UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AN EXPERT SYSTEM FOR WELDING PROCESS VERIFICATION USING MS VISUAL BASIC

Thesis submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Manufacturing Design)

By

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as partial fulfilment of the requirements for the Bachelor of Manufacturing Engineering (Manufacturing Design). The members of the supervisory committee are as follow:

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En Shajahan B. Maidin

Main Supervisor

(Official Stamp & Date)

DECLARATION

I hereby, declared this thesis entitled "Development of an Expert System for Welding Process Verification using Ms Visual Basic" is the results of my own research except as cited in references.

Signature : …….

Author's Name : ……

Date : ……

ABSTRACT

Welding process selection consideration is normally made on several factors which involves an expert in this field to make the decision process. The development of an expert system will save time of knowledge transformation from an expert to a trainee and enhance the decision making process. This project describes the development of the Expert System shell for Welding Process Verification using Ms Visual Basic 6.0 as development tool and Ms Access 1997 as its database. There are three components that make the system work; user interface, search engine, and knowledge database. The user interface represents several options on joint type, material type and thickness as criteria selection for the user. The search engine will link to the database corresponding to the selection of the user. The output from the search is the suitable welding process and the weld quality level. The program runs successfully and solves the problem.

ABSTRAK

Langkah membuat keputusan dalam pemilihan proses kimpalan melibatkan beberapa faktor. Perkembangan perisian pakar dapat menjimat masam transformasi pengetahuan dari pakar ke pelatih dan memantapkan proses membuat keputusan. Projek ini menerangkan pembangunan perisian pakar untuk Pengesahan Proses Kimpalan denagan menggunakan Ms Visual Basic 6.0 sebagai alat pembangunan dan Ms Access 1997 sebagai pangkalan data. Terdapat tiga komponen yang membolehkan sistem ini berfungsi, iaitu lampiran pegguna, enjin pencarian, dan pangkalan data. Lampiran pengguna mempersembahkan beberapa pilihan tentang jenis sambungan, jenis logam dan ketebalan logam. Enjin pencaraian akan berhubung dengan pangkalan data untuk menyuaikan pilihan

DEDICATION

"To my beloved parents, Mr Krishnan a/l Marimuthu and Mrs Devi Rani a/p Kuruppan, whom give me love and support ……."

"To my family ……always believe in me……"

"To my friend who cares for me……"

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List of Abbreviations, Symbols and Specialized Nomenclature

AI	Artificial Intelligence
AWS	American Welding Society
ES	Expert System
FCRAW	Flux Core Resistant Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
GUI	Graphical User Interface
IDE	Ideal Development Environment
ISO	International Standard Organizations
LBM	Laser Beam Welding
MIG	Metal Inert Gas
MS	Microsoft
OFW	Oxyfuel Gas Welding
RSW	Resistant Spot Welding

RW	Resistant Welding
SMAW	Shielded Metal Arc Welding
TIG	Tungsten Inert Gas
UTeM	Universiti Teknikal Malaysia Melaka
VB	Visual Basic
VBA	Visual Basic Access

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CHAPTER 1
INTRODUCTION

1.1 Background of the Problem

Welding process is one of the three major categories of joining process, classified by American Welding Society (AWS) (Kalpakjian.S, 2001). At present, there are three major groups of welding processes. They are fusion, brazing, soldering, and solid state. Welding process selection depends on factors such as product design attributes, process attributes and material attributes. Experienced manufacturing engineer will often make correct decisions regarding processes based by experience. However, they may not be able to consider processes that are new or unfamiliar. Moreover, current information technology developments have resulted in specialization and standardization in almost all fields. Thus, there is a need of expert system to aid the welding process verification (Darwish S.M and etc, 1997). By extracting knowledge from human experts and transferring it to computable forms, the costs of knowledge reproduction and exploitation can be greatly reduced. At the same time, making previously private knowledge available for public test and evaluation can accelerate the process of knowledge refinement. In this project an expert system welding process verification was developed using MS Visual Basic. The program requires input on joint type to be welded, material type and material thickness. The program will verify the welding process and its quality of weld as the result of output.

