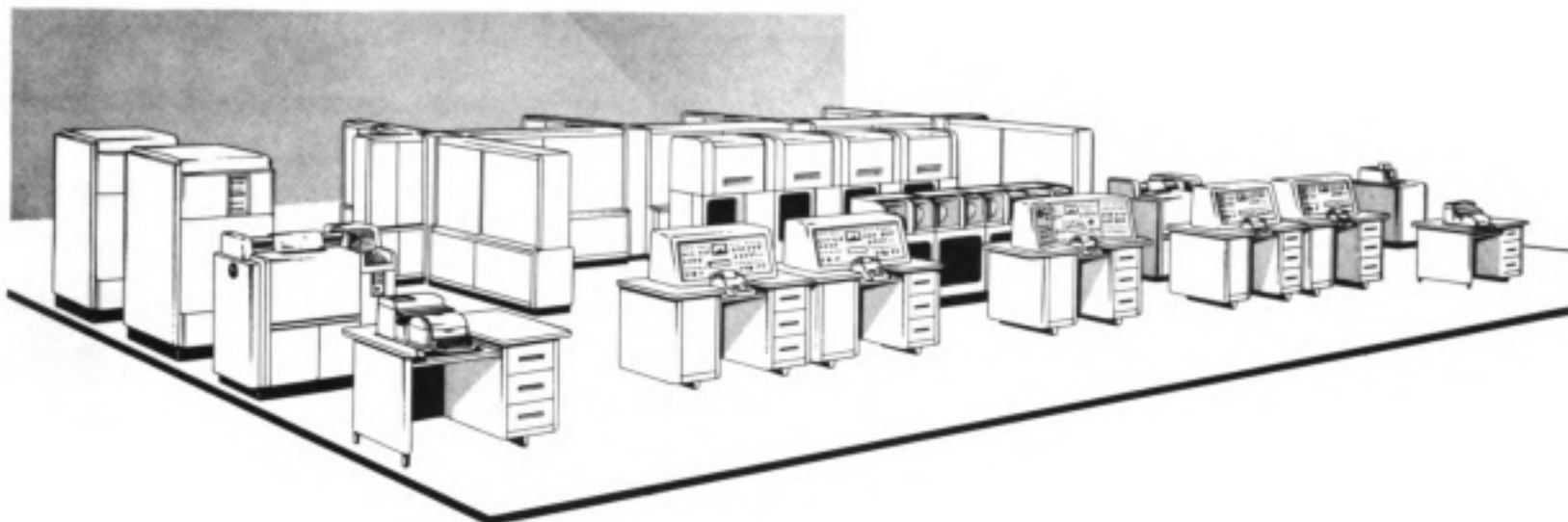


LARC

Livermore Automatic Research Calculator

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division



Picture by Sperry Rand Corporation

APPLICATIONS

University of California Radiation Laboratory
Scientific, general purpose

NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits per word	12
Decimal digits per instruction	12
Instructions per word	1
Instructions decoded	Less than 100
Instructions used	Less than 100
Arithmetic system	Floating and fixed point
Instruction type	One address

Floating point characteristic base 50.

Floating and fixed point operations include single, half double, and double precision. The one-address instruction type is modified by fast-register designations. There is a two digit exponent in

floating point numbers.

ARITHMETIC UNIT

Add time	Microsec 4
Mult time	8-12
Div time	28-32
Construction	Transistors
Number of rapid access word registers	100
Basic pulse repetition rate	2.50 mega-cycles/sec
Arithmetic mode	Parallel
Timing	Synchronous
Operation	Concurrent

All arithmetic operations are complete floating or fixed-point. An add time may involve two shifts, two additions, and an adjustment of a B-box all within the allowed 4 microseconds. Times above include fixed and floating-point operation.

System has addressable A and B registers.

Timing is based on a 4 microsecond storage cycle.

There is a great deal of parallelism within the system. Essentially there are two program controlled computers overlapped with many input-output synchronizers.

Three instruction registers allow overlap of fetch of instruction and operand, indexing and operation.

STORAGE

Media	Words	Microsec Access
Magnetic Core	97,500	0.5-4
Magnetic Drum or Disc	1,000,000/unit drum 2,000,000/unit disc	0-83,000

Basic computer will have 20,000 words of high speed storage capacity.

A storage cabinet will contain 10,000 words of coincident current ferrite core storage arranged in blocks of 2,500 words. Each 2,500 word section is complete with its own storage switches, read amplifiers, and storage register and may be addressed independently of, and concurrently with, any other section.

INPUT

Media	Speed
Punched Cards	600 cards/min
Magnetic Tapes (4 UNIVAC II)	20,000 char/sec
Keyboards (2)	Manual

OUTPUT

Media	Speed
Magnetic Tapes (4 UNIVAC II)	20,000 char/sec
Punched Cards	600 cards/min
High Speed Printer	1,200 lines/min 130 char/line

Input-Output controlled by one input-output processor and buffer registers.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Modular construction throughout.
Solid state devices are used throughout.

CHECKING FEATURES

Check of all input-output operations.
Storage and transfer of all information is checked via a self-correcting (one error per word) check and an odd-even code.
All arithmetic operations are checked by either duplication or use of an active "zero" circuit.
Drum and disc storage utilize five bits/dec dig.
There is a check bit for each decimal digit.

POWER, SPACE AND WEIGHT

All modular units will employ self-contained power supplies operating from a central motor-generator set with a stand by spare.

Heat exchangers will be provided in all units to provide reliable operation independent of room air conditioning.

Basic system requires a 55 ft by 36 ft room.

PRODUCTION RECORD

Number produced 0

University of California Radiation Laboratory System is in the design stage.

PERSONNEL REQUIREMENTS

8 Engineers will be trained to operate and maintain the computer. 20 programmers will be trained to code for the computer. Personnel are being trained by the manufacturer upon request of the customer, however, the system does not necessarily require this number of attendants.

FUTURE PLANS

Government Sample

U. S. Navy David Taylor Model Basin

An order has been placed for a LARC system, which is possibly to be designated "SHARC" for Bureau of Ships Automatic Research Calculator, for proposed delivery in January 1959.

Industrial Sample

Lockheed Aircraft Corporation, Missile Systems Division

Declaration of intentions to order a LARC System made subject to approval of final prices.

INSTALLATIONS

Under construction

University of California Radiation Laboratory
Livermore, California

Proposed

See "FUTURE PLANS"

ADDITIONAL FEATURES AND REMARKS

The basic computing system consists of one input-output processor, twelve drum files, four tape units, one printer at each console, one keyboard at each console and one computing unit. Provision will be made for adding another computing unit, with control console. On-line keyboards will be provided at each operator's and engineer's station.

Operator may interlace the running of two problems on one or both computing units and assign relative priorities.

Solid state components will be used throughout the main computing system.

Marginal checking will be provided.

