A COMPARISON BETWEEN FINITE ELEMENT ANALYSIS CODE AND COSMOS SOFTWARE

BILAL S. HAMID

A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Computer Science)

Faculty of Computer Science and Information System
Universiti Teknologi Malaysia

APRIL 2005

PSZ 19:16 (Pind. 1/97)

UNIVERSITI TEKNOLOGI MALAYSIA

BORANG PENGESAHAN STATUS TESIS❖

JUDUL : A COMPARISON BETWEEN FINITE ELEMENT ANALYSIS CODE AND COSMOS SOFTWARE

SESI PENGAJIAN: 2004/2005

Saya BILAL SADOON HAMID (MC031022)

(HURUF BESAR)

mengaku membenarkan tesis (~~PSM~~/Sarjana/~~Doktor Falsafah~~)* ini disimpan di Perpustakaan Universiti Teknologi Malaysia dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknologi Malaysia.
2. Perpustakaan Universiti Teknologi Malaysia dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☑ TIDAK TERHAD

(TANDA TANGAN PENULIS)	(TANDA TANGAN PENYELIA)
Alamat Tetap:	
19, Sub 56, Sect 428,	
Doura, Baghdad,	**Assoc. Prof. Dr. Dzulkifli bin Mohamad**
IRAQ	Nama Penyelia
Tarikh: **4th April 2005**	Tarikh: **4th April 2005**

CATATAN:
- * Potong yang tidak berkenaan
- ** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD
- ❖ Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Master of Science (Computer Science)"

Signature	:	______________________
Supervisor	:	Assoc. Prof. Dr. Dzulkifli bin Mohamad
Date	:	______________________

I declare that this thesis entitled "*A COMPARISON BETWEEN FINITE ELEMENT ANALYSIS CODE AND COSMOS SOFTWARE*" is the result of my own research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in any candidature of any degree.

Signature : ______________________

Name : Bilal Sadooun Hamid

Date : ______________________

To my beloved mother, father, sister and brother

ACKNOWLEDGEMENT

I must first and formost thank ALLAH for the merciful care that enabled me to complete this work. I wish to express my sincere appreciation to my thesis supervisor, Assoc. Prof. Dr. Dzulkifli bin Mohamad for encouragement, guidance, critics and friendship. Without his continued support and interest, this thesis would not have been the same as presented here. Thanks are directed to Hamdi AbdAl Rahman Joda Mahfuz, Department of Thermofluid Engineering, Faculty of Mechanical Engineering and Firas Noori Ridha, Department of Chemical Engineering, Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malaysia, for the valuable discussions and suggestions.

ABSTRACT

In order to fulfill various needs of different users in different applications, there must exist a mutual understanding between software house and the users. The software developers should know exactly what the users need in their work and the developed software should perform accordingly. The users could come from any discipline, and the designers and the engineers are amongst those. In this project, a study has been carried out to compare the effectiveness between COSMOS software and the finite element generated programming code in order to do stress analysis on 3D object. In this study, the amount of stress will be imposed on subject area, and the resulted effect will be visualized as a gradual changed of colors. The engineers and designers will benefit from this study in terms of increasing their skill in design and obtain a well defined design since the competition become higher day after day.

ABSTRAK

Untuk memenuhi barbagai keperluan para penguna dalam applikasi yang berbeza beza, dipastikan adanya fahaman yang sesuai di antara rumah perisian dan para penguna. Para pembangung perisian mengetahui keperluan para penguna dalam kegiatan mereka oleh krena itu perisian yang sudah di bangungkan mesti memenuhi keperluan tersebut. Para penguna adalah daripada berbagai displin, para jurutera di antara mereka. Dalam kajian ini, perbandingan di antara COSMOS software dan finite element generated programming code untuk menganalisis stress pada objek ber-tiga dimensi. Dalam kajian ini, kadar stress telah di ekspose di atas permukaan objek. Para jurutera akan mendapati manfat dan untung daripada kajian ini untuk menambah keahlian mereka dalam reka bentuk lagi pula untuk mendapati reka bentuk yang jelas dengan pertandingan yang semakin naik.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

With the rapid increase in industry, engineers and designers start to receive a huge responsibility to keep a successful development and continuing progress of industry and updating it with the latest innovations. Designers who are responsible in accomplishing the first step of any plant are in real need to ensure a successful update and safe designs. But it is not an easy job since design processes are very sensitive and can led to undesired result with, fatal result in case there are unnoticeable mistakes and errors in their designs.

