Perspective

The Future of Educational Technology is Past

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Editor's Note: This is the third in a series of invited articles that are published in *CJEC* in Number 1 of each new volume. These articles are intended to serve as a mechanism for addressing the broader issues In educational communication and technology and for challenging our assumptions about the underlying nature and current state of our profession and the professional activities in which we engage. In this year's Perspective P. David Mitchell argues that the traps referred to by Beckwith (*Perspective*. 1988) are unavoidable and that in effect the promise of educational technology as envisioned by Beckwith and others is dead – killed largely by our inability or unwillingness to examine the underlying tenets of our own behavior and to affect change in the processes and practices that have become the field of educational technology. We must adopt a new perspective on the process of learning, the process of teaching , and the process of doing research, he argues, if we are to revive the corpse before It Is buried by someone else,

PROLOGUE

Educational technology appears to be a successful field. Graduates are in high demand, working primarily in industrial training and the formal education system. Salaries and opportunities for advancement apparently are good. New and promising equipment appears on the market regularly, awaiting our exploitation. Educational technology journals and conferences abound. People in traditional disciplines and professions are using some of our "tricks of the trade" and fellow academics recognize the value of educational technology- in short, educational technology seems to be in its prime and enjoying good health. What, then is the meaning of the title?

This paper is an attempt to share my concern about the value of the field of educational technology to our society, especially to those currently in school and university, and to the global society within which we function. It also is an attempt to expand upon the cogent analysis and hopeful prescription of Beckwith (1988), an expansion which will show the impossibility of escaping the traps which he describes. I write as an insider, one who has devoted two decades to helping fulfill Kenneth Richmond's prediction that "educational technology is destined to emerge as *the* central humane discipline of the future" (Richmond, 1967, p. 106). And I write as one who has worked within the philosophical and systemic perspective that Beckwith insists we adopt, as well as within a graduate programme preparing educational technologists.'

Despite my frequent attempts to maintain a balanced perspective on issues, I'm not always antifloccinaucinihilipilificationistically inclined. (Note to proofreader: see OED if spelling checker program chokes on this!) So it is with regret that I now conclude that educational technology has no future – because it is dead (though not yet buried). Any hope for its resuscitation is likely to be misplaced because there is so little understanding of why it died. I hope that this post mortem analysis will reduce our lack ofunderstanding and perhaps contribute to a new life.

In preparing this paper I attempted to raise many questions and to suggest few answers. Moreover, I am aware that most complex problems have many solutions-or none -and that suggested answers are not final. Some comments are deliberately provocative and are intended to stimulate critical discussion; others appear so in the absence of elaboration.

To illustrate, I intend to show that we have failed to tackle the most pressing educational problems and have settled for routine applications more characteristic of a craft. Moreover we have developed virtually no theoretical models (those we use tend to be borrowed) nor do we produce graduates who are likely to do so. The underlying reasons are complex but centre on our adopting a world view that is, if not obsolete, incomplete and useless for understanding the complex problems that need to be solved. Many have argued that we need a new paradigm but this calls for each of us to transform ourselves. We lack the requisite psychotechnology to make this easy. Paradoxically we need this paradigm in order to acquire it.

THE FUTURE OF EDUCATIONAL TECHNOLOGY

In his paper portraying "The Future of Educational Technology," Beckwith argues that, "If we are to survive, purposefully, as the cutting-edge field of our original vision, there are some solution-related traps that must be avoided" (Beckwith, 1988, p. 8). These he classifies as the traps of: "compromised integrity"; "status quo adherence" and "solidification."

In the first trap, we are distracted from actually achieving our educational goals by, for example, dazzling products, pursuit of money, or our employer's goals. In the second, we seek credibility by emulating established professions' inertia. Thus we avoid recommending significant changes in any educational system which employs us to solve a problem. And our notion of acceptable research or conferences is governed by the norms established by others (e.g., psychology).

In the trap of solidification, "The energy needed to apply the intellectual techniques of educational technology to the betterment ofhumankindhas been sapped by solidification within the mode of short-term survival" (Beckwith, 1988, p. 13). The purpose of educational technology becomes lost within the mists of routine applications of standard (though not necessarily valuable) procedures. Thus graduate programmes focus on instructional design and research comes "close to solidification as an inappropriate and limited method of inquiry. The cementing of reductionist, conclusion-oriented, static, systematic research models precludes the needed study and realization of systemic entities" (p. 14). Is there any hope? Beckwith thinks so.