LEPRECHAUN

TRADIC Second Feasibility Computer, LEPRECHAUN

MANUFACTURER

Bell Telephone Laboratories, Incorporated



Picture by Bell Telephone Laboratories, Incorporated

APPLICATIONS

The system was built under a U. S. Air Force contract for programming and logical design research on digital computers for military real-time control applications and as a feasibility model of a direct-coupled transistor logic system and a transistor driven magnetic core storage unit. This solid-state computer features low power and small size. The design emphasizes reliability.

NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	17, including sign
Binary digits per instruction	17, including two spare bits
Instructions per word	1
Instructions decoded	32
Instructions used	28
Arithmetic system	Fixed point

Instruction type
Number range

One address
 $-1 \leq n < 1$

ARITHMETIC UNIT

Add time (Includ. stor. access)	Microsec	40
Mult time (Includ. stor. access)		375 avg
Div time (Includ. stor. access)		520
Construction	Transistors	
Arithmetic mode	Parallel	
Timing	Asynchronous	
Operation	Concurrent	

STORAGE

Media	Words	Microsec Access
Magnetic Cores	1,024	8

There are 18 bits/word stored, including an "odd" parity bit. The read-write cycle is 20 microseconds.

INPUT

Media	Speed
Paper Tape (Photoelectric)	200 char/sec
Keyboard	Manual

OUTPUT

Media	Speed
Paper Tape (Punch)	60 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS ENTIRE SYSTEM

Crystal diodes	300
Magnetic cores	18,480
Transistors	5,000

The above figures are for the computer proper, and do not include input-output equipment.

CHECKING FEATURES

Odd parity checks on storage and input-output operations.

POWER, SPACE AND WEIGHT

Power, computer	0.160 KW
Space, computer	16 cu ft
Weight, computer	450 lbs

Figures are for computer proper and do not include input-output equipment.

PRODUCTION RECORD

Produced	1
Operating	1

This system is a feasibility model and was not designed for production.

RELIABILITY AND OPERATING EXPERIENCE

This system has been completed and is being "checked out".

INSTALLATIONS

Bell Telephone Laboratories, Incorporated
Whippany, New Jersey

ADDITIONAL FEATURES AND REMARKS

LEPRECHAUN features flexibility in the logical interconnections in order to make it useful for logical design research. The operation code has been designed to eliminate the need for many "red-tape" operations. For example, a special unconditional jump operation simplifies the inclusion of subroutines in a program. Address modification is accomplished by direct substitution. This operation, together with a repeat operation, which operates on sequential addresses, gives operation equivalent to a B-box.

The machine contains a manual breakpoint provision, several checking modes of operation and complete marginal checking facilities.

LGP 30

Librascope General Purpose Computer Model 30

MANUFACTURER

Librascope, Incorporated



Picture by Librascope, Incorporated

APPLICATIONS

Manufacturer

Scientific computing, a "minimal" computer.

Industrial Sample

Servomechanisms, Incorporated

System is used for the solution of advanced engineering problems in the field of automatic control.

NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	30 plus sign
Binary digits per instruction	16
Instructions per word	1
Instructions decoded	16
Instructions used	16
Arithmetic system	Fixed point
Instruction type	One address
Number range	-1 to +1

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	8,750 (av)	250
Mult time	24,000	16,000
Div time	24,000	16,000
Construction	Vacuum tubes	

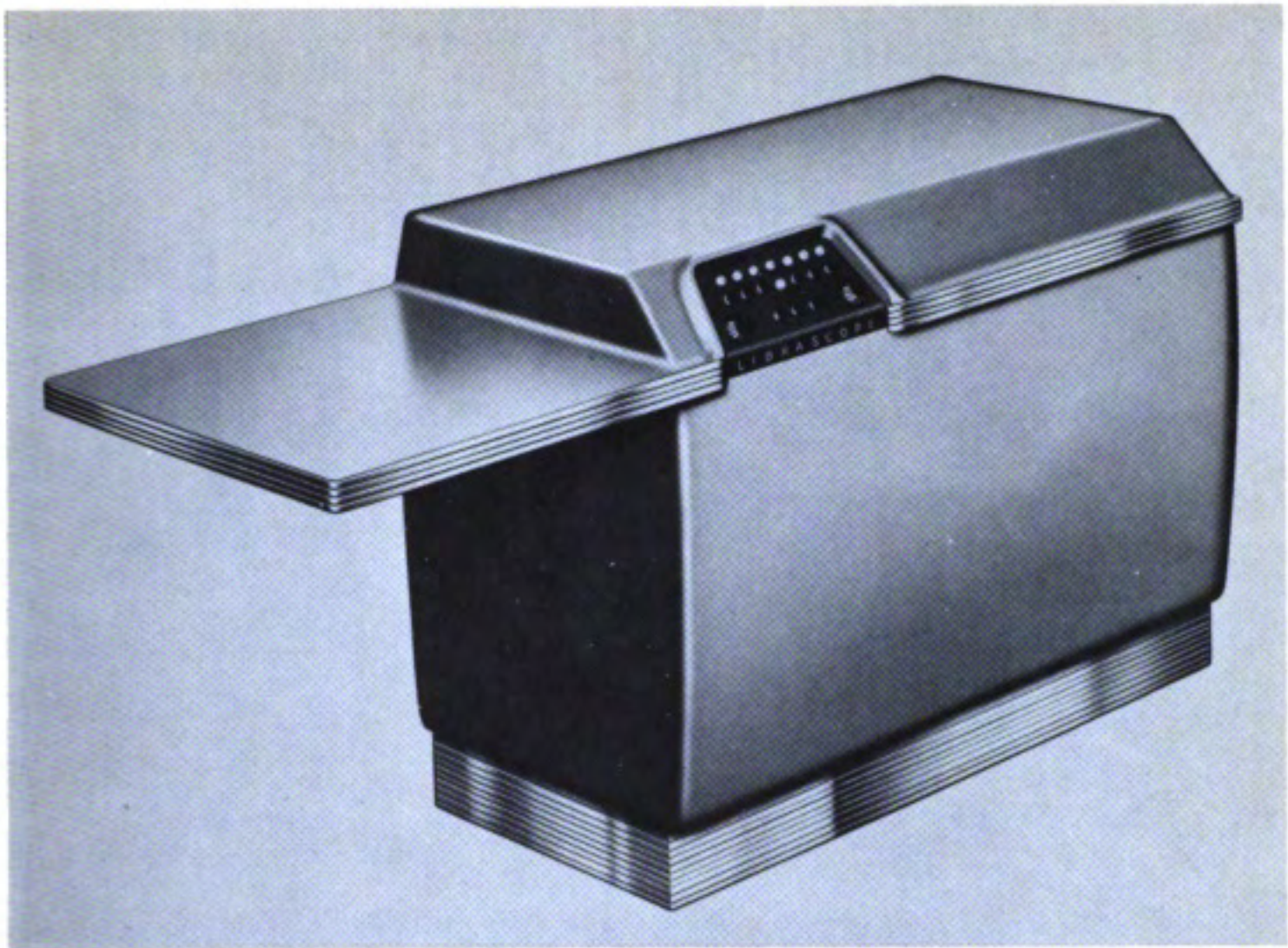
Basic pulse repetition rate	140 Kc/sec
Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

The source of the 140 Kc/sec pulse is a clock track on the magnetic drum. The operation times given above are for a typical short operation.

