DUCTING DESIGN STUDIES USING MULTIMEDIA PLATFORM FOR EDUCATIONAL PURPOSE

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in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "Ducting Design Studies Using Multimedia Platform For Educational Purpose" is the result of my own work except as cited in the references

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Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal - Fluids).

Signature :. .....

Name of Supervisor : Prof. Dr. Md Razali bin Ayob

Date : .....

DEDICATION

I dedicated this Final Year Project to my lovely parent, Mr. Mohd Sobri bin Samsudin, Mdm Saidah binti Ramli and my family because they always keep supporting me and giving me courage in completing this project. Thankful and appreciation I give to Prof. Dr Md. Razali Ayob as my supervisor that always guide me in completing this project. Much appreciation I give to my friends that helps me and guide me in completing this project.

ABSTRACT

Heating, Ventilating and Air Conditioning (HVAC) system is a system that consist of component to treat the air and use it duct network to transmit the treated air to specific location. The duct network of the HVAC system need to be design appropriately in order to reduce loss in the duct, so the treated air can be delivered according to the demand of the place. In order to design a good duct network, ducting design study are crucial to be learn as the behavior of the duct network are explained. For engineering student, the ducting design knowledge are covered in the subject of Air Conditioning System or HVAC course. A ducting design studies involve calculations and theory related to the duct variable, which makes the learning of ducting design topic are complex. For some student, ducting design studies is considered as a challenging subject as it is involving theory, calculation and some consideration. Thus, the project is implemented to propose a multimedia platform in the field of ducting design studies and to create the internet-based learning platform for ducting design studies in order to overcome the problem of learning such as boredom and one-way interaction of learning. By implementing multimedia element in the source of study, the project is proposing an interactive learning by having a multimedia implementation into the learning of engineering topic such as ducting design studies.

ABSTRAK

Sistem Pemanas, Ganti Udara dan Penyaman udara (HVAC) adalah satu sistem yang terdiri daripada komponen untuk merawat udara dan menggunakan rangkaian saluran untuk menghantar udara yang dirawat ke lokasi tertentu. Rangkaian sistem saluran HVAC perlu direka bentuk sewajarnya untuk mengurangkan kerugian udara di dalam salur, supaya udara yang dirawat boleh dihantar secukupnya mengikut permintaan sesuatu tempat. Dalam usaha untuk mereka bentuk rangkaian saluran yang baik, pembelajaran mengenai reka bentuk saluran adalah penting untuk dipelajari supaya seseorang dapat memahami sifat rangkaian saluran HVAC. Bagi pelajar kejuruteraan, pembelajaran mengenai reka bentuk saluran dibincangkan dalam subjek Sistem Penyaman Udara atau kursus HVAC. Pembelajaran mengenai reka bentuk saluran melibatkan pengiraan dan teori yang berkaitan dengan pembolehubah salur, yang menjadikannya sebagai satu subjek yang kompleks. Bagi sesetengah pelajar, pembelajaran mengenai reka bentuk saluran dianggap sebagai mata pelajaran yang mencabar kerana ia adalah melibatkan teori, pengiraan dan beberapa pertimbangan. Oleh itu, projek ini dilaksanakan untuk mencadangkan satu platform multimedia dalam mempelajari reka bentuk saluran HVAC dan mewujudkan platform pembelajaran berasaskan internet untuk mengatasi masalah pembelajaran seperti kebosanan dan interaksi satu arah didalam pembelajaran. Dengan melaksanakan elemen multimedia dalam sumber pembelajaran, projek ini mencadangkan pembelajaran interaktif dengan menyuntik elemen multimedia ke dalam pembelajaran berkaitan topik kejuruteraan seperti pembelajaran mengenai reka bentuk saluran HVAC.

