit is millimetres. If every 10 drawing unit to be printed out as one millimetre, the plot scale needs to be set to 1:10. This means when measuring on paper the size needs to be multiplied by ten to have the true dimension.

- There is an easy way to set scales in AutoCAD by using the zoom factor and xp value. Zoom xp option represents the zoom factor in relation to the actual size of paper in paper space. Zoom xp value can be set in view ports instead of setting plot scale.

There are several golden rules for setting the scale and unit for plotting:

- An appropriate drawing unit must be selected before the start of the drawing.
- Modelling should be drawn in model space.
- Everything drawn in model space should be in full size 1 to 1. Drawing scale can be decided upon printing stage.
- Printing or plotting should take place only in paper space.
- Set the correct plot scale in according to the paper size and drawing unit.
- There is an easy way to apply plot scale by using zoom xp value in view ports in AutoCAD.

Use the controls at the bottom left of the AutoCAD window to switch between the model space and layout windows. There can be any number of layout windows in a drawing and they can be used to show different views of the items drawn in the model space.
Right click on the Quick View Layout button and select Page Setup Manager from where the properties for the Layout sheet may be modified.

The table below provides information for sheet sizes and drawing boarder sizes.

<table>
<thead>
<tr>
<th>Paper size</th>
<th>ISO Boarder Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4</td>
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</tr>
<tr>
<td>A2</td>
<td>420x594</td>
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<tr>
<td>A1</td>
<td>594x841</td>
</tr>
<tr>
<td>A0</td>
<td>841x1189</td>
</tr>
</tbody>
</table>

**VIEWPORTS**

A View-port acts like a window through which you can view the drawing drawn. More than one view-port may be set in a layout and so it is possible to have windows set to different scales in order to show detailed areas without the need to redraw the part at a larger scale. View-ports can be created from any shape.
Select View-ports from the View Panel.

**EXERCISE**

- To demonstrate PaperSpace, the drawing Table and Chair will be used. You can download this file from the online folder.
Select Layout1 at the bottom left of the AutoCAD window.

This should take you to PaperSpace layout 1.

Delete the existing created view-port by selecting the rectangle line around your drawing and click delete on your keyboard. This should result of a blank sheet of paper.

Right Click on the Quick View Layout button and select Page Setup Manager from where the properties for the Layout sheet may be modified.
 Modify the Page setup information to match the following and click OK.

1. Choose an appropriate printer.
3. Select Scale 1:1
4. Landscape for the Drawing orientation

The paper now should been adjusted to an A3 size with an appropriate border.

- From the View Tab, select New on the View-ports Panel.

- Select Single and click OK.
- Draw a window on the left side of the paper to represent View-port as shown below, your drawing should appear in the view-port.

- Double click inside the view-port or type in Mspace on the command line so you can access the drawing inside the View-port.
- The border line for the View-port should turn into black thick line.
- Adjust the view as shown below
- Click on the view-port scale at the bottom of the screen and select 1:30.

- Now double click on the space outside the view-port to deactivate the View-port.
- On the home tab from the draw panel draw a circle of radius 85 in the empty space to the right of the view-port.
Click on the View Tab and from the view-port panel select Create from Object.

Select the circle, your drawing should appear inside the circle. You have converted the circle into a View-port.
Double click inside the circle and use the pan and zoom tools to adjust the view to only see the block with the dimensions.
Select the scale to 1:8 then only use the pan to centre the view if needed.

Double click outside the view-port to deactivate it.
Zoom into the space left at the bottom of the circle
Select the new button on the view-port panel and select single, click OK
Draw a view-port.
Use the zoom and hand tools to adjust the view to only view the title box.
- Double click on the Not to Scale text, for example modify to Layout:1:30 Single:1:8
- Adjust the height to 25 so it can fit within the space.

- Double click outside the view-port to deactivate it.
- Zoom out; the drawing is now ready to print.
Interactive Medium

Both lines have been drawn using exactly the same set of co-ordinates, but the results are dramatically different.

The RELATIVE entry has simply used the @ symbol to identify the starting point of the line. This is the most commonly used method for entering POLAR co-ordinates as it provides better control of the drawing.