Industrial Sample

Servomechanisms, Incorporated

Addition time of 2,260 microseconds, and multiply and divide time of 19,000 microseconds, including



Picture by Librascope, Incorporated

storage access time, is obtained with proper programming.

STORAGE

Media	Words	Microsec Access
Magnetic Drum	4,096	7,500

An "Interlace" system is used so that a complete instruction can be done in 2,200 microseconds, including both accesses when optimum programmed. The maximum operation time is 15,000 microseconds, or the time for one revolution of the drum which rotates at 4,000 RPM.

Industrial Sample
 Servomechanisms, Incorporated
 A relatively simple programming method allows minimum access at all times.

INPUT

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
Keyboard (Flexowriter)	Manual

Industrial Sample
 Servomechanisms, Incorporated
 High speed paper tape and punched cards will be available.

OUTPUT

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
Printed Page (Flexowriter)	10 char/sec

Industrial Sample
 Servomechanisms, Incorporated
 A Mosely plotter is used to plot curves from the output (Flexowriter) tapes.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	112 (Miniature, computer type)
Tube types	7 Primarily 5687, 5965 and 5915
Crystal diodes	1,500 Subminiature
Separate cabinets	1

Printed circuits are used extensively.

CHECKING FEATURES

Fixed
 Stop on Accumulator overflow in addition, subtraction, or division.

POWER, SPACE AND WEIGHT

Power, computer	1.5 KW
Space, computer	22 cu. ft. 8 sq. ft.



Picture by Servomechanisms, Incorporated

Weight, computer 800 lbs.
 Capacity, air cond. Internal blower only
 Computer can be plugged into a 15 ampere, 110 volt, 60 cycle line.

Industrial Sample
 Servomechanisms, Incorporated
 The machine adds about 0.42 Ton to the air conditioning requirement of a closed room. It is estimated that 1-1/4 Ton is required to air condition room, operator and 2 observers, if required.

PRODUCTION RECORD

Produced	12
In production	50
Operating	12
On order	30
Delivery time	3 Months

COST, PRICE AND RENTAL RATE

Approximate cost of basic system \$39,600.
 Rental rates of basic system \$ 1,100/month.
 Service and maintenance contracts are available.

Industrial Sample
 Servomechanisms, Incorporated
 Curve plotter cost \$5,000 and basic system cost \$30,000.

PERSONNEL REQUIREMENTS

Manufacturer
 Most users have 1 or 2 programmers/operators.

Industrial Sample
 Servomechanisms, Incorporated
 For one 8 hour shift, one full time maintainer-operator is required, in addition to the partial services of one programmer.

RELIABILITY AND OPERATING EXPERIENCE

Manufacturer
 Operating ratio (Good/Attempted to run) 0.93 to 0.97

FUTURE PLANS

Industrial Sample
 Servomechanisms, Incorporated
 It is planned to integrate the system into the Engineering Department. Much formal mathematics will be by-passed on many problems.
 Griscom-Russell Company
 System on order.

INSTALLATIONS

California Institute of Technology
Pasadena, California

Convair Division
General Dynamics Corporation
Pomona, California

Ethyl Corporation
Baton Rouge, Louisiana

Esso Corporation
Baton Rouge, Louisiana

Servomechanisms, Incorporated
Westbury, New York

The Griscom-Russell Company
Massillon, Ohio

ADDITIONAL FEATURES AND REMARKS

Industrial Sample
Servomechanisms, Incorporated
Primary applications are essentially mathematical,
such as matrix inversion and equation solving.

LINCOLN MEMORY TEST

Lincoln Laboratory Memory Test Computer

Lincoln Laboratory
Massachusetts Institute of Technology



Picture by Lincoln Laboratory, Massachusetts Institute of Technology

APPLICATIONS

Simulation and data reduction, real time operation. The research reported in this computing system description was supported jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

NUMERICAL SYSTEM

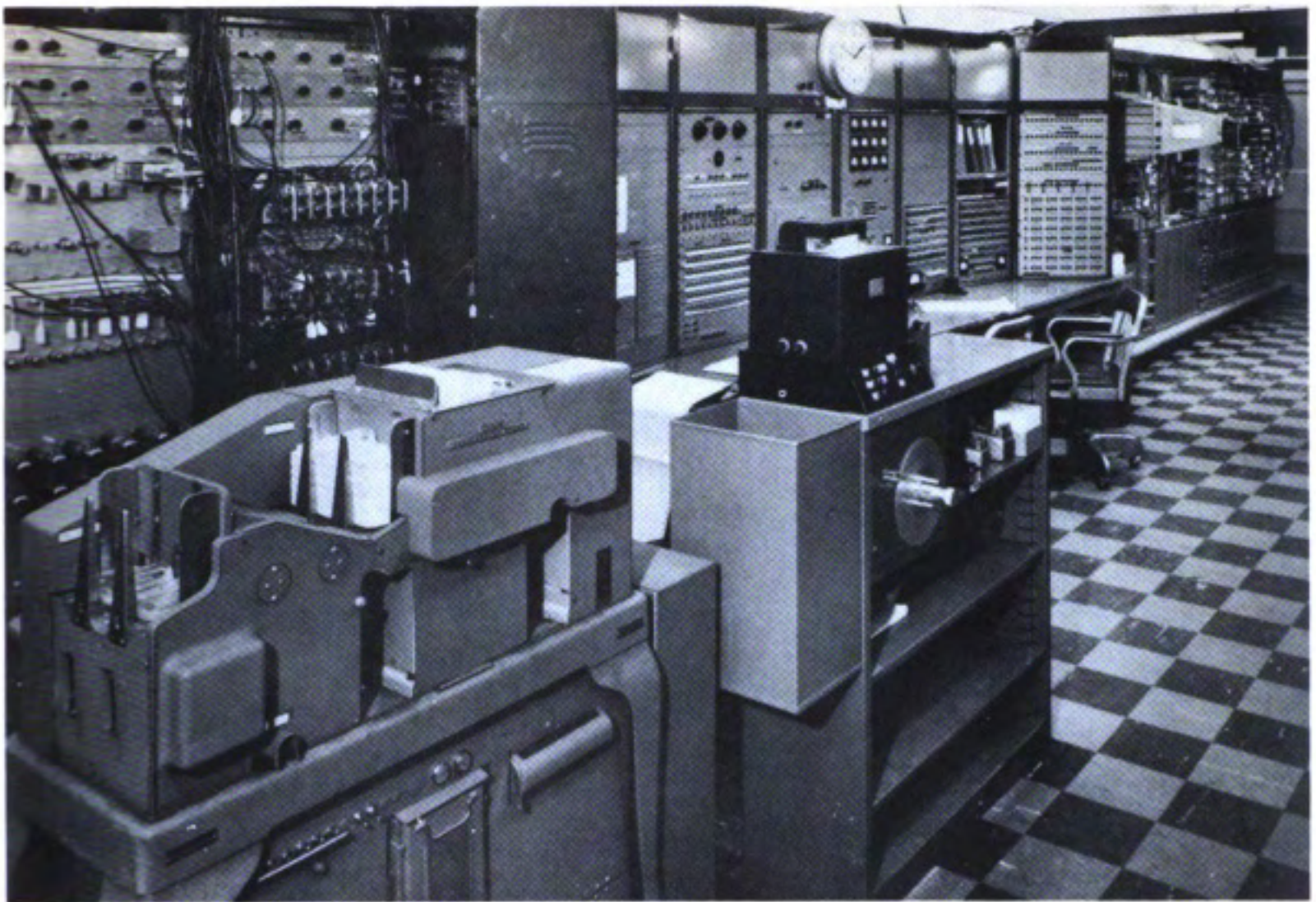
Internal number system	Binary
Binary digits per word	16
Binary digits per instruction	16
Instructions per word	1
Instructions decoded	32
Instructions used	28
Arithmetic system	Fixed point
Instruction type	One address
Number range	$2^{-15} - 1$ to $1 - 2^{-15}$

