Novel STEP-NC Control System

By

Muhammad Faiz Bin Mohd Azani

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Business Information System)

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CERTIFICATION OF APPROVAL

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Business Information System Programme
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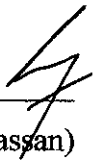
Approved by,



(Dr. Mohd Fadzil Hassan)
UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
July 2010

CERTIFICATION OF ORIGINALITY

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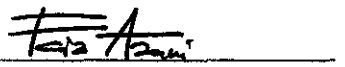

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Novel STEP-NC Control System

Muhammad Faiz Bin Mohd Azani

Universiti Teknologi PETRONAS

This project comprised of knowledge derived from software engineering & mechanical engineering utilizing Visual Basic.Net and Standard for Exchange of Product Data Numerical Control (STEP-NC). Visual Basic.Net is a system development tool whereas STEP-NC is a control interface for Computer Numerical Control (CNC) machine tools. The objectives of this project are to develop a system for controlling and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC), to establish bi-directional data transfer between CNC Controller and the Turn-Mill machine, to establish Extensible Markup Language (XML) & delimiter text file as neutral data file, and to utilize Visual Basic.Net as a tool for application development. There are few problems caused by existing systems such as existing system does not support bi-directional data transfer between Computer Numerical Control (CNC) and the Turn-Mill machines, current system does not provide External Markup Language (XML) as data file for data transfer between Computer Numerical Control (CNC) and the Turn-Mill machine, and existing systems do not generate 'neutral data'. This project used 'Phased-development' as research methodology. After the completion of this project, there are few solid findings are found which are Visual Basic.Net is capable to develop a system for controlling and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC), the 'Novel STEP-NC Control System' is capable to support bi-directional data transfer between Computer Numerical Control and Turn-Mill machine, and the 'Novel STEP-NC Control System' is capable to generate XML data file and delimiter text file as 'neutral data'.

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INTRODUCTION

1. INTRODUCTION

1.1 Background of study

This project comprised of knowledge derived from software engineering & mechanical engineering utilizing Visual Basic.Net and Standard for Electronic of Product Data Numerical Control (STEP-NC). Visual Basic.Net is a system development tool whereas STEP-NC is a control interface for Computer Numerical Control (CNC) machine tools.

1.2 Problem statement

There are **three (3) main problems** experienced by existing system:

- Existing system does not support bi-directional data transfer between Computer Numerical Control (CNC) and the Turn-Mill machines.

- Current system does not provide External Markup Language (XML) as data file for data transfer between Computer Numerical Control (CNC) and the Turn-Mill machine.

- Existing systems do not generate 'neutral data'.

1.2.1 Existing systems do not support bi-directional data transfer between Computer Numerical Control (CNC) and the Turn-Mill machine.

This is the biggest problem experienced by the existing systems toward Turn-Mill machine operation. The existing systems only allow one way data transfer between Computer Numerical Control (CNC) and the Turn-Mill machine. This is meant data only can be stored and sent to Computer Numerical Control (CNC) without enabling the user to retrieve data back for amendment, modification, alteration and adjustment.

1.2.2 Current systems do not provide External Markup Language (XML) as data file for data transfer between Computer Numerical Control (CNC) and the Turn-Mill machine.

This is the major missing in existing systems where they are not consisted of XML data file. External Markup Language (XML) is a machine readable file that will enable the Computer Numerical Control (CNC) to read the data sent by the user by the 'Novel STEP-NC Control System'.

1.2.3 Existing systems do not generate 'neutral data'.

The existing systems do not generate any file that can be recognized as 'neutral data'. The function of 'neutral data' is to allow any system or database to utilize it for other purposes.

1.3 Project Significance

This project carries many significances and contributions to manufacturing engineering. By having 'Novel STEP-NC Control System' it will ease and solve many existing obstacles, constraints and problems which lead to bottleneck situation that related to the Turn-Mill machine. Benefits of this project:

- To best of author's knowledge, there is no existing system currently using Visual Basic.Net for developing STEP-NC Control System. Thus the point of novelty in this project is the 'Novel STEP-NC Control System' is the first in the world that use Visual Basic.Net as application tool to develop STEP-NC Control System.

- The 'Novel STEP-NC Control System' capable to establish bi-direction data transfer which allows the user to access the Computer Numerical Control (CNC) that controls the Turn-Mill machine in two ways directions which enable the end user to store and retrieve data from database.

- Amendment, modification, alteration and adjustment are certainly can be made and stored back to database system by using the function of bi-directional data transfer provide by 'Novel STEP- NC' . This can allow the exchange of experience between the shop floor and the planning department. Thus, changes will not be lost when the part program is called again the next time.

- The production processes in plant could be more efficient and effective.

- Enable the manufacturer to cut the time of production, cost and man power of production activities.

1.4 Objectives

- To develop a system for controlling and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC).

- To establish bi-directional data transfer between CNC Controller and the Turn-Mill machine.

- To establish Extensible Markup Language (XML) & delimiter text file as neutral data file.

- To utilize Visual Basic.Net as a tool for application development.

1.5 Scope of study

This project is covered a few scopes that related to software engineering and manufacturing engineering. From software engineering side, Visual Basic.Net is a application tool that being utilized to develop the 'Novel STEP-NC Control System' From manufacturing engineering side, STEP-NC is a control-interface for Computer Numerical Control (CNC) machine tools that is capable to be controlled by 'Novel STEP-NC Control System'

1.6 Relevancy of the Project

This project has strong relevancy with the study field of the author due to involvement of software engineering field in this project. The author has is studying in program of Business Information System (this program is under Computer Information System of Universiti Teknologi PETRONAS) with majoring in Knowledge Management and minor in Corporate Management. In addition, the author has learned many courses that related to software engineering. Hence, the relevancy points of this project are:

- This project use Visual Basic.Net as development tool to develop 'Novel STEP-NC Control System' which is this tool has been learned by the author in software engineering courses.

- The knowledge of software engineering is mandatory for the author achieve the objectives of this project such as to develop a system for controlling and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC), to

establish bi-directional data transfer between CNC Controller and the Turn-Mill machine, to establish Extensible Markup Language (XML) & delimiter text file as neutral data file and to utilize Visual Basic.Net as a tool for application development.

1.7 Feasibility Analysis

1.7.2 Technical Feasibility

- Familiarity with Application (VB.Net): More familiar

- Familiarity with Technology (STEP-NC): Familiar

- Project Size
  - ♦ People: Two (Mr. Muhammad Faiz and Mr. Mesfin)
  - ♦ Timeframe: 31 weeks (24th January 2010 - 27th August 2010)

1.7.3 Scope Feasibility

- This project focuses on the aspects of software engineering and manufacturing engineering.

- This project is conducted and covered within the knowledge derived from Turning and Milling process, technology of STEP-NC, and Visual Basic.Net

- This project is planned to be completed in two semesters which is in

January 2010 and July 2010.

1.7.4 Organizational Feasibility

- Project champion: Dr. Ahmad Majdi Bin Abdul Rani, Head Department of Mechanical Engineering Department of Universiti Teknologi PETRONAS is well positioned to supervise and lend support and idea to complete this project.

- Project supervisor: Dr. Mohd Fadzil Bin Hassan, Head Department of Computer Science and Information of Universiti Teknologi PETRONAS is responsible to monitor the progress of this project by providing consultation and expertise in software engineering area.

- The users of the system including lab technicians and machine operators are expected to experience the benefits of 'Novel STEP-NC Control System'.

2.2 Turn-Mill Machine

2.2.1 Definition of Turn-Mill Machine

Turn-Mill Machines is a machine that capable of both rotating workpiece operations (turning) and rotating-tool operations (namely milling and drilling). Generally these machines are based on lathes. The machine is typically recognizable as a horizontal or vertical lathe, with spindles for milling and drilling simply available at some or all of the tool positions. With a machine such as this, a part requiring a variety of operations can be machined in one setup, particularly if a sub spindle allows the part to be passed from one spindle to another during machining. More recently introduced turn/mill machines depart from the lathe design into something much more like a hybrid machine combining a lathe's chucks and spindles with the travels and milling power of a machining center. One of the most significant issues with these types of machines in general is figuring out just which parts to run on them. Many shops have discovered that, even though these machines developed from lathes, they are not necessarily limited to round parts. Various non-round parts can be machined on the same platform as efficiently, if not more efficiently, than on a machining center. [1]

2.2.2 The Operations of Turn-Mill Machine

In simple statement, Turn-Mill Machine has various tasks and works it could perform. But, in general term, it is capable to generate flat and curve surfaces on a work piece by involving multiple rotating relative motions cutter. It also can be used to design complex shape and prototype. Below is the example list of some of its functionalities:

- Cutting – cut work piece into parts.
- Drilling – create hole on work piece.
- Rebating – reduce the work piece surface.
- Routing - an overhead cutting tool drills into the work piece and then cuts the desired interior shape.
- Straight Turning – reducing diameter by feeding cutting tool parallel to work piece surface thus might results all the surfaces are same of each inches.
- Rough Turning – removing a lot of work piece surface in one path.
- Tapper Turning – producing taper along the work piece surface.
- Contour Turning – creating curved and cylindrical shapes by feeding a tool cutter along a curved line.
- Grooving – creating a long, narrow cut or indentation in a surface.