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LIST OF ABBREVIATION

CAI	Computer Aided instruction
CBT	Computer-Based Training
HTML	Hypertext Mark-up Language
HVAC	Heating, Ventilating and Air Conditioning
ILM	Interactive Learning Module
MOOC	Massive Open Online Course
URL	Uniform Resource Locator
VAV	Variable Air Volume

LIST OF SYMBOL

Δp_t	Total pressure
$p_{t,1}$	Total pressure at station 1
$p_{t,2}$	Total pressure at station 2
p_s	Static pressure
p_v	Velocity pressure
ρ	Density of air
V	Velocity of the air in the duct
D_e	Equivalent round diameter
A	Cross sectional area of the duct
p	Perimeter of the duct
C	Coefficient of loss
f	Friction coefficient
L	Length of the duct
D	Diameter of the duct

CHAPTER 1

INTRODUCTION

1.1 Background

Heating, Ventilating and Air Conditioning (HVAC) is a term used to describe the control of treated air and delivered to the intended space or system. The basic components of HVAC are compressor, condenser, expansion valve and evaporator. The air conditioning process is the total control of temperature, the air humidity, supplying outside air for ventilation and control the air movement in the occupied space. In HVAC system, there are five basic processes required to condition the air which are heating process, cooling process, humidifying process, dehumidifying process and cleaning process (R. McDowall, 2006).

HVAC ducting system play a main role in transmitting the conditioned air to the specific space. According to C. Aydin and B. Ozerdem (2005), HVAC system is the branching network of round and rectangular tube of sheet metal, fiberglass board or a flexible plastic and wire composite that include a large number of components such as dampers, turning vanes, variable-air-volume (VAV) control units, cooling or heating coils, supply and return registers and the sensors for temperature, humidity, smoke, carbon dioxide concentration, pressure and flow rate.

There are many types of ducting system available nowadays and the design of the ducting system are influencing the utility bills of the building. By studying ducting design

methodology, building clients able to choose most suitable design for their ducting network of the HVAC system. A bad design and installation of ductwork may result in the poor air flow and consuming higher electricity. Therefore, a ducting design consideration is an important element to be highlighted when any ducting network to be installed in HVAC system of a building.

The main idea of a ducting design study is to consider duct right size and suitable duct network for installation. The learning of ducting design involved calculations and theory that make the subject matter becoming a little bit more complicated. Thus many students found that ducting design studies is a challenging subject as it is involving theories, calculations and some design judgement. A multimedia approach is considered as a good platform to represent the ducting design studies as it involves a combination of media to represent the course content, which offer variety of techniques so much so making learning of ducting design more enjoyable.

1.2 Problem Statement

The ducting design studies are crucial as to achieve an efficient and effective environmental control system. When ducting design configurations looked in details, one realized that there are a lot of consideration to be accounted for in producing a good ducting design. For mechanical engineering student, the ducting design knowledge is taught in Heating, Ventilating and Air Conditioning (HVAC) course.

The conventional way to learn and deliver ducting design or any other engineering courses is to use a classroom method and theories are enhanced in an engineering laboratory. The classroom method is using unilateral communication where only one person is conducting the class, namely the educator. According to M.Z.M. Zin, A.A. Sakat, N.A.

Ahmad and A. Bhari (2013), unilateral communication by educators would eventually led students to act as a passive recipient, hence, would raise boredom. This would effect and limit the student's ability to understand the subject, thus student may not capable to apply their knowledge practically later.

In order to present a more enjoyable and creating interest amongst students especially in ducting design studies which full of facts and making judgement, a modern approach which is effective must be found. The best practice in today's education system is to maximize the multimedia applications. The multimedia platform for educational purpose is believe can enhance the student understanding by serving the student with a variety of media applications in order to keep the learning activities meaningful and help the student to enhance understanding during revision session.

1.3 Objective

This project has two objectives. The first is to propose a multimedia platform for engineering educational purpose in the field of ducting design studies. The second objective is to apply an internet-based learning platform for the ducting design studies of HVAC.

