UNIT 2 THE TECHNOLOGY COMPONENT

Structure

2.0 INTRODUCTION

Computers have fundamentally changed MIS from an abstract concept to concrete system that provide insight, competitive advantage and avenues to leverage business. The unprecedented technology breakthroughs and the price performance advantages that accompany these breakthroughs provide ample business opportunities to adapt, innovate and modify existing MIS systems. This unit surveys these technology developments from a used perspective so as to provide insight into the ever changing scene. The database management system is covered in more detail; historically DBMS (Data Base Management System) and their earlier incarnation of file processing systems provided the primary vehicle for developing Management Information Systems.

2.1 OBJECTIVES

After going through this unit you should be able lo :

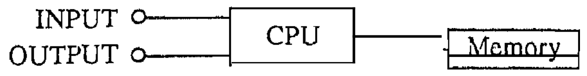
- appreciate the ever changing hardware and software scene
- appreciate dramatic developments in the telecom area
- get an insight into the tools of database management
- appreciate the impact of the emerging expert systems and the tools of artificial intelligence.

2.2 OVERVIEW OF COMPUTING TECHNOLOGY

The engine that runs the management information systems is the modem digital computer. Starting with the first ENIAC [ ] machine, computers have undergone spectacular growth in speed, processing power; interestingly there has been a steady decrease in costs and the size leading to what is generally known as micro-miniaturisation. To add to the attraction is the steady increase in reliability of the equipment.

Starting with the *first generation* that was built on vacuum tubes, the *second generation* machines *were* built using transistors; the *third generation* made use of large-scale integration while the *fourth generation* machines (the current ones) use Very Large Scale Integration(VLSI) as the basis of the technology. Current research efforts are aimed at the replacement of silicon that forms the basis of VLSI technology of tho present with non-silicon materials, At least two companies Cray & Convex have already built their first GaA processor.

Conceptually all the present day computers are built on an architecture originally proposed by Von Neuman. The concept is quite simple. It is a sequential processing machine that can store programs and data. Even though the programs are instructions that operate on data they both can be stored together and can change meanings contextually. Using primary memory, control unit and arithmetic-logic unit the system can take data from an input data channel and output data on an output channel. Such a simple model is so powerful that it encompasses the entire spectrum of the machines today (excepting the few parallel processors being built in the recent years).



Computers are being built in so many sizes, shapes and with varying capabilities that it is difficult for any ode including a professional to gel a clear holistic picture. One classification that is generally used to classify lhem as micros, minis,.mainframes and super computers. Even though for convenience the classification is based on some specifications, it gets very confusing with rapid strides being made in the processing power. Yesterday's mainframe becomes today's micro! Nevertheless the relative picture stays even though the individual specifications keep changing.

	Micro	Mini	Mainframe	Super
Cost	<Rs.1,00,000	<Rs.1 Million	<Rs.10 Million	<Rs. 20 Million
Powers in MIPS	1+	10+	20+	100+
Data bus	8 bit	16 bit	32 bit	64 bit
Memory	1 MB	10 MB	100 MB	400 MB
Example	IBM PC	HCL Horizon	IRM 3090	CRAY YMP

Adding to the confusion is thc super-micro, super-mini classifications that describe positions in between.

An interesting characteristic of computer technology is the rapid strides being made in every sector. The processors arc becoming more and more powerful,The *microprocessors* (which are actually a computer on a chip) from independent vendors like Intel, Motorola, AMD, NEC, Hitachi, etc. are so dominant in the market that proprietary processors arc practically non existent the lower end. Even at the higher end the new generation RISC (Reduced Instruction Set Computers) form MIPS, Sun, DEC, IBM, Apple etc. are becoming more dominant. Only at lhe still higher end wc find proprietary *macro processors* like CRAY and IBM processors.