To come up with a proper design it is essential then to check up the entire design and to address the weakness in the design. From this point of view it comes crucial to have certain tools represented by programs and softwares that could with the aid of computers to identify the weakness and the error in those designs that, consequently, would lead to a high quality product and time saving process.

Unfortunately, up to now designers and engineers are still suffering from a high shortage in these tools causing a delay in some designs and unpredictable mistakes in others due to the less helpful tools exciting now. Therefore, to find an ideal and accurate design it is necessary to carry out long and complicated calculations on the object to reach at the optimum design after a series of tests. However, under some circumstances, it may become difficult to perform these tests for several reasons, first of all, the highly cost calculation for the individual test and also due to the fact that some of these tests can be carried out repeatedly to stand at some details that require high accuracy and a great deal of certainty in determining the deflection points. This may provide a higher possibility to address the weaknesses in the object and consequently can be handled through a better treatment to achieve the ideal design (Akin, 1990).

The process of determining the weaknesses in any object represents a critical issue due to the difficulties associated in the calculation. To detect these weaknesses accurately in spit of these tests can be recorded on video tape or through the use of sensors to record the tests results. These difficulties are raised from the unclear change which is almost invisible for direct human observation. For example, the total failure of an object as a subsequent of a partial collapse under the effect of progressive stress could be noticeable for human observation in some cases and unnoticeable in other cases as a final result due to the experimental physical environment. Accordingly, considering this situation it becomes questionable that when and where the deflection had started on the object (Lee and Kim, 2004).

Taking these difficulties into account it is necessary then to carry out these complicated calculations on highly speed computers that would save appreciable efforts, cost and time. Moreover it provide the possibility of getting advantages from using these computers in computer graphics field that give a better vision on the object using color distinguishing codes which have been defined previously.

1.2 Problem Statement

The use of AutoCAD software facilitates faster and speedy methods for designers and users to reach at the desired objects designs in well views. Furthermore, it helps those users to adapt with their designs by providing easy tools for carrying out further modification in the designs. AutoCAD software contains many toolbars which give assistance to users to draw the object in well and smooth way. However, this software is incapable to provide all design requirements to the designers as they want more details on the analysis that could be performed on their designs. This is because the AutoCAD software is designed for drawing objects. It does not provide such operations or instructions like stress analysis. Hence, another software is required to accomplish the mission of analysis on those objects drawn in AutoCAD. One of the most useful softwares for this purpose is the COSMOS software which equipped with many facilities enabling designers to carry out a comprehensive analysis on different type of objects drawn or designed by AutoCAD.

Using high level languages such as OpenGL or C++ or BASIC to generate their own codes and could be possible for designers and users with program experiences for performing stress analysis on certain materials which are not available in the standard list of these softwares, and consequently different properties which are not accounted for. From this point of view, it is the reason why a large softwares like AutoCAD and COSMOS till now are containing features of adding or expanding the libraries in each of these softwares, in order to give the possibility for adding some modifications which can be considered as a system development and also to get an appreciable knowledge in how to use and get the optimum benefit from these softwares (Woo *et al*., 1999).

1.3 Objective

1. To study and test the behavior of stress forces based on Finite Element Analysis.
2. To make comparison study of the proposed technique with COSMOS software test.

1.4 Scope

The scope for this project is drawn on the following unit:

1. A modeling object is drawn using AutoCAD 2000 software.
2. The designed object is formed on a box of 10×.20×180 mm
3. The stress amount that is enforced on the object is 10 N/mm

4. Visualization of the stress analysis will be based on predefined color distribution template.
5. Mesh processing for the modeling technique will be based on triangles instead of polygons.

1.5 Summary

Finite element Model used for dividing the object into small pieces to facilitate calculation procedure. The changes occur on a part due to the fact that all parts are contained in the entire object. Therefore, it is expected that a better results could be achieved if the object is divided into a larger number of pieces, which it may exceed hundreds or thousands of parts related to one object. This may lead to better knowledge and accurate computing to what could be occurring to the object. Nevertheless, the time will be increased as a result of the long calculations on a large number of parts. However, time factor will be sacrificed to get a better and valuable results needed for the test.

To reach this objective, it is important to address several scopes that is adapted to achieve the goal. The 3D object will be modified by adding several properties to the previous ground objects such as changing the original specification of the object. The next step is to identify the characteristics of the object and its behavior at that specific condition of the test. The test that will be considered in this work is the stress test to figure out the changes occurring on the object within the progress of the test.

