Int. J. Engng Ed. Vol. 10, No. 1, pp. 76–82, 1994
Printed in Great Britain.

The Role of Educational Technology in Engineering Education—an Indian Scenario

K. L. KUMAR
Professor of Educational Technology, Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016, *India*

This paper critically reviews the status vis-à-vis the conceptual framework of educational technology in India. It provides glimpses of isolated success stories against the overall dismal picture and resistance to change. Generations of media appear to impact fleetingly on engineering education. Developments in video formats, computer capability and instructional design are at a subcritical level. Faculty development programmes continue to bring greater awareness but appear to stop there. Greater effort and enthusiasm are necessary for the acceptance of educational technology in engineering education.

FROM ENTERTAINMENT TO EDUCATION

HISTORY reveals that media which succeeded in entertainment have then been tried in education. Development of slides and photography was largely due to holiday-makers. Radio and video have proved their potential for mass entertainment. Computers and video games have swamped the market. Audio, video and computer resources are now beginning to make an impact in education.

A news item on multimedia vision in the *Hindustan Times* in September 1992 noted that a Bharatnatyam recital by Geet Govindam was presented in a multimedia version [1]. An amalgamation of music, dance, light and video presentation of Jyotsna was supported by audiovisual slides of icons and miniature paintings depicting the love story of Lord Krishna. The slides also featured Jyotsna in different emotional sequences from the story and carried the drama forward so that she did not have to enact the entire story on the stage and instead chose only those parts most conducive to her dance. The reason for using such a presentation is that the attention span of an audience is limited to $1\frac{1}{2}$ hours and there is a great deal to be shown!

This example makes a case in point. If there is a great deal to be shown for entertainment, there is more to be done in education. The rate of visualization by students is much higher than the rate of spoken words; media can bridge the gap. The attention span of a typical adolescent learner is merely 20 minutes for a single activity. Multimedia can provide a change of activity. Multimedia must enter education. The élite may continue to debate its pros and cons, and teachers may not want to take up the challenge of designing and preparing audiovisuals, but the students certainly need them for better learning experiences.

CONCEPTUAL FRAMEWORK

Educational technology is conceived as the sum of 'technology in education' and 'technology of education'. It encompasses the role of hardware in educational processes as well as the techniques and methodologies that comprise the software as shown in Fig. 1.

Some of the oft-quoted definitions of educational technology in India are as follows:

• Commission on Instructional Technology, USA:

> Educational Technology is a systematic way of designing, implementing and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and non-human resources to bring about more effective instruction.

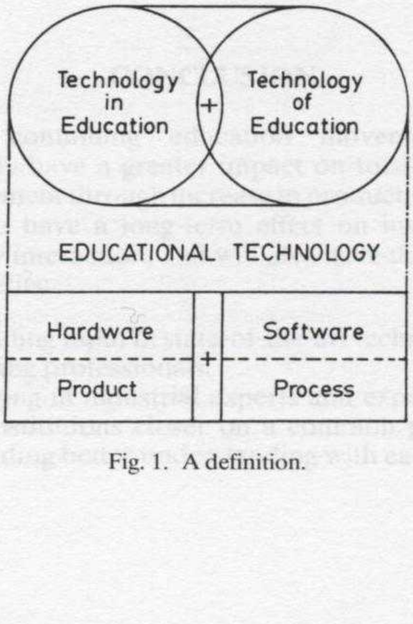

Fig. 1. A definition.

- Association for Educational Communications and Technology, USA:

  Educational Technology is a complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems, involved in all aspects of learning.

- Council for Educational Technology, UK:

  Educational Technology is the development, application and evaluation of systems, techniques and aids to improve the process of human learning.

- National Centre for Programmed Learning, UK:

  Educational Technology is the application of scientific knowledge about learning, and the conditions of learning, to improve the effectiveness and efficiency of teaching and training. In the absence of scientifically established principles, educational technology implements techniques of empirical testing to improve learning situations.

All the definitions lead us to believe that educational technology is technology of education more than technology in education. Moreover, it is also believed that there are greater chances of success if it is pursued with a systems approach. As a system it has the subsystems of instructional design, communication techniques, learning psychology, teaching methodology, audiovisual resources, curriculum development and evaluation techniques as shown in Fig. 2. The process and product concepts of educational technology are integral to the systems model.

