



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JET FIGHTER (TYPHOON) LASER CUTTING PROJECT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Process) (Hons.). The member of the supervisory committee is as follow:

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ABSTRAK

Project ini menceritakan tentang teknik dalam pembuatan teka-teki dengan menggunakan pemotongan laser. Tujuan menjalankan projek ini adalah untuk memberi pendedahan dalam penggunaan mesin laser dan pendedahan dalam pembuatan teka-teki. Selain itu, projek ini juga bertujuan untuk menentukan tahap pemotongan yang baik. Ujian kekasaran permukaan dijalankan bagi mengenalpasti kelajuan potongan yang sesuai. Bagi kajian ini, jet pejuang (Typhoon) telah dijadikan sebagai model untuk penghasilan teka-teki. Dalam penghasilan teka-teki, ketepatan pemotongan dan reka bentuk yang tepat penting bagi memastikan teka-teki ini dapat berfungsi dan di pasang dengan betul. Pemotong laser digunakan bagi memotong kepingan-kepingan teka-teki. Jenis bahan yang digunakan adalah *galvanize iron* (G.I) yang berketebalan 2mm. Akhir sekali, kepingan-kepingan tersebut akan dipasang membentuk jet pejuang (Typhoon) dan kekemasan kepada produk.

ABSTRACT

This project tells us about the techniques in the manufacture of the puzzle by using laser cutting. Purpose of this project is to expose the use of laser machines and disclosures in the manufacture of the puzzle. In addition, this project also aims to determine the level of good cuts. Surface roughness tests carried out to identify appropriate cutting speeds. For this study, the jet fighter (Typhoon) was used as a model for the production of the puzzle. In the production of the puzzle, precision cutting and an important proper design to ensure that this puzzle can be functional and properly assemble. Type of material used is galvanize iron (G.I) the thickness 2mm. Finally, the laser cutting is used to cut pieces of the puzzle. The pieces will be assembled to form a jet fighter (Typhoon) and finishing the product.

DEDICATION

Dedicated with deepest love to:

My beloved family for their support, guidance and love.

My dearest friends for being there whenever I needed them.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

AutoCAD	- Automatic Computer Aided Drafting/Design
CAD	- Computer Aided Design
CO ₂	- Carbon Dioxide
DXF	- Drawing Exchange Format
FYP	- Final Year Project
G.I	- Galvanize Iron
HAZ	- Heat Affected Zone
LASER	- Light Amplification Stimulation Emission of Radiation
MASER	- Microwave Amplification by Stimulated Emission of Radiation
min	- minute
mm	- millimeter
NC	- Numerical Control
Nd:YAG	- Neodymium: Yttrium-Aluminum-Garnet
PSM	- Projek Sarjana Muda
UTeM	- Universiti Teknikal Malaysia Melaka
2-D	- Two Dimension
3-D	- Three Dimension

CHAPTER 1

INTRODUCTION

This chapter views on the project. The introduction, the jigsaw puzzle and laser cutting machine. In this chapter describes the problem statement, objectives and scope of this project.

1.1 Background

This project revolves around the making of the puzzle. This project is to commercialize the puzzle. This project is a laser cutting project, laser cutting machine is been used. In randomly, this project will begin by designing pieces of the puzzle. Then process to select the best cutting speed to get the good surface of product. Next follow it with the process of cutting the pieces. The finally is the assembling process undertaken to get the product in which the model jet fighter (Typhoon) and then finishing with painting. There are two element that want to be introduced before go through more detail about this project. The two elements are about jigsaw puzzle and laser cutting.

1.1.1 Jigsaw Puzzle

Jigsaw puzzle made up of small pieces that were designed and sewn together to produce an image or structure. A jigsaw puzzle made up from pieces which interlocked between two pieces with an open slot. To develop three-dimensional

object, a polarity of such two-piece parts can be inter-fitted together. The puzzles become more challenging when the number of pieces needed to complete a puzzle increases and unusual shape of puzzle. Puzzle not only for children, but the puzzles are very popular among young adults.

