Birthing the Computer

Birthing the Computer:

From Drums to Cores

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This volume is dedicated to my mother, Dolores, and to my wife, Chryl, who have supported this endeavor – each in her own way. Their forbearance allowed me to work on the multiple volumes in this series concurrently. My children, Rebecca and John, both put up with dad's passion for documenting historical computing machines. And, the family cats – Annie, now deceased, and Izzy, Scooby and Tatiana – have all taken turns at sentry duty lying behind my keyboards and ensuring that I worked diligently.

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INTRODUCTION

This volume is the second of a multiple volume set on Historical Computing Machines. We continue with the evolution of computing systems from two perspectives. First, a variety of memory systems evolved to provide larger, faster memories. As a consequence, computing machines became more capable and evolved through enhanced functionality. We also see the beginnings of I/O systems which allowed users to interact with the system, and to have persistent storage that was somewhat easier to use for their programs and data.

PART I

MAGNETIC DRUM MACHINES

Pre-core memory machines relied on a variety of devices to provide working memory, including magnetic drums, mercury delay lines, and plated wires. Drum memories were one of the earliest mass storage devices attached to computing machines. Several variations will be addressed in coming chapters as auxiliary storage devices after magnetic disks were developed. Magnetic drums were rotating cylinders whose exterior surfaces were coated with a ferromagnetic material. In most early systems, a linear array of read/write heads was positioned along the length of the drum to store and retrieve bits of data by magnetizing positions on the drum's surface.

Gustav Tauschek, an Austrian national, invented the first magnetic drum in 1932. Early in his career, Tauschek developed several punched card accounting machines. In 1932, he received a US Patent, No. 1880523, entitled "Setting Device for Calculating Machines and the Like", which clearly depicts a rotating drum on which data could be recorded. The patent was received for the magnetic drum. His device could record about 500,000 bits or about 62.5 Kbytes.

The idea of the magnetic drum was further elaborated at the Institute for Advanced Study (IAS) in Princeton, New Jersey in 1946 as a way to provide additional, easily accessible storage for the IAS machine. In the early 1950s, engineers at Engineering Research Associates (ERA) designed and developed a magnetic drum for the main memory of the ERA 1101 (Hill 1950, ERA UNK). Other manufacturers also designed and used their own magnetic drums in 'one-off' designs until the mid-1950s. By then, magnetic drums came into wide use as computer manufacturers developed product lines that needed highly reliable magnetic drum subsystems for main and auxiliary memories for their computers. Reliable, low-cost magnetic drums of varying capacities enabled the production of lower-cost reliable machines.

In its most basic form, a magnetic drum was a cylinder coated with a ferromagnetic material and mounted either vertically or horizontally on a spinning shaft. Most magnetic drums had one head per track. The heads

did not move. The controller selected the head for the track where the data was stored and waited for the data to come under the head. However, the Univac FASTRAND drums had multiple moving heads which reduced cost but increased latency to access and transfer data. As wait time was due solely to the rotational latency of the drum, a number of sophisticated schemes were developed for early machines to optimize the placement of data on the drum. Knowing the time it took to load an instruction or data item from a particular location on the drum, the programmer could place the next sequential data item just at the point where the previous read ended and a new read could begin.

It is interesting to note that the concept of a drum is retained in today's UNIX and variant systems. /dev/drum is used to refer to the default virtual (swap) device. (Gloutnikov UNK)

Part I explores a few of the magnetic drum machines. Others will be described in volumes associated with specific manufacturers, such as National Cash Register (NCR), the Consolidated Engineering Corporation CEC 201, which became Datatron and was bought by Burroughs, and the General Electric GE 210.

Chapters:

CHAPTER ONE

IBM 650 MAGNETIC DRUM CALCULATOR

The IBM 650 was IBM's first commercial computer offering. It was a general-purpose, stored-program computer that used a magnetic drum for the primary memory. Hence, it was called the Magnetic Drum Calculator. It evolved from IBM's Card Programmed Calculator (CPC). Frank Hamilton, who designed the ASCC and SSEC, was the designer. Figure 1-1 depicts the IBM 650. The basic characteristics of the IBM 650 are depicted in Table 1-1 (IBM UNKa, Weik 1961).

Figure 1-1. IBM 650 Magnetic Drum Computer
Source: IBM UNKa

Table 1-1 IBM 650 – Basic Characteristics

Characteristic	Value/Explanation
Internal Representation	Fixed Point Decimal
# Bits/Word	70 (10 digits of 7 bits each) plus 1 bit for sign
#Instructions/Word	2
# Instructions	42
Instruction Type	Two address: operand and next instruction
CPU Technology	Vacuum Tube
CPU Registers	3 Accumulators – 10 digits (Upper, Lower and Distributor)
Main Memory	Magnetic Core: 60 words Magnetic Drum: Basic: 2,000 words (Model 2); 4,000 words (Model 4) Expanded: up to 10,000 words
Add Time	Fixed Point: 760 microseconds
Multiply Time	Fixed Point: 12 milliseconds
Divide Time	Fixed Point: 16.2 milliseconds

Several thousand of the IBM 650s were delivered beginning in December 1954. This machine's base price was approximately $182,000. It could also be rented for about $3,500 per month. At the time, the rental price was about the same as required to rent a fully loaded Cadillac from General Motors.

