

**Study on an Integrated System of Rapid Prototyping and  
Manufacturing for 3D Digitizer to CNC Mill**

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## **ABSTRACT**

The main purpose of this project is to develop a low cost, effective, user friendly interface software for staff and students to integrate the designing and manufacturing facilities in the Institute of Technology and Engineering (ITE) at Massey University, Palmerston North, New Zealand. The project involves establishment of an integrated CAD/CAM/CAE system, the identification of software requirements, selection of software development tool kit, definition of hardware configuration, software development and final experiments and tests.

ITE has a laboratory, where are equipped with one CNC milling machine, one CNC lathe, one Injection Moulding machine, one desktop 3D scanner and one 3D plotter. In addition, all the CAD/CAM/CAE software have been installed on the PCs. Based on the analysis and utilisation of these existing facilities, it is found that they are not smoothly integrated; no linkage between the CAD/CAM/CAE system and desktop Rapid Prototyping facilities; file formats used by each of the system are not compatible.

Through this project, the investigation of the possibility to integrate the system and the feasibility to develop a software to bridge the 3D scanner and the CNC mill, was carried out. A first try was successfully made using Borland C++5.0 to convert the 3D scanned data into NC program. Then, using Borland C++ Builder 5.0 created a user-friendly interface for conversion of 3D Digitizer to CNC Mill. Next, the different scales of wax models were satisfactorily processed on the CNC milling machine by inputting the converted NC program.

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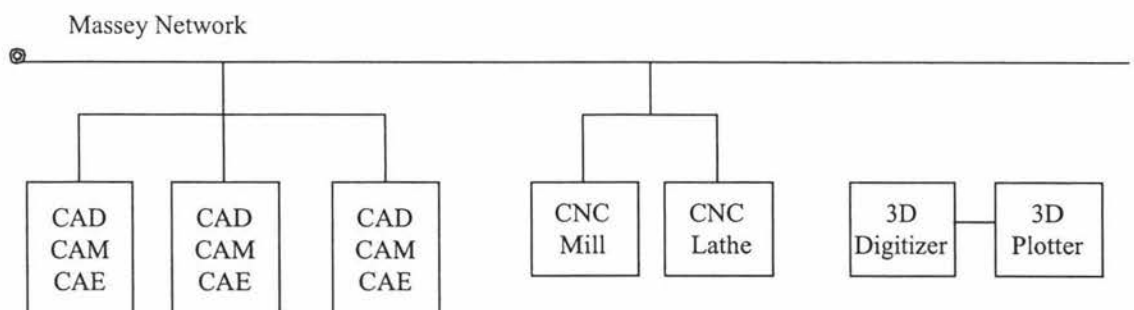
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## Chapter1 Introduction

Computer-aided design (CAD), Computer-aided manufacturing (CAM) and Computer-aided engineering (CAE) have become three essential parts of many manufacturing industrial companies. Computer Integrated Manufacturing (CIM) is no longer a new term to industrial companies. However, to establish a low cost, effective computerised design and manufacturing environment is still a challenging topic to small or medium-sized companies. This research project is to demonstrate how to develop low cost software to integrate design and manufacturing facilities. The project work involves the identification of software requirements, selection of software development tool kit, definition of hardware configuration, software development and final experiments and tests.

The project was proposed based on the facilities of the Institute of Technology and Engineering (ITE). ITE has a workshop which equipped with one CNC milling machine, one CNC lathe and injection moulding machine. All the CNC machines are networked to the CAD/CAM laboratory where all the CAD/CAM/CAE software installed. Beside these above-mentioned facilities, ITE also has a desktop 3D scanner and a 3D plotter. However, all these facilities are not smoothly integrated, especially the desktop facilities. Figure 1-1 illustrates the facilities in ITE before this research project proposed.



**Figure 1-1 The Facilities in ITE Before This Project**

The problems with these facilities are:

- 1) Any model scanned by the 3D scanner can only be reproduced by the 3D plotter. There is no linkage between the CNC machines and the 3D scanner.
- 2) There is no linkage between the CAD/CAM/CAE system and the desktop Rapid Prototyping facilities.
- 3) The file formats used by each of the system are not compatible.

It is expected that, through this project, a software could be developed to bridge the 3D scanner to the CNC mill, and to demonstrate an integrated CAD/CAM/CAE and CNC system. Based on such a background, the project first made a study on ITE's hardware and software to investigate the possibility to integrate the system and the feasibility to develop a software to bridge the 3D scanner and the CNC mill. The study clearly showed that the software is a must to convert the scanned data into NC program. A first try was carried out using Borland C++ 5.0. This is because Massey has Borland's development tool kit. Following the success of the first try, the project then identified Borland C++ Builder 5.0 as the development tool kit and began to develop the window-based software for bridging the 3D scanner to the CNC facilities.

The main objectives of this project are:

- To study the possibility of setting up a system which integrates CAD/CAM/CAE systems, CNC, a 3D scanner and a 3D plotter.
- To investigate the possibility of using a CNC Mill machine to produce models with scales by converting the scanned data from the physical part into NC Mill programs.
- To develop a user-friendly interface to bridge the 3D scanner to the CNC mill