All said and done, technology-based education is usually equated to educational technology. Efforts at introducing educational technology in curricula, therefore, revolve around the use of audiovisual media. Some aspects of instructional design, learning psychology and teaching methods constitute the input to the effective utilization of audiovisuals rather than emerging as primary components of the educational technology systems. One of the reasons for this phenomenon is that the departments of education in universities across India [2], which have introduced educational technology as a separate subject at B.Ed. M.Ed. and M.Phil. levels, have listed audiovisual topics under this subject. This is explained by the fact that other topics, e.g. instructional design, learning psychology and evaluation techniques, already exist as separate subjects, and only the technology-based aspects have been brought in.

Another reason is the narrow interpretation of the word by the user. Engineers tend to assume it to be the use of technological equipment in teaching; they do not wish to be concerned with the theories of learning, models of teaching, principles of motivation, etc. which are equal partners in the systems concept of educational technology.

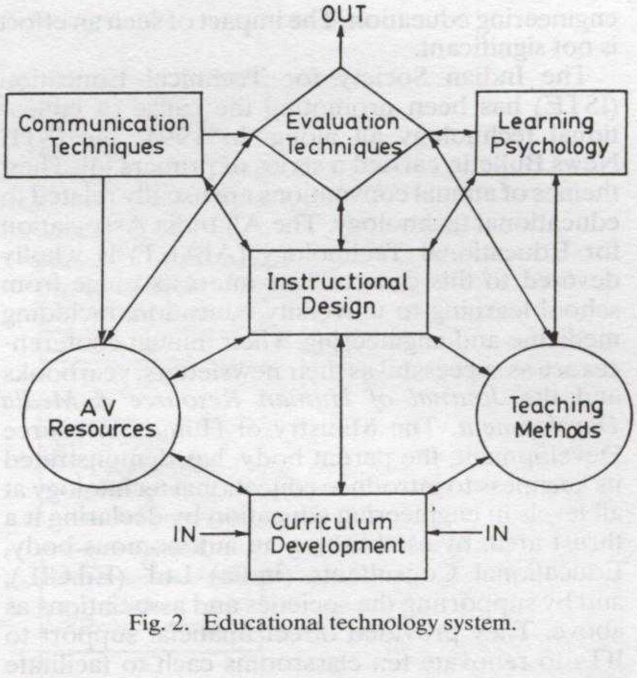

Fig. 2. Educational technology system.

MAY I COME IN, SIR?

Educational technology is likely to make an impact in engineering education if the hardware makes its entry into the classroom and laboratories! But in this respect educational technology is still in its infancy. Audiovisual units at engineering institutions have one or two sets each of overhead projectors, slide projectors and video cassette players. Only some places, such as the Indian Institutes of Technology (IITs), have large numbers of rooms equipped with overhead projectors on trolleys. The system of loaning equipment, carrying it to and fro, etc., has been formal as to be demotivational. In the classroom, chalkboard must be supplemented by the audiovisual hardware installed permanently [3] as is being done in developed countries. Laboratory instruction has even greater scope for being made more effective. Slide-series and video programmes can be employed to introduce the experiments, to demonstrate the procedure and points for observation and to show the relevance of the theory and experiments by showing real-life examples to the students.

All the four Technical Teachers Training Institutes (TTTIs) have reasonably sized audiovisual laboratories for imparting training to groups of faculty members for the preparation of charts, models, filmstrips, slides, transparencies and audio-recordings. This type of effort is supplementary to the introduction of educational technology in classrooms and laboratories. Apart from faculty training, such resource centres can be used to prepare the audiovisual software required in engineering education. The impact of such an effort is not significant.

The Indian Society for Technical Education (ISTE) has been promoting the cause of educational technology all along. In 1991, the ISTE News Bulletin carried a series of primers [4]. Their themes of annual conventions are usually related to educational technology. The All India Association for Educational Technology (AIAET) is wholly devoted to this cause. Their interests range from school learning to university education, including medicine and engineering. Their annual conferences are as successful as their newsletters, yearbooks and the *Journal of Human Resource & Media Development*. The Ministry of Human Resource Development, the parent body, has demonstrated its keenness to introduce educational technology at all levels in engineering education by declaring it a thrust area, by establishing an autonomous body, Educational Consultants (India) Ltd. (Ed.CIL), and by supporting the societies and associations as above. They provided direct financial support to IITs to renovate ten classrooms each to facilitate the use of audiovisuals.