- Cutting Speed: defining surface feet per minute and spindle rotation per minute.
- Feed Rate: define inches per tool; table dimension, number of cutter teeth.
- Axial Depth of Cut: define width work piece surface that engage with the tool.
- Radial Depth of Cut: define the tool is set below work piece surface.
- Depth of Cut: define width work piece surface that engage with the tool.
- Type of Material
- Type of operation
- Horsepower
- Condition of machine

2.2.5 Power Requirement of Turn-Mill Machine

Each work need different power requirement in order to operate Turn-Mill machine. There are **five (5)** factors determine the power requirement: [1]

- Amount of work piece movement
- Chip thickness
- Cutter geometry
- Type of work piece material
- Speed of work

2.3 STEP-NC

2.3.1 Definition of STEP-NC

In author's point of understanding, STEP-NC is a 'brain' for Turn-Mill machine. It is utilize to control the machine by receiving the data from user. Accordingly to STEP-NC official website, STEP-NC or Standard Electronic of Exchange Product Data Numerical Control could be described as a machine tool control language that extends the ISO 10303 STEP standards with the machining model in ISO 14649, adding geometric dimension and tolerance data for inspection, and the STEP PDM model for integration into the wider enterprise. The advantage of having STEP-NC is it supports bi-directional or two ways information flow between the machine and the planning. With STEP-NC, a CNC system is given a full description of the part and the manufacturing process. This description allows the CNC to perform complete safety checking before it begins to make the part, and it allows the CNC to optimize the manufacturing process for its current operating conditions. [2]

2.3.2 Background of STEP-NC

Up to now, part programming for NC machine tools is normally done by using ISO 6983. This standard dates back to the time of punched cards and does not cover the demands of modern NC technology. Within several research projects, such as OPTIMAL and MATRAS, European industries and university institutes have developed a new STEP-compliant programming interface which is based on an object-oriented data model. [2]

The main characteristic of the new interface presents higher level of information. Whilst a part program according to ISO 6983 describes movements (G1, G2, G3) and switching instructions (M3, M8), the new language covers manufacturing tasks (so called "features"). Such a task could be, for example, roughing of a pocket. All operations which are necessary to produce the finished part from the raw piece can be described by a sequence of such manufacturing tasks. [2]

Since the data model describes tasks, the part program sup-plies a higher quality of information to the shop floor. Therefore, modifications at the shop floor can be saved and transferred back to the planning department which enables a better exchange of experience. Through the fact that geometry of raw piece and finished parts are described by using the STEP syntax, a direct exchange of information between CAD/CAM and NC can be realized. Geometry data can be imported directly from CAD systems. Thus, only technology information has to be added in order to generate the part program. [2]

The new data exchange format has been implemented as proto-type for both 2½ D and 3D machining into controllers of 'Siemens' and 'Fidia' as well as into the European open architecture OSACA NC controller and its performance has been proven in laboratorial environments. It will be a cornerstone for a truly open manufacturing environment. [2]

The new data model was introduced to an ISO Working Group and is currently under final deliberation for Draft International Standard (DIS), called ISO 14649 by ISO TC184/SC1. The standard aims to replace the current used ISO 6983 with the new data

model. For the first stage, the general work for milling, including structure and data model was finished. [2]

In order to validate this interface, the European project STEP-NC has been launched. Implementation of the existing data interface for milling will be undertaken as well as extensive tests by end-users. The project started on January 1st 1999 and will continue until December 31st 2001. In total 20 industrial and academic partners with high experience in the fields of CAD/CAM, control, and machine tools in Europe are joining this project. [2]

2.3.3 Latest Research & Development of STEP-NC

A string of researches are done by several bodies and institutes around the globe. In Europe, the initiative for designing a new NC programming interface was started in Europe in the middle of the 90s. In order to evaluate and to further elaborate the standard the European STEP-NC project was funded by the European Commission and Switzerland. 20 industrial as well as scientific partners joined to gather user requirements, define use cases and to realize pilots to evaluate the drafted data models for milling, EDM and contour cutting of wood, glass and stone. Besides the pilots running at university level, 'Siemen's, 'Dassault Systems', 'Open Mind', 'CAD/CAMation', 'OSAI' and 'CMS' did integrate solutions to process STEP-NC in their current industrial products. Thus the high level functionality of theses system was available to the evaluation of STEP-NC. CAD import functionality, technology data bases, machining simulations as well as the execution on different machine tools could

be tested. For further information and the final report of the first European project refer to the menu item EU Project. [2]

In United States, when the normative working group of ISO 14649 did decide to refer to ISO 10303 for geometry definition, the contact to the STEP community was established. Especially Dr. Hardwick (CEO of STEP Tools) did assist the working group in defining the data elements and in handling the STEP data models.
In order to evaluate the possibilities of data integration and exchange between CAD, CAM and CNC in the States the Super Model Project was started in 2000. STEP Tools, the major partner of the project, did realize a first test scenario for milling. Since autumn 2001 the Super Model Project joined together with the Korean projects in the international IMS STEP-NC project. Besides the national project goals the joint project aims to exchange test experiences and to further elaborate the standard. [2]

In Korea two different projects are joining the international IMS STEP-NC project: The University of Pohang with its laboratory "NRL-SNT" dedicated to STEP-NC and a consortium around the Seoul National University. The NRL-SNT did draft with the European project consortium the data model for turning. Within the next steps this data model will be implemented by the Korean and European partners in order to verify the functionality of the turning model (ISO 14649-12). In addition a model for rapid prototyping is planned. [2]

In 2001 the so called Digital Master was started in Japan. This project is not participating in the joint international IMS STEP-NC project. But due to the participation of Dr. Sakamoto in the normative working group of ISO 14649 the ideas

and proposals of the Japanese partners are included into the standardization work and a common STEP-NC model can be achieved. [2]

2.4 Visual Basic.Net

This project used Visual Basic.Net as the application tool to develop 'Novel STEP-NC Control System' with Visual Basic as programming language. The reason why Visual Basic is chosen rather than others due to it is not yet to be utilized to develop STEP-NC Control System.

Visual Basic is the third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model. VB is also considered a relatively easy to learn and use programming language, because of its graphical development features and BASIC heritage. [3]

Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects. Scripting languages such as VBA and VBScript are syntactically similar to Visual Basic, but perform differently. [3]

A programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations. [3]

2.5 Extensible Markup Language (XML) Data File

Extensible Markup Language (XML) is a set of rules for encoding documents in machine-readable form. It is defined in the XML 1.0 Specification produced by the W3C. [3]

XML was designed to store and transport data with focus what data is. People usually confuse with HTML. HTML was designed to display data and with focus on how data looks. [3]

XML's design goals emphasize simplicity, generality, and usability over the Internet. It is a textual data format with strong support via Unicode for the languages of the world. Although the design of XML focuses on documents, it is widely used for the representation of arbitrary data structures, for example in web services. [3]

Many application programming interfaces (APIs) have been developed that software developers use to process XML data, and several schema systems exist to aid in the definition of XML-based languages. [3]

2.6 Delimiter Text File

In computer programming, a delimiter is a character that identifies the beginning or the end of a character string (a contiguous sequence of characters). The delimiting character is not part of the character string. In command syntax, a space or a backslash () or a forward slash (/) is often a delimiter, depending on the rules of the command language. The program interpreting the character string knows what the delimiters are. [4]

Delimiters can also be used to separate the data items in a database (the columns in the database table) when transporting the database to another application. For example, a comma-separated value file (CSV file) is one in which each value in the cells of a table row is delimited by and separated from the next value by a comma. The beginning of a row is indicated by a new line character. [4]

2.7 Existing Systems

To best of author's knowledge, there are few systems that have been developed by other researchers and programmers around the world. However, all of them used Java language and Visual C++. No one of them has yet use Visual Basic as programming language. [2]

The existing systems do not provide the function of bi-directional data transfer between the system and Turn-Mill machine and this has caused some problems for the user. Recall back from the content of Chapter 1; *The 'Novel STEP-NC Control System' capable to establish bi-direction data transfer which allows the user to access the Computer*

Numerical Control (CNC) that controls the Turn-Mill machine in two ways directions which enable the end user to store and retrieve data from database. Amendment, modification, alteration and adjustment are certainly can be made and stored back to database system by using the function of bi-directional data transfer provide by 'Novel STEP- NC'. This can allow the exchange of experience between the shop floor and the planning department. Thus, changes will not be lost when the part program is called again the next time. Without this function, there is big hole of weakness in existing systems. Thus, the function of bi-directional data transfer is really necessary and useful to be established in the 'Novel STEP-NC Control System'.

Surprisingly, there is no one existing systems has provided and generated 'neutral data' to allow other systems to utilize it for other purposes for example; to display data in other interface, to access data to be stored in different database, to use data to be sent to other Turn-Mill machines and so on. Without having 'neutral data', there are many positive future prospects will be limited and cannot be expanded.

2.8 Theory of 'Novel STEP-NC Control System'

This project has added up a series of novelty into STEP-NC development. By highlighting the part of using Visual Basic.Net as application tool to develop 'Novel STEP-NC Control System' that enable bi-directional data transfer between the 'Novel STEP-NC Control System' and Computer Numerical Control that capable to generate Extensible Markup Language (XML) data file and delimiter text file as 'neutral data'.
The main reason why Visual Basic.Net is chosen to be utilized as application tool for developing 'Novel STEP-NC Control System' because Visual Basic.Net is yet not be used by others to develop system to control STEP-NC. Thus, the point here by using Visual Basic.Net is novel for STEP-NC development.

The biggest contribution of this project is to establish bi-directional data transfer between the system ('Novel STEP-NC Control System') and Computer Numerical Control. In order to do it, the functionalities of Visual Basic.Net are utilized especially regarding to its core components such as Serialization & Deserialization (XML) and Sequential File (delimiter text file). By using Serialization it capable to store data in Extensible Markup Language (XML) and transport it to targeted destination. For this project, XML data file will be generated once the user enters all the required data and it will be transported to Computer Numerical Control for reading the data then to tell the machine to perform the work. In addition, XML data file will be sent to Computer Numerical Control through Local Area Network (LAN) cable. Furthermore, the data can be retrieved back for modification, alteration and adjustment for future back by using Deserialization. With this function, the existing XML data files can be retrieved back from Computer Numerical Control to the system ('Novel STEP-NC Control System') for the user to make modification, alteration and adjustment. Delimiter text file is generated for the purpose of human readable file. It will be printed as hard copy or display in computer as soft copy for the other users that not involve in controlling the Computer Numerical Control to get to know and understand what kind of work the Turn-Mill machine is ordered to perform.