His solution is deceptively simple. We need to publicly proclaim our goal to be "the transformation of learners and learning processes" and we need to transform our field into a systemic field which itself could become "the personal learning environment of your dreams – rich, vibrant, alive, dynamic, accelerating- an environment in which . . . research and development, production and dissemination, and teaching and learning are fused so tightly together that transformation is activated and reactivated (Beckwith, 1988, p. 17). Having suggested similar ideas myself (Mitchell, 1970; 1971; 1975; 1978; 1982) I must admit that this vision is appealing. But is it realistic?

ACTIONS SPEAK LOUDER THAN WORDS

These are not traps to be avoided; they are symptoms ofincurable terminal illness. Moreover, the problem is not confined to educational technologists. For most organizations that employ educational technologists, education is no longer the system's purpose; what happens to students is just a by-product of the activity of its professional and bureaucratic core. This is a startling comment to which I'll return later.

Have you ever stopped to consider that perhaps what some of us are doing ought not to be done at all? And other things might be accomplished better by technicians, paraprofessionals and sundry other assistants. How are we to prepare ourselves for future developments (e.g., in micro-electronics, political struggles for declining budgets, cybernetics) when we don't even know what to anticipate? Are some of us failing to do what ought to be attempted and, if so, how do we identify the requisite capability in order to transform the field and to prepare new practitioners of educational technology to undertake these important tasks?

Earlier I asserted that in most organizations that employ educational technologists *education is no longer the system's purpose* ; what happens to students is just a by-product of the activity of its professional and bureaucratic core. What do I mean? Simply put, a system's purpose can be better discerned by asking what the system *is doing,* not what it was intended to do or what its spokesmen claim it's doing.

Typically, the system's core is devoted to self-perpetuation of their roles and functions (no matter how well-meaning the people are). What they *do* defines the system's purpose (cf. Beer, 1986). Thus, teaching becomes defined by philosophers and teachers as what teachers do regardless of whether students learn or even attend school (truancy rates run as high as 30% in some places). Health care becomes defined as what doctors provide (despite findings that nearly half the medical problems may be produced by doctors). Education is defined as happening in schools and colleges despite the prevalence of near illiteracy and limited knowledge or skills amongst students and even graduates. And what about educational technology? There is a dangerous precedent for defining it as what practitioners do; function becomes purpose.

Is this radical approach to purpose reasonable? How realistic is it to think that education is a high priority in the typical school or university? If a visiting scientist from Mars were to visit your institution and attempt to infer that system's purpose by observing how people spend their time and how money is allocated, would he infer education to be its primary purpose? Or would he take the extreme view that, "Universities are machines created by their gods, the faculty, primarily to provide them with the quality of work life they desire. Education of students is the price they must pay for this privilege. Teaching is largely devoted to inculcating students with a vocabulary that enables them to speak authoritatively on subjects they do not understand" (Gharajedaghi & Ackoff, 1985, p. 22). These authors go on to conclude that, "Schools in general, and universities, colleges and departments in particular are organized bureaucratically, that is, mechanistically They strongly resist innovation. They restrain their employees with rigid rules and regulations." (Gharajedaghi & Ackoff, 1985, p. 23).

Let me give you a humorous but true example which illustrates my point that its purpose is what a system ***does.*** A Ph.D. student registered at a certain American university filled out an application form and indicated her first languages were Arabic, Armenian, English, French and Turkish. Later, when the second language requirement for the Ph.D. had to be satisfied – an educational objective intended to guarantee that the student could read work written in another tongue – she was told that since all of these were first languages she must take a second language. Undaunted, she pointed out that computer languages could count and she knew both COBOL and FORTRAN. Equally undaunted, bureaucracy said that they did not count because she had studied them as an undergraduate and already had received credit for them. So she had to study and pass an exam in German! What's the point?," you may wonder. Just this: too frequently educational technologists behave unwittingly like this bureaucrat.

We do so when we try to improve the operation of an existing system without considering its actual and intended purpose; (Do your administrators and colleagues really act as if education were the prime purpose school, college or training unit? Does the Ministry of Education? Do your students? Do you? Would your time be better spent doing something else?)