FACULTY DEVELOPMENT: GO OR NO-GO!

The TTTIs were the first to start teacher training programmes for polytechnic education. A large number of short, medium and long-term courses have since been conducted for a large number of teachers, and some follow-up studies have been undertaken to determine their effectiveness. A typical course content included pedagogy, elements of communication, instructional design and evaluation. It was believed that the polytechnic teachers were already knowledgeable in their subject and such pedagogical input would improve their competencies. Fifteen years of implementation of such programmes revealed that teachers were not teaching significantly better. Newer strategies of education and training were then identified.

In an attempt to change the attitudes of teachers and to make them committed to the use of educational technology in engineering education, an attempt has been made to design and implement long-term courses with equal emphasis on the subject matter and instructional technology. One-year and two-year courses leading to M.Tech.Ed., B.Tech.Ed. and PG Diploma in teaching specific subjects have been offered at the TTTIs. The impact of long-term courses on teachers' performance and students' learning has not been very great, perhaps because the courses have been taken by middle-level teachers, more for the sake of improving their qualification than with the aim of upgrading their teaching abilities.

The Coordinated Thrust Area Project on Educational Technology, financed by the MHRD, resulted in the establishment of centres and schools for educational technology in many institutions. While all of them have had their shares of achievement, the centre at IIT, Delhi pioneered the development of a modular system for faculty interaction. Over a period of five years, it has recorded several thousand person-modules of interaction both at the institutional and national levels. Modules prepared on different topics have since been published as a monograph [5] under the Quality Improvement Programme, University of Roorkee. The structure of the modular programme offered at IIT, Delhi is shown in Fig. 3.

The national review [6] of the Quality Improvement Programme in India has revealed some interesting facts related to educational technology. Heads of institutions desired that 10–12% of courses should be in the area of educational technology in the master's degree programmes of all disciplines, e.g. mechanical, electrical and civil engineering. They have also asked for Pre-Ph.D. programmes to include different topics in educational technology. They have shown willingness to sponsor candidates for research leading to Ph.D. degrees in instructional design, teaching methodology, laboratory development, etc.

Short-term summer and winter courses sponsored by the QIP and ISTE are usually held on different engineering subjects. According to the survey, there is a greater need to hold short courses in the area of educational technology and on thrust-area subjects, both at the major QIP centres and at different engineering institutions in the country. The heads of institutions are interested in institutional development, including different aspects, such as curriculum development, laboratory improvement and innovations in teaching methodology, as much as in subject-matter expertise. They have also asked for faculty exchange programmes and part-time registration of their faculty for research at the higher institutes of learning on these topics.

COUNTRYSIDE CLASSROOM (CWCR) AND BEYOND

The CWCR project aims at reaching out to all categories of learners across the country [7]. Over a period of eight years, four full-fledged centres, called Educational Media Research Centres (EMRCs) and ten small television production centres, called Audiovisual Research Centres (AVRCs), have been established. Of over 1000 higher education television programmes produced by these centres [8] a sizeable number have been on science and technology. Some programmes also relate to instructional technology. The broadcasts aim at upgrading and enriching the quality of education. They overcome the obsolescence of syllabuses and arouse interest in the viewers. The ideological objective of the CWCR is that while the programmes will convey information, greater stress will be laid on the process of converting information into knowledge and, hopefully, knowl-

