Unit 2. Only Two Operations

Objectives of the unit

At the unit end the student should know

- Conversion devices
- Processor
- Radial structure of computer systems
- Programmable computer architecture

Conversion Units

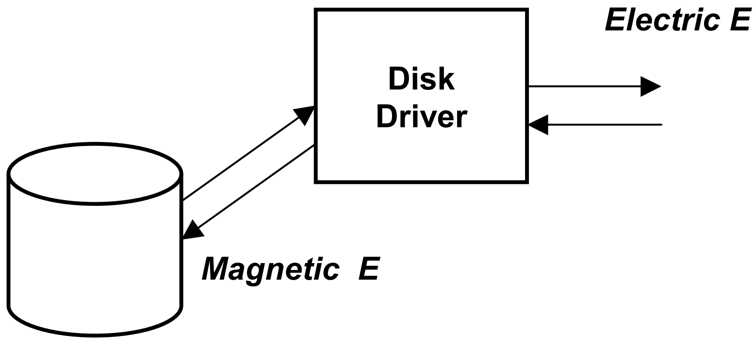


Figure 2-1

Video games and scientific calculations, texts processing and statistical overviews fulfill very different duties. The functions performed by computers seem uncountable. Nobody is able to draw up a complete inventory and to catalogue what a computer can do.
I do not go by this criterion; I shall follow another vein to get the concise understanding of the computer operations. I go on reasoning upon the concepts just introduced and shall arrive at the complete knowledge of the computer functions.

The features of the system S depend on the goods x that S brings forth. Computer systems handle information and we are capable of arguing their major activities from this product. I sum up its features in a couple of points

a) **E** is physical,
b) **E** stands for something.

Consequently computers can do but modify the physical and semantic sides of information. They perform only two kinds of operations that affect on the characteristics a) and b). The units of the computer change E physically and transform the meaning of E.

The computer accomplishes two primary works **And is equipped with two kinds of units**

Facts prove that our reasoning is correct. The computer units fall into only two classes that we shall examine:

A) The conversion unit (TR)
B) The process unit (EL).

* * *

A) Modern computers handle a large variety of physical items. They get mechanical data and deliver electric impulses; they put visual images and emit sonorous waves. A system can process this ample set of signals because the special units TR provide the appropriate messages. In particular TR converts the input into the output to wit the output of TR is physically diverse from the input whereas the significance is unaltered.

I exemplify the features of the most usual conversion units.

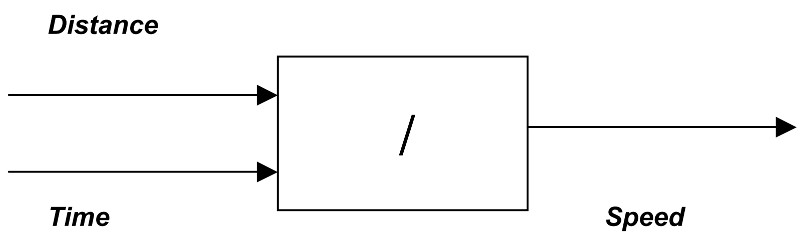
- The printer changes electric impulses into ink letters on the sheet.

- The keyboard translates the mechanical key **A** into a sequence of electric impulses. The meaning of the key **A** equals to the sense of signals.

- The display screen converts electric bits into bright points.

- The disk-driver transforms the magnetic bits of the disk into electric impulses. It changes them even in the opposite direction.

Process Unit



508 Km / 2 hour = 254 Km/hour

508 Km / 1 hour = 508 Km/hour

Figure 2-2

B) The second appliance manufactures information in relation to the point b). The **process unit** gets the input that represents NE1 and outputs the item which symbolizes NE2. In substance, EL provides new meanings.

For ease, the calculator receives two numbers denoting respectively Distance and Time. The division, which gives Speed, sets a clear example of data processing

NE1		→	NE2
Distance	**Time**		**Speed**
5O8 /	**2**	**=**	**254 Km/h**

The value **254 Km/h** represents something new with respect to the input. The number in output denotes something quite dissimilar from the input.

