Chapter 3
Technological Developments in Information Systems relevant to Management of University-College Cluster

3.1 The Information System and the Logical Information Process

There are three main businesses in Institutional Administration - acquiring and paying for input resources, converting inputs into finished services, and selling and collecting payment from customers (i.e. students) for the service provided. Administrators and decision-makers obtain information from an information system to help them manage the business processes. An information system provides this information through three main information processes: recording business activity data, maintaining the stores of data, and reporting information to management. When business processes, management processes, and information processes are integrated, they greatly enhance the organizational effectiveness. The process is illustrated in the Figure 3.1.

![Workflow of Information Process in Information System](image-url)
In any information system application, the method generally followed is to design modular and hierarchical steps of processing, leading to an output in a report form or information having certain value. The steps involved are data processing, transaction processing, application processing and system processing.

3.1.1 **Data Processing**

Data are the inputs into the information system; they are facts and figures about business activities and business processes. The information system captures, stores, combines, summarizes, and organizes data into information that is meaningful to management for reporting and decision making. In any information system, significant care is taken in building the data as a first level input to the system. Though the date is a universal entity in nature, it still requires determination of specification, character and presentation. The data is built through data design and modeling process which provides specification and character to the data. These specifications and characters are used throughout the information system for a variety of applications. Data processing is handling raw data in a systematic manner to confirm to the data quality standards. The system supports the user through checks and controls by responding and communicating errors for correction in the data processing stage. In information system design, the data needs to be designed by fixing its character, value and structure and then be used it in data processing to control its acceptance for further use. To ensure the quality of information, considerable effort is spent on this data control aspect, by way of :-

- Confirming the character, structure and presentation vis-à-vis data design.
- Checking the value of the data vis-à-vis data value specification such as single specific value, range of value, and limit value ranges.
• If a non-conformance is seen, pointing out the error and seeking corrective
response before the processing control shifts to a new field.

3.1.2 Transaction Processing
After the data has been processed, the next step is to process transaction itself with
reference to business rules, policy or guidelines before it is taken up for further
processing. In any case, if the transaction does not conform to the set of specified
conditions governed by the rules the error is displayed for user to take corrective
action. The next check in transaction processing is to confirm internal consistency,
correctness and completeness of the data. The third check after confirming the data
quality and observance of the business rules is for validity of the transaction itself for
its use in application and system processing. The validity of transaction is checked
against the conditions present outside the domain of transaction.

3.1.3 Applications Processing
After data and transaction processing, the data finalized in these two stages gets
posted on the affected files. Application processing is designed to process more than
one type of transactions to bring out the specific business results in one or more
business functions. This processing is carried out once the transaction is processed for
its validity. The application processing means the use of transaction data for bringing
out a particular status. The application could be designed to change the number of
different files holding a variety of information, and for status updation & the status
triggered actions in the related field of the application. The scope of application
processing can be made diverse by incorporating different transactions from the same
application area or associated areas. The advent of communication technology and its
embedded use in application processing extended its scope beyond the boundaries of
the organization. The application can be designed for processing the results, updation of the business status, for triggering predefined actions and also communicating with the affected agencies within and outside the organization. The quality of application design will depend on the inputs provided though transaction processing and data processing. The scope of the application will depend upon the type of interface it provides to the user, in relation to other applications or systems.

3.1.4 Information Systems Processing

The system is a product made up of several applications set in orderly manner to produce a higher-level information output different than the output of the application processing. Normally the system processing addresses the management issues of the business. For example, in the financial system, processing is done for cash management, asset and liability management, working capital management, etc. On the platform of these applications the system is processed for the analysis of a number of aspects of the finance management, such as insights into the funds flows, the sources and the uses of funds, profitability and productivity of the business, etc. It throws light on growth, (past and future) through the analysis of various trends. These outputs are the management information, generally required by the top management responsible in strategic management of the business.

The information system processing are capable of dealing with the data acquisition technologies, processing technology and architecture, networking technologies and communication. Using the system engineering methodologies, when all the information systems in the organization are covered, a stage is reached where the systems are integrated for a still higher-level information output required by all the levels of the management. The systems so designed through an integration process are
called as Enterprise Resource Planning (ERP) systems. These systems help in managing the business as a whole by way of functions and process management as also by providing support through the Decision Support System (DSS). It is a total solution to meet the business information needs, irrespective of the function, process, location, for all the levels of management and people.

