

# NASA TECH BRIEF

## *Marshall Space Flight Center*



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### Marshall System for Aerospace Simulation (MARSYAS)

#### The problem:

A system was needed to allow engineers a quick and easy simulation of physical systems on a digital computer.

#### The solution:

MARSYAS (Marshall System for Aerospace Simulation) is a simple flexible language which can be coded by users unfamiliar with computer programming. It is designed for the engineer with little experience in simulation, who desires to simulate large physical systems. The language can be used to solve a system of differential equations or to simulate control systems, including analog computer block diagrams, or both simultaneously. Thus, the user has the ability to mix differential equations with diagrams in his model.

The block diagrams can contain, among other things, adders, integrators, transfer functions, multiple input/output nonlinear devices, algebraic equations, and nonlinear ordinary differential equations. A block diagram is specified by the user-given names of its model and submodels, inputs and outputs, element names, parameters (if any), and their interconnections. Submodels can be nested to any degree required. Elements can be connected in pairs, in groups, or in any manner desired by the user. A large library of standard elements and excitation functions is part of the MARSYAS system. DEVICE and FUNCTION statement operators allow the user to construct unusual element or excitation functions as needed.

#### How it's done:

MARSYAS is a flexible language in that, with few exceptions, there is no rigid statement-operator structure within a given module. Most statements can be used

without regard for the order in which they appear within the modules. Depending upon the computer system in which MARSYAS is installed, the user has the capability of storing models in a functional data base. The FORTRAN Object Program generated from the MARSYAS Source Program can be extracted and run separately, if the user's computing facility can accommodate this feature. When using CHANGE operators, the user has multiple simulation capability without the necessity of either rewriting his model or re-submitting his deck.

An elaborate plotting system is part of the MARSYAS language, allowing the user nearly unlimited flexibility in specifying his graphical output. Additionally, the Fast Fourier Transform of any output variable can be obtained easily. A tabular listing of a model in the functional data base, or of a model currently being run, can be obtained using the LIST operator. Automatic features of MARSYAS include the detection and solution of linear and nonlinear algebraic loops. For problems which contain discontinuities, the MARSYAS system automatically changes integration schemes to integrate through the discontinuities.

MARSYAS is designed in modular form so that modifications to the system models can be made with a minimum of effort. In order to achieve comprehensive analysis capability and effective computation, modern control theory is used as the mathematical foundation of MARSYAS. The differential equations generated from block diagrams, or coded as equations, are re-arranged internally into vector matrix-state equations which then are solved.

The system language is so designed that the user transmits to the computer only the essential information to describe the mathematical model and to specify

(continued overleaf)

the simulation run. MARSYAS is divided into four successive modules which describe independent functions of the simulation. These modules are as follows:

1. Description Module,
2. Modification Module (optional),
3. Simulation Module, and
4. Post-Processing Module.

The user has the ability to control some of the internal processing of the simulation by specifying his numerical integration method, integration step size, or even the truncation error. Normally, the user need not be concerned with these details, since MARSYAS handles them automatically. MARSYAS names can be up to 36 characters in length, so that the same names as found in engineering documentation can be used. The MARSYAS alphabet consists of the letters A through Z, the numbers 0 through 9, and the backward slash (/). There are no reserved words in MARSYAS.

**Notes:**

1. This program was written in FORTRAN V for the UNIVAC 1108 computer system.
2. Inquiries concerning this program should be directed to:

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