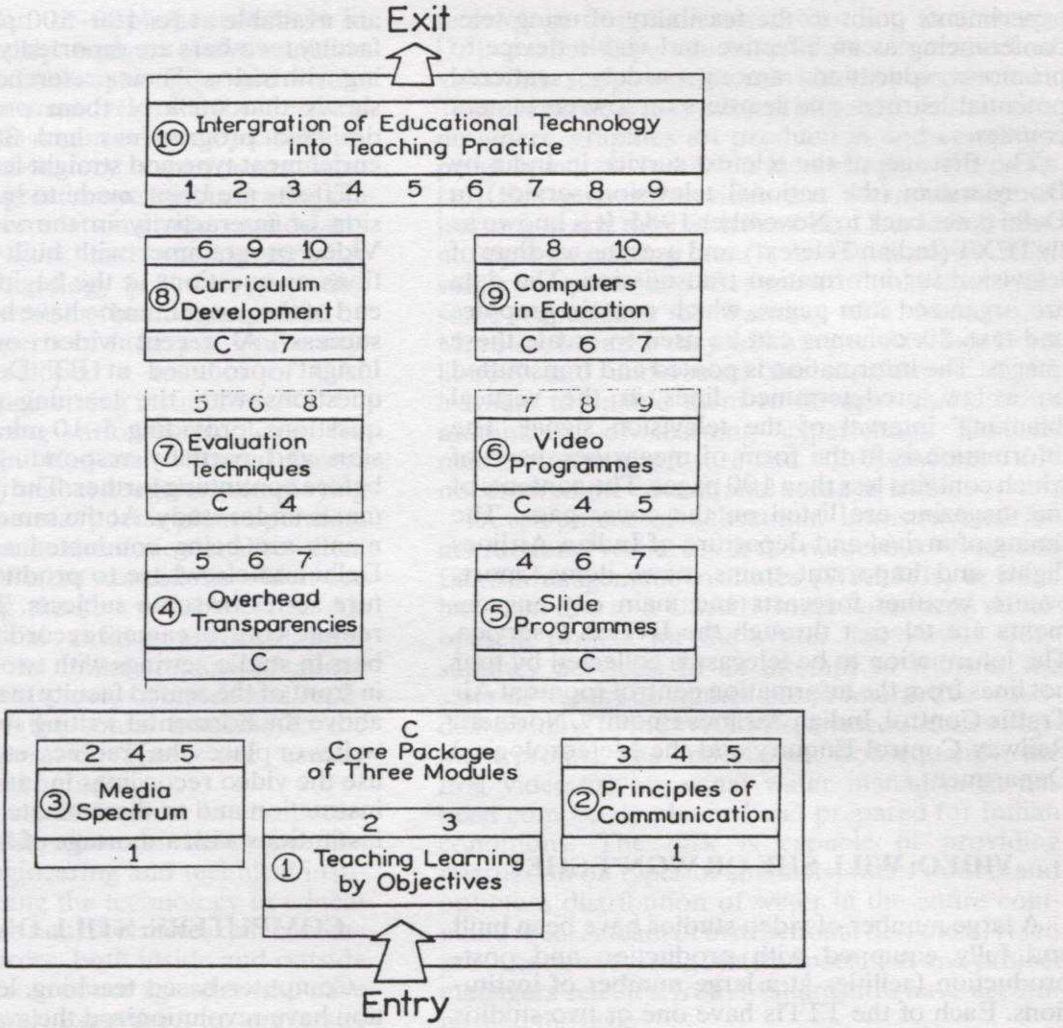

Fig. 3. Structure of the Modular Programme

edge into wisdom. Motivation, innovation, creativity and the ability to analyse are the guiding elements. The University Grants Commission (UGC) has supplied 1500 television sets to different institutions to enable the techers and students to view the programmes.

The CWCR project took off with the launch of the first geostationary Indian national satellite (INSAT-1A) in April 1982. Another satellite, INSAT-1B, provided satisfactory service until 1990; the next one, INSAT-1D, launched in July 1990 opened up new avenues to different users. The latest to be launched was the INSAT-II in mid-1992. It is a multipurpose operational satellite system, possessing capability of cross-country telecommunication, radio and television networking facility, as well as tremendous meteorological capability.

At this stage, a Technical Education Television (TETV) Project is in the offing [9]. A tentative decision has been taken at the MHRD level to start a 30 min telecast for five days a week exclusively for enrichment of higher technological education. It would also benefit serving engineers and supplement non-formal education of all interested in science. It may be mentioned here that no difficulty is perceived for the first year of the project because a large number of telecast-quality programmes are available. Nationwide organization, collaboration between institutions and greater funding from the government would be necessary for the continued implementation of the programme.

There is a great deal of untapped educational potential through ITELSAT satellites located over the Indian, Atlantic and Pacific Ocean regions, covering 160 countries and 67% of the world's telephone traffic. INTELSAT-VI series is a new generation of five commercial communications satellites, the first of which was launched in 1989. Among other things, it made possible a commercial in-flight passenger telephone service, introduced for the first time by Singapore Airlines in 1991. The Videsh Sanchar Nigam in India offers Inmarsat for International maritime clients.