The total realistic solution is possible if the system design in information system processing is a real time system. The real time systems are open in nature having a relational exchange with external world realities. The real time systems integrate the hardware/software, human and databases to capture data, validate transactions, process applications and execute a system to produce a business result. To achieve this, the systems processing requires a high speed data acquisition and control, a high speed transaction processing, an appropriate application processing and highly responsive and sensitive system design and architecture. The system processing design is, therefore, concerned about the performance, which is a result of speed, accuracy and reliability. These issues are handled through the hardware and software technology choice followed by the processing design from data to application through client-server architecture, seamless integration and processing tasks in synchronization, and through a high speed communication.

The data acquisition technologies such as the bar code readers, the hand held terminals; the process embedded data loggers, the image processors, the digitizers, etc. are used for capturing the data inputs. The processing architecture is based on the determination of an on-line real time processing need, distributed database, and processing and application design. It could either be client-server with its variation or a main-frame and host-slave architecture or it could be a distributed processing
architecture with a central system with dedicated data and application servers spanning the entire organization providing autonomy to the user and integrity and security of information to the management. The third technology consideration is on communication. A wide range of technologies on communications are available for choice between the electronic data interchange to fax modem data transfer.

### 3.2 Developments in Information Technology

The major trend-setting technologies that affect educational communication between teachers-learners and the management of networked ‘cluster institutes’ are those which provide operational edge in educational management and in cluster institutional management. As the input data is collectively obtained in normalized databases through operations of different input modules from both this areas, our exclusive study on ‘cluster institutional management’ need review of all the relevant technological developments on both these areas.

#### 3.2.1 Broadband and Mobile Internet

With the emergence of broadband and mobile internet, current efforts by various Internet Service Providers (ISP) are to connect all cities, towns and villages, and offer Wireless in Local Loop (WLL), Direct to Home (DTH) and other latest technologies. ISRO’s Educational Satellite (EduSat) offer KU-band reception and broadband connectivity all over India and made DTH (Direct to Home) communication a reality. The Broadband Internet with Grid Network make teaching and learning possible from Anywhere- Anytime Link, create National /Regional Grid network of educational content and services, which can flow in the network. Electronic Communication tools include electronic mail, voice mail, faxing, Web publishing, bulletin board systems, paging, and Internet phone systems. These tools enable you to electronically send
messages, documents, and files in data, text, voice, or multimedia over computer networks. Powered by new standards and protocols, Internet e-mail has become a fast and convenient way to communication and transfer electronic documents, data files, and multimedia content. This includes net broadcasters automatically pushing information from Internet and Intranet sources into E-mail in-box.

3.2.2 Networking Technologies

The technologies used in transfer of data to remote nodes of the network of cluster institutions may be synchronous or asynchronous. Synchronous means two-way interactions in "real time". Asynchronous delivery does not take place simultaneously. Networking Architecture is moving from cluster to grid networking. The grid computing network is a new advancement in high-performance computing which has moved from cluster of multiprocessor server architecture to a network of geographically distributed heterogeneous desktop, server and storage resources. A state-of-the-art computing and network grid will provide for multi-service convergence (data-voice-video) services. It is a distributed server network connected to every computer. In recent times, there are some initiatives taken to create Networking and IT-infrastructure and facilities to support education and its management. UGC has taken initiative to create network, which could connect all universities and most of colleges in India by creating network and by offering resources for developing IT infrastructure in universities and colleges. UGC has also undertaken a program of e-content creation suitable for e-learning programmes.

3.2.3 Integrated Service Digital Network

A clear trend is the merging of the telecommunication and information services industries. The potential exists for an integrated services digital network (ISDN)
utility. With such a service, multiple networks and services, public and private, are interconnected with a full range of terminal devices. Network access is invisible to the user and information input, storage, and processing functions are located either where user needs require or where access is most efficient. Voice, data, and image transmission are integrated. Some information processing services are carried by the network itself. In the ideal ISDN environment, a single communications utility all telecommunications requirements and provides access to all necessary information processing services. Current difficulties with implementation are lack of standards, incompatibility of interfaces, and the number of providers competing for a share of the communications service market.