1.2 Problem Statement

The growths of industries and technology have resulted in many types of welding process. The selection of welding process depends on many factors. The knowledge of selection is obtained from book and experts. Traditionally, the transmission of knowledge from human expert to trainee requires education and internship periods ranging from 3-20 years (Anon, 2005). Thus, there is a need for transforming the information fast and an expert system. The cost for developing an expert system is expensive. Moreover, the program available will be difficult to be updated by the non- programmer. As a result an expert system shell will be developed for updating welding process verification using Ms Visual Basic and Ms Access tools.

1.3 Objectives

(a) To identify and obtain welding process data & information
(b) To be familiar with the expert system concept.
(c) To be familiar with the concepts of database systems.
(d) To learn MS Visual Basic and Microsoft Access software.
(e) To develop a computerised welding process selection system by using MS Visual Basic and MS Access software tools.

1.4 Scope

In this project the process selection criteria are emphasized on joint type, welding position, quality level, material type and thickness to determine the best selection among competitive metal welding processes. Subsequently 8 types of welding processes have been given consideration. The program was developed using MS Visual Basic as user interface and MS Access as database.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter consists of Literature Review on welding. The types of welding are discuss with selected examples. The technique and tools will be used in this project is also introduced.

2.2 Welding Process Definition

A weld is defined as a localized coalescence of metals and non metals produced by either heating the material at required temperatures, with or without application of pressure or by application of pressure alone and with or without using filler materials by AWS (Jefus.L, 2004). While welding is defined as a joining process that produce coalescence of material by heating them to welding temperature, with or without the application of pressure alone and with or without using the filler metal (Jefus.L, 2004).

Welding process can be classified in many ways. The main classification of welding is Pressure Welding and Fusion Welding. According to ISO 857-1, Pressure welding in which sufficient outer force is applied to cause more or less plastic deformation of both the faying surfaces, generally without the addition of filler metal (Killing.R, 2001). Fusion welding is welding without application of outer force in which the faying surfaces have to be molten; usually but not necessarily, molten filler metal is added. The welding process can be also classified according to

welding technology; solid phase, thermo chemical, resistance welding, arc welding and radiant energy (Kalpakjian.S, 2001). Referring to the Master Chart of Welding of AWS, welding process is classified as Arc Welding (AW), Brazing (B), Solid State Welding (SSW), Soldering (S), Resistance Welding (RW) and Oxyfuel Gas Welding (OFW) (Jefus.L, 2004).

