PERSPECTIVES OF NEW TECHNOLOGIES IN EDUCATION

Plomp, T.J. & Pelgrum, H.

Technische Hogeschool Twente
Nederland

1.Introduction.

When thinking of the theme of the conference and the title of our presentation many conceptual questions arise, e.g. what is meant by new technologies or, more generally, by technology? what are the old technologies? in what respect does technology in education differ from educational technology?
Besides, at present many writers are speaking of information technology or new information technologies, instead of new technologies. In order to be able to discuss perspectives of new technologies in education we have to discuss some conceptual aspects first.
First of all, we will use New Technologies (abbr. NT) in the same meaning as others who are speaking of information technology or new information technologies. When analysing descriptions (or definitions) of technology or new (information) technologies (e.g. Galbraith, 1967, US Office of Technology Assessment (OTA), 1982, and UNESCO, 1983) it can be concluded that NT has to do with storing, retrieving and processing data for the purpose of gaining information to attain certain ends (e.g. acquisition of knowledge, control of process, decision making). However, it is also clear that NT as a concept has no straightforward meaning, because at least four different aspects can be distinguished, viz. (a) the purposeful application of knowledge, (b) the disciplinary and technical knowledge itself, (c) the machines and systems (products) produced by exploiting the knowledge, while UNESCO is using a definition in which is also reffered to (d) the associated social, economic and cultural matters. The fourth aspect has little to do with the description of NT, but is referring to its effects in our society, intended and unintended, desirable and undesirable (Plomp and Van de Wolde, 1985). In principle we will not exclude any of the four aspects.
However, in many publications NT is conceived just as products and (or) disciplinary and technical knowledge. We will therefore elaborate these two meanings a little further.
At present there is a great variety of products which together

form the NT. OTA (1982) gives the following enumeration: computers, cable systems (some with two-way communication), satellite communication, digital telephone networks, broadcast technologies, storage technology (silicon chips, floppy disks and hard disks), video technology and video disks and information services (e.g. videotex systems, information networks, electronic conferencing). All these NT products could be developed out of three advanced technologies (in its second meaning, viz. disciplinary and techni cal knowledge): computer technology, micro- electronics and telecommunication. Computer technology provides us with an immensely powerful and quickly working information processing machine. Microelectronics, as a result of the ongoing miniaturisation in electronics, allows us to mass-produce powerful data microprocessors (the 'brains' of NT products) at very low costs. Telecommunications give the means to communicate informa- tion over distances, accurately and speedily. In summary, the new technologies provide us with immense possiblities for storing, retrieving and processing data, which can be utilized not only in business and industry, but also in education.

Before discussing the perspectives of new technologies (NT) in education, we will first characterize changes in our society which (partly) determine desired or necessary changes in education (section 2). Because new technologies refers to the existence of old technologies, we will discuss some developments of the old technologies and the lessons learned from this (section 3). Then, in section 4, the consequences of the new technologies are discussed on three levels, viz.the general goals of education (4.1), the curriculum and course level (4.2) and the teaching and learning aids (4.3). In the final section we will discuss the consequences for further research, in an international context.

2.The changing society.

The above mentioned information processing functions of the NT are so intensively used in business, industry and the service sector, that several authors, e.g. Toffler (1980), Naisbitt (1980) and Häfner (1981, 1982) have argued (in different styles), that our society is changing from an industrial society to an information society, this means a society in which most of the people work with information rather than produce goods, and in which information has become an important commercial product. Characteristic for the changes in our society is that many human activities, manual as well as cognitive, are or will be taken over by information technology systems. Some examples from business

and industry, which illustrate this proposition, are: computer aided manufacturing (robots), computer based process control, computer aided design, electronic mail and electronic banking.
Häfner (1981) rightly concludes that the informational environment in the eighties will cause a new balance of storage, retrieving and processing data between human beings and machines.
Besides these (and other) examples, illustrating that in business and industry jobs are vanishing and (presumably) fewer new jobs are created, the influence of NT is already manifest in existing jobs and will become more so. Just two examples as illustrations: the use of wordprocessors in the work of secretaries and the use of interactive videosystems by sales people to show specific features of new products (e.g. already applied on a large scale by the automobile industries in the USA).
We may conclude that mainly because of economic arguments such as competition, cost-effectiveness, and pressure of the computer and communication industry, business and industry are demonstrating a 'natural affection' towards NT and its applications.

To complete this picture, we also have to take into consideration the homes. Things usually happen in the households quite naturally. This is also true with respect to information technology as we have experienced in the last decades: television with distance operation, automatic washing machines, a variety of computer games and, more recently, microcomputers have found their way into our homes without problems. In this perspective it is not surprising that toy manufacturers in the USA are the largest buyers of silicon chips (Hawkridge, 1983).
Given the natural development of these processes we may expect further development in the homes in the near future, such as individualized use of NT (e.g. paid-TV, interactive access to databanks) that will be available via cable, video, recorder and satellites, or interactive videotex-systems, combining the TV-set, the home-computers, the central computers and centralized data storage via telephone lines. All these developments will also greatly enlarge the possibilities of taking part in educational activities in a variety of individualized settings outside the traditional schools.