The memory segment is changing fast. While in the 70's main memory (also known as Random Access Memory — RAM) of 1 MB was considcrcd large, today wc talk of large machines with 256 MB — 1 GB of RAM. In early 80's the RAM chips used to be 16K chips while today we mostly come across 256 KB DRAM chips and increasingly tend to use large capacity DRAM chips.

The secondary storage devices used to be dominated by mngnetic media, like lhe ubiquitous magnetic tape. Miniaturised tape cartridges arc slowly replacing the bulky spool type magnetic tapes. While thc tapes are sequential access devices, we have a whole gamut of direct access devices. The floppy drive (changeable media) is the most popular direct access storage media. The early generation of 8" floppy disks have disappeared cvcn in the Indian scene practically giving way to 5.25" disks in several categories (Double Sided Double Density DSDD with 360KB capacity, High Density with 1.2MB capacity being the most popular in India). The new 'pocket' size 3.5" (1.44MB capacity) mini floppy drive will definitely replace the 5.25" floppies in the next two or three years. The 3.5" disk is better made, well protected, more handy and has larger storage capacity. Both the media (floppy disks) and floppy disk drives (device to read the floppy disk) are locally manufactured in India (Amkette, Verbatim diskettes and L&T floppy disk drives).

The hard disk scene also offers a bewildering variety. By the time the Indian vendors got into the PC business the 10MB disks had become obsolete. So, we have disks drives of 20MB, 40MB & 80MB capacity being manufactured locally (L&T). A large variety of disk drives with capacities up to 1.3GB (1 Gigabyte = 10,000 MB) are available in the market to suit the varying needs.

A new generation of optical storage technologies are slowly appearing in the market. These devices being non mechanical have a superior reliability and life. Once again we have a variety of technologies starting from CD–ROM (a read only sequential device) to floptical drives (optical floppy drives) to optical disks. This technology is yet to arrive in India (by way of local manufacture).

The peripheral devices (incidentally no longer peripheral in overall investment) offer a bewildering variety as well. Luckily card readers, card printers have moved to the museums. The most common peripheral, viz. a CRT based VDU, often called terminal is available from a large number of vendors. Based on 2 standard emulation originally developed at DEC (Digital Equipment Corporation) they are available as VT-1—, VT-220, VT-320 terminals. The more sophisticated ones emulate Tektronics graphics terminals and are loosely called Tek terminals. Specially designed to display local scripts we have Indian Script Terminals too, generally called GIST terminals. Terminals which can generate PC scan codes, called PC terminals are also available.

While the terminal are both input and output devices we have a large number of output devices like printers and plotters. Printers constitute a sizable peripheral investment particularly in business applications that rely on "black and white" records. Starting from low cost, draft quality 9 pin Dot Matrix Printers (DMP) to 24 pin Letter Quality Dot Matrix Printers, we have line printers (300 lpm/600 lpm), line matrix printers (dot matrix printers that print like line printers) and the expensive pretty printing laser printers. In the Indian context we have an excellent choice — Dot Matrix printers from Wipro-Epson, TVSE, Line printers from Lipi, Data Products and Transmatic and Laser Printers from HCL-HP and Modi Xerox. The plotter market is more focused on engineering segment.

A number of other devices like Mouse, Digitizer/tablet, Scanner, etc. are used for more specific applications and are not covered in this quick overview.

On the software side, there is an equally impressive growth. The first generation machines needed to be programmed in their native machine language. The next generation could be programmed in a more human (and hence higher level) assembler language. The third generation machines could be programmed in a still more human application specific (and hence called higher level languages) like FORTRAN (Scientific), COBOL (Business), ALGOL (algorithm), SNOBOL (String Processing), LISP and PROLOG (AI), Pascal (instructional), making computer programming into a major learning activity with millions of people acquiring skills in programming using these languages. So much so, that many people carry the feeling that Computer Science is nothing but learning a series of Cacophony languages like COBOL, Pascal, C in street corner shops!

Recently there has been a generation of languages' like FOCUS, Application by Forms, SQL, QBE which make the job of developing applications much faster. These application generators are generally known as the 4GL (4th Generation Languages).