Even if the numbers are identical, the significance differs between the input and the output. As an example, if Time is 1 hour, than Speed equals to Distance but their meanings are quite unequal.

Distance		Time		Speed
5O8	/	**1**	**=**	**5O8** Km/h

Common processors receive and transmit electric bits. EL does not change information physically whereas it handles the significance.

EL appears creative because it obtains new information for people; instead the device does not invent. It applies the procedures assigned by engineers. The machine doesn't work after a personal idea. Intuition does not stimulate EL that executes rigidly the program instructions.

Computers process the numbers E that usually represent the material objects EN: dollars, cars, cities, individuals, pounds, volts, meters etc. The machine is very useful because of these practical meanings. Very rarely, EL handles abstract values. The computation of these numbers is an exceptional job. **If you take the exception for the rule, you will never grasp the practical purposes of computers in the world.** The abstract interpretation whitens or cancels the outstanding importance of the machine in your mind. I shall elucidate again this crucial topic in the last chapter.

Process Unit (contd.)

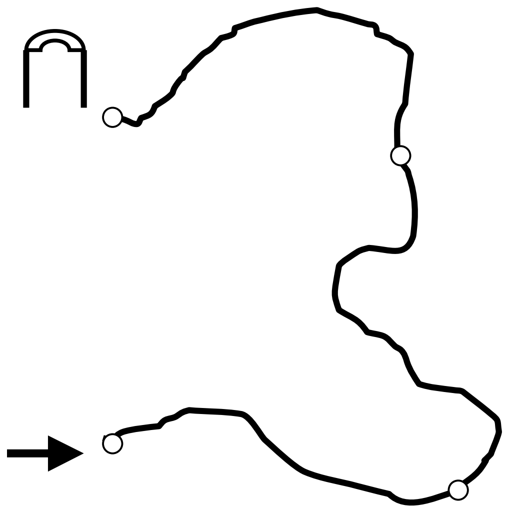


Figure 2-3

Now imagine that this formula exhibits the speed of a car running the first lap

5O8 / 2 = 254 Km/h

The computer calculates the second lap speed

734 / 3 = 247 Km/h

Then the third lap and so on. EL quickly computes all the laps and lists the performances of the car on a sheet of the paper.

This printout is although somewhat aged and consumers prefer to see the results in a more vivid fashion. Today they see a car moving on the screen, because the device displays the whole race on the basis of the EL computations.

Processors are so much effective that an entire complicated event can be **simulated** in a realistic form. Simulations regard past, present and future events, they are prepared for work and leisure. They forecast the weather, they represent an economic system and the earthquake effects, the satellite launch, a football match and uncountable other occurrences.

The simulation of a real or imagined environment may be experienced visually in the three dimensions of width, height, and depth The so called **virtual reality** provides an interactive experience in full real-time motion with sound and possibly with tactile and other forms of feedback. The simplest form of virtual reality is a two-dimension image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse. More sophisticated efforts involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and joystick devices that let you feel the display images.

Computers produce astonishing output on the basis of the input parameters and simulations constitute an excellent example of the information processing in accordance to the definition I have just given.

Note that the unit EL is able to achieve whatever outcome because of the digital technology. If the computer is analog, it is able to perform a prefixed number of functions, because every analog operation must be invented. Instead EL produces all the results you want through the bare combination of bits as we have just commented in the previous chapter.