An academic discount of about 60% made the machine available for $72,800. For many universities, the IBM 650 was to be their first computer. The academic discount was conditional on the institution teaching computer-related courses. IBM foresaw that a lack of computer professionals would hamper their ability to sell machines into markets that could effectively use them. IBM seeded the programming industry through its academic discount by encouraging the teaching of computer-related courses. The graduates who used IBM computers in their courses were more likely to become buyers of IBM computers when they entered the commercial marketplace.

The last IBM 650 was sold in 1962. However, industry and universities continued to use these workhorse machines for over 10 more years.

1.1 650 System Architecture

The IBM 650 system architecture is depicted in Figure 1-2. The CPU consisted of three units: the accumulator, the distributor, and the adder. All data entering the accumulator first had to pass through the distributor and

the adder. Data going from the accumulator to general drum storage also passed through the distributor.

Arithmetic operations were performed using the contents of the distributor and the contents of the accumulator using the adder which processed data one digit at a time.

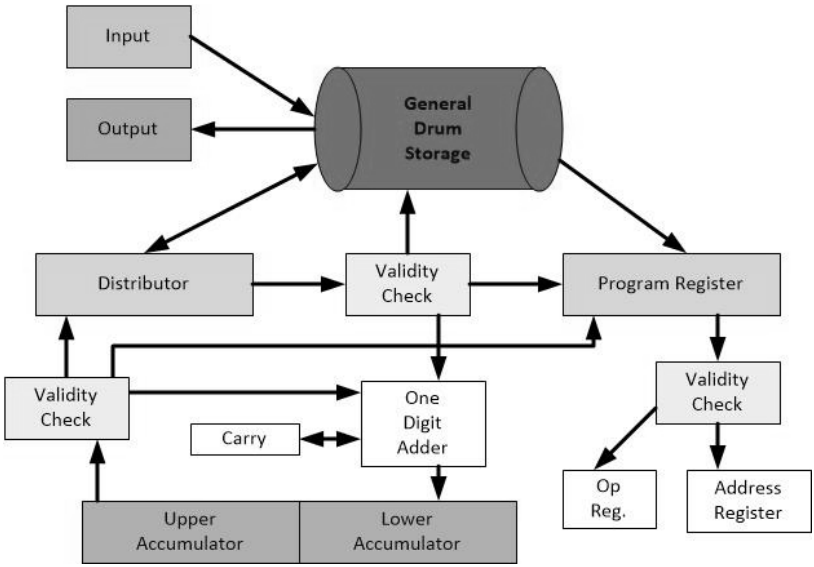

Figure 1-2. IBM 650 System Architecture
Source: Adapted from Andree 1956

1.1.1 Magnetic Drum Memory

The IBM 650 primary memory was provided by a magnetic drum, which originally had 1,000 words, then 2,000 words of storage, later expanded to 4,000 words and then, 10,000 words. Figure 1-3 depicts the magnetic drum assembly.

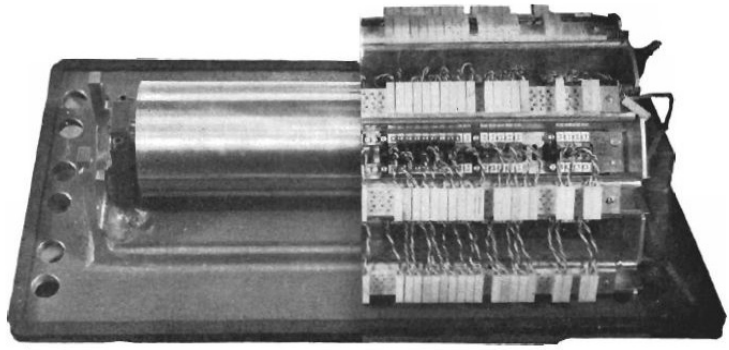

Figure 1-3. IBM 650 Magnetic Drum Assembly
Source: IBM 1957b
Courtesy of International Business Machines Corporation, © International Business Machines Corporation.

The drum had a speed of 12,500 rpm. Parallel to the axis of the drum were attached several inductive heads that read and wrote the information. The general storage portion had 2000 words where ten-digit words could be stored. The word position was location by determining first one of the 40 five-track bands, then determining the angular displacement of the word along the track. Figure 1-4 depicts the layout of the drum.

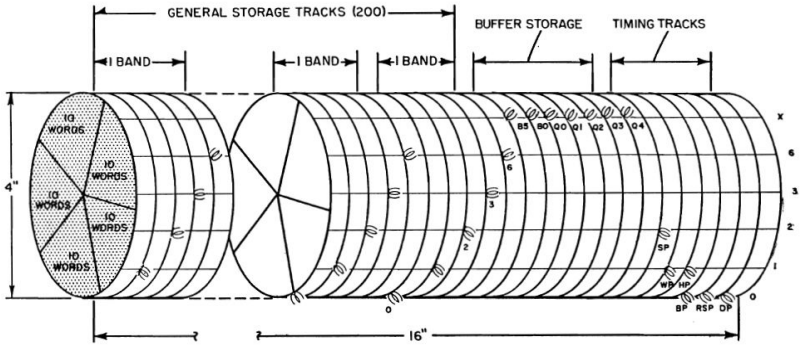

Figure 1-4. IBM 650 Magnetic Drum Arrangement
Source: IBM 1957b
Courtesy of International Business Machines Corporation, © International Business Machines Corporation.