G-CUEING MICROCONTROLLER
(A MICROPROCESSOR APPLICATION IN SIMULATORS)

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Digital Simulation of aircraft flight requires the iterative solution of a time and event dependent mathematical model. Simulation realism is enhanced by high rate of solution. A simulation whose solution rate produces cues which are perceived to be the same as real-world cues, is considered a real-time simulation. Achieving real time simulation is a prime consideration in simulator design.

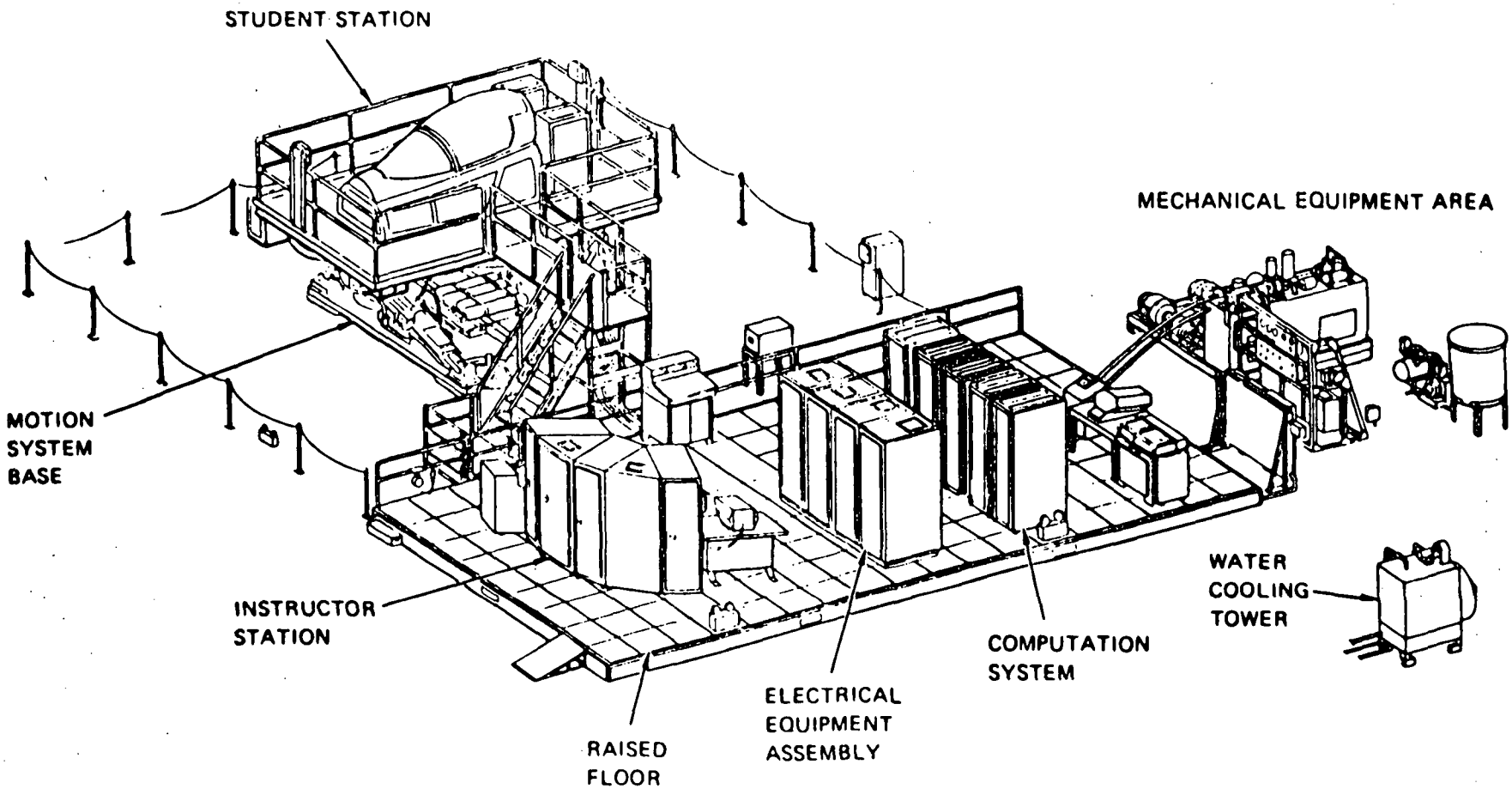
The computation system required to produce real-time simulation is either a single, high cost, extremely high speed processor, or an array of less powerful processors which share the computation task. When multiple processors are used in such array, each is usually dedicated to a simulation subtask and must operate synchronously with the other processors in the array.