The role of education

What will be or should be the role of education in this era of information technology?
Schools, as the places where traditionally most of education takes place, are less open systems than the world of business and

industry or the home. A consequence of this fact is that developments in the schools take place less naturally or at least at a much slower pace. This is to a large extent due to the organizational and budgettary structure, or our educational systems lack the mechanisms for an alert and quick response to the developments which are taking place in the world outside the schools. Yet, the schools, where students have to be prepared for their future role in our society, should react to the developments of new technologies in our society. The changing balance between human and automatic information processing, examples of which have been described earlier, is asking for a new approach to and a new plan for education. The fact that many manual and cognitive skills are being taken over by machines will - if education does not change - result in a discrepancy between the goals for which students are educated and the skills which our society demands of school graduates. In this context Häfner (1981, 1983) speaks of a crisis in education.

What should be done to overcome this potential crisis in education? How is it possible for education to continue to fulfil its tasks in the future, viz. to prepare people for their future functioning in our society? One thing is clear: neglecting NT will not be allowed. It is not possible either to address the question whether or not the computer, or NT generally, should be introduced in education. It is no longer an issue, because computers are already used in many schools. The main question to be ans wered now is: How should schools react to their changing information environment? The possible answers to this question will depend on how schools, or more generally our educational systems, including national, regional and local governments, conceive their mission in our society and on how they believe they have to respond to developments in our rapidly changing society.

3. The old technologies-educational technology

Speaking of new technologies suggests that there are also 'old' technologies. Before discussing the meaning and consequences of NT for education, we will first analyse what can be conceived as old technologies and what lessons can be learned from our experiences with the application of old technologies in education.
The use of technological products for educational purposes is probably as old as mankind: we know e.g. of clay-tablets, handwritings, printed books and (wall)pictures. All of these were applied for educational purposes. Technological products of the

fifties and sixties are e.g. film-strips and slides, motion pictures, programmed instructions, television and also the computer (at that time main frames) (see e.g. Gerlach and Ely, 1971 and Brown, Lewis and Harcleroad, 1973). When applied in education the words educational technologies are commonly used. From the development of educational technology much can be learned which is useful when trying to shape responsible applications and uses of NT in education.

Several authors have analysed the developments with respect to educational technology (e.g. AECT, 1977; Saettler, 1978; Davies, 1978; Romiszowski, 1981; and Plomp, 1982). From these analyses three types of descriptions, and therefore of applications, of educational technology are emerging. Educational technology one is in essence a 'product' approach, viz. all sorts of materials, machines and hardware (esp. audiovisual products like television, projectors, recorders, language laboratories, etc.) as technical aids in teaching: aids to presentation, to assessment, to demonstrations, to the solution of logistic problems, etc. The presupposition behind this approach is that the quality of education will improve when the newest equipment is used in the educational process (this thinking was analogous to manufacturing conceptions in industry). Komoski (1984) points to the fact that schools that purchase and teachers who use such materials have delegated most of the important curriculum and instructional design decisions to the material's developer (which fact is frequently not recognized by educators and administrators). When the material selection process in the school has failed to produce an adequate fit between a product, a teacher and a learner, instructional design decisions made by the material's developer are frequently disagreed with or ignored by the teacher (Komoski, 1984, p. 11). If we add to this, that for many of these 'old' technologies we hold that teachers were insufficiently trained to use them appropriately, it is not surprising that much of this type of educational technology passed out of the schools and the classrooms.

Educational technology two refers to the knowledge about the process or techniques for designing software or instructional materials or programmes (e.g. programmed instruction). This technique is characterized by a stepwise procedure: define objectives, decide method, develop resources, test, evaluate and implement (Davies, 1978). An objection to this concept of educational technology is that is too easily and selfevidently suggested that a problem in education should be conceived as an instructional problem which can be solved by just applying this type of educational technology. But both educational technology concepts do have their limitations. They refer only to parts of

the teaching and/or learning process: educational technology one to new teaching aids with the risk of not considering the teaching/ learning process as a whole; educational technology two to knowledge about the instructional design process with the risk that too easily systematically designed instruction is chosen as the solution without considering other alternatives. Stated in other words: central in educational technology one and two is the technology (i.e. the product or the design process) as the selfevident solu tion to educational problems and not the educational problem in its context for which a solution is needed.
A real breakthrough in educational technological thinking was the growing understanding in the sixties that the real improvements in education cannot be attained by merely considering isolated parts of the educational process, viz. those parts which can be easily approached with fashionable machines or modes of instruction. Inspired by developments in other disciplines (e.g. engineering, business administration), a holistic approach developed gradually: a problem must not be isolated from its context, but has to be analysed in this context and approached with an open eye for the many factors which determine this context and can play a role in the solution. This process can be characterized as a development from closed systems thinking to open systems thinking. This problem centred educational technology three can be characterized as a systems approach. It is important to point to the fact that the other concepts of educational technology are essential parts of the systems approach of educational technology because they can serve as valuable means in attaining certain goals or objectives.