Full Treatment

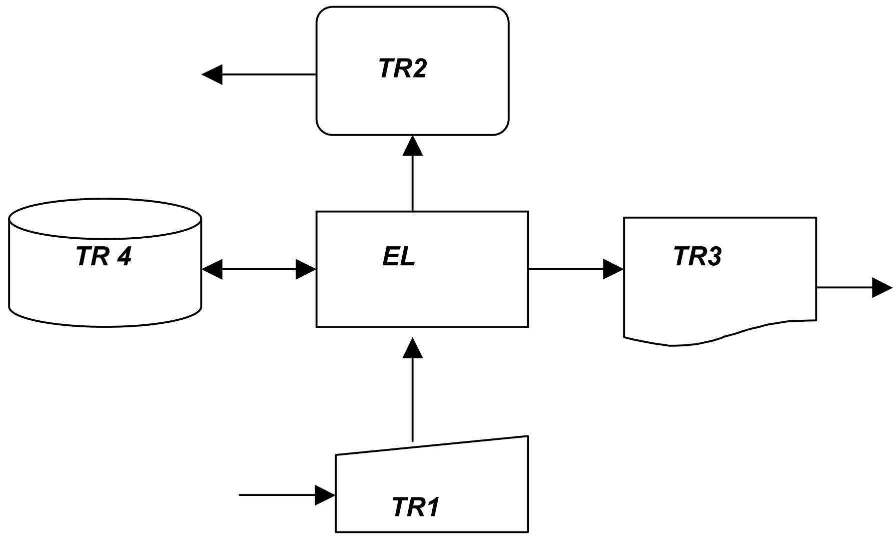


Figure 2-4

The essential activities of the computer system lead us to the discovery of its architecture. Once again I argue upon the knowledge just got.

EL is able to output any contents, due to the digital technology, but needs pieces of information physically homogeneous. Appropriate conversion units adapt them in aid of EL so that the machine accepts and delivers an ample variety of informational forms.

This requirement yields that TR units are placed at the periphery while EL lies at the centre (Figure 2-4bis). Because of their positions

- EL is named **central unit**;
- TR is named **peripheral** (or **input/output unit)**.

The computer structure consists of several peripherals and one central unit.

The machine assumes the *radial* configuration and experience upholds this conclusion. For ease, the Personal Computer in Figure 2-4 includes the keyboard TR1, the screen TR2, the printer TR3 and the disk drive TR4. The star-shape is evident.

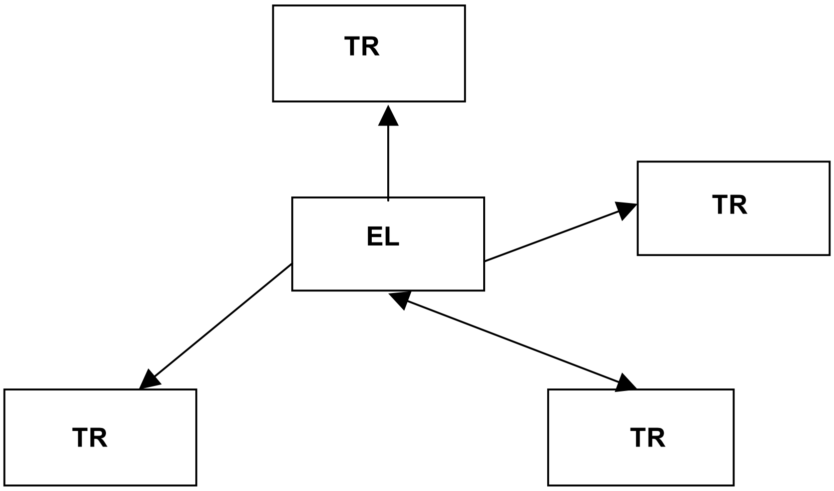


Figure 2-4bis

This pattern clarifies the identity of a unit when it appears confused to the sight. For example the hard disk drive, integrated in the central box, is nevertheless a peripheral.

* * *

Since centuries, man invented several devices capable of manipulating the physical form of information. Most of them marked the mankind advance. Printers, telegraphs and radio equipment are remarkable examples of conversion units invented from time to time.

Information processing instead was manual for millennia. A few analog tools aided people until the late nineteenth century, when mechanical calculators and tabulating machines, oriented to digital technology, began actually to support the human calculus.

The first computer was built around the middle of the twentieth century. It was the first machine capable of the full treatment of information by means of the conversion unit and the digital processor. Computers gave information the works. Electronics has progressively improved the performances. Circuits became ever more speed and currently conversion units are capable of managing a variety of media such as fax, radio, DVD etc. Every day they bring evidence of fulfilling any informational duty.