Apart of already mentioned above, XML data file and delimiter text file can be used as 'neutral data'. They can be used for other purposes. These 'neutral data' can be used by other machines to be read in other ways to perform other works and they also can be accessed by other databases in order to store in other places and mediums. Thus here is another novelty of this project which is 'Novel STEP-NC Control System' is capable to establish 'neutral data' for other applications to use it for other purposes.

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

3.1 Research Methodology

This project uses 'Phased development –based' as the project methodology. The reason methodology is selected and chosen prior to the advantage of quickly getting useful software into the hand of users. While the software does not perform all the functions the users need at first, it begins to provide business value sooner than if the software were delivered after completion. Due to users to begin work with the system faster than system completion, they are more likely to identify important additional requirements sooner than with sketch and structured design situations.

In addition, 'Phased development –based' is the best use for this project because the development progress need to be demonstrate and presented regularly to the client, Mr.Mesfin. The purpose of demonstration and presentation is to get his confirmation either all the expected system is meet the requirement and standard.

Furthermore, the methodology of 'Phased development –based' also allow the author to use his creativity and ideas to develop system prototype as much as he wants because the methodology allows the author to start develop the system prototype with new idea of analysis that will result in design phase and then make impact in implementation phase

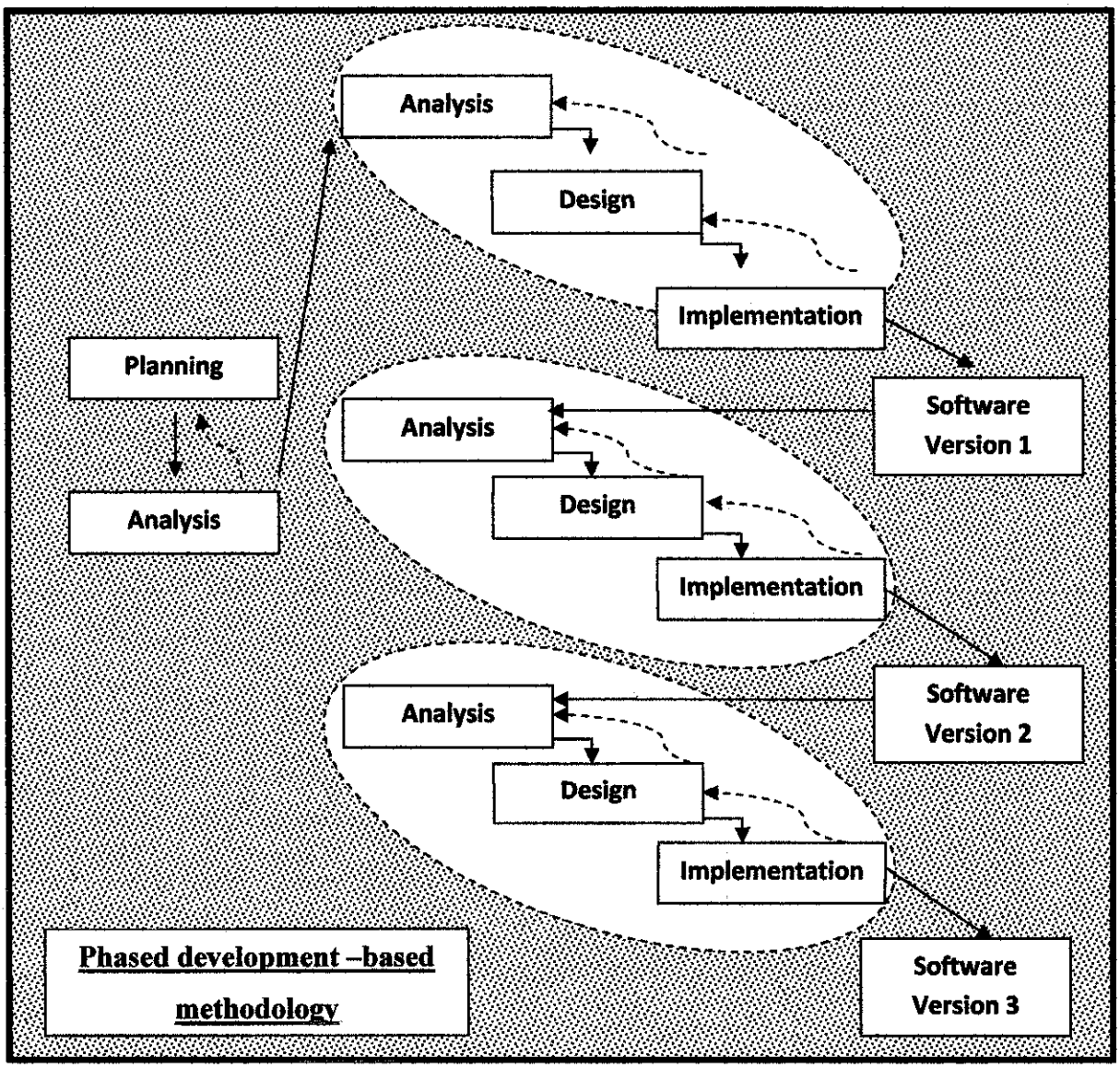


Figure 2 : Phased Development methodology

3.2 Project Activities

Due to fully development will be made within 'Final Year Project 1' (in Semester January 2010) and 'Final Year Project 2' (in Semester July 2010), the project activities are consisted of planning, analysis, design, testing and implementation.

3.2.1 Activities in planning phase

For planning phase, some discussions have been made by consulting Dr. Mohd Fadzil Bin Hassan regarding to the flow of the project. The discussed matters were about the programming tool that might be used, the key persons to be approached or the identified clients that could contribute and initiate the project, the key words that might be useful to be identified which could lead to the research method and the significance of the project itself.

Then, the author has been introduced to Dr. Ahmad Majdi Abdul Rani, the owner of this project and Mr. Mesfingizaw, the project partner who is currently doing his PhD in Mechanical Engineering program. Both of them are classified as the author's client.

At the beginning of the planning phase, the first thing has been discussed is the application tool of programming that will be used. Based on the author's expertise and

skills he acquired, the project coordinator prefers to choose Visual Basic.Net as the main programming tool for this project.

Eventually, the clients also were looking for developer who capable to develop this project by using Visual Basic.Net. One of the clients, Mr.Mesfingizaw has asked the author to use Visual Basic.Net because of the project requirement to establish and generate XML data file and delimiter text file and Visual Basic.Net is so capable to do so.

The project planning was discussed further and detail between the author and the client, Mr.Mefsingizaw. Some matters have been discussed such as the functions of system that are going to be developed, the interface, the theme, the type of database, the data formats and the support application that might be used.

3.2.2 Activities in analysis phase

For analysis phase, several meetings and discussions have been made with the project supervisor, Dr. Mohd Fadzil Hassan and the client, Mr. Mesfingizaw about what areas

need to be focused and highlighted in order to obtain and gather the data and information that might contribute and help the project progress.

Based on the author's analysis, the project is suited to Business Process Improvement (BPI) as the analysis technique due to its approach upon the project by making moderate changes to the way in which the organization operates to take advantages of new opportunities offered by technology in this project and how the existing systems might be improved. The client, Mr.Mesfingizaw has contributed at explaining the core and backbone source of knowledge regarding to Turn-Mill machine process.

Also, Mr.Mesfingizaw has provided some tutorial videos that are very informative and useful for describing and clarifying the basic process of both machines. He also gave many tips and hits about how to develop the control system for STEP-NC. However, the analysis phase went narrow to four (4) points which are the basic process of Turn-Mill machine, the function of bi-directional data transfer, generating XML data file and delimiter text file, and the establishment of both of them as 'neutral data'.

In addition, several studies about the machines have been done with the purpose of obtaining the extra knowledge about the machine features and operations. The Turn-Mill machine has been monitored and observed closely about how they perform work. By doing these, indirectly the existing understanding could be expanded and deeper.

Apart of that, some interview with Mr.Mesfin have been conducted with the some questions have asked. The examples of frequent interview questions have been asked are:

- What is the problem with the current system?
- What is the limitation of current system?
- What areas need to be improved?
- How to increase the efficiency and effectiveness of the current system?
- When the system should be completed?
- What areas need to be focused in the project development?
- What kind of interface design that the client want?
- What kind of functions that the client wants?
- What type of database that the client wants to use?

3.2.3 Activities in design phase

3.2.3.1 Semester January 2010

Due to suggestion and request by Dr. Mohd Fadzil Hassan and Mr. Mesfingizaw, the Final Year Project 1 was included the design phase as it was planned to be accomplished in this semester. The design is about programming a simple prototype. The purpose of having the prototype is to give the clients about the ideas and opinions of further

development since this project is based on from sketch. Thus, by developing the prototype, which is currently in progress, might boost the speed of development of the project in way of generating of innovation about how the final project outcome will be.

The design phase officially started with the sketch on the plain sheet of paper. The client, Mr.Mesfin drew the interface he wants. He also decides what kind of functions he wants to use in system. However, the design is subject to change from time to time according to changes in future requirement. It is also accordingly to the project methodology which is 'Phased-development'. Prior to the client expects the project is to be developed from the time being, the design has been transformed into prototype.

