Image Cover Sheet

CLASSIFICATION	SYSTEM NUMBER 203307
UNCLASSIFIED	

TITLE

CONVERSION OF THE AST FINITE ELEMENT CODE TO THE DEC ALPHA COMPUTER

System Number:

Patron Number:

Requester:

Notes:

DSIS Use only:

Deliver to:

National Defence
Research and Development Branch

Défense nationale
Bureau de recherche et développement

DREA CR/95/479

CONVERSION of the VAST FINITE ELEMENT CODE to the DEC ALPHA COMPUTER

by
D.P. Brennan — J.D. Covill — M.F. Palmeter
J.C. Wallace — Q. Liu — M.W. Chernuka

MARTEC Limited
1888 Brunswick Street, Suite 400
Halifax, Nova Scotia, Canada
B3J 3J8

CONTRACTOR REPORT

Prepared for

Defence Research Establishment Atlantic

Centre de Recherches pour la Défense Atlantique

DEFENSIO PER SCIENTIAM

Canada

PLEASE DIRECT ENQUIRIES TO:

THE CHIEF,
DEFENCE RESEARCH ESTABLISHMENT ATLANTIC,
P.O. BOX 1012,
DARTMOUTH, NOVA SCOTIA, CANADA
B2Y 3Z7

National Defence
Research and Development Branch

Défense nationale
Bureau de recherche et développement

DREA CR/95/479

CONVERSION of the **VAST** FINITE ELEMENT CODE to the DEC ALPHA COMPUTER

by
D.P. Brennan — J.D. Covill — M.F. Palmeter
J.C. Wallace — Q. Liu — M.W. Chernuka

MARTEC Limited
1888 Brunswick Street, Suite 400
Halifax, Nova Scotia, Canada
B3J 3J8

Scientific Authority Layton E. Gilroy

June 1994

W7707-3-IBHO/01-OSC
Contract Number

CONTRACTOR REPORT

Prepared for

Defence Research Establishment Atlantic

DEFENSIO PER SCIENTIAM

Centre de Recherches pour la Défense Atlantique

Canada

ABSTRACT

A summary of the work related to the development of a RISC-based version of the VAST suite is presented. This work was prompted by DREA's recent decision to replace the aging VAX 6420 VMS mainframe cluster with a number of RISC-based Alpha workstations. A number of problems were encountered during the conversion code, the most significant of which was related to the failure of the FORTRAN intrinsic function "INQUIRE".

Résumé

Un résume des travaux relatifs au développement d'une version à architecture RISC de la suite VAST est présenté. Ces travaux font suite à la décision récente du CRDA de remplacer les gros ordinateurs VAX 6420 VMS vieillissants par des stations de travail Alpha à architecture RISC. Il a fallu faire face à un certain nombre de problèmes durant le portage des codes, dont le plus important est dû à l'échec de la fonction intrinsèque "INQUIRE" du FORTRAN.

TABLE OF CONTENTS

1. INTRODUCTION

A recent review of DREA's computing requirements has resulted in the decision to replace the aging VAX 6420 VMS mainframe cluster with a number of RISC-based Alpha workstations. As a result, much of the code now resident on the mainframe cluster, including the VAST finite element code, must be ported to these new platforms.

Martec Ltd., because of its unique knowledge of the VAST suite, has been tasked by DREA to port the VAST codes to the DEC Alpha computers and to optimize this code for the these platforms. In addition, this work addresses the need to create an X-windows version of the supporting VAST graphics libraries, PLOTVX and PLOTGUI, in order to replace the current GKS or PLOT10 versions.

In the following report, details related to the development and incorporation of Alpha versions of each of the three VAST codes (VASGEN, VAST, and VASTG) will be presented.

2. GENERALIZED WORK PLAN

Since the development of a RISC-based version of the VAST suite required the expertise of a number of Martec professional staff, the most economical approach involved developing the code at the Martec office. Unfortunately, the equipment necessary for the operation of an X-terminal off the Alpha workstations via external modem could not be secured by Martec. As a result, it was decided that the code would be ported initially to Martec's RISC-based Hewlett-Packard 700 series workstation, where the bulk of the code development and testing would be performed. Once the code was deemed to be in a stable condition it would then be ported to DREA's Alpha, where the final refinements and testing could be completed.

3. CONVERSION OF THE VAST SOLVER

The installation of the VAST solver on the Alpha proceeded without any difficulty. Previous experience gained while preparing RISC-based versions of the code for the HP-720 computer allowed Martec staff to generate an executable version of the code on the Alpha workstation relatively quickly.

The source code was transferred from the VAX 6420 to the Alpha workstation (node "BADECK") via the FTP file transfer facility. Unfortunately the verification of the code proved to be difficult due to both the restriction on available disk space on the Alpha workstation and its relatively poor performance when two or more processes were running at the same time.

In order to verify that the output generated by this new RISC-based version of VAST was consistent with the older VMS version, a number of sample problems were run under both operating systems and the results compared. Table 1 provides a complete listing of the analysis options considered. For all models considered, the RISC-based and VMS versions of the VAST solver produced identical results.