Cartesian Co-ordinates - Absolute Entry

OK, you've seen the theory and examples, now it's time for YOU to enter some co-ordinates!

For a tip, move the cursor over the co-ordinate entry box.

To clear your entry use the backspace key.

If you enter 3 incorrect co-ordinates you'll be taken back to the previous explanatory slide.

What is the co-ordinate for this point?
Cartesian Co-ordinates - Absolute Entry

OK, you've seen the theory and examples, now it's time for YOU to enter some co-ordinates!

What is the co-ordinate for this point?

Use the axis lines to help you. Remember which one to read first, then the other. What else do you need to include?

Cartesian Co-ordinates - Absolute Entry

OK, you've seen the theory and examples, now it's time for YOU to enter some co-ordinates!

What is the co-ordinate for this point?

Correct co-ordinate, well done. Now try the next one.
Cartesian Co-ordinates - Absolute Entry

OK, you've seen the theory and examples. Now it's time for YOU to enter some co-ordinates!

What is the co-ordinate for this point?

Incorrect co-ordinate. Try again.

Correct co-ordinate, well done. Now try the next one.
Absolute Polar Co-ordinates

Using **ABSOLUTE** co-ordinate entry for **POLAR** co-ordinates means the end point of the line is always drawn by measuring from the ORIGIN POINT 0,0 at the distance and angle specified.

Relative Polar Co-ordinates

The line is drawn a distance of 8 units at an angle of 30°.
Polar Co-ordinates Relative Entry

OK, you've seen the theory and examples again, now it's time for YOU to enter some co-ordinates!

Starting from 0,0 - what is the Relative Polar co-ordinate to Point 1?

Correct co-ordinate, well done. Now try the next one

Starting from 0,0 - what is the Relative Polar co-ordinate to Point 1?
OK, you've seen the theory and examples again, now it's time for YOU to enter some co-ordinates!

All distances are either 5 units or 10 units.

Point 2 - what is the Relative Polar co-ordinate from Point 1?

Incorrect co-ordinate. Try again.

Correct co-ordinate, well done. Now try the next one.

Point 2 - what is the Relative Polar co-ordinate from Point 1?
Videos with Instructions and Audio

In this example, each tick represents one drawing unit.

Degrees are measured counter-clockwise as positive.

6 < 45
MODIFICATION COMMANDS

WINDOW SELECTIONS

GRIP POINTS

PROPERTIES MANAGER

MODIFY PANEL

CHAMFER
ARRAYS

Creates multiple copies of objects in a pattern

RECTANGULAR  POLAR

FILLET THE INNER EDGES WITH 10 RADIUS
If every 10 drawing unit to be printed out as one millimetre, the plot scale needs to be set to 1:10.

This means when measuring on paper, the size needs to be multiplied by ten to have the true dimension.
Maze Game

Notes:

This is the maze game designed to help you understand the general co-ordination input system in using CAD.

How to play the game?

There are three co-ordination input methods available at the top of the game - absolute co-ordination, relative co-ordination, and angular co-ordination. The goal of this game is to move the RED ball to reach the EXIT point.

To move the RED ball in the maze, first choose one of the input method, and then click on the pull-down button (Green Arrow), pick a number to set the co-ordination value (the value you choose will appear above), once you set both values in a input method, click "GO" button to run the program.

You can also click the RESET button on the screen to start the game again.
Appendix B – Samples of Assessment Briefs

This assessment of the selected modules for the system implementations purposes comprised of two coursework components, which worth 50% each:

- In the first assessment, students were required to create a two-dimensional Third Angle Projection orthographic engineering drawing to BS 8888 standard using Motorsport based component. Students were assessed based on: presentation, design representation, use of layer, line-type, dimensioning, blocks, utilising paper-space, and other features such as producing a cross section view with hatching.