Experiments on teleconferencing in India include those at the Space Applications Centre, Ahmedabad. Studies on press interviews and educational purposes were conducted by employing satellite and terrestrial circuits, one-way television and two-way audio channels. Results of the experiments point to the feasibility of using teleconferencing as an effective and viable device to promote education among widely scattered potential learners and learners on low-enrolment courses.

The first use of the teletext service in India by Doordarshan (the national television service) in Delhi dates back to November 1985. It is known as INTEXT (Indian Teletext), and uses the medium of television for information transmission. The data are organized into pages, which contain graphics and text. Six columns can be used to create these images. The information is pooled and transmitted on a few predetermined lines in the vertical 'blanking' interval of the television signal. The information is in the form of magazines, each of which contains less than 100 pages. The contents of the magazine are listed on the cover page. The timing of arrival and departure of Indian Airlines flights and important trains, news items, sports events, weather forecasts and main city engagements are telecast through the INTEXT service. The information to be telecast is collected by four hot lines from the information control rooms at Air Traffic Control, Indian Airlines Enquiry, Northern Railway Control Enquiry and the Meteorological Department.

VIDEO: WILL SHE OR WON'T SHE?

A large number of video studios have been built and fully equipped with production and post-production facilities at a large number of institutions. Each of the TTTIs have one or two studios and each IIT has created one of its own. In addition, all the EMRCs and AVRCs in the universities have video studios. Their Educational Television Studios have a complete range of professional equipment for outdoor and indoor video productions with audio mixing capabilities and limited computer graphics. The infrastructure is adequate for 20–30 high-quality scripted video programmes and 200–300 lecture recordings annually at each place. A recent survey conducted by the author reveals that the utilization factor of the studios is extremely low. The number of scripts in hand is inadequate and hence there is spare capacity at most of the places. In spite of this fact, new studios continue to be built, resulting in a financial drain. The reasons for inadequate faculty interest in script writing include the absence of research on the effectiveness of different forms and formats of video for learning.

Research findings on video utilization in engineering education [10] point to the fact there is a general lack of interest on the part of management to acquire and to encourage teaching with video. The survey showed that 80–88% of institutions have colour television sets, VCRs and a place for viewing, but there is only 15% frequency of viewing with no access to students.

This revelation is disheartening in view of the fact that video cassettes on a wide range of subjects are available at Rs 100–500 per cassette, and the faculty members are reportedly interested in teaching with video. Their preference pattern for video shows that 60% of them preferred good well-designed programmes and 30–50% would like enrichment type and straight lecture recordings.

Efforts are being made to incorporate a dimension of interactivity in the video medium itself. Video programmes with built-in rhetorical questions or questions at the beginning or toward the end of the programmme have been tried with some success. A recent video on 'Mechanics—An Insight', produced at IIT Delhi, integrates the questions with the learning process by raising questions, providing 5–10 min pauses for discussion and partially responding to the questions before continuing further. The impact of such a format is under study. At the same time, some experiments are being conducted at the IIT Bombay, Delhi and elsewhere to produce talking-head lecture series in some subjects. These are low-cost, remote-control camera recordings of faculty members in studio settings with two fixed cameras, one in front of the seated faculty member and the other above the horizontal writing surface where he/she writes or places the graphics, etc. The intention is to use the video recordings in tutored-video mode of instruction and to disseminate the programmes to institutions with a shortage of faculty members.

COMPUTERS: STILL ON THE FRINGE

Computer-based teaching, learning and evaluation have revolutionized the system of engineering education in many parts of the world. The impact, however, is insignificant in India. There is neither lack of awareness in India nor the expertise to develop CAL/CAI or CML software. The advantages of computer-assisted instruction—e.g. to enable students to visualize and learn theoretical concepts, to comprehend abstract ideas, to interact, etc.—are well understood [11]. There are many examples, such as turning around a three-dimensional phase diagram, zooming in at a desired location and taking two-dimensional cross-sections or colour graphics displays of vector fields or animated sequences of moving objects. Yet, there are very few completed and well-documented CAI packages.