Nowadays, the puzzle is easily available in stores. There are various types of puzzle that was released today. Jigsaw puzzle game is one of the famous puzzles. Jigsaw puzzle requires the installation of many small pieces and each part has a small part of the picture. The pieces were installed and finally produce a complete picture. Crossword puzzle grid words which takes the form of square or rectangular black and white squares. The goal is to fill the white boxes with letters, forming words by resolving several types of questions or instructions leading to the answer. Plain black is used to separate words or phrases. Another type of puzzle is logic puzzle, combination puzzle, construction puzzle and others.

1.1.2 Laser Cutting

The term of “laser” stand for Light Amplification Stimulation Emission of Radiation. The laser beam invented by the introduction of the gas and electricity in a closed chamber. In the chamber, the electricity broke the gas energy is released causing it resonates between the mirrors in the chamber. Optimal energy is released through a transmissive mirror while it is resonates the intensity increased energy. The beam is then directed to a focusing lens and is further intensified. At this point the laser beam becomes a usable cutting device.

There are two common types of lasers in industrial laser which CO₂ and Nd:YAG. CO₂ use a gaseous medium for the lasing action while the Nd:YAG use a crystalline material. There are several advantages of using laser cutting. The narrowness and accuracy of the cut together with relatively shallow heat affected zones (HAZ) with negligible surface cracking are major advantages of this process. It's also ability to cut incredible complex shapes. This advantage makes it can produce a huge variety of different products.

1.2 Problem Statement

Puzzle is one of the famous games, not only among children but adults are also interested. This research will focus on a study the technique in manufacture puzzle. For this final year project, the Jet Fighter (Typhoon) serves as a model to produce a puzzle. Expose student in the usage of laser cutting and manufacturing process especially in assemble product. This project is to construct the assembly of the model jet fighter by using laser cutting machine. Choose the suitable cutting speed to get the good surface roughness and used it to cut the product. Generate NC code according to CNC laser cutting machine that available in the manufacturing lab.

1.3 Objectives

There are objectives that must be achieved in this project:

- (a) To study the techniques of manufacturing a puzzle and design considerations.
- (b) To analysis the effect of cutting speeds for surface roughness.
- (c) To familiarize and apply laser cutting machine processes and operations.

1.4 Scope

This project focuses on the cutting process for making puzzle by using laser cutting machine which located at machine shop Universiti Teknikal Malaysia Melaka (UTeM) as shown in Figure 1.1 below. With the best choice of cutting speed, which is choosen by do the analysis in the different cutting speed into five samples. This study also focuses on design and assembles for the product.



Figure 1.1: Laser cutting machine (LVD).

Laser cutting is used as a machine to cut the puzzle. In this project, galvanise iron (G.I) with 2mm thickness is used as a cutting material. Jet fighter (Typhoon) puzzle is design and drawn by using CAD software and programming codes is created for the fabrication purpose. Make the model of jet fighter (Typhoon) by assemble all the part that already cut.

1.5 Structure of Dissertation

This dissertation is structure into five chapters. This report not only for FYP/PSM 1, but also include FYP/PSM 2. For the first chapter is about introduction. In this chapter describe about the background, problem statement, objective and scope of the project. Second chapter explanations about the literature review. In this chapter contain history of puzzle, type of puzzle, laser cutting and type of laser cutting. For the third chapter show the methodology of this project, where the planning of task that will be followed to finish this project. The results and discussions of the project show in the chapter four. Chapter five explains the conclusion achieved in this project and also the some suggestion to future work.

CHAPTER 2

LITERATURE REVIEW

In this chapter explains on literature review of making puzzle and laser cutting machine. This chapter describes the history and some types of puzzles that have been produced. The puzzle can be classified in many forms, such as for learning, for the game to enhance children's creativity, a fun game, and can also be an interesting art. The other hand, this chapter also contains information about the laser cutting process, where there are three distinct types such as fusion cutting, sublimation cutting and oxygen-assisted cutting. This chapter also include the laser cutting consideration and some information about aerospace finishing.