3.2.4 Intelligent Workstations

The concept of an intelligent workstation (also termed a professional workstations or a personal workstation) is a combination of a personal computer and access to local and wide-area networks. “Families” of workstations with modular components can be tailored to individual needs while remaining compatible with other machines. For example, a secretarial workstation may have powerful word processing capabilities while the managerial workstation may emphasize audio voice message facilities (through automatic dialing and voice message recording), but the two stations can communicate. Software capabilities for support of knowledge work functions may be “packaged” with the hardware; programming languages and other development tools are also available for developing application software.

Integration of Facilities: A key concept in the design of workstation for knowledge work is integration of facilities. Rather than separate hardware, software and
communications for each of the components, these components are integrated into one facility. There are two types of integration: function and physical.

*Functional integration* implies that the different software support functions for knowledge work are provided as a single system. For instance, electronic mail, word processing, storage of data, and access to external databanks can all be accomplished at the same workstation. Functional integration also means that the user can access these facilities through a single consistent interface and can switch from one task to another and back again (much as one does when working without the support of a workstation). For instance, a user may be preparing a document and be interrupted by a mail message, read the message, and then go back to the document. Ideally, function integration also allows a user to create a graphical representation using data from an external databank and/or internal historical data and merge it with a document.

*Physical integration* refers to the hardware, software and communications features required to accomplish functional integration. There are several elements of physical integration:

- **The user interface**
  - The software should allow for several workspaces to be accessed concurrently, so that the user may combine elements from each and switch easily from one to the other. This feature is often called multitasking. It is commonly implemented by having multiple windows displayed on the screen at the same time, each representing an active task.

- **Multiple media**
  - The system should permit the certain and editing documents from different media: text, graphics, database and voice.

- **Access to outside services**
  - Though the network component, the user should be able to access external databanks and information retrieval services, public
electronic mail services or service unrelated to the current task such as electronic banking.

Physical interconnection

Even when multiple products from multiple manufactures are used, it should be easy to interconnect them to exchange information.

It should be noted that the concepts of functional and physical integration described here represent an ideal rather than the current state. It is particularly difficult to meet the requirements for integration that require some degree of consistency or standardization across vendors, i.e., access to outside services and physical interconnection among different types of equipment. Thus the concept of integration should be viewed as a ideal accepted but ideal goal toward which new technology is moving.

3.2.5 Groupware for Enterprise Collaboration

Groupware are collaboration software that are designed to make communication and coordination of workgroup activities of members located in different locations, to accomplish joint projects and group assignments. For example, groupware products like Lotus Notes, Novell Group Wise, Microsoft Exchange, and Netscape Communicator support collaboration through E-mail, data and audio conferencing, discussion forms, scheduling and calendaring, and so on. Internet technologies like Web browsers and servers, hypermedia documents and databases, and intranets and extranets are providing the hardware, software, data and network platforms for many of the groupware tools for enterprise collaboration that business users want. Groupware provides software tools for electronic communications, electronic conferencing and collaborative work management. Figure 3.2 illustrates an overview of Groupware Solutions.
3.2.6 Database Management System, Data Warehousing and Data Mining

Database Management Systems have developed primarily with the objectives of storing raw data in well designed databases through Data Warehousing, to be called through database program packages to produce defined information through Data Mining. Such information systems that following a hierarchical model, employ hierarchical or tree structures to represent the relationships among entities. A record may have multiple records subordinate to it, which in turn may have multiple records subordinate to them. In the order words, multiple records of particular type “belong to” (are subordinate to) a single record of another type higher in the hierarchy. “parent” records can have several “children” records, but a “child” can have only one “parent” show a simple schematic of a hierarchical tree structure. Many natural relationships among entities can be represented adequately in a hierarchical structure (e.g., multiple employees “belong to” a single department) and processing efficiency is often very high.

The shortcomings encountered with a hierarchical data structure can be avoided with network database structures. A hierarchical structure has one superior record for one or more subordinates. A network system allows a given entity to have any number of...
superiors as well as any number of subordinates. The relationships between entities must be represented. A common approach is multiple pointers, usually with a link node record representing the connection between the two entities.

Although many of the problems inherent in a hierarchical structure do not exist with a network database, a major disadvantage of a network structure is its complexity. A user of a network system must have explicit knowledge of the relationships represented, including the link nodes, in order to accomplish a query or an update. In addition, knowledge of the physical storage structure, including how links are physically represented, is required for efficient use of many network systems.