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Excl. Stor. Access Microsec
Add time	6	2
Mult time	40	36
Div time	74	70
Construction	Vacuum tubes	
Timing	Synchronous	
Operation	Concurrent	

Time between successive clock pulses is not fixed.
Multiply time is average, divide time is fixed.

Arithmetic mode Parallel



Picture by Lincoln Laboratory, Massachusetts Institute of Technology

STORAGE

Media	Words	Microsec Access
Magnetic Core	4,096	2
Magnetic Drum	24,576	10,000
Magnetic Tape	3 Units	80 words/inch
Toggle Switches	32	Read only
Plugboard	32	Read only

Rewrite time on magnetic core is 5.6 microsec.
 Three units of magnetic tape. There are 16 bits/word. Tape speed is 75 in/sec. Access time is 10,000 microsec (average) plus 10 N/block of N words, for magnetic drum.

INPUT

Media	Speed
Photoelectric Tape Reader	67 words/sec
IBM Card Reader	100 cards/min
Magnetic Tape	80 words/inch

CRT Display

3 lines per 16-bit word used on photoelectric tape reader. 48 16-bit words/card.

OUTPUT

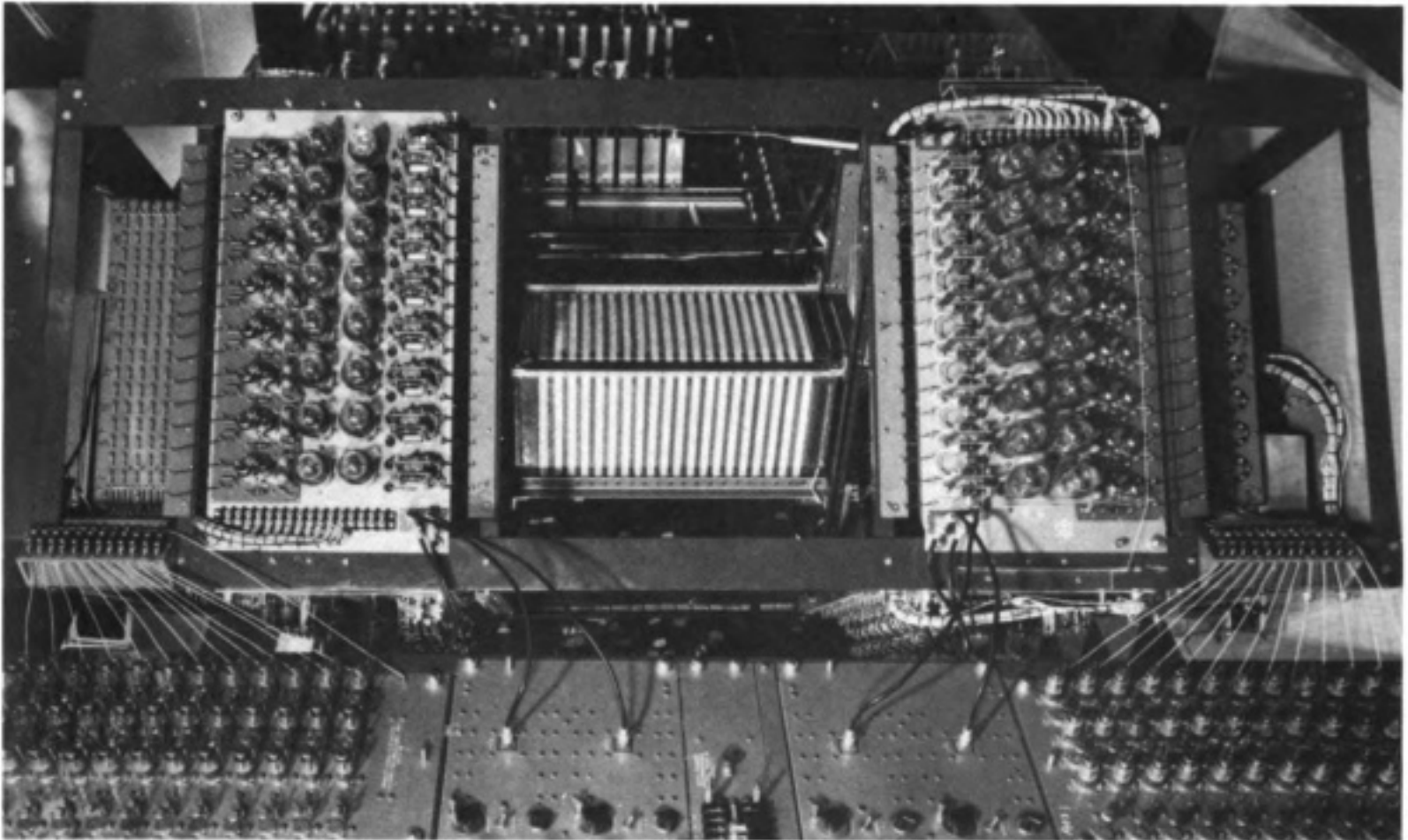
Media	Speed
Flexowriter Print	8 char/sec
Magnetic Tape	80 words/in 75 in/sec
IBM Punch	100 cards/min 48 16-bit words/card
CRT	25 microsec/spot 10 bits decoded for CRT

CRT display with camera operating at 2 frames/sec.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	5,864
Tube types	20
Crystal diodes	12,500
Magnetic cores	69,632
Transistors	22

All cores are utilized in the memory. Of the 5,864 tubes, there are 9,089 cathodes. 75% of the tubes are type 5965, 5998, 7AK7 and 6145.