We do so when we try to operationalize important educational intentions by composing and writing behavioural objectives, the sum of which falls short of the envisioned end-stage (e.g., the "good doctor" or the "good educational technologist" is a person who is far more than the component objectives of his professional courses).

We do so when we decide that we will produce a film or a series of TV programmes and look around for a topic rather than looking for an educational problem that needs to be solved and undertaking analysis to see which media/methods/content mix is most propitious.

We do so when we design so-called individualized instruction that fails to take into account the idiosyncratic background and learning styles of students and the network structure of knowledge in the discipline that would allow a student to build better conceptual links between what he knows and what he needs to know.

We do so when we design research projects that contribute little or nothing to the theory or practice of education but simply show our prowess as surveyors or experimenters.

And most pertinent here, we do so when we think a common preparation for educational technologists would look like the course of study we followed. What is the intended purpose of a system that produces educational technologists? What kind of person do we hope to turn out and what will that person need to know, believe, hope, fear, love and do? Expressed otherwise, what can an educational technology program do for society?

THE CHALLENGE TO EDUCATIONAL TECHNOLOGY

Educational technology must be dedicated to the efficiency of education as a whole and not simply to specific operations. An operational and philosophical analysis of educational technology, calls for a consideration of overall problems of education which educational technologists may be able to tackle before proceeding to the lower-order problem of designing a curriculum for them. The field of educational technology -in its concern for the optimal organization of education – must not be limited to time-honoured structures. Not should it perpetuate failures. We might serve our stewardship better by devising activities and forming environments which permit people to live fully and intensely both within and outside so-called educational institutions.

While rich countries provide tax-supported schooling for 12 to 20 years, half the world's children cannot attend school. This paradox underscores the need for change. The world's education system grinds on, consuming ever-increasing amounts of money in response to demand for educational services regardless of whether education is the outcome. But school costs in both affluent and penurious nations rise more rapidly than enrolments or national incomes. No country in the world can afford to satisfy its educational needs by schooling alone. Does educational technology offer any hope?

The Sisyphean educational imperative is to provide access to stored human experience – ideas, knowledge, skills – and opportunities to develop what is needed for personal and cultural development.

Enormous problems must be solved ifmankind as a whole is to share in the potential for human comfort, achievement and eudaemonia now restricted to a tiny minority. To refurbish our ideas about how to implement man's educational aspirations we need to develop the requisite theory and practice of educational technology along the lines suggested by Beckwith, but going much farther. Then educational technology can achieve the lofty ideals ascribed to by many of us.

The concept of lifelong education provides an altered perspective of profound significance for educational technology. Changing from dedication to efficiency ofinstructional activities to dedication to the effectiveness of human existence – which is what education entails – may reflect less a change in intellectual and communications technology than in priorities. But it calls for a new paradigm too.

Education refers to certain activities concerned with the intentional organization of ideas and learning opportunities by which successive generations are encultured and trained to sustain themselves and contribute to society. Continuing education presents two challenges. How can each nation enhance its collective intellectual capacity and skills? How can each person develop his personality and meet his educational and cultural aspirations?

Two currents of thought, the one emphasizing education as a productive investment for development of society and the other emphasizing personality development need to be combined. What is the scope of education today?

WHAT IS AN EDUCATIONAL PROBLEM?

If educational technology is to contribute to the solution of educational problems, we must first come to grips with the scope and purpose of education. Educational technology then may be in a position to identify worthwhile solutions.

The essence of technology, and therefore educational technology, is knowledge about relationships. Thus if we perform action X, there is a probability, P, that a given outcome, Y will occur. Alas in education and training it seldom is clear what action X is most likely to produce the intended result Y, especially without also producing unintended and conflicting outcomes. Moreover, Y is seldom unambiguous and confounds different, even incompatible, goals (e.g., attempting to optimize the state of interacting subsystems). Recall that the term education incorporates at least two different concepts; the personal experiences of someone coming to understand or appreciate or reflect upon the world; and the organized attempt to produce those experiences in a number of other persons. How can we optimize both? (Operational research holds some promise for systemic analysis in this area but we have yet to see much in the way of results.)

The Scope of Education

An educational problem may be far greater than the restricted vision of many observers. Thus an instructional design problem may be considered in isolation but the instructional system itself is embedded in an organization (school, corporation) that has other subsystems with different goals, priorities and resources that interaet with it.And this organization, in turn, is embedded with other interacting subsystems in a larger system. ‘lb complicate matters even more, each learner has his/her own system of knowledge, values, goals, etc.