A database employing a relational structure consists of a set of tables. In each table, the rows (called tuples) represent unique entities or records and columns represent attributes. Each table is a relation, and so a relational database can be thought of as a collection of tables. Relations are represented by common data values in different relations (table). Relational data structures are based on a formal theory of relational algebra, which uses very specific terms to refer to the concepts underlying the structure. Conceptually, they are straightforward in design when compared to hierarchical and network structures. The difference between the hierarchical or network structure is the type of relationship built in - hierarchical or network. If a new relationship is to be added, new connections and access paths must be established. In a relational database, access paths are nor predetermined. Creating new relations simply requires a joining of tables. Relational databases are therefore the most flexible and useful for unplanned, ad hoc queries. The pre-established relationships of the hierarchical or network structures require more complex data definition and data manipulation languages. Maintenance is more difficult. The relational model data
definition and data manipulation languages are simple and user-oriented. Maintenance and physical storage are fairly simply. However, if there are large number of records (say more than a million), and/or performance requirements are critical, relational databases are suitable; if transaction volumes are large, and ad hoc queries are very infrequent, the hierarchical or network models are more efficient than the relational model.

3.3 Tech-Institutional Developments

3.3.1 Virtual Universities

During the last few years, many universities and colleges are getting ready to face the impact of globalization and emerging competition in education sector by forming consortia of colleges and universities. The major approach employed is to form partnership with other colleges and universities and to offer the best available educational expertise, courses and services to students both on-campus and off-campus. Some of the management services like consortia-wide online admission, collection of fees through banks through e-banking have already been started in some places. Many colleges and universities formed partnerships - virtual universities, through using ICT applications, working together in practical ways to plan programs, develop the required content and ensure the delivery of those programs and support services to the students (example, some Kolkata based Colleges under Calcutta University).

3.3.2 Evolving National E-Educational Network

Development of national network offer weaker and disadvantaged colleges & universities to join regional/national consortia and offer best educational services to their local students by offering personalized services, the scheme of which include:
1. National educational network connecting all institutions through broadband connectivity.
2. Indian Knowledge Grid to enable content to flow to anyone anywhere and anytime.
3. Granulated Object Based Content in a Meta-database.
4. Promotion of national and region level consortia of colleges and universities.
5. National quality assurance and accreditation mechanism.
6. National and regional credit banking and certification mechanism for students to take education from different universities/colleges.

3.3.3 UGC-Inter University Information and Library Information Center

Leveraging on the latest technology, INFLIBNET was created as a virtual network of people and resources in academic institutions with an aim to provide effective and efficient access to knowledge through innovation and collaboration, with the vision:-

- To provide seamless, reliable access to scholarly, peer-reviewed electronic resources to the academic community in all educational institutions with a focus on services and tools, processes and practices that support its effective use and increase value of this information.
- Build and strengthen ICT infrastructure in educational institutions with value-added services.
- Develop tools, techniques and procedures for secure and convenient access management enabling users to access information in electronic format from anywhere, anytime.
- Develop resource selection guides and online tutorials for effective delivery and usage of e-resources.
- Facilitate creation of open access digital repositories in every educational institutions for hosting educational and research contents created by these institutions.

It’s mission are :-

- Achieve complete automation of libraries in educational institutions
- Create union catalogues of documents available in libraries in online and real-time environment.
- Provide seamless and ubiquitous access to scholarly, peer-reviewed electronic resources to the universities.
- Promote digitization of legacy documents and creation of content in e-format (including electronic theses and dissertations, electronic version of research articles, working papers, technical reports, concept papers, technical reports, annual reports, statistical data, etc.) in universities.
- Promote setting-up of open access digital repositories in universities for hosting content created in the process mentioned above.

- Develop expertise in
  - Digital content creation;
  - Process of digitization; and
  - Managing digital depositories.

- Impart training in applications on various aspects of new technology to achieve goals mentioned above.

UGC-INFLIBNET Scheme provided grant-in-aids to universities to set up Local Area Network (LAN) using Hub/Switch and CAT 5/6 cables within their libraries in their campuses and ‘SOUL’ software. Since ‘SOUL’ is based on client/server architecture, it is essential that the server and all other nodes be connected by LAN. There are more
than 100 nodes connected in LAN in the Centre. INFLIBNET Centre desires that each university should establish a LAN in it's campus linking all the departments including library. This LAN in turn will be connected to the UGC-INFONET. The infrastructure setup include well-equipped server laboratory with Intel PIV, Servers running on Linux Enterprise Edition Ver 4, Windows Server 2003, Windows NT/ 2000 Advance Server, and separate mail server and mailing lists running on Linux, Network protected by Firewall running on Linux as well as UTM. The Centre has 512 Kbps & 2 Mbps Leased Lines from ERNET for Internet connectivity. New high end RISC server is being added to the existing infrastructure.