1.4 Scope of Project

This project will only focus on the ducting design of HVAC course. Next, the multimedia platform use in this project is OPENLEARNING^{TM}. This platform also used internet as an enabler. The OPENLEARNING^{TM} is the webpage that support Massive Open Online Course (MOOC). The content covered in this ducting design studies dwelled on the design methods which are part of the standard syllabus of HVAC course.

CHAPTER 2

LITERATURE REVIEW

2.1 Ducting Design Fundamental

Ducting design is a part of HVAC system study. Ducting design refers to the design of ductwork (duct network) of HVAC system that enable to transfer the treated air to the desired location of a building. The building and home require a fresh distributed air to pursue a higher indoor air quality at different zone in the building by using a duct system (H. Chen et al, 2016). Cigdem Aydin, Baris Ozerdem (2004) stated that HVAC duct system is a branch network that consist of round or rectangular trunk made from sheet metal, fiberglass board, flexible plastic and also another air conditioning component such as cooling coil and dampers.

Patrick (2010) stated that ductwork is a system that transfer the air from one point to another from the fan efficiently so that the cost of operating the ductwork, noise, heat gain and losses can be minimalized. Another important key in a ducting design is the ability of ductwork to withstand internal pressure and contains of air to distribute to the proper location (PJ Brooks, 2010). The size of ductwork, design construction and installation are also important in the ducting design. Poor design and construction of ductwork may result in discomfort of occupant and increase the electricity power demand due to reduction of overall efficiency of the heating and cooling equipment in building (C. Aydin, 2004). The most basic arrangement for the duct system must have a constant speed of fan and having a constant

volume when the air is flowing in the duct, and serving the separated zone within the ventilated volume (R. Whalley et al, 2010).

2.2 Pressure in the Duct

The root of ducting design is based on fluid dynamic where Bernoulli Equation is the main governing formulae. When the focus of basic of duct design is considered, change in elevation of the system is unimportant. It is also assumed that there is no heat transfer in the system; whether adiabatic or isothermal and air density is assumed as the standard density (Patrick, 2010). When these assumptions are highlighted, the simplified Bernoulli equation for fluid resistance in the ducting design between two stations are

$$\Delta p_t = p_{t,1} - p_{t,2} \tag{1}$$

where p_t is the total pressure,

$p_{t,1}$ is the total pressure at station 1 and

$p_{t,2}$ is the total pressure at station 2.

For the total pressure at each station, it depends on static pressure and velocity pressure at that station. The formula for total pressure in a station is given by

$$p_t = p_s + p_v \tag{2}$$

where p_t is the total pressure,

p_s is the static pressure and

p_v is the velocity pressure.

The static pressure is the pressure that exert in all directions equally in the specific station and the velocity pressure are the pressure that represent the kinetic energy. Velocity pressure is a vector quantity and is calculated using the following formula

$$p_v = \rho\left(\frac{V^2}{2}\right) \tag{3}$$

where ρ is the density of air and V is the velocity of air in the duct.

2.3 Pressure Losses in the Duct

In ductwork, there are two types of losses occurred, which are friction loss and dynamic loss. The friction loss happens in the ductwork because of the viscosity of the fluid and the exchange of momentum between molecules in the ductwork in laminar flow and different velocity in turbulent flow. The equation of friction loss can be determined using Darcy and Colebrook equation. Other method of acquiring friction loss is to use friction chart which is much simpler than the former. See Figure 2.1. In this particular work, it is suggested to use the friction chart rather than the equation of Darcy and Colebrook. However, the friction chart is only applicable for round duct shape. More similar charts should be found if the duct cross-sectional shape is not round. Hence, before the friction loss of the ductwork can be determined, it is crucial to identify the duct shape. If the duct shape is not round, convert the duct configuration to the round duct by using the formula of equivalent round (Patrick 2010).

$$D_e = \frac{1.55A^{0.625}}{p^{0.250}} \tag{4}$$

where D_e is the equivalent round diameter for equal air flow, length and fluid resistance, inch (mm); A is the cross sectional area of the duct, inch^2 (mm^2) and p is the perimeter of the duct, inch (mm).

