UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF LINE WIDTH AND TYPE CONTROL OF 2D CAD SOFTWARE BASED ON ISO TECHNICAL DRAWING STANDARD

PITOON NOPNAKORN

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By

PITOON NOPNAKORN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

To My Parents

One who ever shared a moment of his love and
one who has strived patiently for their beloved children

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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October 2003

Chairman: Associate Professor Napsiah Ismail, Ph.D.

Faculty: Engineering

Engineering drawing is the media of communication in manufacturing process. In order to communicate in the same graphic language in engineering, the technical drawing standard has been specified by the International Organization for Standardization (ISO).

Some commercial CAD softwares such as AutoCAD, AutoSketch and Solid Edge provided high-end ability to work whether in 3D or 2D space. Their width, length and proportion of printed lines conform to the ISO Technical Drawing Standard. But the procedures and interface to create line width and line type for simple drawing are sometime tedious and complex. The aim of this research work is to develop a 2D CAD software with emphasize on line width and line type control based on the ISO technical drawing standard for technical drawing.

The ISO 128 part 20, 21, and 24 are fundamental standard applied to the proposed software. The design of User Interface (UI) has been done in Windows XP operating system environment and Pascal-based Delphi 5 Standard as the visual programming tools. The format of drawing file was designed as the independent format, textual file, on the basis of Computer Graphics Metafile format (CGM) and Data Exchange File format (DXF). Seven drawing were printed in various line widths from 0.25 mm to 2.0 mm. Every drawing was proved the line width, length of line elements and continuous line are the same dimension as a manuscript drawing and specification in the ISO standard. The human-computer interfaces of the developed software were simplified for line width and line type control. The time taken to produce a technical drawing is less as compare to commercial softwares such as AutoCAD, AutoSketch and Solid Edge. Keystroke-level model was applied for this purpose.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN PENGAWALAN LEBAR DAN JENIS GARISAN PADA PERISIAN 2D CAD GERDASARKAN LIKISAN TEKNIK PIAWAI ISO

Oleh

PITOON NOPNAKORN

Oktober 2003

Pengerusi: Profesor Madya Napsiah Ismail, Ph.D.

Fakulti: Kejuruteraan

Lukisan kejuruteraan adalah media untuk berkomunikasi dalam proses pengeluaran. Untuk berkomunikasi menggunakan bahasa grafik yang sama dalam aspek kejuruteraan, satu piawai lukisan teknik telah ditentukan oleh International Organization for Standardization (ISO).

Sesetengah perisian CAD yang seperti AutoCAD, AutoSketch dan Solid Edge dipasakan menyediakan kebolehan yang tinggi untuk kegunaan dalam ruang 3D atau 2D. Lebar, panjang dan nisbah garisan bagi perisian ini yang dicetak menepati piawai lukisan teknikal ISO. Tetapi prosedur serta antaramuka untuk menghasilkan kelebaran garis dan jenis garis untuk lukisan mudah kadangkala rumit dan komplek. Kajian ini bertujuan untuk membangunkan perisian 2D dengan penekanan kepada pengawalan lebar dan jenis garisan berdasarkan lukisan teknik piawai ISO untuk lukisan teknikal.

ISO 128 bahagian 20, 21 dan 24 mempakan piawai asas yang digunakan dalam perisian yang dicadangkan. Perekaan perantaramukgan pengguna (UI) telah dibuat dalam persekitaran "Windows XP" danpiawai "Pascal-based Delphi 5" telah digunakan sebahai alut "visual programming". Format untuk fail lukisan telah dureka sebagai format tersendiri, fail "textual", dengan basis "Computer Graphics Metafile format" (CGM) dan "Data eXchange File format" (DXF). Tujuh lukisan telah dicetat dalam berbagai lebar garisan, laitu dari 0.25 mm sehingga 2.0 mm. Setiap lukisan telah dibuktikan dengan lebar garisan, panjang elemen garisan dan garisan bersambung yang mempunyai dimensi yang sama dengan lukisan manuskrip dan spesifikasi dalam piawai ISO. Perantaranmukaan manusia-komputer untuk perisian yang telah bangunkan telah dimudahkan bagi kawalan lebar garis dan jenis garis. Masa yang diperlukan untuk menghasilkan lukisan teknikal adalah kurang jika di bandingkan dengan perisian komersial seperti AutoCAD, AutoSketch dan Solid Edge. Model 'Aras-keystroke' telah di gunakan untuk ini.