To cater to the need of Executive Support Systems there are more specialised languages like IFPS (Interactive Financial Planning Systems) from ExecuCom and INTELECT a natural language based query system from IntelliCorp.

The programming languages and the applications interface with the hardware through another piece of software called Operating Systems, information systems professionals may never program the operating systems directly but still need an appreciation of the capabilities of such software. They vary in complexity considerably too, While there are proprietary operating systems like IBM's MVS, DEC's VMS many are converging towards the Unix operating system or its variant. Unix originally was developed in several academic/research institutions under AT&T's sponsorship, Currently it is marketed by AT&T. Several vendors port it on to their hardware platform and sell it under their names like HP-UX from Hewelett Packard, A/IX from IBM, Convex-OS from Convex. Unix like operating systems are multi user operating systems allowing several people access the system simultaneously, On the PC side we have the Disk Operating System DOS (in several versions) that is primarily a single user and single tasking. A graphical user interface GUI that permits multi-tasking and provide a consistent interface across all applications is available as Windows Operating System on PC class machines. On the Unix O/S also GUI's like open windows from Sun, Motif from OSF (Open Software Foundation), NewWave from HP are becoming available.

Among the application software that has the profound impact on business application is trio - word Processing, Spreadsheet and Database. In the Indian context the dominant Word Processor is Word Star, the dominant Spreadsheet is Lotus 1-2-3 and the dominant database is dBase. They are marketed respectively by Sujata, ITC and Wipro Systems. The business graphics software is slowly catching up — thanks Io the popularity of Harvard Graphics (marketed by NIIT). As a desktop publishing software Ventura from Xerox (marketed by Microland) is the most popular along with Indian Language support (Prakashak). The high end database management system (DBMS) market is dominated by Oracle, Ingres, unify, Sybase and Informix.

The scene in this area will be changing continuously. What is attempted here is to present the current picture in a perspective that end users can develop an appreciation and insight without getting lost in the immense variety of options available in every segment.

2.3 OVERVIEW OF COMMUNICATION TECHNOLOGY

The communication revolution has not logged behind either. The POT (Plain Old telephone) got a metamorphosis with the advent of low cost phone chips into a smart phone. Offering such frills like repeat dial lo start with they offer increasingly complex features like memory dial, tune/pulse changer, hands-free dialing, timer, wake up calls, hold features, etc. Ultimately features like piclurc will also be supported in addition to cordless, radio cellular and other features, leading to an Intelligent Customer Premise Equipment providing integrated voice, data, fax and picture capability. Other value added schemes are answering paging, etc.

As the exchange front things are moving Loo. The mechanical exchanges are giving way to analog electronic exchanges and ultimately digital exchanges. They provide special services like call forward, conferencing, etc. thal significantly help business. Special services like directory services, toll-free services, call-collect services along with itemized accounting are natural by products of such exchanges with significant impact on business practices. The innovative experiment of C-DOT contributed significantly Io this arena.

With the increase in sophistication of exchanges and computers the two are getting to influence each other significantly. The computer communication in a local area nelwork (LAN) does not make use of telephone nelwork, but wide area nelworks (WAN) primarily make use of telephone nelwork. Remote communication using a low cost PC & modem is possible even in India today. With the distance no longer the problem, emerging services called nelwork sauces like electronic mail, remote login, remote databases access and search. are becoming possible. These also can affect business practices significantly.

2.4 DATABASE TECHNOLOGY

2.4.1 Introduc'tion

At the heart of the information systems of an organisation is the central repository of corporate data that must be accessed and used by every section of the organisation. This data resource is traditionally called the database of the organisation. The modern information system primarily aims at organising this data resource in an effective manner - for flexible yet controlled access keeping the security and privacy issues in a cosl effective yet very fast, corporate wide access. This is precisely the technology of the database. A typical analogy is the management of corporate finance. The financial management structure of the organisation provides for an operating procedure, authority, control in the form of budget and security measures; yet with a flexibility that day-lo-day operations run smoothly. Just as financial management has evolved over the years - from barter to currency trade to financial market to instruments of finance, databases have evolved from traditional paper files to computer files to a modern sophisticated software widely known as database management syslems (DBMS).