2.1 Jigsaw Puzzle

Williams (1990) stated, the origin of the puzzle started in the 1760s when European map pasted on the wood and cut into small pieces. Since then, a map of the puzzle became popular educational games among the children in learning geography. Around 1900's, the puzzle among adults began to be introduced and in 1908's the puzzle game become more popular until there are people who get addicted to playing the puzzle.

A few years later emerged two distinct innovations in industry puzzle. First, Parker Brothers is a famous game manufacturer has introduced a figure pieces in "pastime" puzzle on their brand. This type of puzzle is easy to assembly. To attract fans of puzzle, its pieces shaped like animals and other objects. The purpose is to close its disadvantage that is easy to assembly. Second, the creation of the puzzle is to reduce

the risk of losing pieces of the puzzle. In 1909, Parker Brothers had halted production of toys and focus entirely on the production of the puzzle; it is because of the widespread response in this game (Williams, 1990).

With the onset of Great Depression in 1929, the puzzles are gaining favor among young adults and culminating in 1933 with the achievement of 10 million per week. Puzzles used as a way to escape from the problems faced at the time. Due to lack of income, the puzzle is not only a home entertainment but it has become entertainment in the shops, In fact the puzzles become easier owned (Williams, 1990).

In addition, there is another development in the creation of the puzzle where the puzzle introduction of die-cut cardboard for adults. With the low cost of production, enable to lower their marketing price. In mid-1932, there was a way to become a trend for the state advertising puzzle, which offers the puzzle with every purchase of certain products such as toothpaste and a flashlight. In the autumn of 1932, has introduced a weekly jigsaw puzzle. The jigsaw puzzle pieces in the show every week in the newspaper the day Wednesday. People rushed to get the puzzle pieces to solve the weekly puzzle (Williams, 1990).

Puzzle par or better known as the 'Rolls Royce jigsaw puzzle' right introduced as a result of recession. Two people unemployed that Frank Ware and John Henriques have cut their puzzle first in the table space in 1932. Ware and Henriques has created a puzzle that has the advantage of the weakening influence of the old puzzle with pieces of the corners and edges (Williams, 1990).

After World War II, the deteriorating wooden jigsaw puzzle. Cutting for wood puzzle took a long time, it cause the prices increasing and lead to a decline in sales this puzzle. In 1958, Parker Brother has stopped production of the puzzle. Next, in 1974 both Frank Ware Par and Straus also halt production of the puzzle.

Steve Richardson and Dave Tibbetts saw puzzle as an opportunity to fill the vacancy. They were establishing Steve puzzle, which it has succeeded well received as previous puzzles. Steve puzzles is better than before as the puzzle accredited in

design and pattern cutting. Steve is experimenting in creating three-dimensional puzzle that can stand on its own. Steve's success in the creation of the jigsaw puzzle has been to convince people, and led to the resurrection of hand-cut and custom puzzles widely. Near past has led to many design innovations have also been turned into a puzzle. Nowadays there are wooden puzzles cut by using computer-controlled water jets or lasers. Puzzles can be found today in various forms according to the requirements of the individual (Williams, 1990).

2.1.1 Type of Puzzle

Jigsaw puzzles consist of an assembly of small tiles which are designed to be fitted together in order to create an image or structure. There are many types of puzzles today. Puzzle is also available in various shapes, appearance and size. There are several types of materials used in manufacture of puzzle such as wood, cardboard and other.

A series of novel sculpture-puzzles is illustrated, with mathematical explanation as a Figure 2.1, the piece of puzzle based on pentagon. Each part consists of similar form which will snap together form symmetry (refer to Figure 2.2). These parts are flat to facilitate the trade of cutting or sheet materials such as wood, cardboard, metal or plastic. The fabrication technology is controlled by a computer is needed to ensure the accuracy of cuts so that each part can be mated properly. Among the tools that are used for tasks such as laser cutting is cut, by solid freeform fabrication techniques, or by a pair of scissors and paper. Their intricate geometric forms make for challenging assembly puzzles and attractive artworks (Hart, 2006).