The prototype is completed with basic functions or with incomplete features. The reason is the client wants this prototype to be as platform and the additional features will be added from time to time based on additional requirements in the future as the project development keep progressing. As for now, the current status of the prototype in terms of the functions of database which is the two ways directions have been accomplished well. Till this semester, the 'Novel STEP-NC Control System' is capable to store the data to the database and to retrieve the data from database.

In detail, the process of design the system prototype has went through four (4) steps. The steps are (kindly refer to the next page):

1. Interface structure design

   The interface structure defines the basic components of the interface and how they work together to provide functionality to users.

2. Interface standards design

   The interface standards are the basic design elements that are common across the individual screens, forms, and reports within the system.

3. Interface design prototyping

   An interface design prototype is a mock-up or the simulation of a computer screen, form or report.

4. Interface evaluation

   The interface evaluation could be defined as they method of how to improve the interface design before the system is complete.

3.2.3.2 Semester July 2010

Some improvements and modifications are required to be implemented upon the system itself due to suggestion and recommendation from the client, Mr. Mesfin. The 'Novel STEP-NC Control System' is totally changed in terms of design such as the interface layout, interface appearance, color and also the code parts. The functions are also added especially into areas of 'Project', 'Main Work Plan' and 'Features'.

The changes also affected database area where the early planning was to use Microsoft SQL Server as the database for this system and it is replaced by Microsoft Access 2007. The main reason of this change is the complexity issue occurred in programming part. To save time and add efficiency in programming progress, Microsoft Access 2007 is chosen to replace Microsoft AQL Server due to its less complexity and difficulty faced by the author to configure and establish the database in the 'Novel STEP-NC Control System'.

Another change is ASP.Net no longer being used as platform for developing this system. Previously, ASP.Net has been seen as the main platform or medium for this project but since XML data file has been discovered to be used as medium of data transfer between 'Novel STEP-NC Control System' and Computer Numerical Control (CNC), ASP.Net is no longer being considered. Another reason of this decision is the client, Mr.Mesfin did not want this system to be used in online platform to avoid some constraints and problems.

3.2.3 Activities in testing phase

The 'Testing phase' is divided by two parts which are 'Functionality Test' and 'Configuration Test'. 'Functionality Test' is about to test the 'Novel STEP-NC Control System' itself. The purpose of this testing is to determine and spot any error regarding to bi-directional data transfer, data validation, database connection, the generating function of XML data file and delimiter text file, and the whole process of system working. In

addition, the 'Functionality Test' requires people from software engineering background to conduct it since it will involve a lot of programming validation and debugging processes.

The 'Configuration Test' is about to test the 'Novel STEP-NC Control System' with the Turn-Mill machine. The purpose of this testing is to validate compatibility element between the Turn-Mill machine and the 'Novel STEP-NC Control System' in order to ensure that both of them can work together. In addition, the 'Configuration Test' requires people from manufacturing engineering background to conduct it since it will involve a lot of technical issues and matters regarding to Turn-Mill machine.

However, due to a decision made between the author and the client, Mr. Mesfingizaw about the testing phase, the 'Functionality Test' is conducted by the author and the 'Configuration Test' is conducted by the client. The justification of this decision is listed below:

- The author has strong knowledge and skill in software engineering to conduct 'Functionality Test'.
- The client, Mr. Mesfingizaw has deep knowledge and skill in manufacturing engineering especially regarding to Turn-Mill machine because this is his topic for his PhD study.
- To avoid time to be spending on the areas that not related to the author and the client strong knowledge.
- To speed up the time to produce the expected results.
- To increase the accuracy of testing results.

3.2.3 Activities in implementation phase

So far, the project is not yet to be implemented in real world because the 'Novel STEP-NC Control System' is still in testing part which is in 'Configuration Test'. Accordingly to the client, Mr. Mesfingizaw this system will be analyzed and improved (if any) from time to time until the testing part is fully satisfied all the standards and requirements set by ISO 14649-12. The author's part is stop until this level and the rest of this system is all depend on the client, Mr. Mesfingizaw.

3.3 Gantt Chart

**The Gantt chart is attached in Appendices (Appendix 1)*

3.4 Tools required

3.4.1 Software

- Microsoft Visual Basic 2008 Express Edition. (main development tool)

  Microsoft Visual Studio Express is a set of freeware integrated development environments (IDE) developed by Microsoft that are lightweight versions of the Microsoft Visual Studio product line. The idea of express editions, according to

Microsoft, is to provide streamlined, easy-to-use and easy-to-learn IDEs for users other than professional software developers, such as hobbyists and students. The final versions were released on November 19, 2007 and the service pack 1 versions were released on August 11, 2008. In line with popular demand since the Visual Studio 2005 Express Editions, these editions will always remain free-of-charge. [3]

- Microsoft Access 2007 (database support)

  Microsoft Access 2007 is a relational model database application produced by Microsoft. It has many functions to store and track data.

3.4.2 Hardware

- 'Mazak', the Turn-Mill machine (available at Building 16 of Mechanical Engineering Department, Universiti Teknologi PETRONAS)

CHAPTER 4

RESULT AND DISCUSSION

4. RESULT

4.1 Findings

Throughout of development of the 'Novel STEP-NC Control System', there are several results and findings have been produced and generated by the author. First and foremost, the author has found the solid results and findings stated that:

- Visual Basic.Net is capable to develop a system for controlling and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC).
- The 'Novel STEP-NC Control System' is capable to support bi-directional data transfer between Computer Numerical Control and Turn-Mill machine.
- The 'Novel STEP-NC Control System' is capable to generate XML data file and delimiter text file as 'neutral data'.