Picture by Lincoln Laboratory, Massachusetts Institute of Technology

CHECKING FEATURES

Fixed
 Core memory parity check
 Tape parity check
 Arithmetic element checks

Optional
 Identity check instruction

POWER, SPACE AND WEIGHT

Power, computer 42.8 KW, 42.8 KVA
 Space, computer 3,045 cu. ft., 435 sq. ft.
 Space, air cond. 1,480 cu. ft., 157 sq. ft.

Area and volume computed by frame base and height.
 Air conditioning is by chilled water.

PRODUCTION RECORD

Produced 1
 Operating 1

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
3-8 Hour shifts	6	12

Above includes allowances for vacations, illness, and staff rotation. Normal office work and computer record keeping increase the total personnel by 4.

RELIABILITY AND OPERATING EXPERIENCE

Average error-free running period	7.1 hours
Good time	1,567 hours
Attempted to run time	1,620 hours
Operating ratio (Good/Attempted to run)	0.97

Figures based on period 1 August 56 to 31 October 56
 Acceptance test 1954

FUTURE PLANS

Immediate plans are for a new and improved type of Input-Output control that will allow concurrent operation of all Input-Output devices.

New devices to be added during the coming year are a high-speed (Soroban) paper tape punch and additional IBM card machines. At present an analog-digital converter is being installed as a direct input to the computer.

INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
Lexington 73, Massachusetts

ADDITIONAL FEATURES AND REMARKS

The following pertains to the pictures in the order in which they appear.

First picture: Ferranti tape reader and Flexowriter at extreme left, indicator fuze panel for marginal check lines at extreme right.

Second picture: Modified IBM 513 punch and Ferranti tape reader in foreground. Computer controlled camera near extreme right above back of chair.

Third picture: On central frame, from the top, diode address decoding matrix, selection drivers, magnetic core memory and selection drivers. On the left side are the "X" memory address register, read-write control and "Y" memory address register.

Computer has 2 floating address, assembly - conversion programs: "SAF", a limited and somewhat inflexible assembler is very fast through extensive use of magnetic tape. "SYAD", a slower but more flexible assembler is limited by the speed of present paper tape devices.

Each instruction pulse in the main control has the option of specifying "non-standard" time interval and/or sequence for the next pulse. Such flexibility greatly aids in addition or modification of instructions.

LINCOLN TX 0

Lincoln Test-Experimental Computer - 0

MANUFACTURER

Lincoln Laboratory, Massachusetts Institute of Technology



Picture by Lincoln Laboratory, Massachusetts Institute of Technology

APPLICATIONS

Manufacturer

An experimental digital computer used to test advance design techniques, including very large core storage and transistor circuitry.

The research reported in this computing system description was sponsored jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	18
Binary digits per instruction	18
Instructions per word	1
Instructions decoded	25
Arithmetic system	Ring-adder
Instruction type	One address
Number range	Not appropriate

Three instructions are addressable and 1 is micro-

programmable.

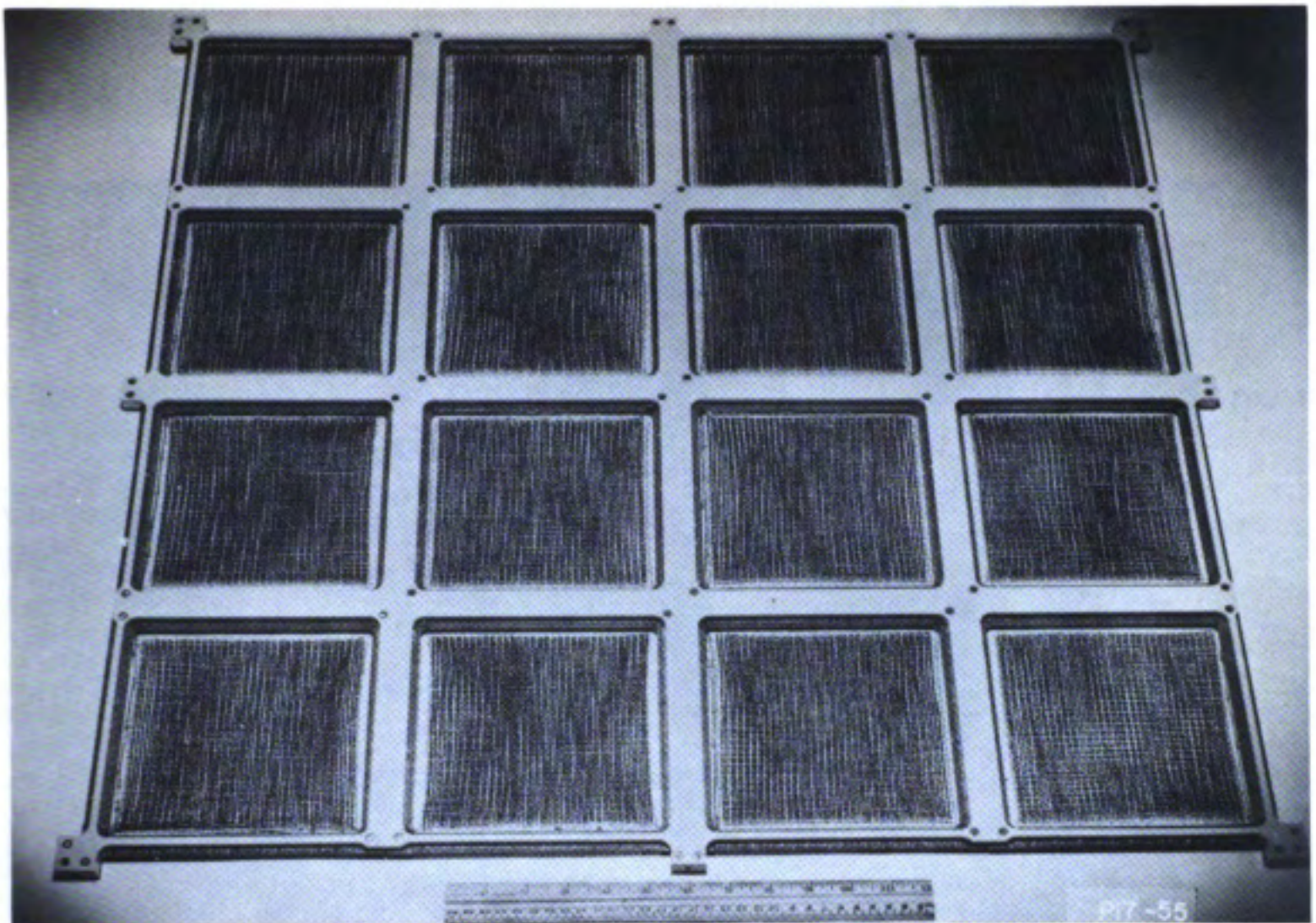
ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Excl. Stor. Access Microsec
Add time	6	1
Mult time	1,000	1,000
Div time	1,000	1,000
Construction	1,000 transistors	
Arithmetic mode	Parallel	
Timing	Synchronous	
Operation	Concurrent	

Computer performs 83,000 additions per second. Multiply and divide is programmed.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic core	65,536	18/word	3
Flip-flop	1	18/word	0.5
Toggle Switch	16	18/word	3



Picture by Lincoln Laboratory, Massachusetts Institute of Technology (TX 0 and TX 2 Memory Plane)

A parity bit is additional. Read-rewrite time is 6 microseconds.