I can condense the long history of ICT in a few lines thanks to the conversion unit and the process unit that are essential manipulations of information. The variety of TR and the digital character of EL allow us to understand the technical progress in the informational realm.

Intriguing Hierarchy

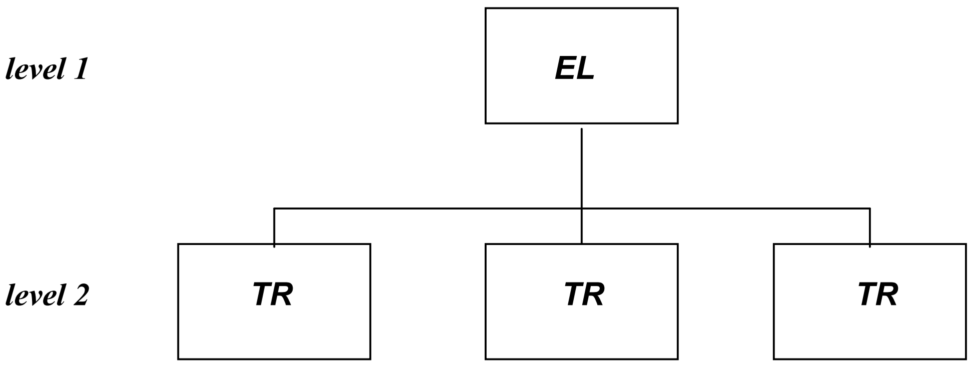


Figure 2-5

The peripheral TR converts the data that EL requires. TR serves EL, in other terms they make a hierarchical tree. The hierarchy property of the units consists with the star arrangement, in fact the peripherals scatter over an area and EL supervises them from the centre (Figure 2-5bis).

In conclusion hierarchy is a two-fold property because:

(1) The TR units serve EL.
(2) EL manages the peripherals.

The hierarchical diagram sums up this fundamental relation existing between the hardware units of the machine. We shall see how the hierarchy impacts also on the structure of software programs.

Hierarchy is the fundamental feature of a computer system

Hierarchy, that is dependence and conditioning, does not imply any philosophical or human significance; instead it entails that the lower part of the machine operates under the control of the upper component.

We shall examine in the last chapter the origins of this fundamental quality of the computer systems.

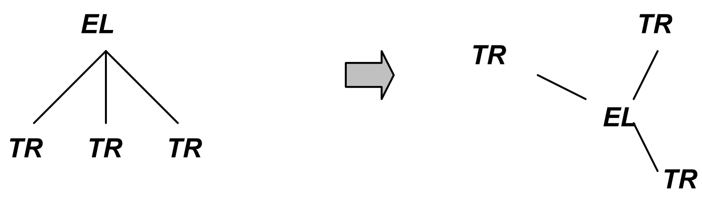


Figure 2-5bis

The study of information has led us to the basic functions of a computer and in turn to the star-diagram and the tree-diagram. You have realized the reasons of the computer architecture thanks to the notion of information, conversely common textbooks do not introduce any preliminary concept. They give the hardware units as facts and force the minds to accept them such as.
Some texts illustrate the computer structure through the following model.

Figure 2-5tris

Input/output units serve most mechanical systems. You find them in a lot of engineering applications hence Figure 2-5tris is absolutely trivial. The authors do not specify in what consists the process; which are the scopes of the input/output units, and do not elucidate the thorough transformation of information. The diagram deviates the mind because a computer system is star-shaped and not linear. Lastly this presentation ignores the hierarchical links between the units.
In short the model INPUT-PROCESS-OUTPUT offers a good example of the rough culture on computer system fundamentals in high schools and even in universities.
Not to worry if companies lack skilled users and technicians!