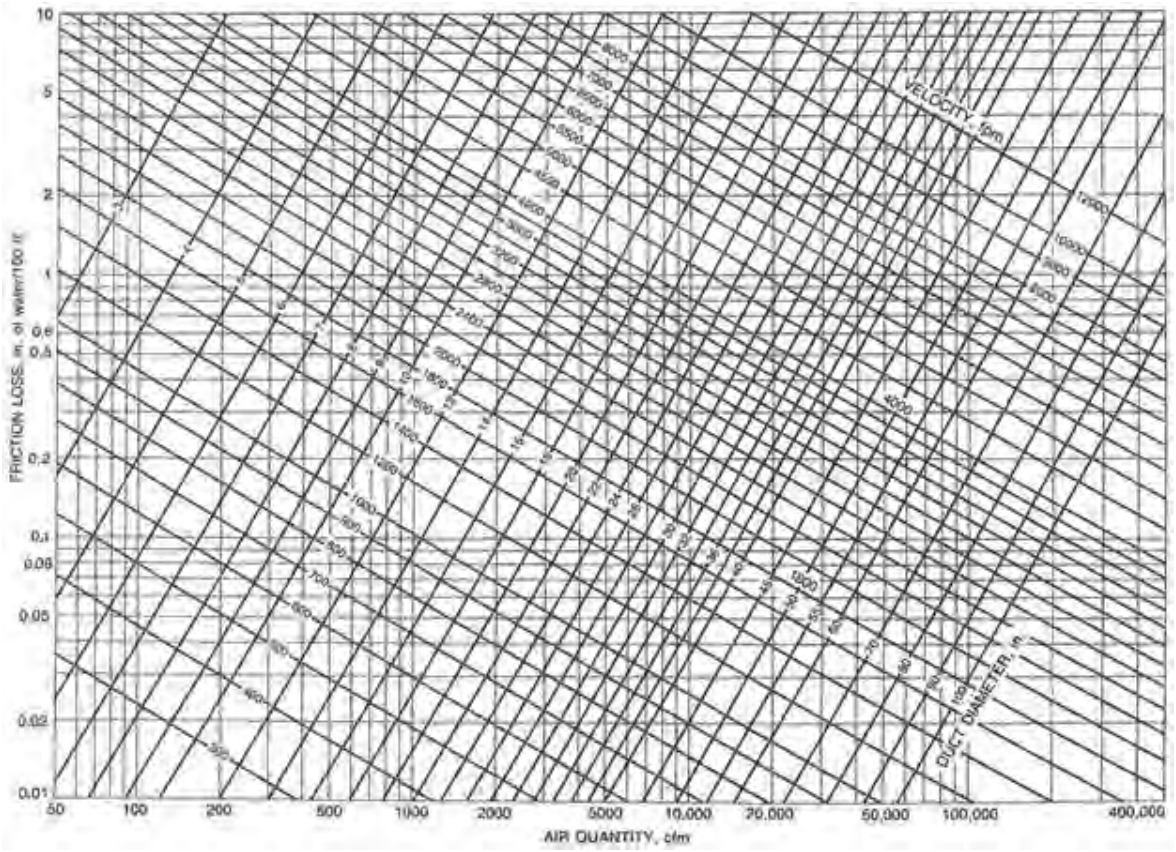

Figure 2.1: Friction chart. (courtesy of www.ashrae.org)

Another loss in the ductwork is the dynamic loss. The dynamic loss can occur from duct fitting that change air flow path direction and also due to flow disturbance. The examples of fitting that caused the dynamic loss are entries, exits, elbows and junctions. To determine the dynamic loss, the formula can be derived from the formula of coefficient of loss, *C*. The coefficient of loss can be determined by using experimental method where the ductwork is measured between two stations which housed the fitting. The equation of coefficient of loss can be presented by