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I certify that an Examination Committee met on 3rd October 2003 to conduct the final examination of Pitoon Nopnakorn on his Master of Science thesis entitled "Development of Line Width and Type Control Of 2D CAD Software Based on ISO Technical Drawing Standard" in accordance with Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

PITOON NOPNAKORN

Date: 7 Jan 2004

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NOMENCLATURE

2D	2 dimensions space
3D	3 dimensions space
ADA	A computer language derived from Pascal, used primarily by the military.
ANSI	The American National Standards Institute
ASCII	American Standard Code for Information Interchange
B-reps	Boundary representation
Bézier Curve	A curve that is calculated mathematically to connect separate points in smooth, free-form curves and surfaces of the type needed for illustration programs and CAD models.
Bitmap	A graphics file format which store, manipulate, and represent images as rows and columns of tiny dots.
BSI	British Standards Institution
CAD	Computer-Aided Design
CGM	Computer Graphics Metafile: a file format for the storage and retrieval of picture information.
CRT	Cathode-Ray Tube, an electron tube, or evacuated glass container
CSG	Constructive Solid Geometry
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
dpi	Dot Per Inch
DXF	Data Exchange File
HCI	Human-Computer Interface
IGES	Initial Graphics Exchange Standard
ISO	The International Organization for Standardization

JISC	Japanese Industrial Standard Committee
MIT	The Massachusetts Institute of Technology
Modula-2	Language that emphasizes modular programming. High-level language based on Pascal, characterized by lack of standard functions and procedures.
RAD	Rapid Application Development
Raster Graphics	A method of generating graphics in which images are stored as multitudes of small, independently controlled dots (pixels) arranged in rows and columns.
SAGE	Semi-Automatic Ground Environment
STEP	Standard for the Exchange of Product Model Data
SDPM	Software Development Process Model
Vector Graphics	A method of generating images that uses mathematical descriptions to determine the position, length, and direction in which lines are to be drawn.

CHAPTER 1

INTRODUCTION

Engineering drawing is the main method of communication between all persons concerned with design and manufacture of components (Boundy, 1980). Its main role functions as a graphic language transmitting ideas from the draughtsman or designer to the end user, management and professional engineering staff for carrying out engineering projects. The technical drawing standards have been issued with the implementation of the International Organization for Standardization (ISO). They are presented as technical drawing according to the international manufacturing language of engineering in most countries.

Generally, most of the countries that are rich in industrial manufacturing technology also established official agency that approves and develops standards. The American National Standards Institute (ANSI), British Standards Institution (BSI), Deutsches Institut für Normung e.V. (DIN, the German Institute for Standardization), and Japanese Industrial Standard Committee (JISC) are examples of standard agencies found in the United States of America, Britain, Germany and Japan respectively. ANSI and BSI implemented the Imperial unit for their standard while DIN and JISC implemented the Metrics system. As the role of predominant industrial countries, some of their standards are adopted as ISO international standards in

the Metric system, for example, the unit for length is measured in millimeter (mm).

Among the ISO standards, mechanical engineering drawing is standardized in various aspects including the size and layout of drawing sheets, application styles, representation of drawing elements and application in CAD system.

1.1 Problem Statement

Generally, ISO mechanical engineering drawing comprised of continuous line and non-continuous line. Non-continuous lines are the lines that are drawn with the combination of line element such as gap, dot, dash and long dash. These lines are called dashed line, long dashed dotted line and long dashed double dotted line. They can be made in any size of the width that specified by ISO. However, the lengths of line elements are proportioned to line width.