The early generation of file processing system relied on islands of data across the organisation - every functional unit maintaining its own set of application programs and data - finance sub-system, purchase sub-system, etc. such an organisation was simple to operate and had local control, Historically the functional units took to computerisation based on individual initiative and this model was viable. With the corporate vision including information system in its agenda, this model has to change. The data redundancy and the resulting inconsistencies had to go; the constantly changing corporate information must be instantly available to cvcry comer of the organisalion thereby propelling the need for DBMS.

The superiority of Database Management Systems over conventional file processing systems can be explained with the help of the following example.

Consider the student record administration in a typical College or University. Assume that in our hypohetical university the DOSA (Dean of Students Affairs) maintains all the personal record like permanent address, scholarship status, medical records, hostel dues, etc. and the DOAA (Dean of Academic Affairs) maintains all the academic information like courses, grades, ranks, awards, summer projects, theses projects, etc. In a traditional approach the DOSA office and h e DOAA office will have independent files and independent programs. By the very nature of the operation some information like student name, address, department, etc. will have to be duplicated in both the files. Since the final certificates are printed by the DOAA office the students arc likely lo point out any minor crrors in their names like misspellings, last and first name intcrchangcs which arc rather common among Indian names. The same student may not take the same care to correct the name crrors in the DOSA office because of its inconsequential position. Hence within the same institute/college/university the same information is maintained to varying degrees of accuracy. This obviously is not serious but an information about a student getting terminated on academic efficiency may not be reflected in the DOSA office leading to a lost of opportunity of not collecting a substantial amount of dues/fine from the library/labs/hostels of the institute from the dismissed students. Even delay of this vital information is reaching DOSA office may lead to substantial losses for the institute. Such deficiencies arise due lo inconsislcncy of data among different units of the organisation. Replicating the same information in many departments also leads to substantial data redundancy leading lo large scale store inefficiency. Often such an redundancy is uncontrolled; the extent of redundancy may not be known at all. For performance consideration some amount of redundancy may be inlroduccd but that is *controlled redundancy* by design and not by default.

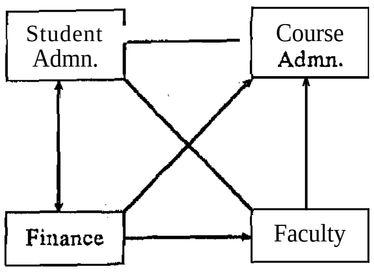
Another drawback of multiplication of data may bc representation inconsislcncy; for example, one of the files may contain the address fields neatly dccomposcd into street address, city and postal adtlrcss by a not so imaginative department may have kept the entire address Geld as single field making a query about all the addresses in a specific city nearly impossible. The data is there and yet not there!

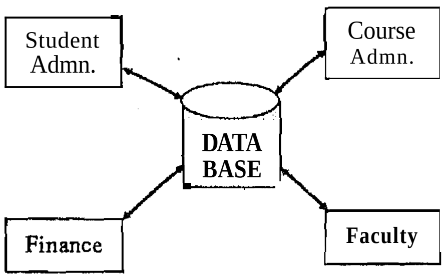
A related but more common side effect of duplication is unit inconsistency; for example' DOSA office may maintain die students annual scholarship value, while DOAA maintain the monthly scholarship value, while DOAA maintain the monthly scholarship amount. Unfortunately the files may not contain information about the units, i.e., annual/monthly, etc. so that a not-so careful application program involving both the files may generate a lot of garbage output!