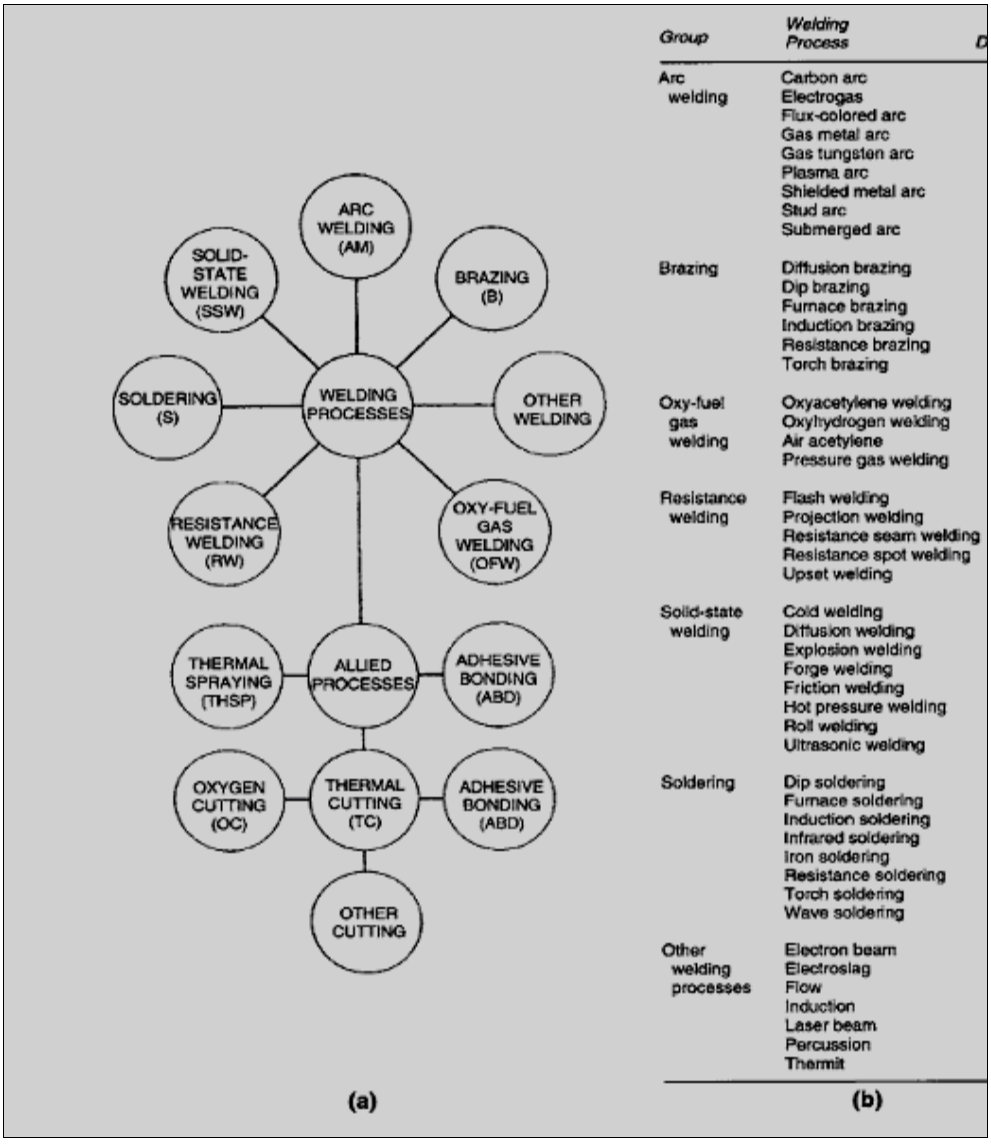

Figure 2.1: Master Chart of Welding and Allied Process (AWS).

Source: Jefus.F (2004)

2.2.1 Arc Welding

The term arc is like lighting and actually a form of emitted gas (Killing.R, 2001). In arc welding process, the source of heat is received from electrical energy. The arc is generated between the tip of electrode and the work piece (Kalpakjian.S, 2001). The types of welding categorized in this section are Shielded Metal Arc (SMAW), Gas Metal Arc (GMAW), Flux Cored Arc Welding (FCAW) and Gas Tungsten Arc Welding (GTAW)(Figure 2.1).

2.2.1.1 Shielded Metal Arc Welding (SMAW)

Shielded Metal Arc Welding is categorized as one of oldest, simplest and versatile joining process. The basic principle of this welding process, weld forms when molten metal from the tip of the consumable electrode flows together with the molten metal from the edges of the work piece. The coating of electrode provides shield to the weld area (Figure 2.2) (Kalpakjian.S, 2001). The advantage of this process is low cost. The weld is high quality if the suitable electrode is selected. However, the most important factor affecting the quality is the operator skill because the process is normally done manually (Houldcrof.P, 1990). The process is best suited for work piece thickness of 3mm-19mm (Kalpakjian.S, 2001). Field of applications suggested for this welding process are in structural steel work, shipbuilding, general engineering, process plant, pipe work repairs and maintenance (Houldcrof.P, 1990).

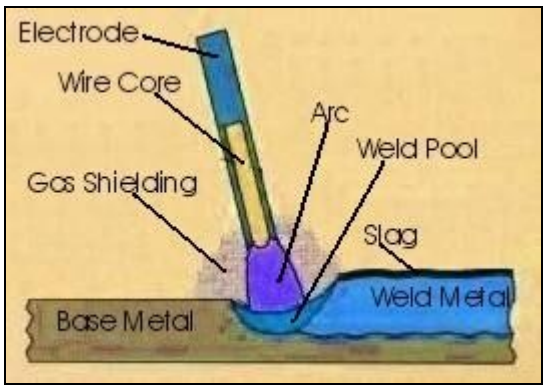

Figure 2.2: Shielded Metal Arc Welding Process.
Source: American Metallurgical Consultants (1999)