- In the second assessment, students were required to create a 3D CAD assembly model for a Motorsport component, such as suspension model, brake system or an engine. The 3D model consisted of the main assembly made from several parts. Students were assessed based on: design layout and features, accuracy and scale of models, innovation, design intent and exploded parts with the use of layers.
Module Title: Computer Aided Design for Motorsport
Module Code: 4MV004
Module Leader: Amal Oraifige
Coursework Assignment No: 1 of 2
Assignment Title: Rocker Arm Drawing
Weighting: 50%
Issue Date: 05/10/09
Hand-in Date: 17th December 2009
Introduction
In industry you are highly likely to be given hand-generated sketches of components that need to be detailed on a CAD system as fully orthographic engineering two-dimensional drawings with dimensions. This assignment simulates that scenario.

Learning Outcomes
Learning Outcomes that you have to satisfy for this assignment:

1. Demonstrate a knowledge and understanding of the AutoCAD software’s tools and fundamentals.
2. Apply and use AutoCAD software to produce 2D engineering dimensioned component drawings.

The Brief
You have been given the three-dimensional sketch shown below and are required to detail it up as full orthographic two-dimensional engineering drawings:

![Rocker Arm Sketch](image-url)
Your drawing must have the following items included in it:

- A border and title block of appropriate size and form to accommodate all of the views and dimensions for your drawing. The title block should include your name, the date the drawing was completed and the name of the component, at least.
- Five orthographic views of the component ((two end elevations, a plan, a front view and Section view A - A). The views should be neatly spaced out within the drawing border and all views should be drawn full size (not scaled). The views should be laid out on the drawing sheets as shown below:

![Diagram showing layout of orthographic views]

- The views should all be correctly laid out as Third Angle Projection (NOT First Angle Projection).
- The component should be dimensioned with the dimensions being well spaced out such that they are legible and do not clutter each other, or the views themselves. The dimensions should be such, that, there is enough information provided by them for someone to be able to actually manufacture the object, if they were given your drawing. It is advisable to share out the dimensions between all four views to avoid clutter.
- You must use appropriate layers for each of the elements of your drawing, e.g. title block, border, hidden detail etc. and these should be assigned different line colours.
Reading Materials
Module lecture and support notes on Blackboard

See also module reading list
Note: These sources are guides only to commonly available material. Students will also be expected to consult other relevant source material according to the nature of their project.

Submission Requirements
The following deliverables are required:

- Two-dimensional Third Angle Projection orthographic engineering drawing to BS 8888 standard of the Rocker Arm (shown in sketch format in the Brief). Your drawing should have a consistent format consisting of a border, title block, well-spaced on an appropriately sized layout with neat, orderly dimensioning. The drawing should be appropriately sized such that all views are shown full size, not scaled. The work should be submitted in AutoCAD 2010 format on a CD to the Student Support Centre. You should also include an A3 sized colour printout of your drawing with your CD. Please make sure that your name is clearly legible on both the CD and printout such that they cannot be confused with other students work.

Submission Dates
See front sheet.
The assignment must be handed in to the Student Information Centre on or before the dates of submission. Late submission will be penalised.

Plagiarism
Please note that plagiarism is an academic offence and that if any two, or more, submissions for this assignment are considered to be produced as a result of plagiarism from an original, then this will be investigated further and could result in students, who are proven to have plagiarised, failing this assignment and, therefore, the module.
Assessment Criteria
All grades given for assignment work are provisional until confirmed or otherwise by the relevant examinations board.

Performance Criteria

A+ TO A- Excellent
Outstanding; high to very high standard; a high level of critical analysis and evaluation, incisive original thinking; commendable originality; exceptionally well researched; high quality presentation; exceptional clarity of ideas; excellent coherence and logic; Trivial or very minor errors.

B+ TO B- Very good
A very good standard; a very good level of critical analysis and evaluation; significant originality; well researched; a very good standard of presentation; pleasing clarity of ideas; thoughtful and effective presentation; very good sense of coherence and logic; Minor errors only.

C+ TO C- Good
A good standard; a fairly good level of critical analysis and evaluation; some evidence of original thinking or originality; quite well researched; a good standard of presentation; ideas generally clear and coherent, some evidence of misunderstandings; some deficiencies in presentation.

D+ TO D- Satisfactory
A sound standard of work; a fair level of critical analysis and evaluation; little evidence of original thinking or originality; adequately researched; a sound standard of presentation; ideas fairly clear and coherent, some significant misunderstandings and errors; some weakness in style or presentation but satisfactory overall.