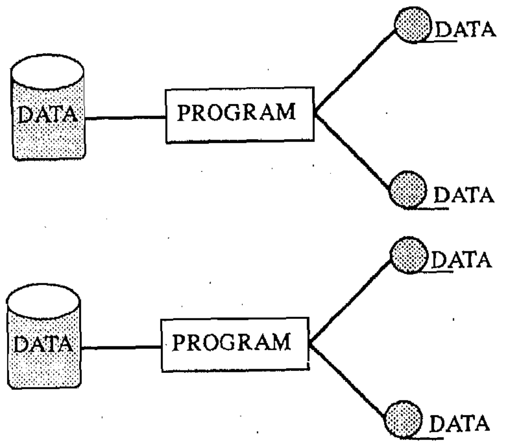
The more serious draw backs of traditional file processing system is the lack of privacy/security/controlled access mechanism that modem DBMS provides. With the increasing importance attached to data and its view as corporate resource, such issues are of paramount importance. The modern DBMS provide for precisely such features.

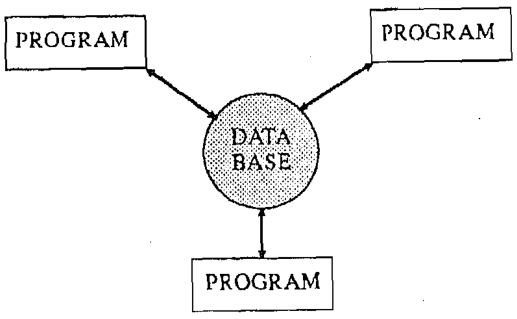
At a conceptual level all these deficiencies can be attributed to just one short coming of the file processing system. They impose a close dependency between programs that use the data and data themselves. The modern DBMS on the other hand provide *program-data independence* that basically scparatc a physical structure of the data (file) from the logical structure of the data used inside programs. By providing such an independence DBMS provide a superior system of filc handling leading to a very high level of flexibility, consistency and simplicity. Essentially they allow applications to write programs that are general enough to operate on files whose structures can be made available to the program. In other words DataBase Management Systems are generalised filc processing systems.

The precise distinction between traditional file systems and DBMS are explained through the following diagrams:

