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Microcomputer Numerical Analysis System for Gas Dynamics Application

FINAL REPORT
Contract No. NAS8-34592
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By

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Forward and Summary

This document represents the final report on Contract Number NAS8-34592 by Continuum, Inc., Huntsville, Alabama. The effort reported herein was in support of the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Marshall Space Flight Center, Alabama. The Technical Representative for NASA was Mr. S.H. Guest (ED24).

The original objective (scope) of the effort was to deliver a microcomputer version of the Continuum gas dynamic numerical analysis on existing NASA equipment. It became apparent during the course of the contract that the interests of NASA would be much better served by the delivery of a dedicated system designed and developed by Continuum, which would provide NASA with additional hardware ideally suited to the specific task at no increase in cost. Accordingly, the contract was modified to reflect this new development. The details of the modification and the delivered capability will be discussed in greater detail in the ensuing technical discussion.

All objectives of the contract have been met or exceeded in a timely fashion within the original budget.

Technical Discussion

Continuum, Inc. has developed a new approach to the numerical solution of the equations of motion describing the behavior of compresible fluid flows in complex domains. The methodology is so powerful that problems that previously could only be addressed on fourth generation computers can now be solved on microcomputers.

The intent of the original contract (NAS8-34592) was to provide this new capability on an existing NASA/MSFC microcomputer. The tasks under the original scope of work are given below.

- **Task 1 -** Install mathematical model of variational analysis on NASA/MSFC microcomputer. The model shall be capable of providing transient data evolving to steady state.

  a. The contractor shall provide its current variational analysis plus incorporate sufficient new developments such that time varying inlet conditions and more general geometrics are available.

  b. Checkout and demonstrate operational capability of the Task 1a. analysis.

- **Task 2 -** Document and familiarize NASA/MSFC personnel with the use of the program/microcomputer.

  a. Provide adequate documentation of the computer program and its input/output such that NASA personnel can understand the workings of the program and be able to operate the system with little or no outside assistance.

- **Task 3 -** Recommend equipment necesary to create an advanced work station for future applications.

a. Survey equipment capablities and identify microcomputers and peripheral equipment consistent with the objective of an advanced work station.

b. Recommend best equipment for the advanced work station considering cost and power required for a satisfactory capability.

The technical investigations and development necessary to provide the mathematical model with the increased capability called for in Task 1a. were successfully accomplished early in the study. A completely general geometic capability was developed. This capability could describe a domain (two-dimensional or axisymmetric) of virtually any size and complexity. An unlimited number of corners, walls, inlets and imbedded bodies could be defined and successfully analyzed. Additionally, a procedure was developed which adequately treated multiple time varying inlets. Thus, all of the requirements of Task 1a. were satisfied.

Preliminary investigations had been conducted regarding suitable low cost equipment for an advanced engineering work station before beginning the subject contract. Through these investigations we had identified the most cost-effective and powerful microcomputer and associated peripheral equipment. Continuum, Inc. made the decision to program and market a dedicated engineering work station which had all of the capability required by the contract. Because Continuum would underwrite the software development, the entire dedicated work station could be delivered to NASA at a cost consistent with the funds remaining in the contract.

NASA, therefore, would receive the engineering work station along with the associated equipment for the amount contracted for delivery of software on their existing system only. NASA then would be able to utilize its original existing microcomputer for other tasks. Additionally, the work station would have color graphics; a capability which was not originally contemplated using the NASA/MSFC equipment.

These facts were brought to the attention of the NASA technical personnel and contracting officer. A modification of the contract was made, at the convenience of the government, with the following statement of work:

The contractor shall deliver the following system:

1 ea. CM-1000 Numerical Gas Dynamics Work Station, consisting of:

SOROC Technology user interface display/keyboard
Intelligent Systems color graphics display unit
T.I. Printer
Intel Analyzer
Software for numerical application of Variational Analysis Program

Additional requirements were installation, checkout, familiarization and documentation.

Continuum delivered, installed and checked out the work station on April 12, 1983. A familiarization (orientation) course was given to interested NASA technical personnel, and a reference manual* for the system was provided. (Additional copies available upon request).

The above actions therefore satisfied the requirements of the original scope and its subsequent modification.

* "CM-1000 Engineering Analysis Workstation; GD-1 Gas Dynamic Analysis Package, Reference Manual", May, 1983.

Conclusions

The scope of work of the original contract and its modifications were successfully completed in time and within budget. The capability delivered is in excess of that originally proposed due to improvements made in the variational approach. Using its engineering work station, NASA/MSFC is now able to analyze many complex compressible gas dynamic problems which were previously tractable only with large-scale computers, and with long developmental lead times.

It is Continuum's pleasure to have been able to participate in this important effort.