INPUT

Media	Speed
Photo Reader	250 lines/sec
Flexowriter	Manual
Toggle Switch	Manual

OUTPUT

Media	Speed
Flexowriter	10 char/sec
Display (CRT)	16 microsec/spot

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	440
Tube types	3
Crystal diodes	350
Magnetic cores	1,245,773
Transistors	3,500
Separate cabinets	5

Three major tube types, a small number of others. Most tubes are used in the large memory. The transistors are the Philco L-5122 Surface Barrier Transistor.

CHECKING FEATURES

Parity check on memory systems. Maginal checking is built in.

POWER, SPACE AND WEIGHT

Power, computer	10 KW
Space, computer	1,000 cu. ft. 200 sq. ft.
Weight, computer	4,000 lbs.
Capacity, air cond.	40 Tons

Above figures are approximate. Air conditioner is necessary for memory only.

INSTALLATIONS

Produced	1
Operating	1

PRODUCTION RECORD

Lincoln Laboratory, Massachusetts Institute of Technology, Lexington 73, Massachusetts

ADDITIONAL FEATURES AND REMARKS

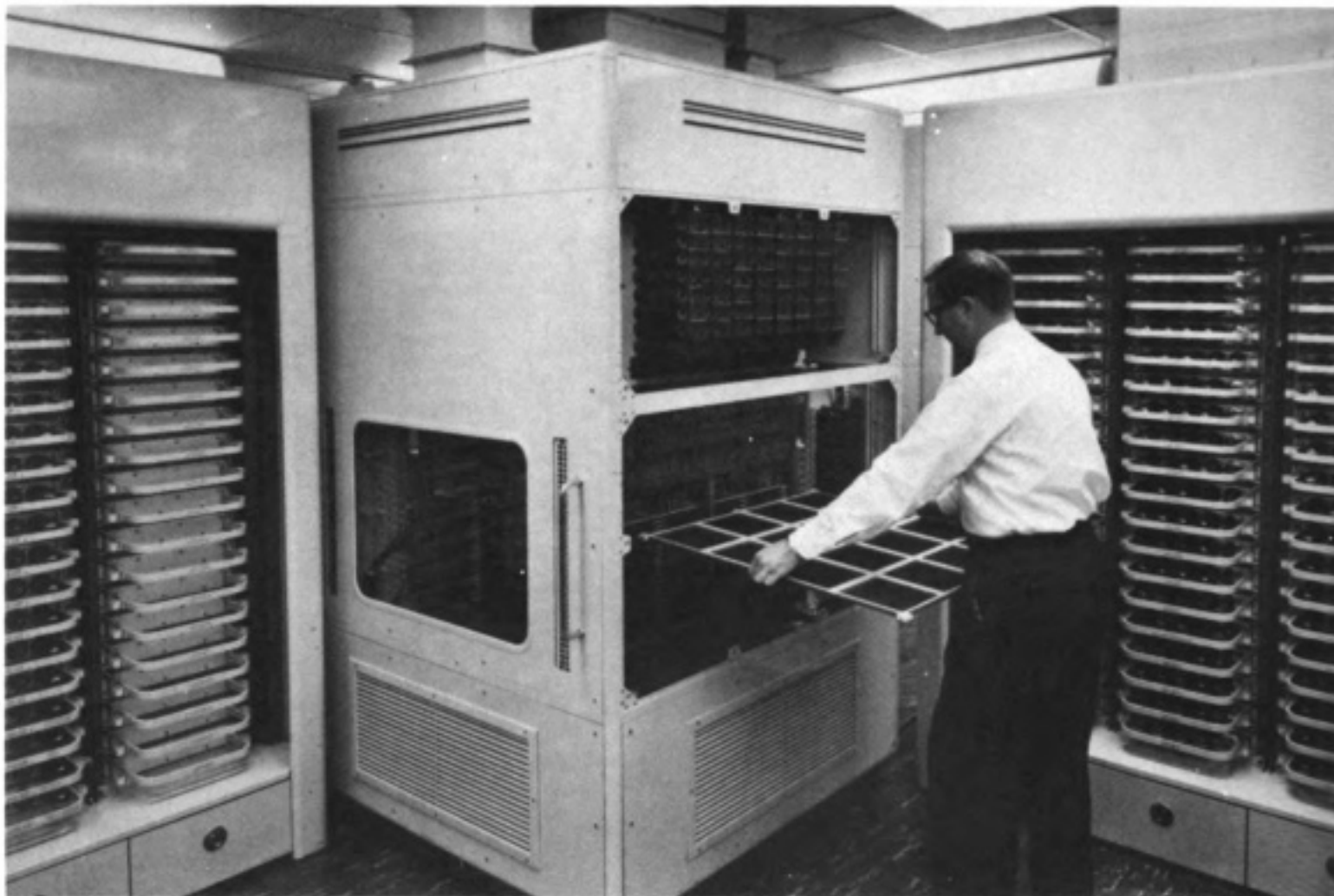
One picture shows close-up view of magnetic core memory plane and other picture shows random-access core memory, frame of memory-core selection-switch drivers, computer arithmetic element and control element, and computer operating console.

LINCOLN TX 2

Lincoln Test-Experimental Computer - 2

MANUFACTURER

Lincoln Laboratory, Massachusetts Institute of Technology



Picture by Lincoln Laboratory, Massachusetts Institute of Technology (TX 2 and TX 0 Memory Stall)

APPLICATIONS

Manufacturer

Scientific research, simulation, and control. The research reported in this computing system description was supported jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	36
Binary digits per instruction	36
Instructions per word	1
Instructions decoded	64
Arithmetic system	Fixed point
Instruction type	One address, indexable
Number range	2^{-35} -1 to $1-2^{-35}$

ARITHMETIC UNIT

Operation	Incl. Stor. Access Time Microsec	Excl. Stor. Access Microsec
Add	6	1.5
Mult	10	10
Div	54	54

Construction 5,000 transistors
Arithmetic mode Parallel
Timing Synchronous
Operation Concurrent

Computer performs 166,000 36-bit additions per second, 60,000 36-bit multiplications per second, and 14,000 divisions per second. The 36-bits may be split into four 9-bit groups, two 18-bit groups, or a 27-bit group plus a 9-bit group. Up to 4 separate operations may be performed simultaneously.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic Core	65,536	36/word	3
Magnetic Core	4,096	36/word	2

A parity bit is additional. Read-rewrite time is 6 microseconds.