One such dedicated processor is the G-Cueing Microcontroller (G-CM). The G-CM consists of a tandem pair of microprocessors, dedicated to the task of simulating pilot sensed cues caused by gravity effects. This task includes execution of a g-cueing model which drives actuators that alter the configuration of the pilot's seat.

The G-Cueing Microcontroller receives acceleration commands from the aerodynamics model in the main computer and creates the stimuli that produce physical acceleration effects of the aircraft seat on the pilots anatomy. One of the two microprocessors is a fixed instruction processor that performs all control and interface functions. The other, a specially designed bipolar bit-slice microprocessor with on-board hardware multiply and firmware implemented divide square root and sine functions, is a microprogrammable processor dedicated to all arithmetic operations. The two processors communicate with each other by a shared memory.

The G-Cueing Microcontroller contains its own dedicated I/O conversion modules (analog-to-digital, and digital-to-analog) for interface with the seat actuators and controls, and a DMA controller for interfacing with the simulation computer.

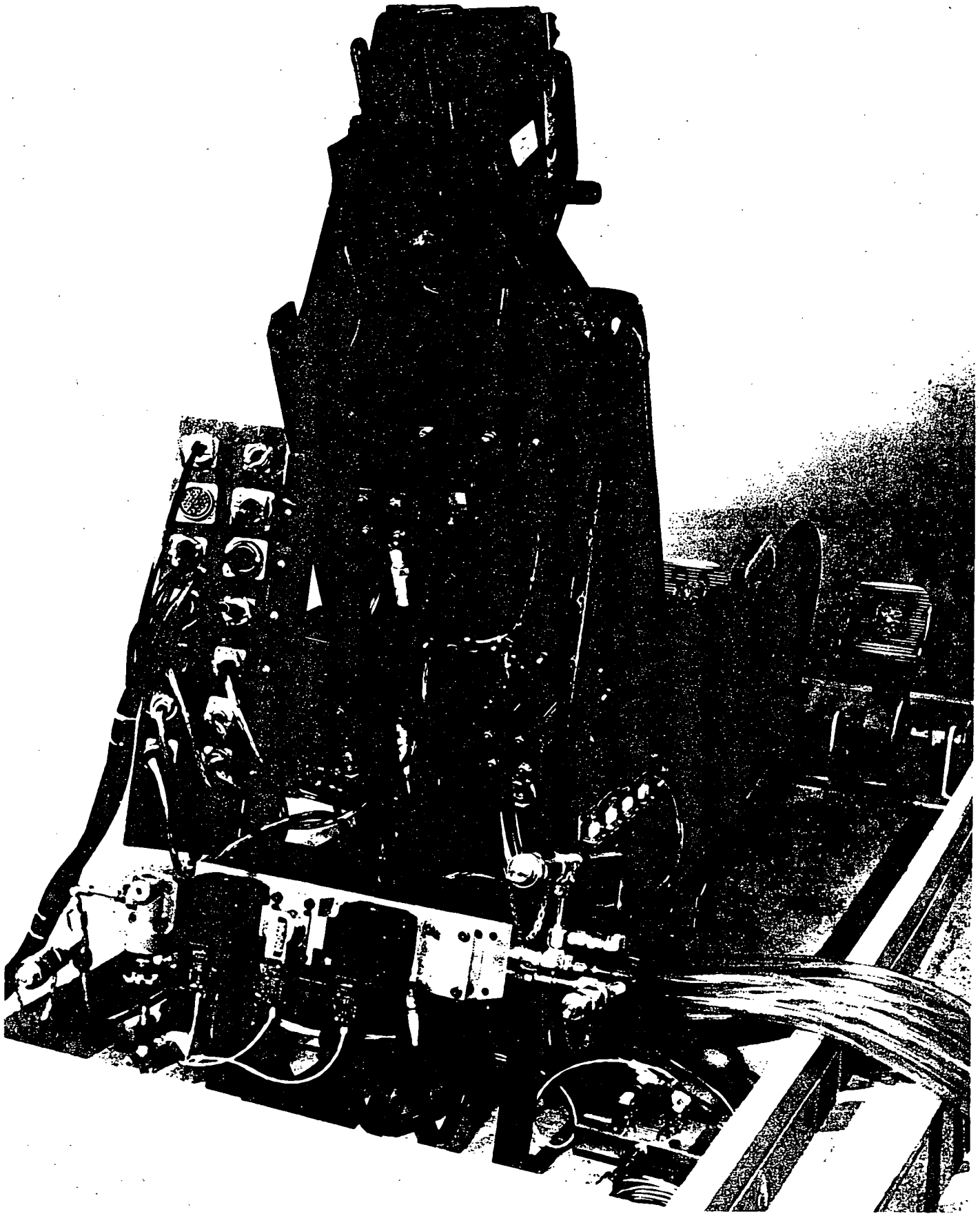
Even though the microcontroller is programmed to perform the g-cueing model, it is not limited to this specific application. Any application which can be microcoded within the available memory, the available real time and the available I/O channels, could be implemented in the same controller. Furthermore, the microcontroller capacity can be expanded by the addition of memory and I/O modules.