Most CAI lessons are imported from overseas. A large number of lessons was received from Britain under the Computer Literacy and Studies in School (CLASS) project in 1983–84. The project, implemented by the Ministry of HRD and the Department of Electronics, made a reasonable impact at the school level. Some institutes of higher learning were asked to develop further software. IIT Kanpur [12] have contributed significantly by developing 16 packages in physics, chemistry and mathematics. They have taken a lead in developing some lessons for engineering students as well. They have also proposed a dynamic process of learning through CAI. A plan of implementation is in progress. Simultaneously, analysis of the available software has revealed their strengths and weaknesses. A similar effort may overcome the inertia in preparing software for engineering subjects. Studies on simulated laboratory experiments have revealed that there is great scope for innovating the use of computers in simulation mode, particularly to avoid repetitive work and wasting time. A comprehensive methodology [13] for preparing computer-based software has been documented by a team of leading experts of Jadavpur University. They have also developed a number of CAI packages for use in engineering institutions.

Computers are being variously employed for training in India. The National Thermal Power Corporation (NTPC) has been regularly employing computers to train thermal power plant operators on simulators. Computer simulation enables them to respond under different conditions which are generated by altering the key variables. The Air Force and commercial airlines use computer-based simulators in the initial training of pilots. Such simulators are extremely complex and replicate the response of the actual machine to the stimulus of the operator. These are usually imported or assembled in India.

There is a great deal of interest in computer-based multimedia instruction in India, but the country's premier engineering and technical institutions are not yet using the technology in education [14]. Motivation and incentives have come from a variety of sources, both inside and outside the country, ranging from donor agencies who have provided training and expertise, to university faculty, to feasibility studies assessing the use of technology in institutions. According to a survey [15], partial expertise is available in respect of videodisk script writing an videodisk production. There is no dearth of subject expertise, instruction designers, graphics art production and computer programmers in India. It is increasingly well known [11] that interactive video has the advantage of learning at any time with flexibility, random access, multiple branching, etc. It is felt, however, that subject experts and designers should first gain some experience of learning with multimedia. More so, because they will have to develop visual literacy and understand the capabilities of the learners to enable them to navigate through the multiplicity of learning experiences. Further, media-effective software and CD-ROM have still not entered the educational scene in India.

Development of substantial infrastructure for instructional resources at the numerous Water and Land Management Institutes (WALMIs) in India has been due to a USAID-India-sponsored development project for the Water and Power Consultancy Services. In an attempt to transfer the state-of-the-art computer-based interactive videodisk training to the WALMIs, a videodisk development project was undertaken. Consequently, the first videodisk on canal water management has been completely planned and prepared for Indian conditions. The disk is capable of providing instruction on types of channels, water outlets and optimum distribution of water in the entire command area. A team of instructional designers, video producers, authoring system specialists and project managers selected from Maharashtra have accomplished the task.