INPUT

Media	Speed
Paper Tape Reader	250 lines/sec
Analog to digital conv.	100,000 samples/sec
Flexowriters	Manual
Light Pen	

OUTPUT

Media	Speed
Flexowriters	10 char/sec
Display Scope	10 microsec/spot
High-speed printers	1,000 char/sec

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	610
Tube types	4
Crystal diodes	Negligible
Magnetic cores	2,540,000
Transistors	25,000
Separate Cabinets	4

Most of the tubes are in the large memory. A small number of other tube types are used in addition to the 4 major types. The transistor types include Philco Surface Barrier L5122, Philco Micro Alloy L5134, GE 2N167, GE 2N188A, GE 2N123, WE GA 52830, Sylvania GT901, Sylvania GT903.

CHECKING FEATURES

Parity check on memory systems. Machine has built-in marginal checking.

POWER, SPACE AND WEIGHT

Power, computer	14 KW
Space, computer	1,000 cu. ft. 200 sq. ft.
Weight, computer	4,000 lbs.
Capacity, air cond.	40 Tons

Air conditioner is required for core memory only.

PRODUCTION RECORD

Produced	0
In production	1
Operating	0

FUTURE PLANS

A floating point system is to be added. Input-Output system is to be expanded.

INSTALLATIONS

Lincoln Laboratory, Massachusetts Institute of Technology, Lexington 73, Massachusetts

ADDITIONAL FEATURES AND REMARKS

64 index registers and counters are utilized. Arithmetic element can be used in various word-length modes:

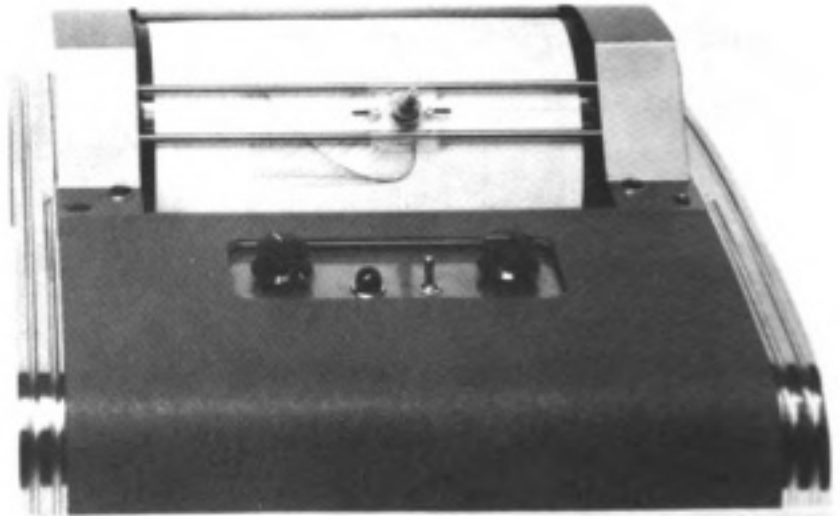
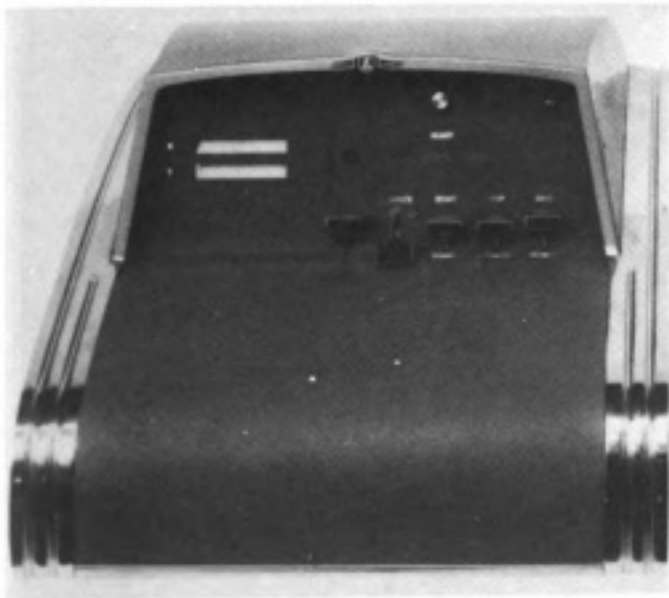
36-bit
18-18-bit
9-9-9-9-bit
27-9-bit

Multi-sequence operation is possible.

LITTON 20 40

Litton 20 40
Portable Digital Differential Analyzers

Litton Industries



Picture by Litton Industries

APPLICATIONS

Manufacturer

Solution of linear and non-linear differential equations, simulation and system analysis.

Government Sample

U. S. Naval Postgraduate School
Education, science and engineering.

NUMERICAL SYSTEM

Manufacturer

Internal number system Binary
Binary digits per word 18
Arithmetic system Floating point

Number range $\pm 131,000$

This system is a digital differential analyzer and not an arithmetic computer.

Government Sample

U. S. Naval Postgraduate School
Operation on fixed point basis scaled between $-1 \leq n < 1$, with a fixed program.

ARITHMETIC UNIT

Timing Asynchronous
Operation Sequential

STORAGE

Manufacturer

Media	Words	Digits	Microsec Access
Magnetic Drum	20	1,600	15,000
Magnetic Drum	40	3,200	30,000

This is not actually comparable to a general purpose digital computer, since the functions of storage are quite different. The model number corresponds to the number of words of magnetic drum storage.

Government Sample

U. S. Naval Postgraduate School
Each of 20 integrators contains, in part, an R-Register and a Y-Register and the contents of each of these registers is considered as one word. The drum turns at 3600 RPM, with integrators being processed once during each drum revolution.

INPUT

Media	Speed
Tape Fill	20 integrators/min
Curve Follower	62 increments/sec
Manual	2 integrators/min

OUTPUT

Media	Speed
Graph Plotter (Digital)	31 increments/sec
Dig to Analog Converter	31 increments/sec

Digital information is displayed on cathode ray tube on front panel of computer.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	46
Crystal diodes	500
Separate cabinets	1 plus input-output devices

The WE404A is a type of tube used.

CHECKING FEATURES

Manufacturer

Fixed
Checking features are included.

Government Sample

U. S. Naval Postgraduate School
Overflow in a register will stop computation.

POWER, SPACE AND WEIGHT

Manufacturer

Power, computer 0.33 KW
Space, computer 0.5 Cu. ft.
Weight, computer 70 lbs.

No air conditioning required. A small fractional horsepower blower for ventilation is integral with computer.