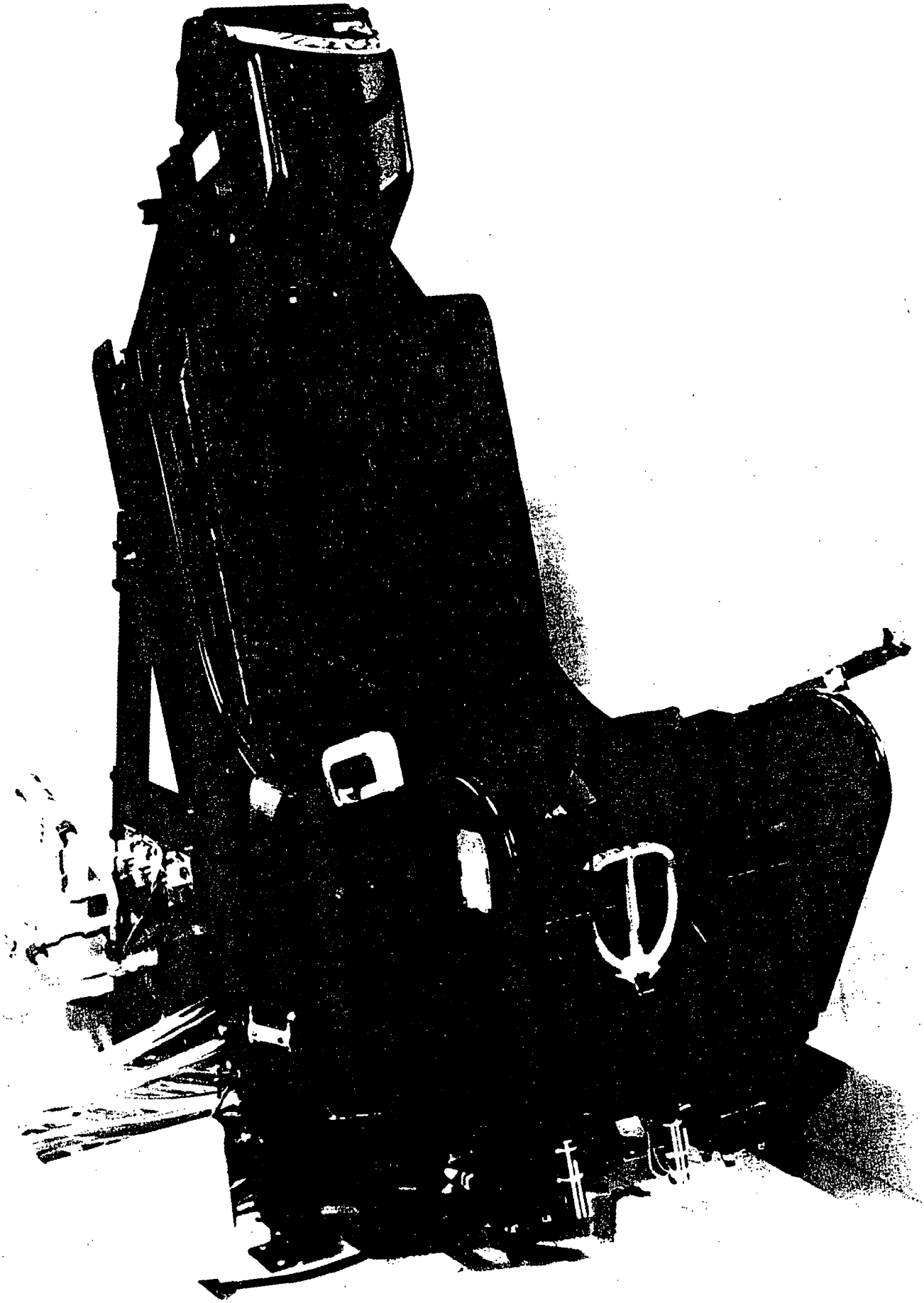


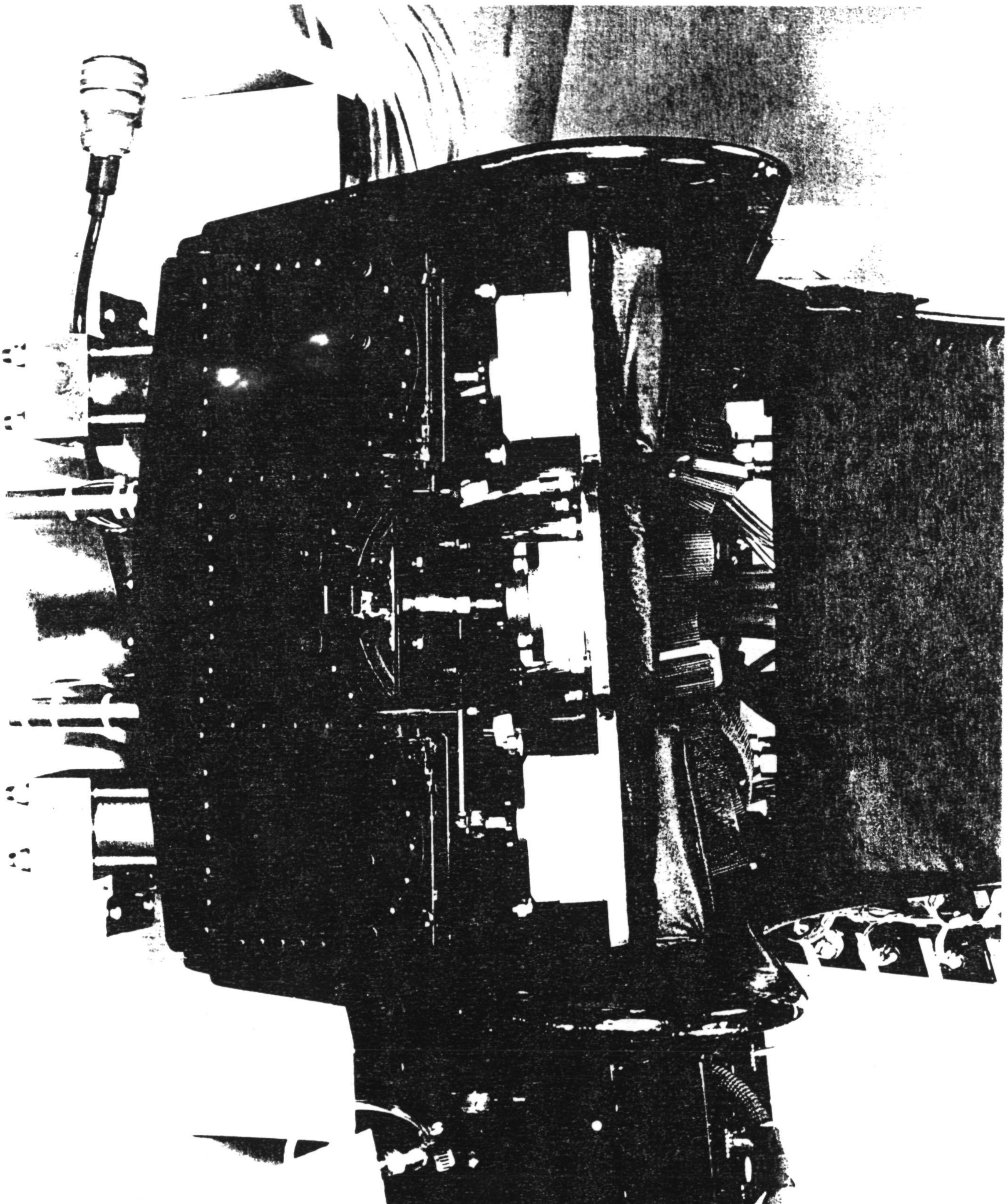
ISOMETRIC VIEW

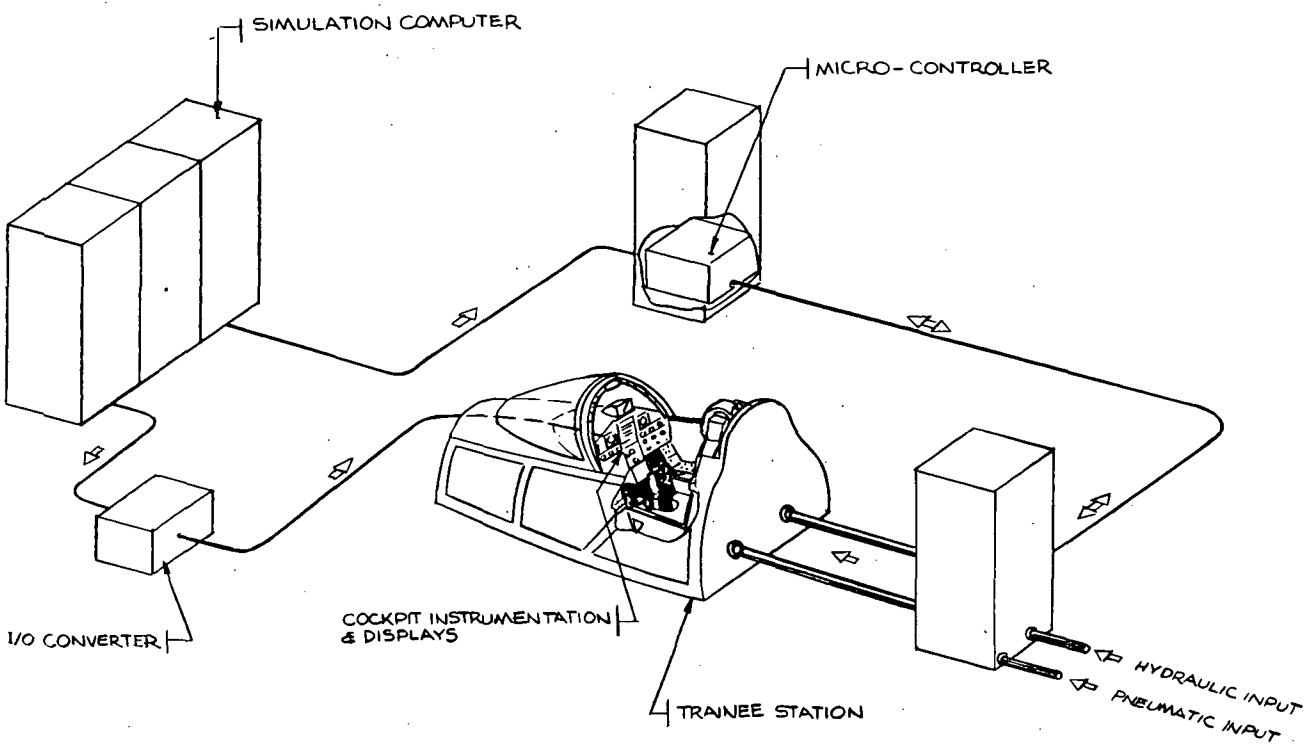
F-15

MISSION IN
PROGRESS

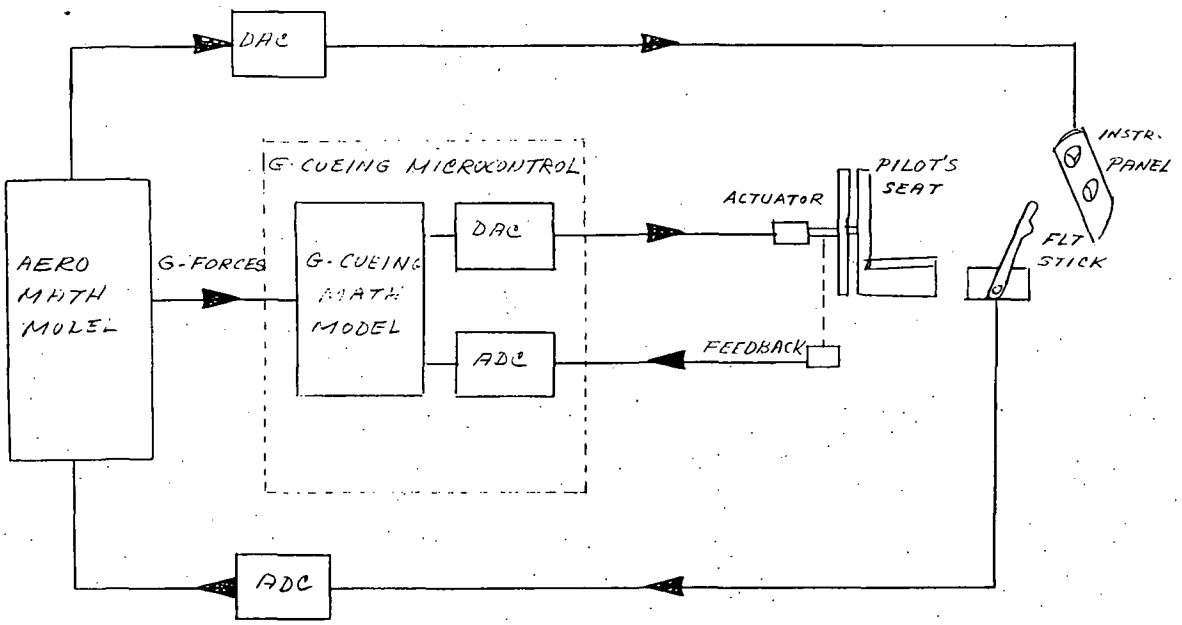




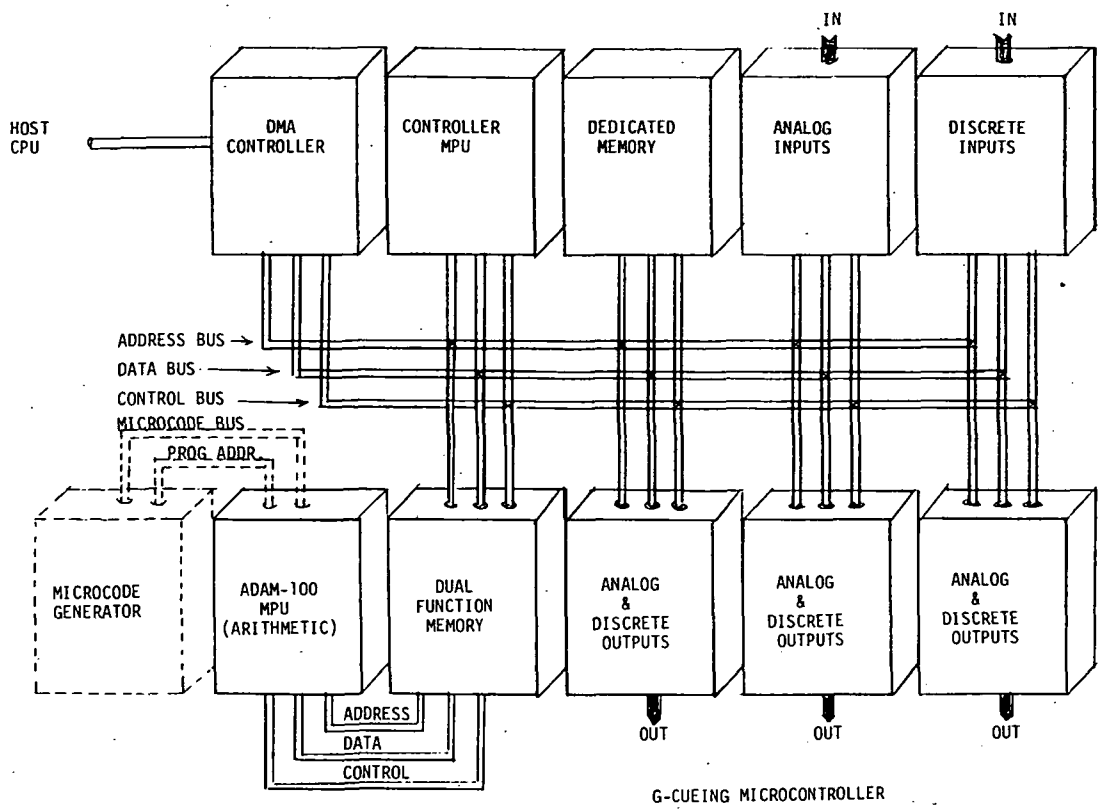