From these developments with respect to the old technologies, Plomp and Van de Wolde (1985) point to some lessons that can be learned when we consider the perspectives of NT in education. In doing this we are referring to the introductory section where we point to four aspects in the definition of NT.
First, NT has to be conceived as more than just a collection of modern technological products which have to be used in education while their usefulness are taken for granted. This is a too limited concept, because too easily, the means may become the central focus of attention without considering the ends for which the NT products are meant to be instrumental (see our earlier reference to Komoski, 1984).
For the same reasons NT just as a body of disciplinary and technological knowledge, which can be introduced in education e.g. by teaching courses in informatics, is a too limited concept when considering the potentials of NT in education. From the developments of the 'old' technologies it can be learned that conceiving NT in either one or both meanings carries the risk

that NT in education deteriorates into dropping technology in the schools either as products or as new courses without taking into account the needs, the problems and the limitations of these schools. This lesson from the history of educational technology may seem trivial, but is not a trivial one at all. We all know stories of authorities (local, regional or national) or parent-teacher associations which were putting pressure on the schools to introduce computers, while they were not prepared at all for this type of innovation or did not even have any ideas about what to do with it. At the other side, much can be learned about the poten tials of NT in education when, being aware of the limitation of the context, a careful study will be made of NT as a product or as a discipline in education.
The impact of NT in education will be stronger than that of the old technologies. The arguments for this position stem not only from essential differences between the old and the new technolo gical products, but also from the influence of NT in our society and the consequences thereof for the goals of our educational systems.

4. New Technologies in Education

In an OECD study, when analyzing the forces underlying the technological demands for and on education, the following argu ments are put forward for introducing NT in education (OECD, 1984):

1. The needs of the economy: to produce specialised manpower.
2. The need to prepare the young to be functional in a society permeated with NT, by giving them also a basic education in NT.
3. The improvement of the teaching/learning process: NT adds new powerful tools to education, by which its quality and effectiveness can be improved, especially low achievers and gifted may profit from this advantage.

The needs of the economy refer to the role of NT in vocational education. Although this application of NT is very important we will not discuss vocational education separately in this paper (see for a discussion e.g. Plomp, 1985).

The second need deals with the general preparation of all pupils to become functional and responsive citizens in our society, while the third need refers to the use of NT, at present especially computers, as an aid in teaching and learning. Considering the

last two needs we may conclude that NT will influence education on three levels; viz. a) the general goals of education, b) the curriculum and the courses taught in schools and c) teaching and learning aids. We will discuss those three levels in the following sections. In doing this we will rely heavily upon the work of Van de Wolde and Plomp (Van de Wolde, 1984, and Plomp and Van de Wolde, 1985).

4.1. New Technologies and the General Goals of Education

Though new technologies and their application in education has only recently gained public attention and a widespread use in the schools, often its impact on the educational systems has partly been recognised. Favourable aspects seem to be those the present system can quite easily deal with, e.g. the use of drill and practice programmes.
However, it should be noticed that the impact of NT on the educational system will be radical. Education has to reconcile itself with the new technologies. This implies that school curricula have to be attuned to living in the information society and to the development of qualities in which the machine (c.q. computer) can be no competitor of human beings (Van de Wolde, 1984). Many topics and subject matter, as they are taught today, with an emphasis on memorization or reproduction of facts, may no longer be of relevance in the information society. As Simon (1971) states, the meaning of the verb to know is changing from what you have in your head to what you are able to access. Or stated in other words: the disconnection of knowledge accumulation and knowledge application, already set in with the introduction of printing, seems to become definite by now. For this new type of knowing not only analytical, but above all creative and synthesising skills are needed. According to Hunter (1982), handwriting, spelling, arithmetic computation and memorization of facts are examples of basic subjects that may be deemphasized in favour of problem solving, information handling, experimentation and greater social interaction. Without drawing the same conclusions immediately, one may say that our schools should concentrate more than till now on the development of productive (instead of reproductive) skills, i.e. higher order skills, which enable people to generate and evaluate answers adequately by themselves, when new circumstances arise. Such 'metaskills' can be developed by learning to learn and learning to solve problems. This implies that in our curricula accents cannot be laid exclusively on content, but in a greater degree also on learning processes (Van de Wolde, 1984, Plomp and Van de Wolde, 1985).