ABSTRACT
Digital technology has made significant impact in many areas of teaching and learning. Among the widely used methods are computer-based training (CBT) and computer-based learning (CBL). Nowadays, various fields of study use CBT and CBL as the aids to conduct their respective teaching and training activities. Electrical Discharge Machining (EDM) is a machining technique classified under advanced manufacturing process. EDM is typically used to shape high hardness and high strength-to-weight ratio materials, which include various types of alloys and composites. Due to its special characteristic, EDM has been regarded as one of the most important advanced manufacturing process. The main objective of this study is to develop a CBT system for EDM process that could assist mechanical and manufacturing students to have better understanding of the process. The module was aimed to suit the syllabus requirement at first-degree level.

Keywords
Multimedia courseware, E – manufacturing, electrical discharge machining, advanced manufacturing process.

1. INTRODUCTION
Computer technology has made a significant impact in many areas of teaching and learning. The introductions of desktop computers, word-processing packages and presentation preparation tools have improved greatly the quality of the material presented to students and used in lectures.

The use of simple database packages and spreadsheets has improved and simplified record keeping at all levels within education. One of the most significant impacts has come through the use of supportive learning mechanisms such as computer-based training (CBT), computer-aided learning (CAL) and multimedia courseware [8].

These technologies make use of various forms of interactivity to engage the student in effective, and often novel, learning experiences. Among the fields that had utilized multimedia courseware for their training purposes are virtual factory management [7], nuclear and radiochemistry [6], automotive industry [5], finite element analysis and aircraft maintenance [9], failure analysis and Process Safety Management [10] and inspection training (Gramopadhye et al, 1998).

2. OVERVIEW OF ADVANCED MANUFACTURING PROCESSES AND ELECTRICAL DISCHARGE MACHINING
Advanced Manufacturing Processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical, or chemical energy (or combinations of these energies) but do not use a sharp cutting tool in the conventional sense [5].

Some of the processes were developed since World War II in response to new and unusual machining requirements that could not be satisfied by conventional methods. Among the importance of having advanced manufacturing processes are:

- Need to machine newly developed metals and non-metals with special properties that make them difficult or impossible to machine by conventional methods
- Need for unusual and/or complex part geometries that cannot easily be accomplished by conventional machining
- Need to avoid surface damage that often accompanies conventional machining

Electrical Discharge Machining (EDM) is a machining technique classified under advanced manufacturing process. It utilizes thermal energy to remove excess material during machining process. The working principle behind EDM is that it removes material from a work piece through the use of electrical discharges as the means of machining a work piece [5].

It is a manufacturing process in which the occurrence of successive discharges between an electrode (tool) and a work piece will melt and blow away certain part of the work piece material. Figure 4 respectively shows the overall setup and close-up view of gap, showing discharge and metal removal mechanism.
3. DEVELOPMENT OF MULTIMEDIA COURSEWARE FOR MANUFACTURING ENGINEERING

Multimedia courseware also loosely referred to as computer-based training (CBT), computer-assisted instruction (CAI) and computer-aided learning is defined as a type of education in which the student learns by executing special training programs on a computer. For this study, the main objective is to develop a CBT module for Electrical Discharge Machining (EDM) that could assist mechanical and manufacturing students to have better understanding of the EDM process.

According to [2], computer based training (CBT) is an all encompassing term used to describe any computer-delivered training including CD-ROM and World Wide Web. Some people use the term CBT to refer only to old-time text-only training. Meanwhile, Computer Numerical Control (CNC) is an elective subject for Bachelor of Manufacturing Engineering program. Students that undergo the course need to do laboratory tasks using CNC machine. Table 1 shows some of the related studies recently conducted on CBT in Manufacturing Engineering field.

### 3.2 Designs for Interaction

An important part of designing an interface is the creation of clear and unmistakable interactive control. Interactive control such as hyperlinks, hypertext, button, image maps and hot spots add functionality to the interface and are a prominent feature of navigation scheme.