4.1.1 System Architecture

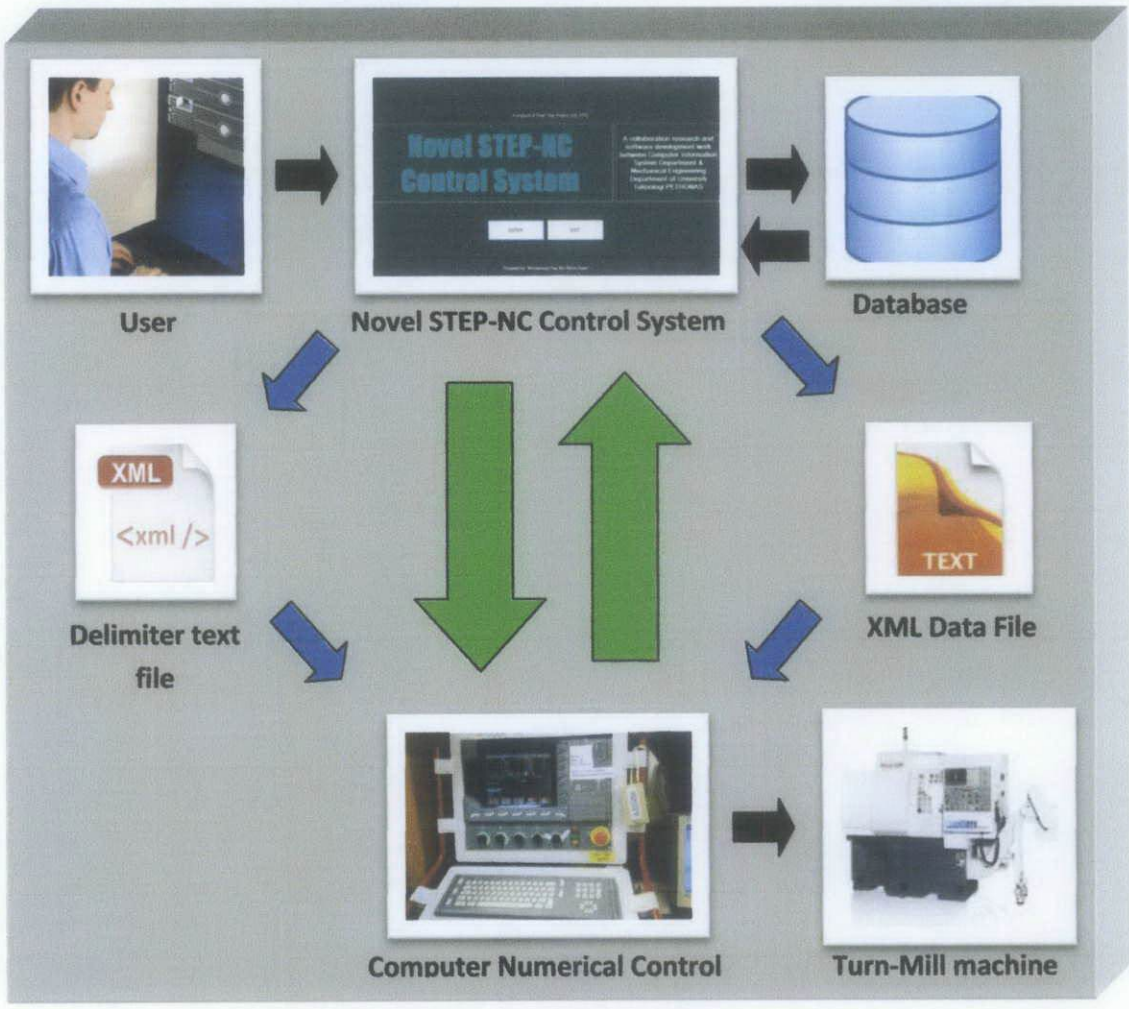


Figure 3: System Architecture

4.1.2 Class Diagram

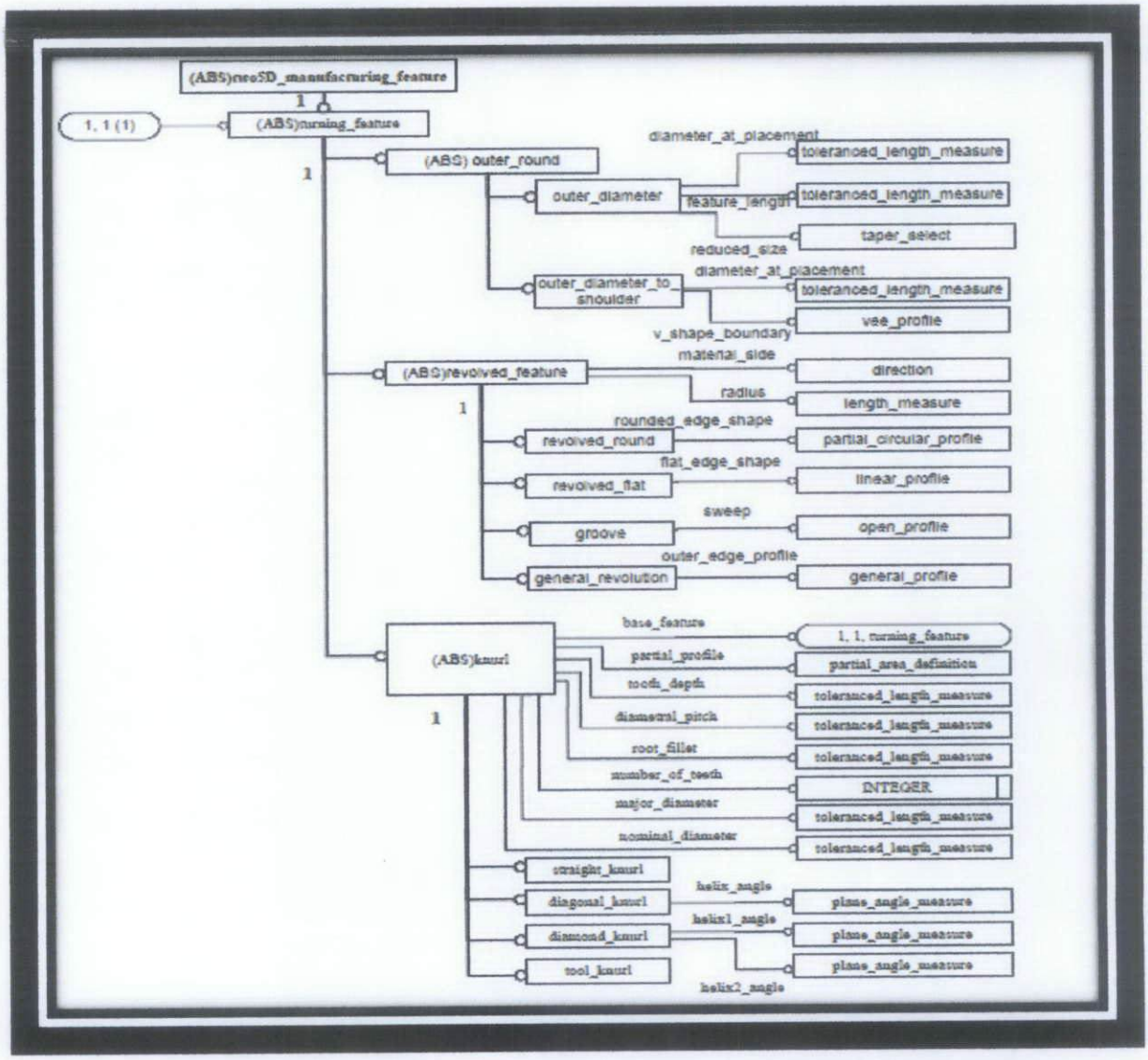


Figure 4 : Features Class

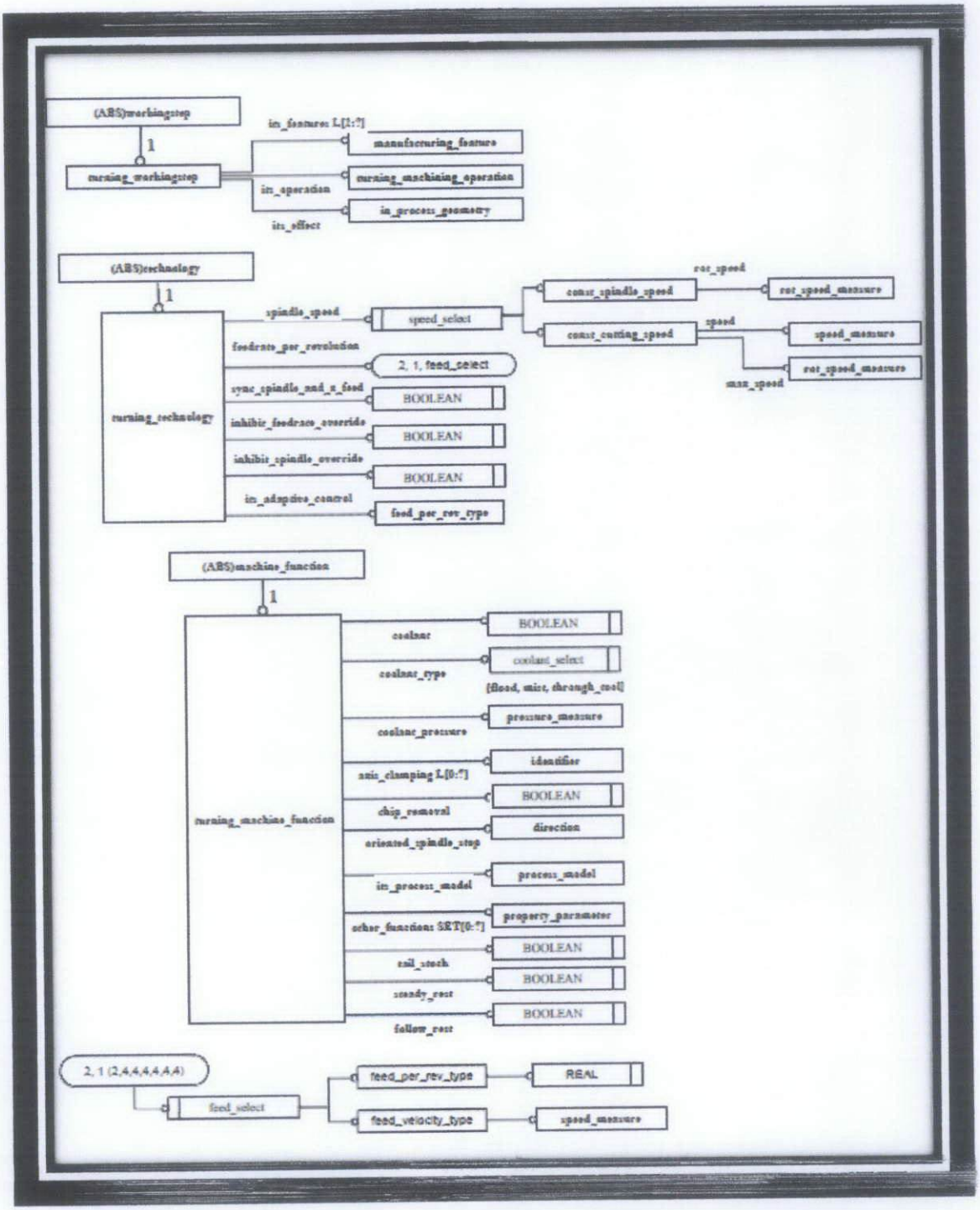


Figure 5 : Working Step Class

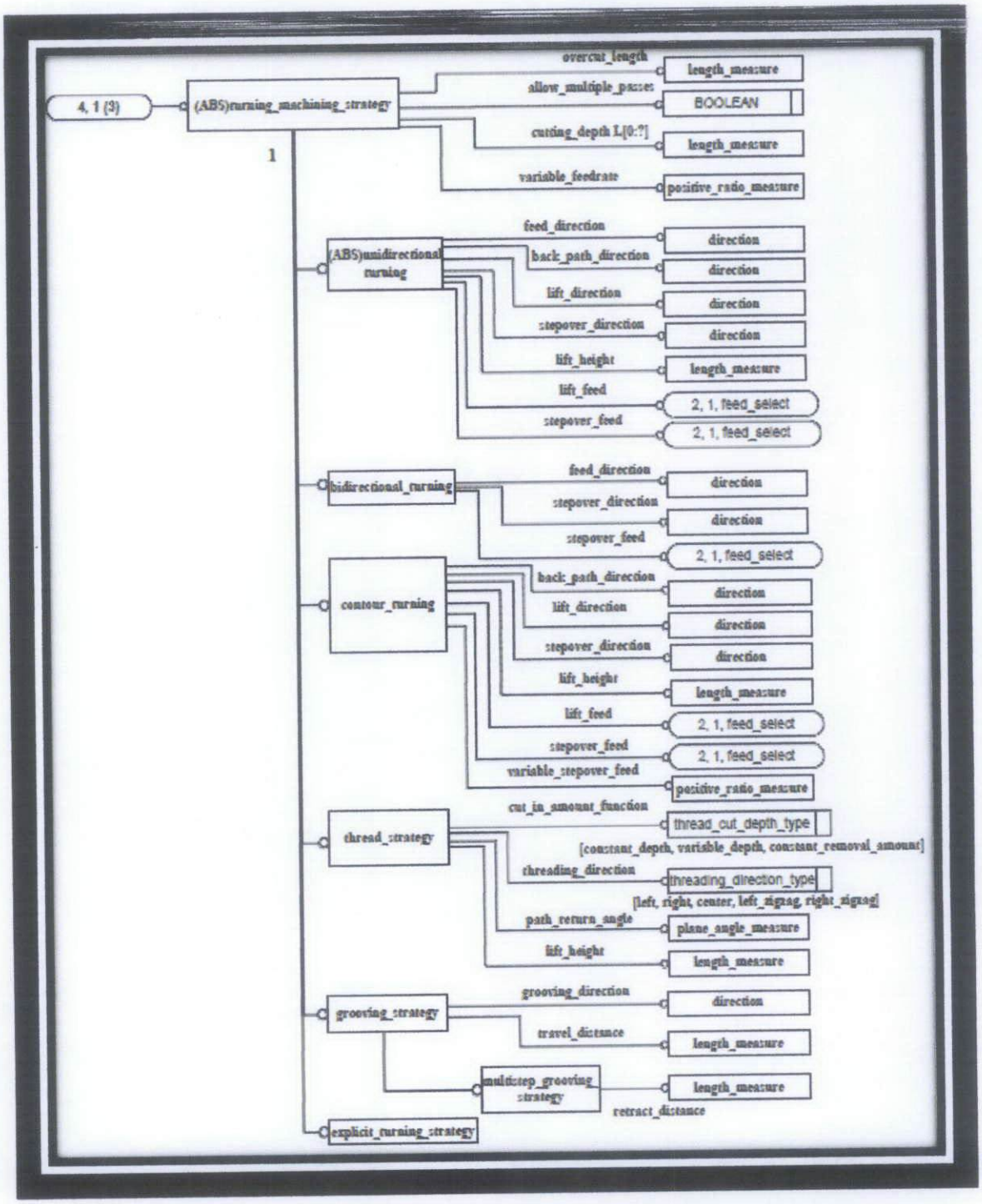


Figure 6 : Machine Strategy Class

4.1.3 Use Case Diagram

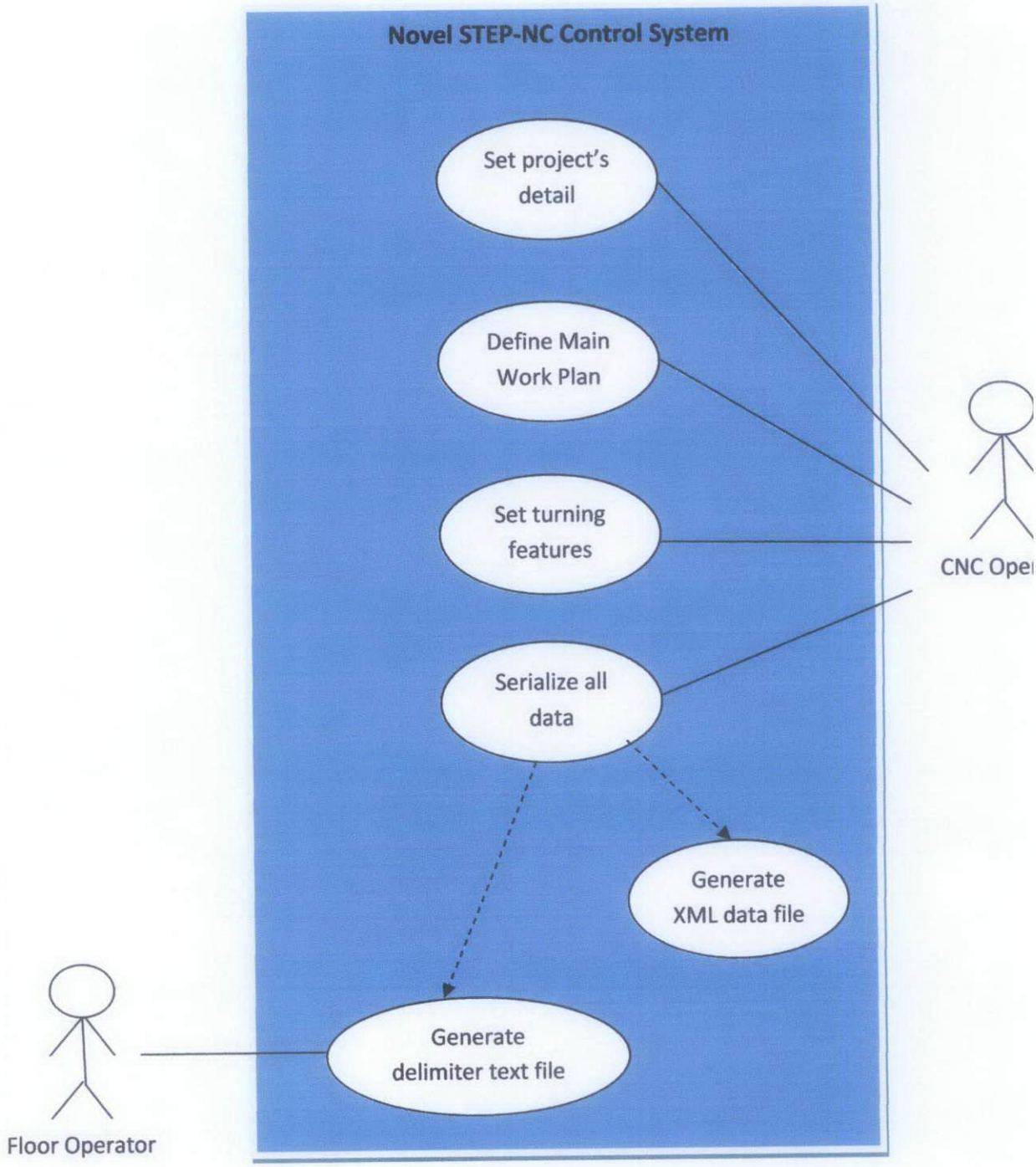


Figure 7 : Use Case Diagram

4.1.4 Activity Diagram

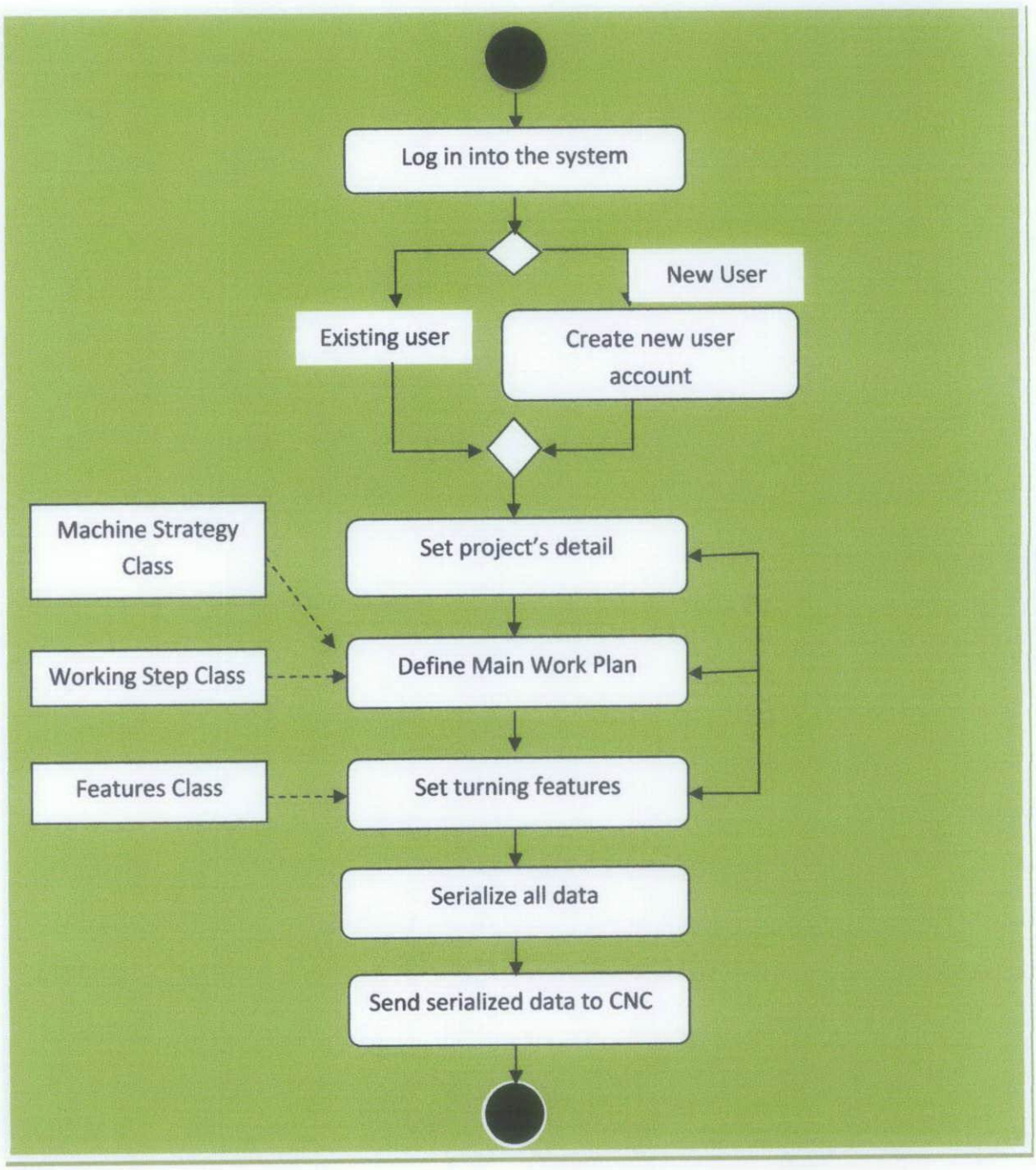


Figure 8: Activity Diagram

4.2 Project Deliverables and Discussio

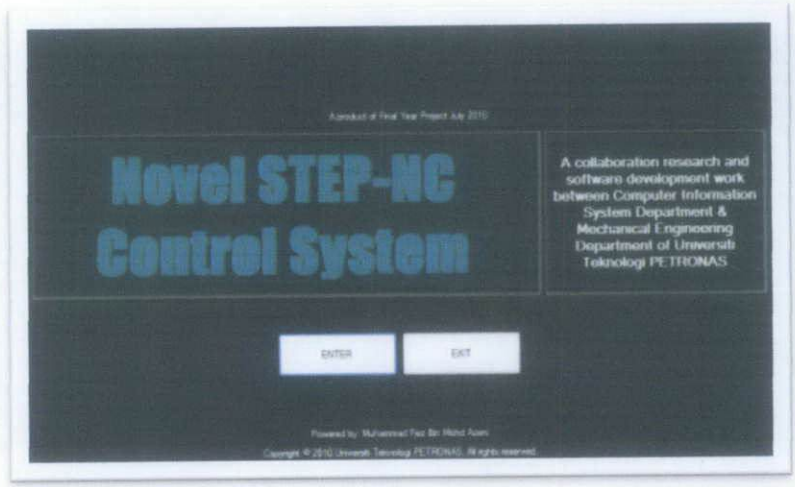


Figure 9 : Introduction Interface

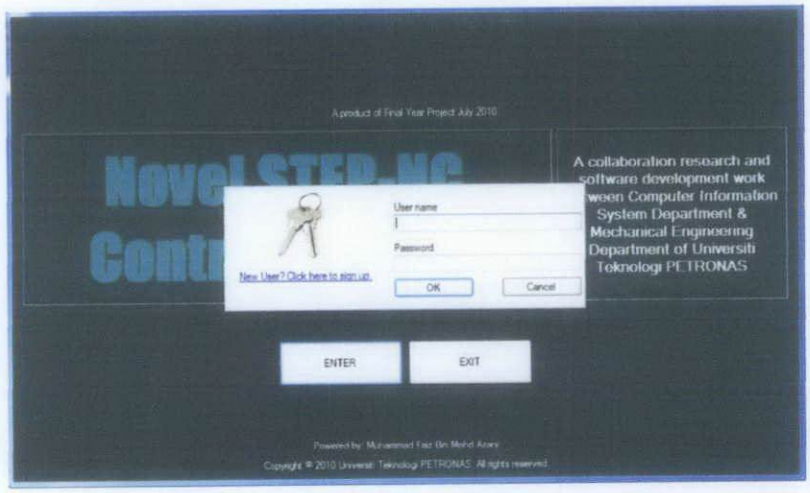


Figure 10 : Log In Interface (for registered user)

This interface consists of 'Log In' function for registered users. The users need to enter 'User Name' and 'Password' in respective text boxes.

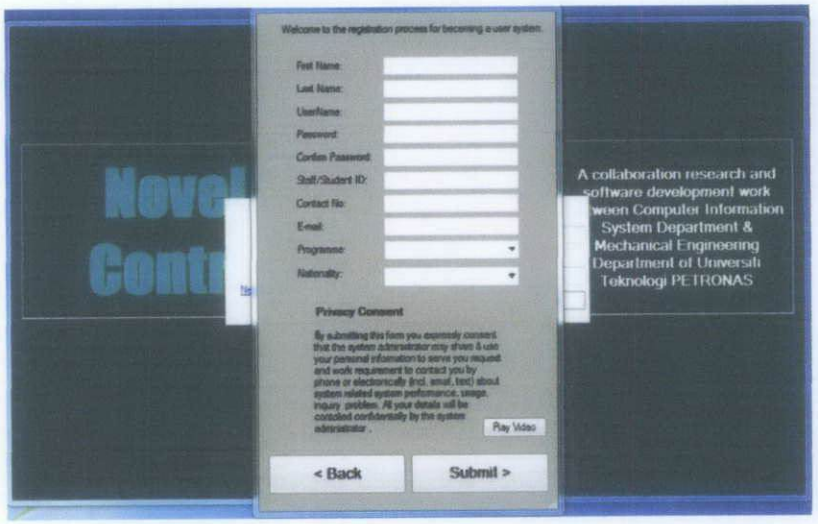


Figure 11 : Registration Interface for new user

This interface consists of 'Registration Form' for new user or first timer of the 'Novel STEP-NC Control System'. All first timer need to register here in order to grant access of this system. This function