Programmable Computer Architecture

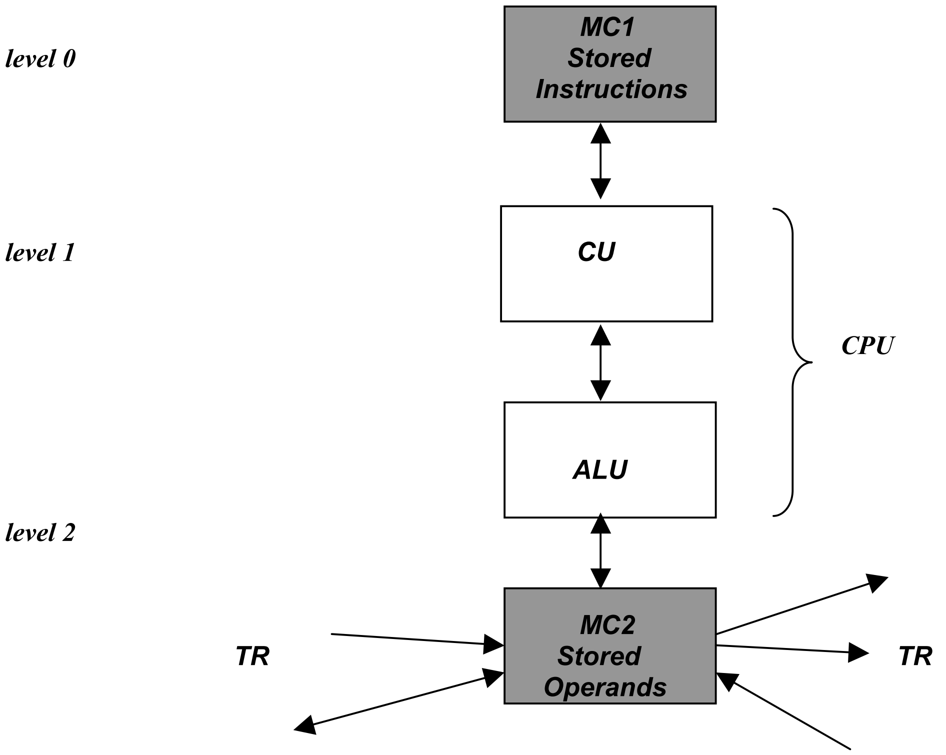


Figure 2-6

The radial graph and the hierarchical tree provide the preliminary views of the computer system. How are they put into practice? Which are the details?

I) - In conformity with the schemes 2-4bis and 2-5 the unit EL executes the logical/arithmetic operations such as this division

5O8 / 2 = 254 Km/h

And guides the machine. Therefore, the central unit splits into the **Arithmetic and Logic Unit (ALU)** and the **Control Unit (CU).** The former specializes in computing; the latter co-ordinates the peripherals and ALU. As an example, CU triggers the operations of ALU and input/output units in sequence, one after the other. CU manages also accidents, breakdowns and errors beside ordinary situations.

II) - Common experience shows how information processing is dynamic and ever changing. For example, programmers have frequently to update the accounting program due to laws, new procedures, unpredictable market changes, sudden events etc. From this premises we argue that the computer cannot be completed in the factory because producers cannot foresee the jobs that the machine will carry on. They build the computer machine in an incomplete form; later the purchaser assigns the program of work to the hardware appliances. Computers are programmable because of their changeable tasks (I shall revert to this subject in the late chapter). Only the owner can delegate the precise job in front of the specific situation tot he machine. In practice, we add the memory **MC1**, devoted to **the program instructions**, and the memory **MC2**, which contains the **data processed by the program**.

The instructions of MC1 direct the entire work hence they lie at the top of the hierarchy. Then we draw the control unit that manages ALU, the peripherals and MC2 ranking the same level. We complete the hierarchical scheme with the star composition of the peripherals and obtain the **stored-program computer architecture**. Nearly all the computers in the world share this pattern today and they evidence that our inferences are correct.