3.3.4 ELMS Applications

The Efficient Learning Management System (ELMS) is a web-based course components management system. It is not a simple ‘source providing’ and ‘source retrieving’ system, or ‘content management system’, but rather provides flexible courses management functionalities and systemic learning objects/tools (with measurable learning outcomes), such as educational information system for enhanced learning (EISEL), virtual collaborative and peer-to-peer testing environment (VLE), personalized mini-case development environment (PMDE), interactive computer aided learning (ICAL), higher order thinking skills tool (HOTS), and self maintaining forum (SMF). These learning objects are part of a larger enterprise-wide learning management system with an integrated backend that allows ‘data chunks’ to be reused and recycled. A major effort had been undertaken in 2006 to integrate all the learning objects into the enterprise-wide learning management system. Together with service objects, role objects and interface objects, they form an interactive teaching/learning platform.
The ELMS architecture entails five major components that identify different integrated solution for a true learning management system.

**ELMS Management Center**: It is the central module of ELMS. It interacts with other modules and controls the data flow and execution orders between the modules. It also is charged of initializing ELMS.

**Learning objects & Learning Objects Organizer**: They are designed for regular learning activities for students. Each learning object has the same database hierarchy. A common interface is defined for each learning object. Learning objects organizer controls the behaviors of each learning object. When a learning request is retrieved in ELMS management center, a control message is passed into Learning objects organizer. Then Learning objects invoke relevant methods defined in learning objects interface.

**Role objects & Role Objects Organizer**: Role objects refer to different roles in ELMS, including administrator, instructor, student, teaching assistant (TA), technical assistant and moderator. User roles are treated as objects in ELMS. The behavior of role objects is mastered through role object organizer.

**Service objects & Service Objects Organizer**: Service objects are a set of tools working with learning objects. They assist in the way learning objects behave, and provide a communication platform for users with different roles in ELMS. Communications between service objects and learning objects are accomplished by ELMS management center, service objects organizer, and learning objects organizer.

**Reporting objects & Reporting Objects Organizer**: Reporting objects provide convenient tools to generate system reports for instructors, administrators and students. A report object provides a type of reporting service. For example, academic reporter retrieves students’ daily activities from learning objects, and generates
reports. A reporting objects organizer is used to organize all report objects and communicate with learning objects.

3.3.5 Central Plan Scheme Monitoring System (CPSMS)

CPSMS is a Central Sector Plan Scheme of the Planning Commission and is being implemented by the Office of Controller General of Accounts. The scheme aims at establishing a suitable on-line Management Information System, and Decision Support System for the plan Scheme of the Government of India. With 139 Central Sector Schemes (CSS) and more than 800 Central Sector Scheme (CS), along with state plans and Additional Central Assistance (ACA), the CPSMS aims to track almost Rs. 300,000 crores. The system is envisaged to track the fund disbursement from Government of India up to the last beneficiary under plan schemes and ultimately report utilization under these scheme at different levels of implementation on real time basis.

The overall objective of CPSMS is to facilitate online transaction monitoring by way of performing the following activities:

1. Release of Funds:
   - To capture all releases from the Central Civil Ministries to State/ Special purpose Vehicles (Societies) / Autonomous bodies/ NGOs/ Individuals
   - To register all agents receiving these releases
   - To capture component wise releases expenditure from Special Purpose Vehicles (societies) / Autonomous bodies/ NGOs to subsequent implementing agencies in the states/ UTs.
2. Utilization:

- To capture beneficiary wise and component wise fund utilization by implementing agencies at the state. District, Block and loser levels under various plan schemes of government of India.
- Payment to ultimate beneficiary through the banking channel.

3. Reforms in the areas of Public Financial Management:

- Move from prescriptive fund release system to ‘just in time’ fund release system minimizing float with the banks hereby leading to a better fiscal deficit management.
- Moving from the system of booking fund releases as ‘expenditure’ to a system of booking actual utilization reported from the field as ‘expenditure’
- Providing on-line status of fund utilization of a real time basis both under the fund developed through the treasury route and SPV route, leading to a better Decision Support System.