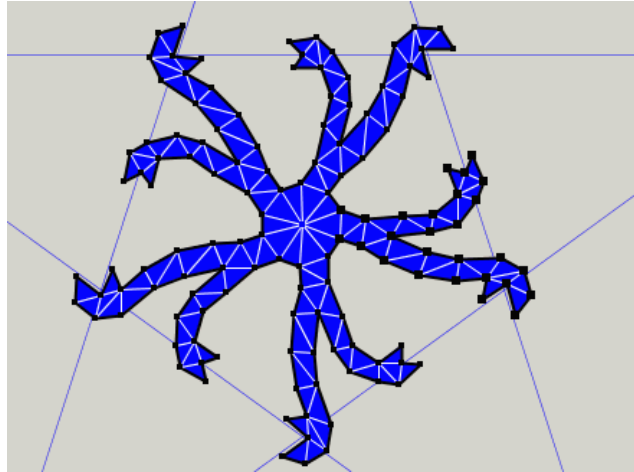


Figure 2.1: Flat piece layout, based on pentagon (Hart, 2006).

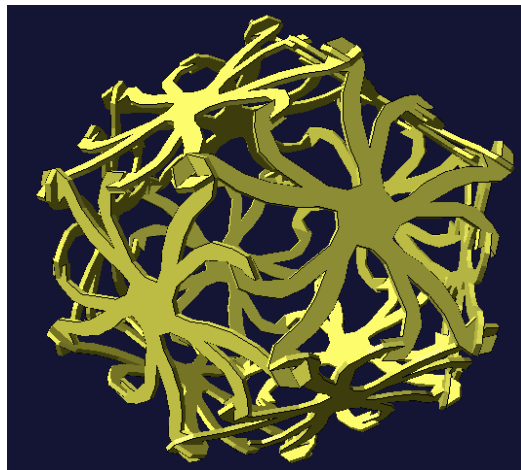


Figure 2.2: Assemblage of twelve pieces (Hart, 2006).

Puzzle is also applied in the form of greeting cards, greeting cards which contained sculpture combined with 3-D model kit as shown in Figure 2.3. This invention must be at least one or more inscribed parallel plane rectangular sheets which are bound in dependant form to enable an open and close greeting card function. Figure 2.4 shows the technique to assemble this greeting card puzzle. This card will apply by recipient to deploy invention's construction system by implementing tools and parts embodied in novelty card. All construction elements, tools and parts derive only from the planar sheet that comprises the invention. The result of assemble the puzzle shown in Figure 2.5 (Bettin, 2010).

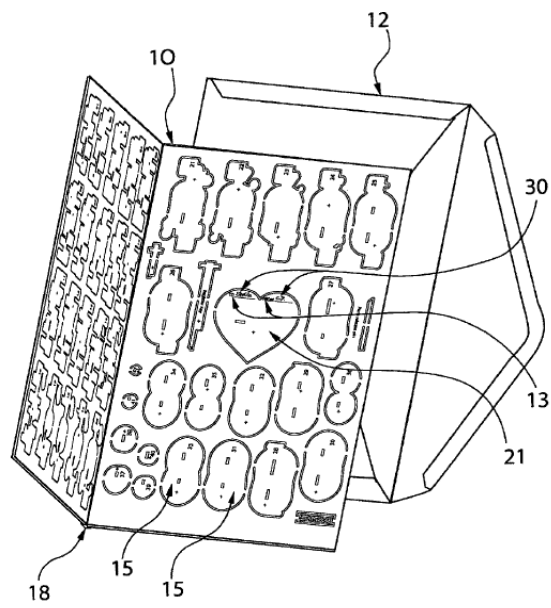


Figure 2.3: Complete trimetric view of the elements of the presented invention (Bettin, 2010).