FM Unsatisfactory
Overall marginally unsatisfactory; some sound aspects but some of the following weaknesses are evident; inadequate critical analysis and evaluation; little evidence of originality; not well researched; standard of presentation unacceptable; ideas unclear and incoherent; some significant errors and misunderstandings. Marginal fail

F Very poor
Well below the pass standard; a poor critical analysis and evaluation; no evidence of originality; poorly researched; standard of presentation totally unacceptable; ideas confused and incoherent, some serious misunderstandings and errors. A clear fail well short of the pass standard

Z Nothing of merit
Nothing, or hardly anything, of merit submitted.
When no work has been submitted the NS notation will apply
Module Title: Computer Aided Design for Motorsport
Module Code: 4MV004
Module Leader: Amal Oraifige
Coursework Assignment No: 2 of 2
Assignment Title: Disk Brake Assembly
Weighting: 50%
Issue Date: 01/02/10
Hand-in Date: 30th April 2010
Introduction
3D modelling is the process of developing a mathematical, wire-frame or solid representation of any three-dimensional object via specialised software. Today, 3D models are used in a wide variety of fields. The engineering community uses them as designs of new devices, vehicles, structures etc... Students will produce a 3D models using AutoCAD package.

Learning Outcomes
On successful completion of the module, you should be able to:
1. Develop and apply CAD system knowledge to produce a fully detailed assembly drawing for a Motorsport application using AutoCAD 2010.

The Brief
Use the following picture as a guide to create a 3D Solid model drawing for a Disk Brake Assembly using AutoCAD2010.
The 3D model needs to have the following minimum parts:
- Caliper Assembly
- Disc Pads
- Disc/Rotor
- Wheel Studs
- Wheel Bearing

Students are required to select any type of a Disk Brake Assembly for a car and use the appropriate dimensions to create a 3D model using AutoCAD 2010. The 3D model needs to be developed using separate parts, which are then assembled into the final design. Resources are available in the workshop to view and examine such assemblies in order to collect the relevant information necessary for this task.

Submission Requirements
- Printouts of different views of the 3D model.
- The 3D file should be submitted in AutoCAD 2010 format on a CD or a USB (can be returned) to the Customer Information Centre. Please make sure that your name is clearly legible on both the electronic device and the printout such that they cannot be confused with other students work.

Marking Criteria

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<th>Presentation of Printouts</th>
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<tr>
<td>3D Solid Model of design using AutoCAD</td>
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<td>(Based on parts, assembly, Scale, Accuracy, proportion; etc)</td>
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<tr>
<td>Use of Layers</td>
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<tr>
<td>(appropriate use of layers for various components and parts)</td>
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</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Submission Date
See front sheet.
The assignment must be handed in to the Student Information Centre at Markeaton site room MS113, on or before the date of submission. Late submission will be penalised.

Reading and support Materials
- Module lectures and support notes
- See also module reading list
- Workshop facilities to examine and measure parts
Note: These sources are guides only to commonly available material. Students will also be expected to consult other relevant source material.
Assessment Criteria
All grades given for assignment work are provisional until confirmed or otherwise by the relevant examinations board.

Performance Criteria

A+ TO A- Excellent
Outstanding; high to very high standard; a high level of critical analysis and evaluation, incisive original thinking; commendable originality; exceptionally well researched; high quality presentation; exceptional clarity of ideas; excellent coherence and logic; Trivial or very minor errors.

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Appendix C – Examples of Generated ILPs

The ILP component within this framework allows students to be in charge of their learning and at the centre of their activities, while also being monitored by their lecturer. This component is linked to all the components within the system. It contains and updates all relevant data about students’ information, learning styles and pre-assessment. ILP also contains an intelligent personal learning advice that records all students’ interaction with the system and also guides them through achieving the learning outcomes of the taught topics within a particular subject.
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Amal Oraishe
## PhD Thesis – An Online Intelligent System for Teaching Engineering Design Technologies

### Table 1: User Performance

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Appendix D – Authors Published Papers

Throughout this research project, for the purpose of evaluating different aspects of the proposed system and identifying how it can affect the quality of learning through its individual components, the author of this thesis has presented and published one journal and two conference papers.