The material that will be chosen for the test is the Alloy steel as an example which is among those basic materials founded in COSMOS software. The COSMOS software will be used for verification purpose in order to evaluate the result and the validity of the algorithm. The stress test that will be conducted is the vertical-cauterized stress test as shown in Figure 1.1. The object will be drown using AutoCAD software and then will be transferred to the COSMOS software for verification in term of strength; shape and degree of deflection though color code distinguishing. This requires an algorithm for Finite Element Analysis (FEA) to operate the process that will be constructed and applied using Turbo Basic compiler or MATHLAB depending on the convenience. The algorithm will provide a complete description of changes occurring on the object within the progress of the test by mean of color distinguishing tool. The shape will be used is the cylinder but also it can be reduced to a part of the cylinder if the mesh calculation or finite element analysis take a long time and hard efforts to obtained on the whole cylinder.

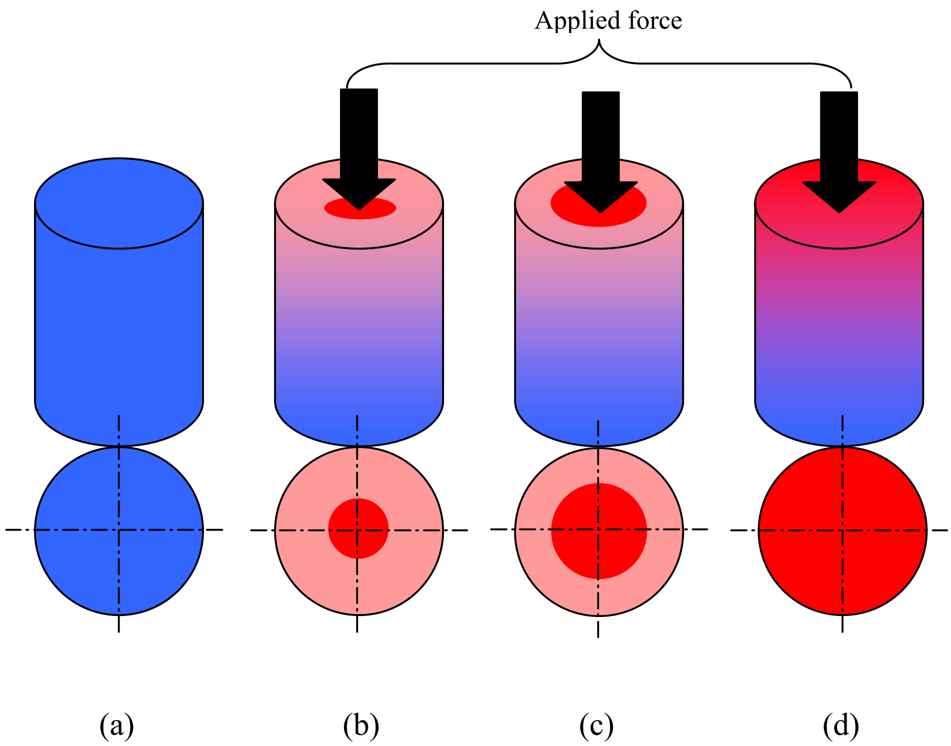

Figure 1.1 Stress test progress: (a) Original Stage, (b) First stage of stress, (c) Second stage of stress, (d) Final stage of stress

Same test will be also applied on a box with specific dimensions, Figure 1.2 shows the box with the proper dimensions, the way of drawing the box, the amount of forces needed to make a stress analysis and other tests including all the results obtain from the test will be illustrate in chapter 3 in this study.