The architecture in Figure 2-6 makes us capable of analyzing the functions of a computer even if they are integrated. For example:

- The hierarchical levels move apart CU and ALU which integrate into the same chip.
- The sections MC1 and MC2 have two distinguished functions even if they make a unique RAM.

Programmable Computer Architecture (contd.)

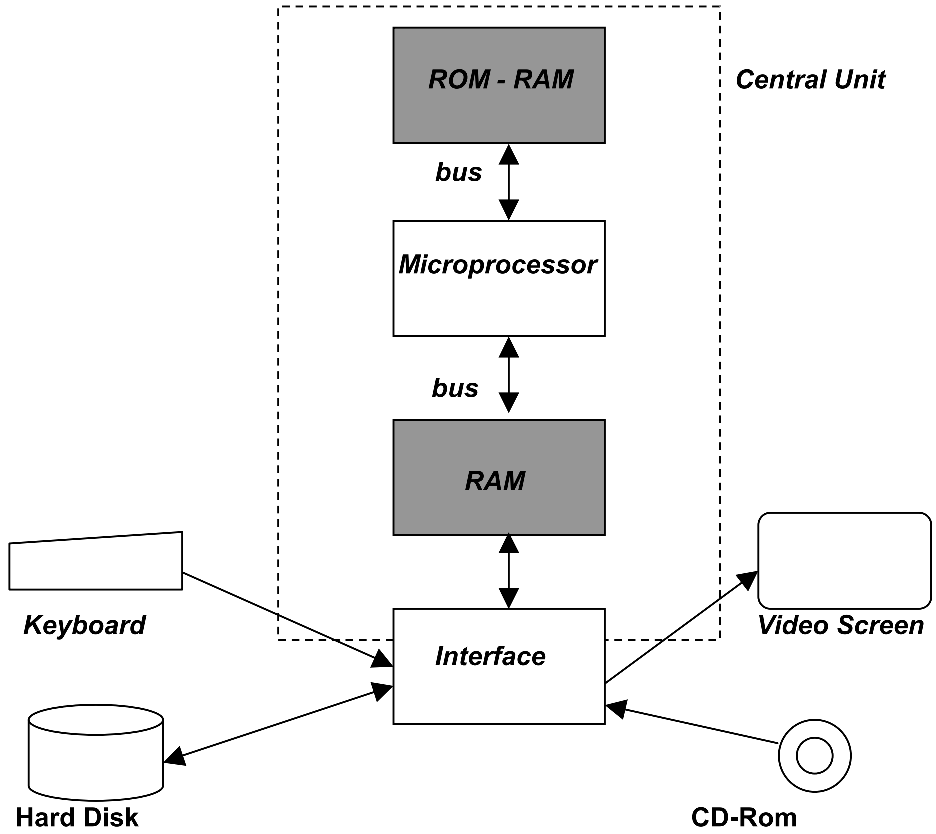


Figure 2-7

The architectural model in Figure 2-6 enable us to interpret the parts and the whole of large and small systems as well. We may dissect mainframes and hybrid computers, robots and palmtops.

Take for example, the personal computer (Figure 2-7) where you find the ensuing components:

- The **microprocessor** includes CU and ALU.

- The **keyboard** and **CD-ROM** convert the input data. The **screen** translates output information. The **hard-disk** converts and stores data in input and output.

- The memory is divided into **ROM** chips that can be only read and **RAM** that enables to write.

- The devices are connected by **bus** which carry data, addresses and controls.
- The **serial gate** and the **parallel gate** make a simple **interface** with the periphery.

Programmable Computer Architecture (contd.)