3.4 The Management Strategies for Tech-enabled Higher Education Sector

The Report of ‘National Task Force on Information Technologies (1998), appointed by the Government of India, observed: “Information Technology (IT) modernizes the economy, expands and deepens the possibilities in education, accelerates growth, creates large-scale direct and indirect employment to the educated youth, and boosts exports. If there is one single technology that can be applied right across all sectors of technology, all areas of administration, all levels of education and all types of services, it is Information Technology. Similarly, if there is one technology where India can emerge as a strong global player in the foreseeable future, it is IT. IT is not
just a technology, nor is it merely a new enabling tool for economics and education. Rather it will lay basis for a whole new global civilization in which Indian values and wisdom will play a defining role”.

3.4.1 IT-enabled Information Systems for College-University Cluster

The development of an information system is not only a technical task but also a political process, depending upon the degree of autonomy of the different units and the relationship between the university and the government. The introduction of information systems in University-Colleges cluster depends to a large extent on the government steering policies for higher education, namely self-regulation within a broad framework of accountability and direct centralized planning and control. It is needed to rationalize the decision-making process, ensure better allocation of resources, increased accountability, transparent operation and evaluation of objectives, for better internal monitoring and modification of the process of management through effective control of the component parts of the system, i.e. evaluation of the achievements of the university-college cluster. Such an information system would have to provide integration of files on the basis of one-time entry of data into centralized common database files setup to make information available on a cluster-wide basis. It would furnish appropriate quantities of organized, detailed information on which the cluster manager can base the planning and make decisions. It would provide for automatic relating of information among sub–systems and automatic cross-referencing among files, as well as give the historical information needed to build and support necessary models and demonstrate the trends and tendencies of the cluster, including indicates the performance of the different sections. It should also support the traditional reporting requirements.
Information systems of higher education institutions may be observed to possess the following real-life characteristics:

(i) installation of departmental computers in Universities and Colleges;

(ii) existence of management support on the mandated delivery of statistical data to outside agencies;

(iii) increasing number of 'marginal' administrative areas supported by computer;

(iv) extension of administrative computing support to decentralized organizational units;

(v) focus on providing support for integrated administration tasks, i.e. transfer of data / documents from one system to another, from one department to another;

(vi) provision of integration between central administration and decentralized units which were supported separately in the previous phase;

(vii) integration of the administrative computing systems in the areas of ‘staff’, ‘students’, ‘financial resources’, and ‘facilities’ with that of the various administrative departments of member clusters for use by institutional managers.

(viii) linking of the University’s central administrative department with that of Colleges’ central administrative departments to each other to cover the entire cluster of institutions in a network.

In many organizations, like that in Calcutta University and Jadavpur University, IT-staff units have evolved in response to the changing role of technology in the workplace, who manage all the elements of the computer operation. The applications were principally supporting the automation of accounting and other process tasks such
as student administration. Specialist database management groups and networks maintenance groups (sometimes hired / outsources) who are IT professionals need to work more closely with the departmental experts and faculty heads in applying technology to the core business of educational service and its administration. This is the stage that is underway in universities through the introduction of educational technology. Now, IT units are forming flexible multi-disciplinary teams to develop and support the new generation of applications, while centralising 'routine' activities (further supported by automation). Thus structures have evolved to some extent in response to developments in technology, to a distributed, client-server focused workforce, where the skilled IT staff are dispersed to the areas where the technology peripherals exist and the centre, if at all, retains a small technical support group that coordinates the support activities.

Within many universities-colleges, the systems development group at the centre principally supports the core administrative systems (Financial, Student Systems, Human Resource and Facilities Management). However, systems development of faculty based needs, either administrative or for teaching are often done at the faculty level. Thus the faculties often have significant autonomy over IT development and support for their own specific user needs. At IIT-Kharagpur, there are many faculty based systems that take data from the Student Information System and feed into systems that support tutorial and class management. These institutions have IT-support split into two - the administrative systems and the academic systems. Academic computing support units include PC installation and maintenance, computer laboratory support, Educational technology services such as audio-visual multimedia production, and some aspects of instructional design are found either under academic computing support or in academic development units (like that in
Multimedia Development Centre, St.Xavier’s College, Kolkata). One significant structural trend occurring within universities is the amalgamation of Library and IT areas (example, UGC-INFLIBNET) and, in some universities, the inclusion of educational technology areas (example, IGNOU). Convergence was initially mostly about libraries re-aligning with computing services, because they were both focused on information services. In the past, this convergent activity was focused on electronic information sources and services. There is an increasing awareness of the implications of convergence for courseware development and the process of teaching and learning (example, IIT-Kharagpur). While often focused on reducing costs, these moves have also provided an opportunity for restructuring to improve the effectiveness of coordination across related areas.