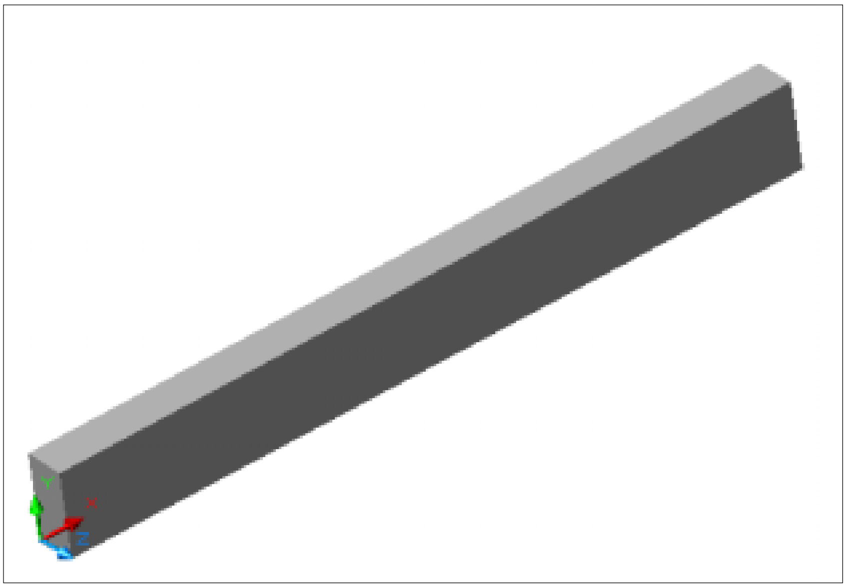

Figure 1.2 A box with 10×20×180 dimensions drawn from the point 0,0,0

REFERENCES

Akin, J. E. (1990). *Computer-Assisted Mechanical Design*. New Jersey: Prentice-Hall, Inc.

Amenta, N. Bern, M. and Eppstein, D. (1999). Optimal Point Placement for Mesh Smoothing. *Journal of Algorithms*. 30: 302-322.

Archer, G.C., Fenves, G. and Thewalt, C. (1998). A new object-oriented finite element analysis program architecture. *Computers & Structures*. 70: 63-75.

Beer, G. (2001). *Programming the Boundary Element Method: An introduction for Engineers*. England: John Wiley & Sons, Ltd.

Bischoff, S. and Kobbelt, L. (2004). Teaching Meshes, Subdivision and Multiresolution Techniques. *Computer-Aided Design*. 36: 1483-1500.

Blake, A. (1990). *Practical Stress Analysis in Engineering Design*. Second edition. New York: Marcel Dekker, Inc.

Brown, D. K. (1990). *An introduction to the Finite Element Method using Basic Programs*. Second edition. Scotland: Blackie & Son Ltd.

Fogarassy, P. Manescu, A., Markkocsan, N. and Rustichelli, F. (2004). Residual Stress Analysis in Near net-Shape Formed Specimens Obtained by Thermal Spraying. *Physica B*. 350: 537-539.

Hearn, D. and Baker, M. P. (1994). *Computer Graphics*. Second edition. New Jersey: Prentice-Hall, Inc.

Kobbelt, L., Vorsatz, J. and Seidel, H. P. (1999). Multiresolution Hierarchies on Unstructured Triangle Meshes. *Computational Geometry*. 14: 5-24.

Lee, D. G. and Kim, S. S. (2004). Failure Analysis of Asbestos-Phenolic Composite Journal Bearing. *Composite Structures*. 65: 37-46.

Mohammed Kabashi Elbasheer (2003). *Analysis of Stresses in Stepped Internally Pressurized Cylinders by Finite Element Method Using Composed Fortran Program & Ansys Package*. College of Engineering Karary Academy of Technology: M.Sc. Thesis.

Peng, J. and Law, K.H. (2004). Building finite element analysis programs in distributed services environment. *Computers & Structures*. 82: 1813-1833.

Poutiainen, I., Tanskanen, P. and Marquis, G. (2004). Finite Element Methods for Structural Hot Spot Stress Determination-A Comparison of Procedures. *International Journal of Fatigue*. 26: 1147-1157.

Smith, I. M. (1998). *Programming the Finite Element Method*. Third edition. England: John Wiley & Sons Ltd.

Tickoo, S. (2000). *AutoCAD LT 2000, a Problem Solving Approach*. New York: Autodesk Press.

Wang, K. Y., Qin, Q. H. and Kang, Y. L. (2004). A modified Isoparametric Mapping Fill Method to Display Color Mapping of Data. *Advances in Engineering Softwares*. 35: 585-591.

Yuste, J. M. G., Montenegro, R., Escobar, J. M., Montero, G. and Rodriguez, E. (2004). Local Refinement of 3-D Triangulations Using Object-Oriented Methods. *Advances in Engineering Softwares*. In press.

Woo, M., Neider, J., Davis, T. and Shreiner, D. (1999). OpenGL Programming Guide. Third edition. Massachusetts: Addison-Wesley.

Zhao, Y. and Tryon, R. (2004). Automatic 3-D Simulation and Micro-Stress Distribution of Polycrystalline Metallic Materials. *Computer Methods in Applied Mechanics and Engineering*. 193: 3919-3934.