is created for security purpose. The user need to fill all the text boxes provided such as user's first name, user's last name, username, password, staff or student ID, contact no, email, program of study, and nationality. This information will be stored in database and only can be viewed by the system administrator for security purpose.

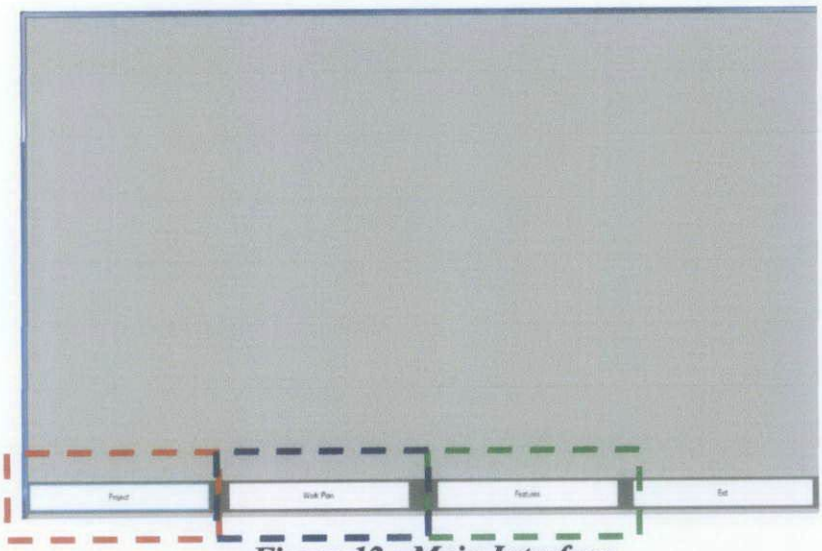


Figure 12 : Main Interface

This interface consists of three (3) main menus of the 'Novel STEP-NC Control System'. Each menu consists of different functions. The first one is 'Project' which is in red color. The second one is 'Work Plan' which is in blue color and the third one is 'Features' which is in green color. When each menu is clicked, the another interface will be displayed to allow the user to use the functions.

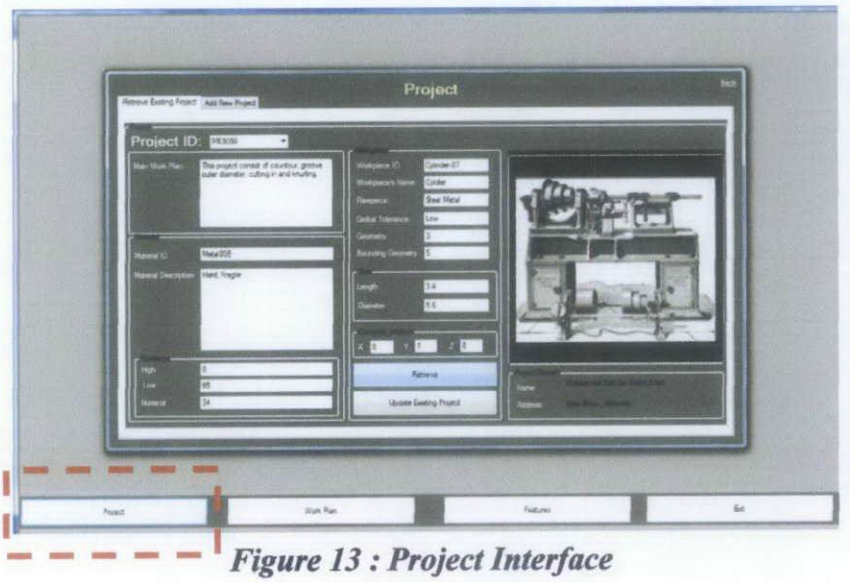


Figure 13 : Project Interface

This interface will be displayed when menu 'Project' is clicked. In this part, the user needs to define the scope of project such as the project ID, description of main work plan, workpiece, material, size, hardness, clamping position. The 'Project' interface also has two core functions which are to store