Recently, the commercial CAD software products in the market, such as *AutoCAD* and *AutoSketch* of *AutoDesk* and *Solid edge* of *Unigraphics Solutions Inc* usually support both American standards and ISO standards to software. Their efficiency line widths, line types and line proportions control, can be used to create drawings in different ways.

For controlling the line width and line type in the drawing process and modifying process, AutoCAD requires six steps for drawing process and two

steps for modifying process. In drawing process consists of the steps as loading line types, creating layers, setting line type, setting line weight, drawing the line and editing line proportion in the object properties. However, in modifying process consists of line weight and line proportion editing.

Meanwhile, *AutoSketch Release7*, which is developed for fast and accurate 2D drawing, comprises of the tools to control the line properties that almost the same as AutoCAD approaches, such as layer controller, line style controller and line width controller. Although it provides some tools for setting line width and line type, but line width and proportion of line element are not as ISO standard because the line width control component is not provided the real number value, as seen in Figure 1.1.

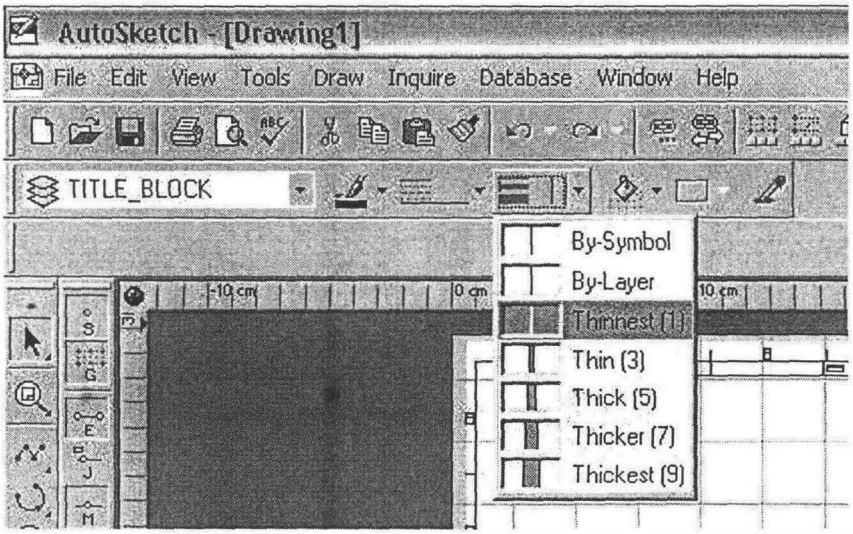

Figure 1.1: Range of line width controller choices of *AutoSketch*

Solid edge is one of the software products for high performance 3D modeling. In version 11, *Draft* module is used for creating the drawing in 2D mode. It embraces two standards, ANSI and ISO. Although it provided the control of line type and width, but the tool for controlling the line element proportion is excluded. Thus, the length of line elements is not proportioned to the line width as specified in the ISO standard.

In conclusion, the *Draft* module which is comprised of the tools to control line width and line type as designated by ISO except for the line elements proportion which is uncontrollable. As *AutoSketch*, it has not provided sufficient precise component to set line width. AutoCAD is an automatic version of CAD software product that can create the drawing as the ISO line constraints. However, its complex procedures are arisen, especially in modifying process. Some features of commercial software are shown in Table 1.1.

Table 1.1: Some features of commercial software

Features	AutoCAD	AutoSketch	Solid edge
Allocate line width as designated in ISO	Yes	No	Yes
Create line type as designate in ISO	Yes	Yes	Yes
Proportionate line elements to line width as designated in ISO	Yes	No	No
Support 3D	Yes	No	Yes
Price	RM14,000 to RM18,000	RM400 to RM700	Not Available