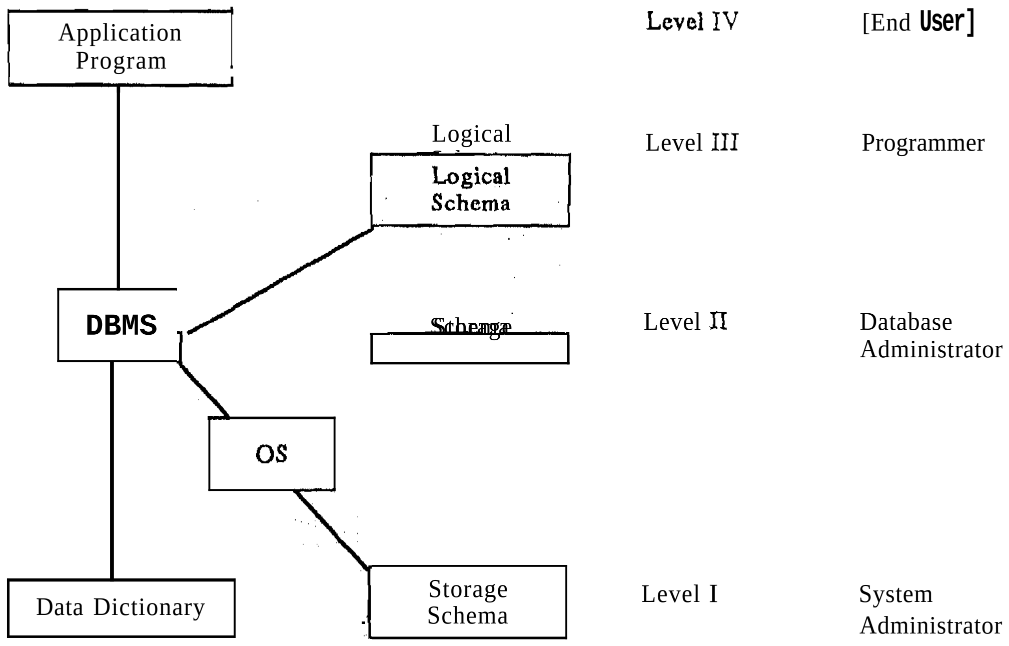






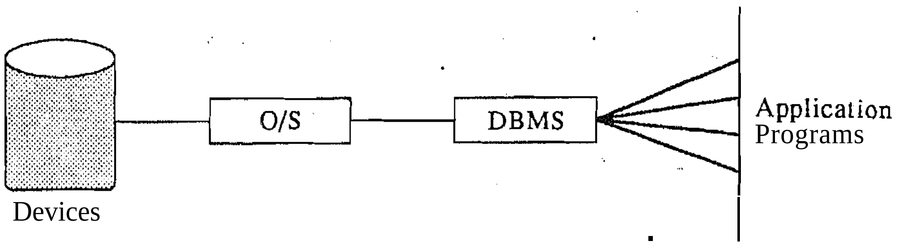


Another significant contribution of DBMS to the data processing field is the introduction of concept of levels of abstraction of data. The physical and logical independence of data permits multiple levels in which the end user/programmer/data administrator may view the data, every view not affecting the other views of data. For example data administration having to change the physical device or the media or location of a file may not bother the programmer at all. Similarly the introduction of a new and more efficient data structure to store a file may not be seen by an end user; in fact an end user may even able to view the data stored in a large DBMS like Oracle/Ingres using a more familiar Personal Computer database system like dBase. Such different views of data by different persons, generally called schema permit a superior architecture for the organisation of corporate data that is at once appealing. This permits multiple specialists like system administrator/programmer and end-user to coexist rather peacefully. Such an architecture can be diagramatically pictured as follows [Date].



Such a division of responsibilities so familiar to organisation pundits also permit a clearly distinguishable partition of the basis activities of file processing: ***data definition*** and ***data manipulation.*** The data definition phase consists of describing the structure of the data and not the contents. Naturally the structure remains invariant over longer periods of time and need be the concern of only the system administrators (a minority). A large number of programmers and end users whose prime concern will be data manipulation adding/deleting/modifying/viewing/querying/searching/sorting data that is subject to a structure that is predetermined. Since the technical back ground of people involved in data definition and data manipulation are likely to be significantly different it is possible to have every specialised data definition construct but very friendly, simple yet powerful languages like SQL (Structure Query Language), QBE (Query By Example), QBF (Query By Form), ABF (Application By Form) which we will consider in later sections.

To the typical user DBMS, which is nothing but a very sophisticated piece of software appears like this



2.4.2 Data Modelling

The database management systems being generalised file processing systems need a model of the data that forms the internal structure of the DBMS software. The earliest of the DBMS viewed the data as a hierarchy—possibly a fall out of the nested level structure of a COBOL record. Such a structure allowed data to be abstracted at different levels of parentage: root, first level child, second level etc. and formed the basis of many o i the early implementation of large scale databases. The classic hierarchical model based DBMS is IBM's IMS (Information Management Systems).

Hierarchical data model effectively use the idea of a hierarchy but cannot model the many-to-one and many-to-many relationships that are common in many business examples. The concept of a boss with several subordinates can be well abstracted by hierarchical model but the same boss may be a subordinate of one of this subordinates, may be in another context, committee, etc. cannot be modeled by hierarchical data model. To circumvent this difficulty the ***Network data model*** was introduced which can model the relationships as a network that is more general than the hierarchy. However this extension also was also of limited help only.

Both the hierarchical and network models suffer from their inflexibility to handle anging database structure. In addition querying the contents of the databases needed complex access mechanism depending on the data item that is being searched. The root level dala item could be retrieved much faster than an item at the deeper levels of hierarchy. Over and above this both the hierarchical and network models were not elegant.