data into database for each of new project and to retrieve data from database for each existing data. This is one of bi-directional data transfer that has been highlighted as the novelty of this system. By utilizing this system, the user can refer back the previous project has been done and also he/she can make alteration and modification about the project data.

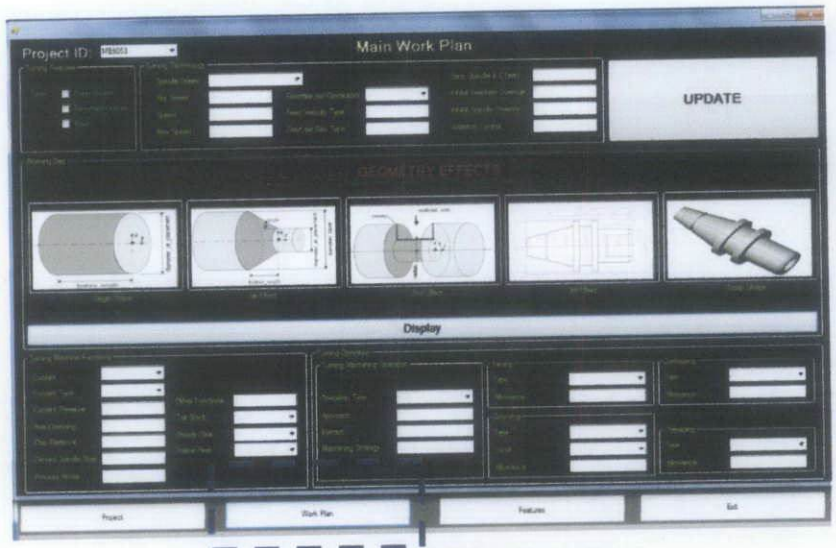


Figure 14 : Work Plan Interface

This interface consists of 'planning part' of the 'Novel STEP-NC Control System'. This part will be displayed and appeared when the user clicks on 'Main Plan' menu. This part will allow the user to set and visualize the shape of workpiece that will be cut by the Turn-Mill machine. The 'Main Plan' interface also has two core functions which are to store data into database for each of new project and to retrieve data from database for each existing data. This is one of bi-directional data transfer that has been highlighted as the novelty of this system. By utilizing this system, the user can refer back the previous project has been done by selecting 'Project ID' and also he/she can make alteration and modification about the project data.