TABLE 1: Analysis Options Considered

Analysis Type	Element Types
Static	Solids, shells and beams
Dynamic via modal superposition	Shells and stiffened shells
Dynamic via direct integration	Shells and stiffened shells
Natural frequency	Shells and stiffened shells
Eigenvalue buckling	Shells and stiffened shells
Random response	Beams

4. GENERATION OF X-WINDOWS VERSIONS OF PLOTVX AND PLOTGUI

4.1 XGKS

The X-windows/GKS public domain software source code was downloaded from the US National Centre for Atmospheric Research (NCAR) site. The installation procedures were altered for the HP-UX and SGI UNIX operating systems. The package was then built and tested. It has significantly faster execution speed than a commercially purchased package on our HP720 workstation (GraFPak GKS). VASTG61 and VASGEN61 were ported to the UNIX environment utilizing XGKS, compiled and extensively tested. XGKS has been found to be very stable.

4.2 FSTAT

UNIX lacks the advanced record manager found in VMS. This meant that the large amount of information available in the VMS FORTRAN "INQUIRE" statement (specifically "record length" and "unformatted") was unavailable under HP-UX. A "C" language routine callable from subroutine "SOPEN" in VAST was written to get more information than is available from within FORTRAN. (UNIX is largely written in "C", thus making the C language the "native" UNIX programming language.)

5. CONVERSION OF THE VASTG CODE

A number of problems were encountered during the conversion of the VASTG program, the most significant of which was related to the failure of the FSTAT subroutines. FSTAT is a Martec library routine which checks, among other things, for the existence of data files. In the latest version of the program, FSTAT employed the FORTRAN intrinsic function "INQUIRE" to establish whether the file exists or not. Unfortunately, the "INQUIRE" function did not function properly on the HP-720 and proved to be unpredictable on several other RISC-based platforms as well. Once the difficulty with the "INQUIRE" statement was discovered, a new routine was developed and used to replace the original FSTAT routine. As a result, VASTG required significant modifications.

In addition to the problems related to the "INQUIRE" statement, underflows caused by the conversion of double precision variables to single precision also caused fatal errors. Fortunately, it was discovered that the HP-UX implementation of FORTRAN 77 [1] does provide a trap handling mechanism that allows the developer of the code to control how a program interruption is to be handled. In order to avoid the program "crashing" on an underflow, VASTG was modified to initiate a specific trap procedure which sets the variable to zero whenever underflows occurred. Trap procedures were also developed for arithmetic overflows.

A number of smaller problems were also identified and corrected during the conversion process. These included: the LOGICAL*1 declaration is not allowed; common blocks and subroutines cannot share the same names; variables initialized in DATA statements cannot be changed during execution of the program and; two-dimensional character variable arrays cannot be declared using formats such as STR*15(5,*), where STR represents the character string variable name.

6. CONVERSION OF THE VASGEN CODE

The failure of the FSTAT routine, and more specifically the FORTRAN 77 "INQUIRE" function, had profound effects on the performance of the VASGEN program. The use of the "INQUIRE" function within VASGEN extended to verification of whether the file in question was opened, and if so, what unit number was the file attached to. Unfortunately, the new routines which were developed to replace the original FSTAT/INQUIRE functions could not be used to establish whether a file was actually opened or not. As a result, the entire file handling logic employed in VASGEN had to be reworked, requiring a significant effort.

REFERENCES

[1] FORTRAN/9000 Reference Manual, published by Hewlett Packard, 1991.

UNCLASSIFIED
SECURITY CLASSIFICATION OF FORM
(highest classification of Title, Abstract, Keywords)

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document Organizations for whom the document was prepared, e.g. Establishment sponsoring a contractor's report, or tasking agency, are entered in section 8.) MARTEC Ltd. 1888 Brunswick St., Suite 400 Halifax, N.S. B3J 3J8	2. SECURITY CLASSIFICATION (overall security classification of the document including special warning terms if applicable). Unclassified

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S,C,R or U) in parentheses after the title).

Conversion of the VAST Finite Element Code to the DEC Alpha Computer

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

D.P. Brennan, J.D. Covill, M.F. Palmeter, J.C. Wallace, Q. Liu and M.W. Chernuka

5. DATE OF PUBLICATION (month and year of publication of document) June 1995	6a. NO OF PAGES (total containing information Include Annexes, Appendices, etc). 9	6b. NO. OF REFS (total cited in document) 1

7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered).

DREA Contractor Report

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address).
Defence Research Establishment Atlantic
P.O. Box 1012,
Dartmouth, N.S. B2Y 3Z7

9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant). 1.g.3.	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written). W7707-3-IBHO/01-OSC
10a ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document). MARTEC TR-94-30	10b OTHER DOCUMENT NOS. (Any other numbers which may be assigned this document either by the originator or by the sponsor). DREA CR 95/479

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)

(x) Unlimited distribution
(   ) Distribution limited to defence departments and defence contractors; further distribution only as approved
(   ) Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved
(   ) Distribution limited to government departments and agencies; further distribution only as approved
(   ) Distribution limited to defence departments; further distribution only as approved
(   ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in 11) is possible, a wider announcement audience may be selected).

UNCLASSIFIED
SECURITY CLASSIFICATION OF FORM

DCD03 2/06/87-M

UNCLASSIFIED
SECURITY CLASSIFICATION OF FORM

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual).

A summary of the work related to the development of a RISC-based version of the VAST suite is presented. This work was prompted by DREA's recent decision to replace the aging VAX 6420 VMS mainframe cluster with a number of RISC-based Alpha workstations. A number of problems were encountered during the conversion code, the most significant of which was related to the failure of the FORTRAN intrinsic function "INQUIRE".

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title).

conversion
X-windows
workstation
mainframe
graphics
computer program

203307

UNCLASSIFIED
SECURITY CLASSIFICATION OF FORM