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Abrom Hisler
Information Processing Division

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GODDARD SPACE FLIGHT CENTER
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It was dissatisfaction with the growing complexities of the basically simple Ptolemaic system that led Copernicus[1] to his heliocentric view of the universe.

The Ptolemaic system, which considered the earth to be the center of the universe, envisioned a structure consisting of a large circle (the deferent) and a small circle (the epicycle) whose center moved on the circumference of the deferent as the epicycle itself rotated. As an example: The planet Venus would rotate about the epicycle, with the center of the epicycle moving about the deferent, at the center of which was the earth. This concept—which required a plethora of epicycles to account for the observed movements of the heavenly bodies—prevailed for 1300 years, despite its complexities, until it was superseded by the Copernican view of planetary rotation about the sun. Yet this very profusion of complexities, literally epicycles upon epicycles, may prove valuable in providing a basic structural concept for present-day computer-program systems composed of many modules.

The Working Group on Design Automation,[2] within the framework of its charter to recommend research efforts in critical areas of solid-propulsion system design, has posed the need for developing a highly flexible master control logic program. This need exists in other technical fields as well, because of the nature of overlap across many lines of scientific discipline.

This so-called "executive logic" must handle a complex integrated computer program of modular structure which combines techniques from various technical disciplines. The modules, as the basic unit of the computer-program complex, must:

- Allow execution in a variety of sequences, as required by the nature of a given problem
- Accommodate new modules under development or planned

[1] Encyclopedia Britannica. 1966. Vol. 6, p. 466

[2] Computer Program Deficiency Areas. CPIA publication 151, August 1967

- Permit effective transfer of data among themselves and with the main program segment in order to process data input to the data-output stage

The accompanying block diagram from the General Missile Sizing Program (GMSP) developed by Douglas Aircraft Company seems to point in the direction of the desired executive logic. It represents the concept behind the "master control which contains only the data input statements, the statements which provide entry to the modules, and the logic specifying the sequence in which modules are called."[3]

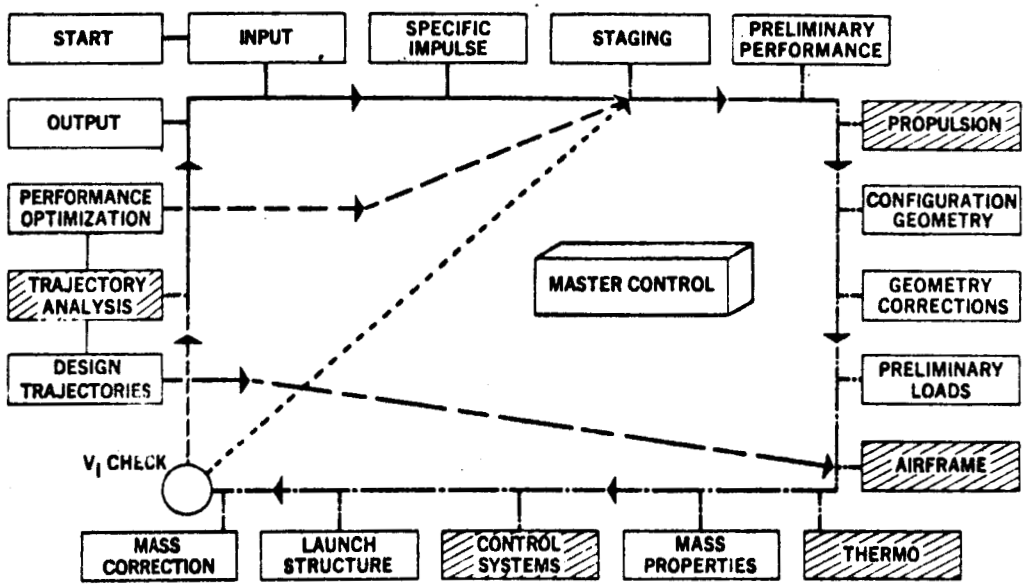

Figure 1. GMSP Block Diagram

A special option, the "Tinkertoy," added to the GMSP master control enables an operator to:

- Modify the operating sequence
- Include any special tests or logic
- Add modules to suit any particular application

[3]Proceedings, 12th Meeting, Working Group on Design Automation. CPIA publication 92, pages 28 and 30. September 1965.

It may be worth while to look at the GMSP master control from the point of view of its structure. Transforming the block to a circle makes it immediately apparent that the master control in effect pivots program control to each of the modules in the order desired. In this way the block diagram can be visualized as a big decision circle in which the radial arm pivots about. The decision-circle concept can then be expanded to assume the static form of the basis Ptolemaic structure of deferent/epicycle (Figure 2.)*

This expanded view of the decision-circle concept "freezes" the motion of the epicycle and thereby evades the complexities of motion while retaining the static structure. Use of the static deferent/epicycle as a recurring building block makes it possible to develop as complex a "frozen" Ptolemaic system as desired to represent a given computer-program complex. Master control would pivot about to any of the subroutine circles having centers on the circumference of the largest (master-control) circle. In turn, a subroutine circle would carry on its circumference the centers of circles representing lesser level subroutines.

On Figure 2, vectors may be drawn showing:

- A line perpendicular to the plane of the paper at the center of the MAIN circle, representing input data entering from below and being released above the MAIN circle plane as output data, after processing within the plane of the MAIN circle
- A sequence starting from the MAIN deferent toward the DECOM 1 module epicycle
- Then extending from the DECOM 1 (now deferent) to the NESS epicycle
- From the NESS (now deferent) to the NESPAK epicycle
- From the NESPAK (now deferent) to the PAK epicycle
- With final return to MAIN either by retracing the previous path, or directly

*Figure 2 represents modules of the IMP-F correction and decommutation computer program, arranged as a Ptolemaic system of decision circles.