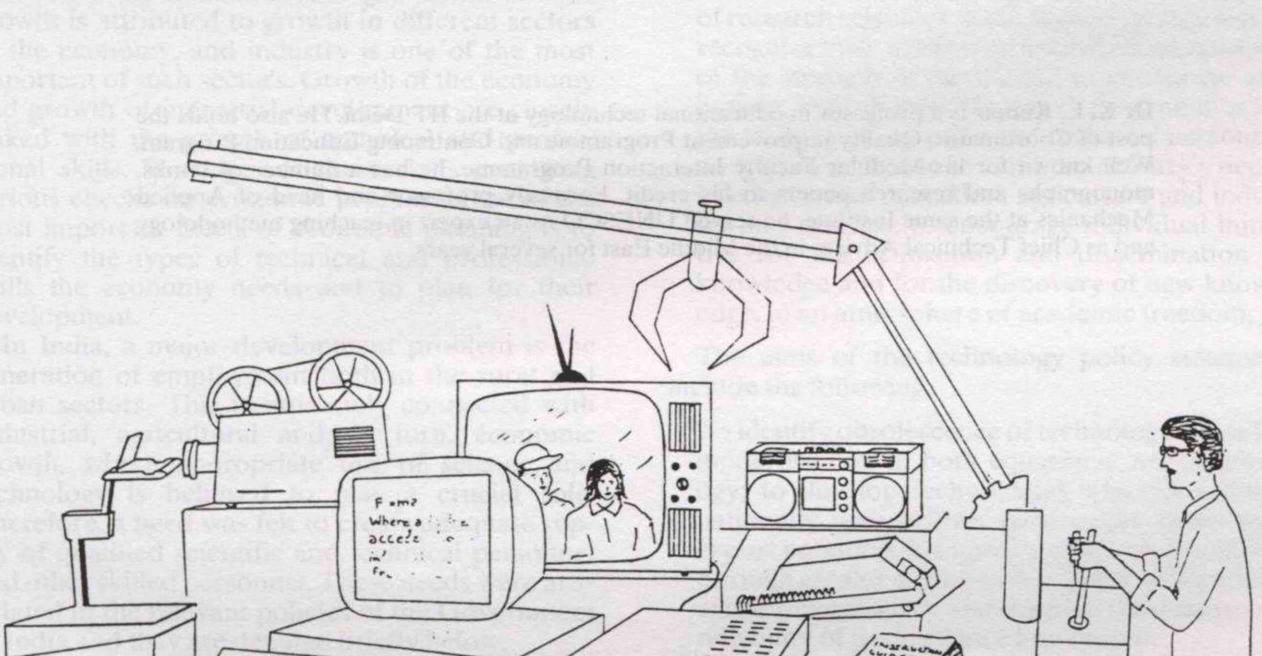

Fig. 4. Media selection.

HUM HONGEY KAMYAB, EK DIN! WE SHALL SUCCEED, ONE DAY!

Do we see a hope that educational technology will prevail at the level of engineering education? We make plans, sing songs and deliver speeches but stay where we are. We cannot be sure when the faculty will be able to select and employ media appropriate to their objectives. Unless we move, the educational technology revolution may not be able to sway the pendulum. Having placed the facts about the present role of educational technology on the table, and in the face of continued resistance from the faculty to change, we can wishfully sing that *we shall succeed, one day!*

Acknowledgements—The author acknowledges the assistance of Ms Madhumita Jaswal, SRA for scanning the literature. Hats off to Professor R. Natarajan for his cool perseverence in getting this article written.

REFERENCES

1. L. J. Shankar, Multi media vision. *Hindustan Times*, 20 September (1992).
2. University of Delhi, Scheme of examinations and courses of study for M.Ed. and B.Ed. examinations, academic year 1990–91.
3. S. D. Patki, Engineering instructional media for technical education. *National Conference on Higher Technical Education and Training, MACT Bhopal Proceedings* (1991).
4. K. L. Kumar, Priming the primers. *ISTE Newslett.* (1991).
5. K. L. Kumar, Audiovisuals on the move. Monograph, University of Roorkee (1992).
6. K. L. Kumar, Report on the National Review of the Quality Improvement Programme conducted by QIP Coordinators (1992).
7. Mehta, M. Countryside Classroom Project in India, Educational Technology Yearbook Vol. 1, pp. 78–89, Jan (1990–91).
8. National Project Implementation Unit, List of learning resources in technical education. World Bank Assisted Project for Technical Education (1992).
9. S. K. Soni, Technical Education TV project. *National Conference on Higher Technical Education and Training, MACT Bhopal Proceedings* (1991).
10. J. Madhumita and P. Dharam, Are we reaching out? *AIAET Conference Proceedings*, Bhubeneshwar (1991).
11. D. G. Muller and R. A. Leonetti, Major technical advancement in training. *Instruction Delivery Syst.* August (1992).
12. S. Tiwari and R. M. Singru, Development of CAI lessons at Kanpur. *National Conference on Higher Technical Education and Training, MACT Bhopal Proceedings* (1991).
13. S. K. Goswami, K. Dutta *et al*., Computer based instruction. School of Educational Technology, Jadavpur University CW/92-03 (1992).
14. K. L. Kumar and G. R. Maughan, India: computer-based multimedia in education. *Instruction Delivery Syst*., **5**(5) (1991).
15. S. K. Soni, Interactive video—an emerging technology. *Education Technology Yearbook 1988*, pp. 441–445 (1988).

Dr K. L. Kumar is a professor in educational technology at the IIT Delhi. He also holds the post of Coordinator, Quality Improvement Programme and Continuing Education Program. Well known for his Modular Faculty Interaction Programme, he has a number of books, monographs and research papers to his credit. Formerly professor and head of Applied Mechanics at the same Institute, he served UNESCO as an expert in teaching methodology and as Chief Technical Adviser in the Middle East for several years.