It is important to remember that, in many document, the controls are the only way that users can activate interactive features. Students learn how to recognize the meaning of symbols and interactive controls in a number of ways, including [3]:

- By example, when someone teaches them the meaning.
- By analogy, when the new symbol or controls is similar enough to another concept that they can make assumptions about the meaning.
- Through expectation, when clicking on a symbol or control always initiates the same interactive functions, for example “next”.

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<td>1</td>
<td>The research addresses the issue of designing a web-based CBT (web based training) course to provide an effective way to learn implicit experience of simulation output analysis [2]</td>
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<td>2</td>
<td>This research develops a Virtual Factory Teaching System (VFTS), which aim to provide workspace that illustrates the concept of factory and shop floor management. The outcomes were categorizes under four domains – web-based simulation, engineering education, networking and virtual factory [10].</td>
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<td>3</td>
<td>Development of an interactive web-based application for Linear Related List was developed in order to make the learning environment interesting and flexible. Equipped with self-revision modules [7].</td>
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<td>4</td>
<td>This research address the issue of the recent graduate and undergraduate student should know widely about Design Of Experiment (DOE) and practically about radiochemistry and nuclear knowledge, which is not widely discussed in book [6].</td>
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can select the content in main menu like in hierarchical flowchart. Figure 3 shows the architecture of the modules of CBT for EDM.

4. DESIGN AND DEVELOPMENT OF CBT FOR EDM PROCESS

The designing stage of CBT architecture and modules CBT is very critical because it will decide on the arrangement of the CBT modules [9]. Therefore, this paper will discuss the design and development of the CBT in detail. The module design covers the architecture and all contents of the CBT.

4.1 Architecture of CBT Modules

In this project, the flowchart of hybrid approach was used to plan and organize the architecture of the computer based training modules. The CBT is started with pretest whereby user has to answer the sequence of questions like in linear flowchart and they can select the content in main menu like in hierarchical flowchart. Figure 3 shows the architecture of the modules of CBT for EDM.

4.2 Multimedia Components of CBT for EDM Machining Operation

Among the most important design aspects of CBT for engineering subject are the simulation, animation and video of the actual operation or principles [10].

This paper discusses about animation and video aspects for the modules developed. Animation is widely used in interactive documents and it is often the best way to present concepts that are difficult to understand or capture on video. Animation is represented by two main branches namely 2D and 3D animation.

2D animation is an evolution from the traditional animator’s art of drawing flat image frame by frame, while 3D animation lets the animator create and present modeled objects and scenes within the computer’s digital space. Figure 4 shows the screen-shot of animation in billet clamping.

Animation is able to highlight important mechanism and sequences that may be difficult to understand through the use of images. Furthermore, it could explain complex mechanism that may be difficult or impossible to capture using video such as valve and cam mechanism. In this project, 3D animation is used to show the sequential of clamping the billet in jaw chuck on the EDM machine.

Figure 2. Conceptual model of teaching using CBT compared to traditional classroom-style approach

Figure 3. Architecture of the modules for CBT for EDM
Video could add enhanced depth of information to an interactive document because images in motion can show information quickly, easily and concisely in a way that text or still images might not [1]. For instance, a short video of fixing tools, billet and machining operation would be more effective and understandable than textual step by step description of the process. Furthermore, video shows the actual sequence and environment of the processes. Figure 5 shows the captured video for EDM process.

### 4.3 CBT for EDM Machining Operation

CBT system for EDM machining process had successfully been developed and tested. The system was developed using Macromedia Authorware as the editing tool and other video and image processing tools. Figure 6 shows the sample of the CBT user interface.

### 5. CONCLUSION

CBT for Electrical Discharge Machining (EDM) process is developed and it had fulfilled the aim and objectives of improving teaching and learning (T&L) activities for the course. Users could use the CBT system through university’s intranet hence complement the T&L activities conducted in the classroom and respective laboratory. Future improvement could be made especially regarding pedagogical aspects where details analysis could be conducted.

### 6. REFERENCES