Increasing competition in the higher education sector due to liberalization and the resulting globalization is leading to greater differentiation among, and an increased strategic focus by university clusters. Three generic strategies are observed to be emerging as universities compete across these six areas:

- a value added strategy for the traditional elite university which uses IT to enrich the student’s experience as a member of a high service, high variety and high reputation educational community;
- a cost-based strategy for a ‘new’ university which focuses on using IT to develop and deliver high quality programs anywhere, anytime for a restricted range of degrees to a mass market; and
- a hybrid, mass customization strategy for a large devolved university, which would use IT to obtain the benefits of a low cost central IT infrastructure, while empowering innovation and student focus in strong academic faculties.
To successfully manage IT based change, universities must meet the challenge of the changing roles and skills requirements. As technology becomes more pervasive in all aspects of teaching and administration, both academic and general staff roles are being transformed. New positions and skills are required across all key areas. From the diversity of staff development strategies and activities that universities are adopting, we may identify three approaches to deal with this challenge.

- The integrated approach with a central unit managing the integration of teaching and learning with IT, emphasizing support for professional development in educational and information technologies and linking it to university goals.
- The parallel approach, creating an IT-based teaching and learning unit which operates separately and in parallel with existing staff development units.
- The distributed approach, which is more ‘bottom up’ and devolves responsibility for IT-based teaching and learning developments to local innovators across a range of faculties and units.

These approaches will need to support an accelerated shift from teaching to learning, delivered not by individual lecturers but by multi-functional teams.

3.4.2 Changes of Outlook in Higher Education System with the Developments in Information Technology (IT)

There are mainly two paradigm shifts in education with the development of information technology. The first is from traditional University to Open and Distance Education (ODE), and the second is from ODE to E-Education. E-Education System requires the following framework and infrastructure:

1. Network with latest hardware and technologies along with broadband connectivity and grid architecture giving network access to anyone, anywhere, anytime.
2. Software tools and techniques that enable creation of databases and information flows, offer facilities to learners, teachers and institutions to receive/give personalized education on a mass scale.

3. Content in e-formats on a knowledge grid that enables teachers and students get personalized curriculum of high quality, relevance and utility.

4. Educational delivery system that ensures quality and developmental relevance of educational offerings (Developmental Education) for individual, institutions and community.

5. Quality Assurance and Certification Mechanism to maintain competitively high and acceptable standards at national and international levels.

The communication technologies are transforming the existing educational system to E-education. The process of globalization and liberalization of economy has already set in and the existing educational institutions have to undergo radical transformation. The present institution centered system is being converted into more students’ centered system. This change in outlook is projected to generate ripple effect to all of the under-mentioned parties concerned.

**Student**- Present student will be the individualized learner. Learner can study at home or work place, the formal presence like today in the institutes will not be necessary. The teaching-learning approaches are more flexible, easily available, self-pacing and users friendly.

**Teacher**- The present classroom teachers in this paperless higher education will work as resource persons, producer of more competent software, ready to face students on small screen and equipped with latest developments in their specialization. That teacher can expand more time on research and innovation.

**Curriculum framework**- Curriculum framework of future will be more flexible,
according to, demand of learner, society and workplaces. Number of courses will be increased and duration will be increased and duration will be more flexible. 

*Universities*- Universities of future will work as resource center. Both human and nonhuman resources are available for individualized learner. These resource centers consist of not only laboratories and e-libraries but also software production cell, simulator cell etc. are also available. Duration of working hours will be more flexible according to learner.

*Management*- Due to liberalization and globalization, the corporate bodies will be more associated with educational system. There will be university-industry collaboration for training and research, support with consultancy of teachers.

*Examination*- The examination system will be more flexible and comprehensive. Larger, reliable and valid sets of questions are available on CD-ROMs or Internet as question bank. Self-evaluation software can be provided with each tutorial package. Learner can get immediate feedback from the system. University examinations are conducted in more convenient fashion and more frequently. Present essay type subjective examinations change into objective type and more objectives based examinations. Technical equipment will be available for all stages i.e. preparation, administration, scoring and interpretation of evaluation procedure.