2.4.3 Relational Model

Codd [ ] in a seminal paper in the mid 70's proposed the ***relational model*** based on the mathematical structure of the ***relation.*** Intuitively in a relational model any database can be viewed as a set of relations with each relation having a simple structure of a ***table*** consisting of a set of ***rows*** and ***columns.*** Every row consists of a multiple tuple with values corresponding to a every column. Every row consists of a tuple with values of the different columns taking values different from that of the different row. The values permitted for every column (defined as domain) is pre-specified so that every tuple looks alike though different. It is generally expected that the rows contain values such that two entries contain values different from each other at least for one column. No ordering of the rows is implied but the columns have specific order; but the column entries take values from a specified domain for every column. In the traditional file processing sense every row is a ***record*** and every column is ***a field*** (sometimes also known as attribute). Such a simple construct is so elegant it is at once appealing. Codd [ ] could also provide a mathematical foundation for relational DBMS using the mathematical notion of relation. Naturally relational DBMS received substantial attention from the developers today almost all systems under development are relational.

In addition to elegance relational systems have some deep conceptual beautifies also. The most striking is the *completeness:* that is in the relational system one operates on relations and get the results of any query or update in the form of relations. This is true for any database that is modeled as a relational database. Because it is sufficient to have operations that can efficiently handle just one data object called table, relational systems have built in simplicity and the accompanying efficiency.

2.4.4 Structured Query Language (SQL)

Another major attraction of relational system is the simplicity of operation needed to manipulate the relations. Any query on a single table can be performed using just two operations SELECT that selects a set of rows (intuitively a horizontal cut of the table), followed by a PROJECT operator that selectively limits the fields (columns) for displaying (intuitively a vertical cut of the table). These two operations can be shown to be sufficient to perform any query or update of arbitrary complexity.

When query or update involves more-than one table we need one more operator JOIN that creates momentarily a large table that matches the rows of two tables joined together over the common field. A simple example will illustrate the point. Consider the relations

Course

cno	ctitle

Student

sno	sname

Enrollment

sno	cno

Join of Student & Enrollment would yield

sno	sname	cno

The SELECT, PROJECT & JOIN operators together are powerful enough that any query of arbitrary complexity can in fact be written in just one sentence though a complicated one! This triplet forms the core of a 4GL called SQL (Structured Query Language) that has become,the de-facto standard query language with even an ANSI (American National Standards Institute) stamp. Every major database vendor provides a SQL capability.

Last but not the least SQL stores the tables and their columnar structure itself as a table so that one can query the table of tables also using similar construct permitting a tremendous flexibility to the end user.

2.4.5 Fourth Generation Language (4GL)

Because of the sheer size of applications of databases the large numbers of end users of databases have been demanding special languages particularly fine tuned for their applications. The early generation of Report Generators belong to this category. In the last few years almost every database vendor is packing a 4GL product with his RDBMS engine.

These 4GL's typically include SQL as their core product. SQL being primarily an 'ad-hoc' query language lacks formatting features. 4GL's provide formatting feature to produce quality reports. Many of the 4GL's also provide a means of 'quick application development' like Application-I3y-Form. Here the user quickly design a few FORM screens for user input and some other FORM screens for user-output. By filling (either full or part) of the input screen the necessary outputs can be generated even by an occasional end user who may be a novice to computers and databases.

Facilities exit to edit/format the user data (like case conversion, numeric/character alignment), databse validation (alpha, numeric, range check) databse look up and feed back (like code number decoding into the actual values, e.g., Roll No. to name).

2.4.6 Complex Database

Recently data models that are more sophisticated are being researched. These models can capture more complex objects than the traditional DBMS could do. The traditional databases were limited to a few data types numeric (integer & real), character strings and special cases (Y/N character string for boolean, dd/mm/yy like character string for date). However, the increasing complexity of database applications calls for handling more complex data objects like scanned images (maps, line drawings, pictures, photographs etc.), audio and video images. Databases to handle such complex data objects are known as ***Multi- Media*** databases.