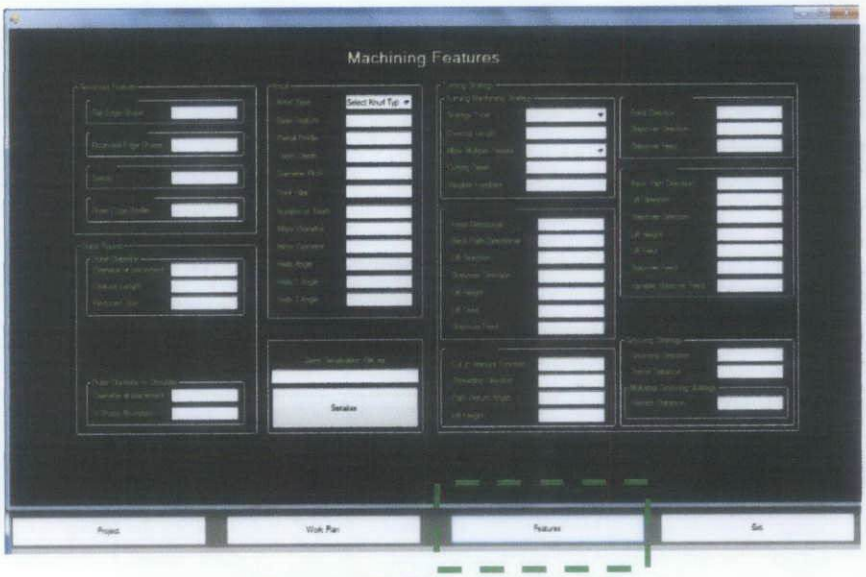


Figure 15 :Features Interface

This interface consists of functions that allow the user to set the Turn-Mill machine's features. This part will be displayed when the user clicks on 'Features' menu. The functions of this part is important for the 'Novel STEP-NC Control System' in order to allow the user to be précised and more detail about the workpiece that will be cut by the Turn-Mill machine. In other word, the functions in this interface will result in machine operation. This interface has crucial role as 'main engine' to run the operation of the machine. Every single of core actions that will be performed by the machine is all will come from here. This part has strong connection with the 'Main Plan' part.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As conclusion, the 'Novel STEP-NC Control System' is capable to control and managing Computer Numerical Control (CNC) of Standard Electronic of Exchange Product Data Numerical Control (STEP-NC). With the great success of the establishment of the novelty function of bi-directional data transfer between CNC Controller and the Turn-Mill machine and also the establishment of Extensible Markup Language (XML) and delimiter text file as 'neutral data' file. All in all, this project is successfully achieved all the expectations and objectives that have been set at the earlier stage of this project.

5.2 RECOMMENDATION

There are some recommendations upon this project that have been considered well by the author to be mentioned for future prospects for the sake of benefits for the project itself or for the projects that similar or almost similar to the 'Novel STEP-NC Control System'.

5.2.1 Suggested Future Work for Expansion and Continuation

- Use the most advance programming tool for developing due to the new features offered by the latest version.

  The author believes this kind of project might get many benefits and advantages if the next similar projects use the latest development application tools. The latest versions of development application tools usually will offer many advance features and selections of functions that might be utilized by the future developer to develop more great and powerful system.

- Encourage more inter-departmental research project.

  The author believe many sides will get benefits and advantages when more inter-departmental research project can be implemented in Universiti Teknologi PETRONAS (UTP) because has many great and precious talents and skills that reside in their students. When the students from different department work together, this will create a new environment and medium for the students to share and expand their knowledge especially between undergraduate and post graduate students. In addition, UTP has students from various backgrounds of study, expertise, race and county. This advantage must be utilized by the top management of education departments to allow their students to make collaboration in research project.

- Expose the developer to the real working industry.

  The author also believes that future developers need to be exposed more to real working industry. This is to ensure that developers might understand more about the root basic of the project and also to appreciate the project more.

REFERENCES

The format of references for the respective sources is as follows:

1. Details about Turn-Mill machine refer to tutorial video of Society of Manufacturing Engineering.
2. Article in report refer to official website of STEP-NC research homepage.
3. Content of Visual Basic.Net and XML refer to Tony Gaddis, Kip Irvine (2008)
4. Description of delimiter text file refer to

Society of Manufacturing Engineering, "The Fundamental Manufacturing Process" of Turning-Milling and Lathe Machining Centre Basic

STEP-NC <http://www.step-nc.org/>

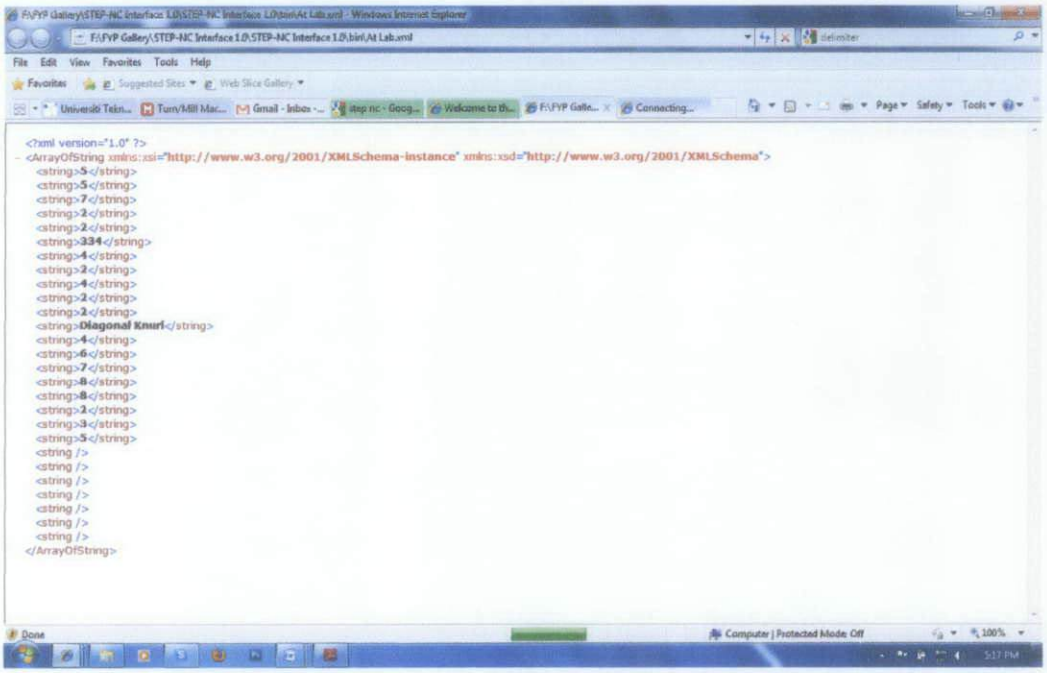
Tony Gaddis, Kip Irvine, 2010 "Starting Out With Visual Basic 2008", 4th Edition

Delimiter Text File <http://en.wikipedia.org/wiki/Delimiter-separated_values>

APPENDICES

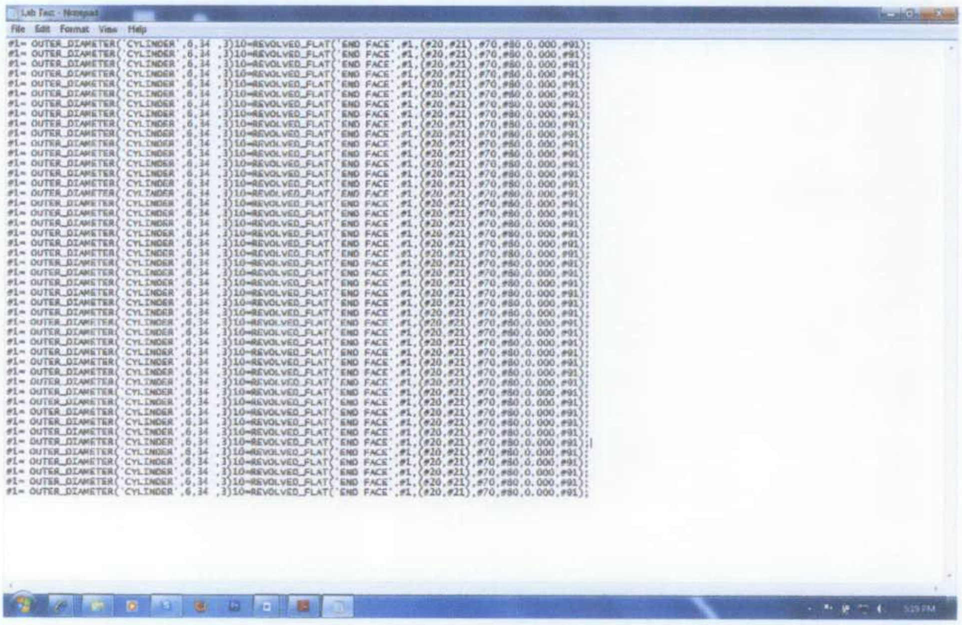
Appendix 1

Appendix 2



Sample of generated XML data file

Appendix 3

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Sample of generated delimiter text file