Government Sample

U. S. Naval Postgraduate School
Computer requires 320 watts, 110 volts, 60 cycle AC, measures 15 x 26 x 10 inches and weighs approx. 70 lbs. The plotter requires 100 watts, 110 volts, 60 cycle AC, measures 19 x 18 x 9 inches and weighs 45 lbs.

PRODUCTION RECORD

Produced 17
Operating 17
Delivery time 2 to 3 Months

COST, PRICE AND RENTAL RATE

Approximate cost of basic system

The Litton 20 is \$12,800
The Litton 40 is \$16,800

Approximate cost of additional equipment

The Graph Plotter is \$3,600
The Paper Tape Punch Reader \$3,700
The Graph Plotter/Follower is \$4,700

Computer prices include training courses in operation and maintenance, and also includes spare plug-in units, diode plug-in test equipment and maintenance and operation manuals.

Rental rates of basic system

Approximately 5 per cent of cost per month with applicability to purchase.

Rental rates of additional equipment

Approximately 5 per cent of cost per month.

Government Sample

U. S. Naval Postgraduate School
Litton 20 \$9,865, Plotter \$2,760.

PERSONNEL REQUIREMENTS

One man operation completely.

RELIABILITY AND OPERATING EXPERIENCE

Average error-free running period 5 to 6 months

Only failures in all equipments in operation have been diode replacements.

FUTURE PLANS

Government Sample

U. S. Naval Postgraduate School
Addition of a paper tape reader is planned.

INSTALLATIONS

Government Sample

Naval Ordnance Laboratory, Corona, California
Naval Postgraduate School, Monterey, California
Naval Research Laboratory, Washington, D. C.
Signal Corps Engineering Laboratory, Belmar, N.J.

Industrial Sample
Sandia Corporation, Albuquerque, New Mexico

ADDITIONAL FEATURES AND REMARKS

Manufacturer

System advantages are simplicity and ease of programming and operation, programming time usually less than an hour, training on the machine requires only 1 day, machine is capable of driving analog actuators directly, and size, weight, power and economy for versatility and utility.

Some of the important features to be found in the LITTON 20 are listed below:

Can be used to solve both linear and non-linear differential equations.

Integration can be performed using any number of independent variables.

Arbitrary functions can be generated within the machine or obtained from curve followers.

Sign reversal can be obtained directly from the output of a working integrator.

Summation of multiple inputs is an automatic feature available in every integrator.

Some partial differential equations can be solved. Simultaneous equations, up to the machine capacity, can be solved.

Every integrator can communicate with all other integrators; any number of multiple inputs can be used.

Equipment:

LITTON 20: Program filled by use of keys located on the front of the computer. Output available from cathode ray display tube on front panel which displays digital information.

Auxiliary Equipment (Optional):

Combination paper tape punch, for preparing input data, and punched paper tape reader for reading prepared data into the computer.

Graph plotter-follower for input of arbitrary functions, and for output of data.

Maximum Accuracy:

One part in 250,000.

Iterative Process:

Every integrator is iterated sixty times each second.

Integrator Interconnections:

Integrators are interconnected by programming and not by plug boards; a mark is recorded in the appropriate digit position for each desired input pick up. Each integrator can communicate with all others.

Solutions:

Any solution is exactly reproducible any number of times.

Specifications

Machine specifications subject to change.



Picture by George Washington University and the Office of Naval Research

APPLICATIONS

Data handling for short, repetitive routines; system is used for research purposes.

NUMERICAL SYSTEM

Internal number system	Decimal
Decimal digits per word	Variable (4-12)
Arithmetic system	Fixed point

The computer is plug-board controlled. The excess 3 system of binary notation is used. The plug-board control provides operations of addition, subtraction, multiplication, input and output, and various logical operations. Electronic selector switches are used (under program control) to alter the plug-board wiring. Several electronic registers hold the results of numerical operations. Drum word length is variable from 4 to 12 decimal digits,

inclusive, but must remain fixed during any drum loading.

ARITHMETIC UNIT

Time	Microsec
Add (Exclud. Stor. Access)	96 + 32d
Mult (Exclud. Stor. Access)	1,660 to 14,000
Rapid access word registers	5
Basic pulse repetition rate	220 Kc/sec
Arithmetic mode	Serio-parallel
Timing	Synchronous
Operation	Sequential

"d" above is the number of digits/word. Multiply time is a function of the word length. The arithmetic mode is serio-parallel, since each decimal digit is serial, the four binary digits, expressing the decimal digit, are parallel.

STORAGE

Media	Decimal Digits	Microsec Access
Magnetic Drum	180,000	17,000 Max
Electronic Registers	55	96-129

The number of words of storage obtainable on the drum varies from 37,300 words at 4 decimal digits per word to 14,300 words at 12 decimal digits per word. The recording method on the drum is the non-return to zero method and the packing density is 140 binary digits/inch. For the electronic registers, the 55 digits are contained in 5 shifting registers and 3 limited storage registers.

INPUT

Media	Speed
Paper Tape	325 or 162.5 char/sec
Paper Tape	200 char/sec
Magnetic Tape	325 or 162.5 char/sec

The paper tape readers are an Electronic Research Associates and a Ferranti reader, respectively.

OUTPUT

Media	Speed
Paper Tape (Teletype)	60 char/sec
Magnetic Tape	600 char/sec
Typewriter	10 char/sec

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	4,500
Tube types	3
Crystal diodes	4,000
Magnetic cores	246
Relays	200
Separate cabinets	3

The three types of tubes are for general use.

CHECKING FEATURES

Fixed
Arithmetic fault overload.

Optional
"Excess 3" false code detector, address overload, product overload, tape-fast overload and significant digit detector.

POWER, SPACE AND WEIGHT

Power, computer	45 KW
Space, computer	190 sq. ft.
Capacity, air cond.	11 Tons

Power above includes air conditioner.

PRODUCTION RECORD

Produced	1
Operating	1

COST, PRICE AND RENTAL RATE

Approximate cost of basic system	\$350,000
Approximate cost of magnetic tape units	\$ 50,000

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
1-8 Hour shift	2	4

RELIABILITY AND OPERATING EXPERIENCE

Average error-free running period	7 hours
Good time	7 hours
Attempted to run time	7.3 hours
Operating ratio (Good/Attempted to run)	0.96
Figures based on period	May 1956 to November 1956
Acceptance test	March 1953

The 7 hours, generally free of error, is obtained after the machine is warmed up each day.

INSTALLATIONS

Logistics Research Project
George Washington University
707 22nd Street, N. W.
Washington 7, D. C.

ADDITIONAL FEATURES AND REMARKS

This computer was an early application of the concept of tailoring a computer to its task. Its application is for research purposes.

FUTURE PLANS

A modification program is underway to provide direct, parallel-reading, punched card input and output. A second magnetic drum is to be provided to map 7 decimal digit numbers into 5 decimal digit addresses for the present drum. It is also planned to increase the number of available plugboard steps.