December 1966

Brief 66-10619

NASA TECH BRIEF

NASA Tech Briefs are issued to summarize specific innovations derived from the U.S. space program, to encourage their commercial application. Copies are available to the public at 15 cents each from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Computer Program Simplifies Transient and Steady-State Temperature Prediction for Complex Body Shapes

The problem:

To devise a fast, efficient method of predicting transient and steady-state temperature distributions throughout an object of complex shape when heat sources are applied to specified points on the object. The method of obtaining temperature distributions of the object under observation must be capable of considering any or all of the three modes of heat transfer: conduction, convection, and radiation. Analyses of bodies of complicated shapes usually require complex and time-consuming manual computations.

The solution:

A computer program which utilizes an electrothermal model to simulate the conductance, heat capacity, and temperature potential of the object under study. The program is capable of evaluating all three modes of heat transfer and will calculate either the transient or steady-state temperature distributions.

How it's done:

The program solves heat transfer problems by establishing analogies between the physical phenomena of thermal heat flow and electrical current flow, and between temperature and voltage potential.

The object under consideration is simulated by a large number of nodal points, each representing a small portion of the object. These nodes form a network which provides an accurate physical definition of the object. The computer then accepts the following input information:

1. The thermal heat capacity of each nodal point.
2. The conductance values of the three possible heat transfer (current) paths between a node and its neighboring nodes.
3. The network nodes to which the initial temperatures (voltages) are applied.

The program then executes:

1. For each node, a value of capacitance, which is an electrical statement of the heat capacity of the object at that particular nodal point.
2. A resistance–capacitance time constant, which indicates the instantaneous value of the current present at a given node.

A printout of the solutions to the transient or steady-state potentials at the network nodes may be requested at any time during the program. Since each nodal point corresponds to one point on the object under observation, the network current values obtained from the printout are directly proportional to the heat flow existing in the object. Nodal voltage potentials obtained from the printout are proportional to the temperature distributions throughout the object.

Notes:

1. The program has been written in the FORTRAN IV language for use on the IBM 7094 computer.
2. The program can be used to solve problems described by a form of Laplace's equation, or the continuity equation. Other possible applications include fluid flow studies, traffic flow problems, and structural analysis.
3. Inquiries concerning this invention may be directed to: COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B66-10619

(continued overleaf)

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: K. N. Giebler
of North American Aviation, Inc.
under contract to
Manned Spacecraft Center
(MSC-989)