2.2.1.2 Gas Metal Arc Welding (GMAW)

This welding process uses a continuous solid electrode and a gas to shield the arc and molten pool (Figure 2.3). The process is flexible because the wire feed unit can be separated from the welding gun with a flexible conduit down which the wire is fed. The welding is carried out on thin material. The position of welding in GMAW is vertical and other positions. Since GMAW is a continuous process it is suitable for operations attached on welding robots. GMAW welding process is suitable for fillet welds. The welding material applicable is non-ferrous metal such as aluminum and copper base. This process is highly used in shipbuilding, structural, process plant, electrical, domestic equipment and automobile industries (Houldcrof.P, 1990). Figure 2.4 shows Gas Metal Arc welding. GMAW is also known as Metal Inert Gas Welding (MIG) (Kalpakjian.S, 2001).

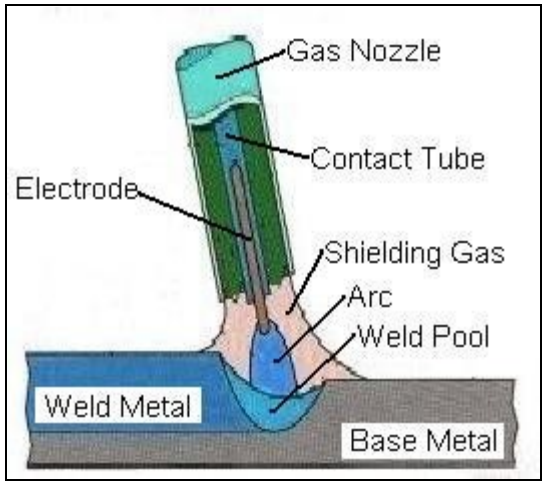

Figure 2.3 Gas Metal Arc Welding Process.

Source: American Metallurgical Consultants (1999)

Figure 2.4: GMAW Welding.

Source: American Metallurgical Consultants (1999)

2.2.1.3 Flux Cored Arc Welding (FCAW)

FCAW is an arc welding using a continuous hollow electrode filled with a flux which provides shielding gases, deoxieders, alloy additions and slag formers as shown in Figure 2.5. Some cored electrodes are designed to use with an additional gas shield, which is usually carbon dioxide or carbon dioxide rich gas mixture. An argon based gas shield is always used with metal-cored wires. This welding is normally non-automated. The advantage of flux wired is having high deposition rates and give deep penetration. Preference to choose the type of solid wires depends on economic considerations. The process is widely used in structural engineering, earth moving plant, shipyard and offshore fabrications. It is frequently used for welding stainless steels and widely employed for hard surfacing. The equipment can be operated by robot (Houldcroft.P, 1990).

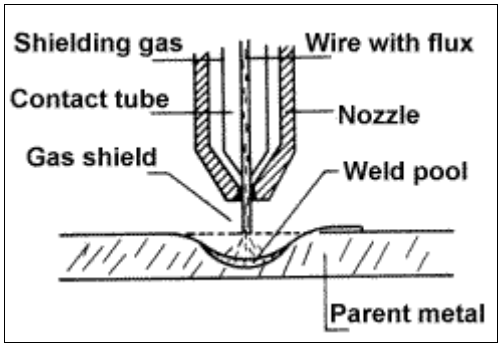

Figure 2.5 FCAW Welding Process.
Source: Johnson.C (2003).

2.2.1.4 Gas Tungsten Arc Welding (GTAW)

GTAW welding process is an arc process in which arc is struck by a non consumable electrode of tungsten to the work, the electrode, arc and molten pool being shielded by a stream of inert gas commonly argon. Filler metal is added separately when needed as shown in Figure 2.6. GTAW welding is a precision welding process. Furthermore this welding can also be done manually. Some joints

do not require filler metal. GTAW welds are high quality, therefore certain metals and alloys cannot be used. GTAW results in good penetration and deposition rate. However both penetration and deposition rate is much less than MIG. GTAW is commonly used in automobile, aerospace power generation, process plant and electrical and domestic equipment manufacture (Houldcroft .P, 1990).