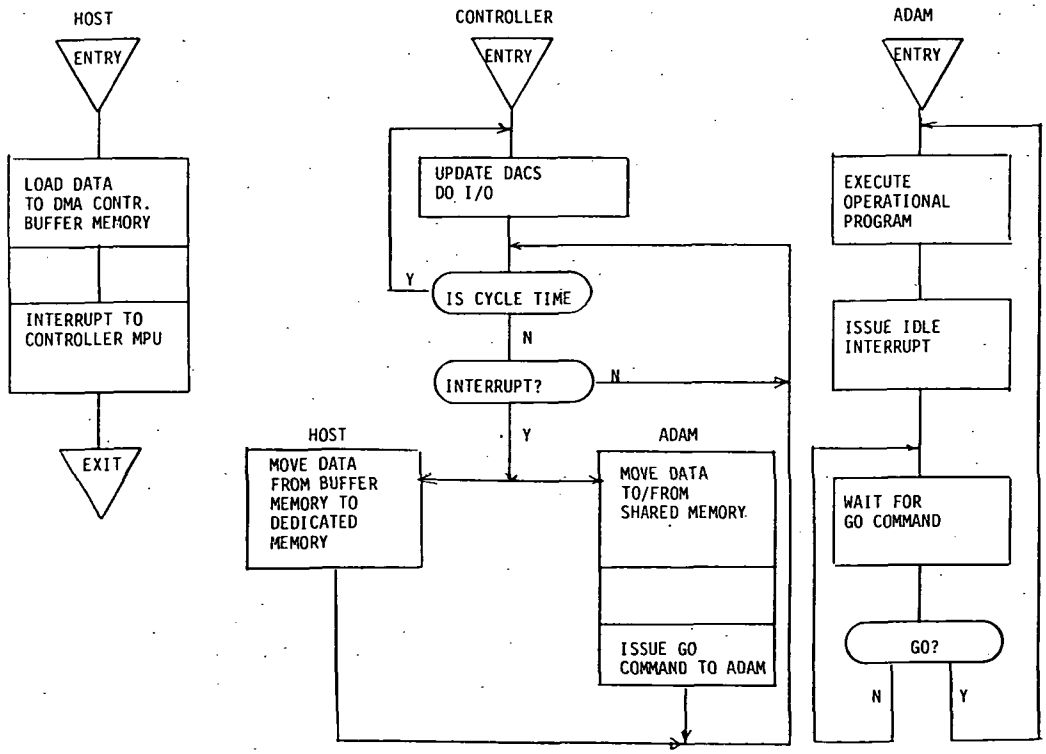
G-CUEING SIMPLIFIED DIAGRAM



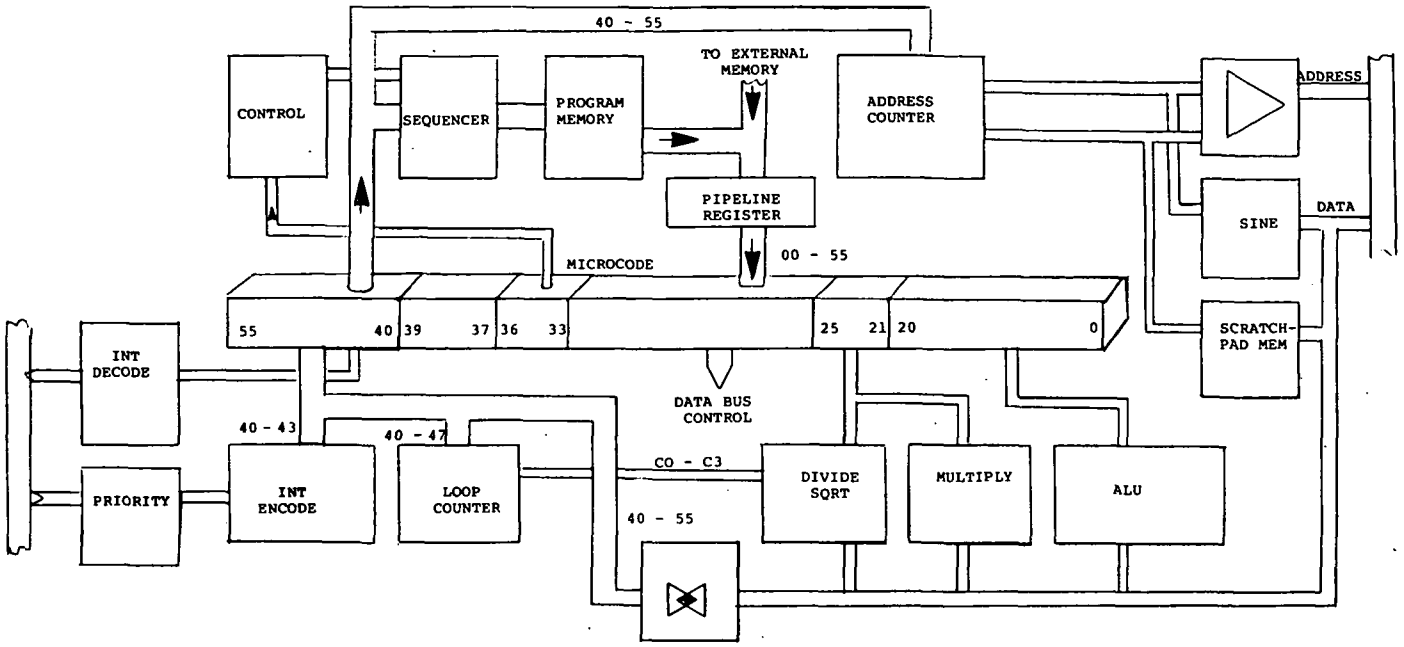
G-CUEING DIAGRAM



G-CUEING MICROCONTROLLER



SYNCHRONIZATION-G-CUEING MICROCONTROLLER



ADAM - FUNCTIONAL BLOCK DIAGRAM

(INSTRUCTION WORD FORMAT)