2.5 DECISION SUPPORT SYSTEMS

Systems that support decisions are simply the Decision Support Systems (DSS). DSS represents both a philosophy and a set of tools. At the philosophical level, it is the next stage of evolution of EDP & MIS. While EDP concentrated on accurate and timely processing of data, MIS emphasized the value added component of dala, namely information. DSS goes one step further in emphasizing the organisation and presentation of information in a manner that has direct releance to the supporting phase of a decision maker. Here the goal is to improve the quality of decision making through information. Naturally the issue of access and flexibility are also important in organising the information.

A more deeper concept that also gets emphasized in DSS philosophy is the recognition of the central role played by decision maker — a human manager. The salutary imporlance of this philosophy indirectly removed by the possible threat posed by some early passionate MIS professionals who proposed that large corporate wide databases would replace the managers. DSS disproved such a myth thereby creating a clearer picture of the role of the machine Vs man.

There are several techniques of decision support. All of them involve an innovative integration of 'what-if' capabilities with data processing/information processing systems. In his seminal text Keen [] refers to several early generation of DSS systems that took great pains to illustrate integration. Such an integration calls for multiple integration at different levels man-machine integration, hardware-software integration and data- model integration. One of the pioneering early DSS implementation GDSS [] integrates a natural resource planner who will use maps — a natural information resource for his profession — with models of location. GDSS [] also used an early integration of a computer graphics software with an OR modeling software. An excellent example of a similar work in the in Indian context is the Gujrat [].

One of the technique that evolved as part of the DSS growth is the influence diagram [Plane,]. This is a graphical tool to document the decision process in the form of logical diagram. It also allows an excellent top-down version of the documentation process of the logic. Using very simple graphical symbols to indicate-goals, decisions and outcomes, influence diagrams capture the essence of the decision maker excellently. Coupled with a powerful decision analysis software like IFPS [], influence diagrams can be an excellent decision tool for the analysis oriented managers.

2.6 KNOWLEDGE BASED SYSTEMS

Knowledge Based Systems (KBS) goes beyond the decision support philosophy to indicate the expert system technology into the decision making framework. Expert Systems (ES) have been the tools and the techniques perfected by artificial intelligence (AI) researchers to deduce decision influences based on codified knowledge. The codification of knowledge uses the principles of knowledge represtntation (part of the large theoretical ideas of knowledge engineering). Typically such codification uses rules like IF-THEN rules to represent logical implications. Using first order predicate calculus, it is fairly easy to construct inference engines that use forward chaining or backward chaining to perform the induction.

One of the earliest expert system that had considerable success was the MYCIN [] project that used expert system based inferencing to diagnose diseases using clinical measurements. Fueled by the eariy success several successful systems have been built to cater the different applications the important one being PROSPECTOR [] for mineral exploration, XCON [] for configuring VAX computer, DENDRAL []. When many other researchers wanted to apply the expert systems ideas lor diverse applications, expert system shells [] were built. These shells have a flexibility that they are independent of the knowledge bases so that one can build just the knowledge base and use the same shell for different applications. Such de-linking of the knowledge base from the inference engine using expert system shells has helped significantly in the large scale application of expert systems to a variety of situations.

2.7 SUMMARY

This unit outlines the spectacular developments taking place in the computing and communication fields; these developments are also leading to changing the role of MIS from a passive data support role to the role of providing new business opportunities and a competitive weapon in the era of ever increasing competitive world. While the mastery of thcsc technologies takes years even for specialized professionals the demanding job of a contemporary MIS professional compels him/her to keep abreast with the changing scenario to exploit the potential of these technologies in an optimal manner.

2.8 SELF-ASSESSMENT EXERCISES

1) Briefly outline the compulcrs and communication revolution.

2) Explain briefly the concept of indcpendence in thc context of DBMS.

3) Define·DBMS in general and Relational DBMS in particular.

4) What are DSS and KBS?

5) What is an Expcrt Systems?