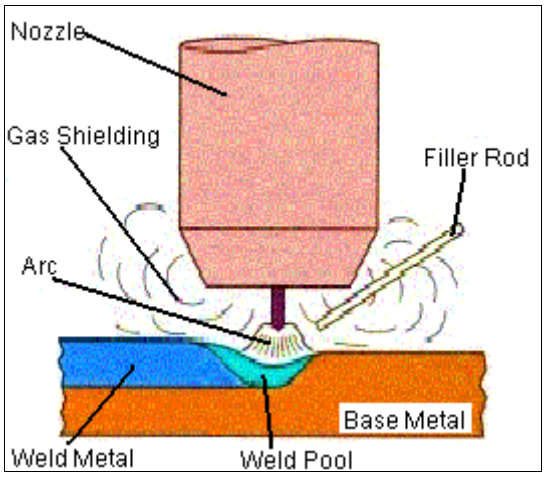

Figure 2.6: GTAW Welding Process.
Source: American Metallurgical Consultants (1999)

2.2.2 Brazing

Brazing is a joining process different from normal arc welding. In brazing a metal or alloy having a melting point lower the parent metal is made to flow by capillary attraction into the space between the parts to be joined under the action of heat. The joint is design to allow capillary attraction by having a gap sufficient for the flow of appropriate flux and brazing alloy (Houldcroft.P, 1990). Brazing can be as described above or braze welding whereby the principle is similar to oxyfuel gas welding using filler metal as shown in Figure 2.7 (Kalpakjian.S, 2001). Brazing is one of the most versatile methods of joining metals in use today. Brazed joints are strong and ductile and the process is highly adaptable and economical. In addition,

braze materials perform well in abrasive, corrosive and high temperature conditions. Brazing has become popular and effective in a variety of industrial uses as well as gas turbine applications (Sermatech International, 2008). An example of application is also in joining carbide to tool bit as shown in Figure 2.8.

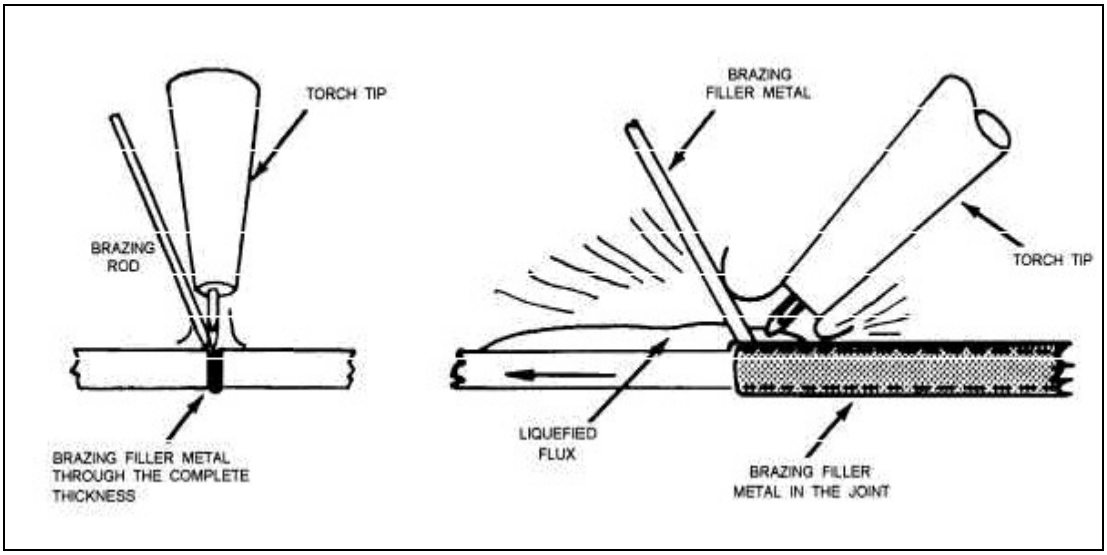

Figure 2.7: Brazing a Butt Joint.
Source: Integrated Publishing (2003)