55 40	37	33	30	26	21	19	17	13	9	6	3	0
BRANCH ADDRESS	TEST	BRANCH CTL	MEMORY CTL	DATA BUS ENABLES	DIV/SQRT MPY/SINE	ALU CARRY	ALU SHIFT	R_B REG ADR	R_A REG ADR	ALU DEST	ALU FUNCT.	ALU SOURCE
1	2	3	4	5	6	7	8	9	10	11	12	13

FIELD	FUNCTION	BITS	
1	BRANCH ADDRESS	55-40	
2	CONDITION CODE TEST	39-37	
3	BRANCH CONTROL	36-33	
4	MEMORY CONTROL	32-30	
5	DATA BUS ENABLES	29-26	
6	DIV/SQRT/MPY/SIN	25-21	
7	ALU CARRY SELECT	20-19	ALU
8	ALU SHIFT SELECT	18-17	
9	R_B SELECT	16-13	
10	R_A SELECT	12-9	
11	ALU DESTINATION	8-6	
12	ALU FUNCTION	5-3	
13	ALU SOURCE	2-0	

1. [ ] INDICATE OPTIONAL ARGUMENT IN INSTRUCTION
2. NOTE THAT ALL CONTROL INSTRUCTIONS WILL BE ENCODED WITH FIELD 4 SET TO 111, FIELD 11 SET TO 001, AND FIELD 12 SET TO 100 ANY OF WHICH MAY BE OVERRIDDEN DURING A MERGE
3. REMAINDER OF FIELDS DEFAULT TO $\emptyset$ AND MAY BE OVERRIDEN

MICROCONTROLLER MEMORY MAP
ON CONTROLLER MPU DEBUG, MONITOR
EPROM
MEMORY EXPANSION (PROGRAM)
EPROM + RAM
MICROPROGRAM GENERATION (RAM)
RAM
DUAL FUNCTION MEMORY (RAM)
RAM
I/O MAP
REGISTERS
TOTAL MEMORY MAP
0
4K
8K
12K
16K
20K
24K
28K
32K