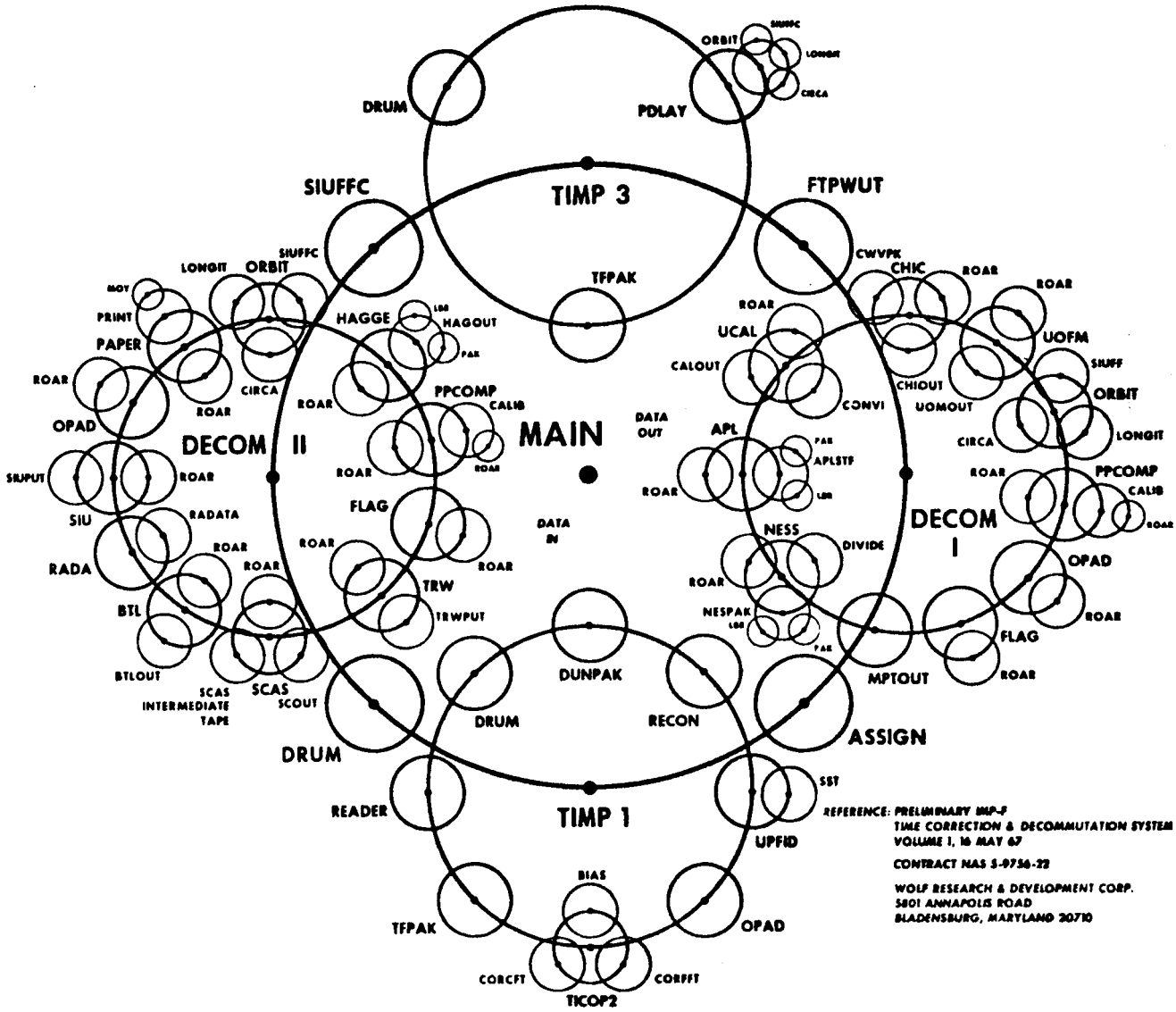

Figure 2. A Ptolemaic System of Decision Circles

During the sequence just described, MAIN would have pivoted about its center to enter DECOM 1, and DECOM 1 would have pivoted about its center to enter NESS, and this pivot action would continue to NESPAK and finally to PAK.

This Ptolemaic concept is valuable as an overall view of the IMP-F computer program to make it tractable and to cope with data flow throughout the computer program. Note especially:

- The frequency with which the ROAR module recurs

- The MAIN radial pivot to eight modules: four rather large—DECOM 1, TIMP 1, DECOM II, TIMP 3—and four very small—DRUM, ASSIGN, SIUFFC, and FTPWUT

Pivot-control number logic is also suggested in FORTRAN language:

INTEGER PV

ASSIGN 1 to PV

GØ to (1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000), PV

Statement 1000 may call DECOM 1; 1100, NESS; 1110, NESPAK; and 1111, PAK.

This suggestion may lead to an entirely new structuring of the MAIN executive program in the shape of the Ptolemaic concept of the IMP-F computer program. The Ptolemaic concept may also answer the need for a highly flexible master control logic program as visualized by the Working Group on Design Automation. The plethora of epicycles so abhorrent to Copernicus may thus be of practical use in structuring current and future computer-program complexes.