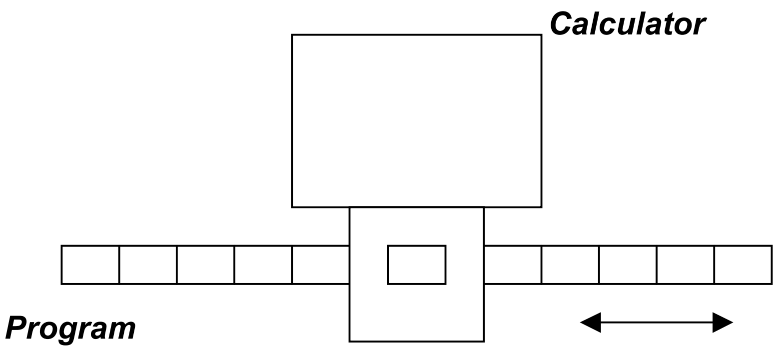


Figure 2-8

Z4, built by the German Konrad Zuse in 1941, *was the first computer in the history*. The instructions were registered in a band that moved into the calculator.

Howard Aiken, built a very like machine, Mark 1, in the late 1941 independently from the German work that Aiken absolutely did not know. *Mark 1* was the first computer in US and the second in the world.

In 1936 Alan Turing, an English logician, had forecast the programmable calculator on the theoretical plane and the Turing machine lead engineers in the pioneer years.

In 1945 John von Neumann improved the computer architecture with the stored program and adding the control unit (see Figure 2-6). He presented the Electronic Discrete Variable Automatic Computer (EDVAC) in a famous article and today *the von Neumann's machine* is synonymous with the "general purpose computer".

* * *

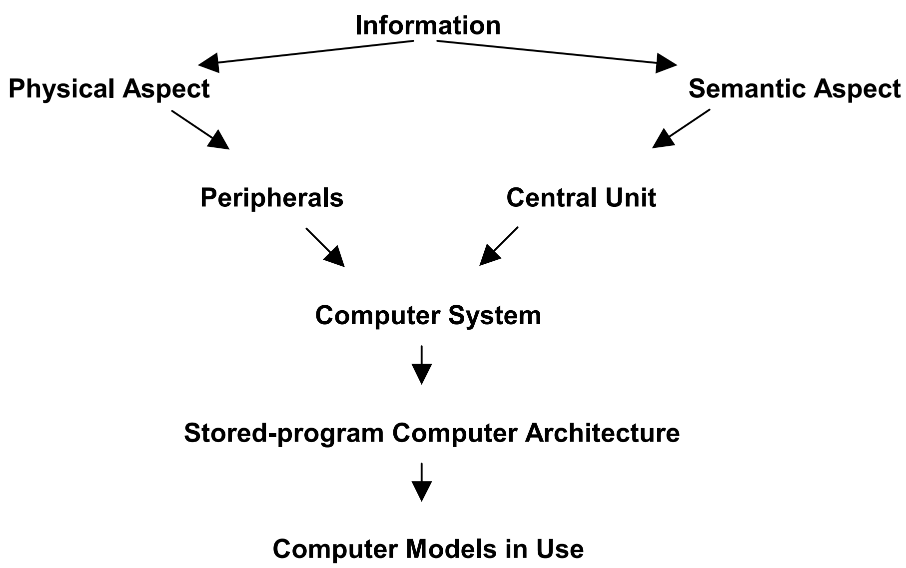
Turing's model still draws the attentions of theoretical researchers, however its utility that was paramount in the forties is darkening. The most evident limit of the

Turing model is the lack of the conversion units; it revolves around programming which is only one feature of the computer system. Moreover modern components are more and more complicated and move away the ancient design. The Turing model is still a reference for logicians who tackle computing on the abstract plane. I have discouraged you from getting this stance because the abstract study simplifies the knowledge of technology and frequently can mislead you. I introduced the computer system through the star-diagram and the tree-diagram that are exhaustive instead of the Turing scheme which reduces the contents of the machine. The present experimental and practical approach will lead us to clarify both the details and to grasp the broad scenario of informatics, which Turing cannot do.

Unit 2 SUMMARY

We have deduced the special jobs of the peripherals and the importance of the information processing from the double nature of information.

We have defined the computer structure as a combination of two main units. We have inferred the architecture of the machine and its hierarchical properties through reasoning and it has not given as a fact.



The computer appears as the thorough system because it is able to accomplish all the possible manipulations of information.

The software program that guides the system constitutes the second property of this machine.