In short, the notion of an educational problem or system should be expanded to include more systems and subsystems. And the boundaries between activities that are labelled educational and those that are not, should be pushed back to encompass informal as well as directed learning. Think for a moment about where you learned most of your attitudes, knowledge and skills. Was it exclusively, or even largely, within institutions labelled educational? Our classical methods of dealing with educational problems cannot be expected to be of much use in tackling such systemic problems.

A Larger Perspective

The world is in a critical phase of its evolution. Astonishing changes in micro-electronics and information technology presage new structures in many areas. We are promised that robots will produce half of our manufactured goods, displace human labour (including cheap labour in the third world) and send countless adults back to school. The opportunity for untold wealth is nigh; so is the possibility of disaster. Various reports suggest that continuous education soon will be a form of universal occupation. Opportunities for educational technology seem endless. Yet most people in the world live in the stick age; they get their energy from burning sticks and their life style centres on hand hoe agriculture. Their children die from malnutrition and disease (both of which are linked to poverty as well as to inadequate education) or military action. They strive for self-sufficiency constrained by their environment. We, in Canada, confront what some fear could herald a return to that life style (insofar as massive unemployment might reduce our economy to a shambles) and others hope could offer a culturally rich and personally rewarding life style. Surely there are real and challenging problems for us to attack. Perhaps, as Schwen suggests, “Our conceptual process traditions will be the most sustaining or enduring approach to solving problems” (1988, p. 25).

Our leaders in government, industry and education face many complex, inter-lockingproblems and possibilities. We are immersed in an era of unprecedented changes in what is possible and in the physical and psychological environment as a result of our decisions. Perhaps most significant is the increasing rate of change. We have just become accustomed to the silicon chip and now must adapt to a protein chip that promises to increase the density of a chip by 100,000 times.Add to this the possibility of neural net computers. Can we even conceive of the potential impact of such a development on education and training? The need for educational technology (in Beckwith's sense) has never been greater. Yet educational technology probably cannot be revived to tackle these complex problems. Computer scientists will be asked to do so.

TOWARD A SYSTEMIC PERSPECTIVE

The Input-Output Model

Most definitions of educational technology assert that it is concerned with applying knowledge, systems and techniques to improve the process of human learning. But virtually all educational technology research and applications have attempted instead to improve instruction, especially through information display systems and clarification of objectives as observables. Even interactive systems over-rely on information retrieval and display rather than responding to what the learner understands about the subject. Educational technology has turned the learner into a programmable machine rather than developing support systems to improve the quality of learner/subject matter interactions. This is primarily because we have failed to reject the notion that teaching causes learning and adhere to a simple cause-effect paradigm.

If we consider the various paradigms that have influenced educational technology, we see that they have been analytic and reductionistic even though different on the surface. Whether we consider the audio-visual, behavioural, neo-behavioural or cognitive models, all treat the learner as an input-output system which somehow responds to information displays by means of (potentially) measurable changes in capability. When we notice differences in learners'behaviour we attempt to relate these to factors under our control (e.g., message design, reinforcers) or uncontrolled variables (e.g., internal vs. external locus of control, gender, learning strategy).

For each of these paradigms the over-riding problem is how the educational system ought to work, both in general and specifically for an identifiable group of learners. This, in turn, leads to the notion that some human being (e.g., educational technologists, trainers, teachers) are expected to apply these causative factors (objectives, advance organizers, instructional materials, rewards or punishments) to other human beings. This is not as simple in practice as one might wish.

Experimental research controls the influence of the environment in order to predict events; a complex, adaptive environment confounds such models. Thus if we perform action X, not only is there a probability of outcome Ybut this action, in turn, generates a cascade of events, some of which may alter X -and thereby alter Y- until the loop is broken. The traditional cause-effect model is useful only up to a point. The environment-free concept of explanation fails to provide an understanding of complex systems of the sort that educators deal with. But there is another problem with the cause-effect model.

Goal-Directed Feedback

What does it mean to be "in control?" In order for a teacher or instructional system to teach (i.e., to control a student's behaviour) the controller must be able to generate or select a desired outcome (e.g., a set of behavioural objectives), discriminate between what is observed to happen and what is intended to happen, and select actions which reduce the discrepancy This is easier to imagine with a human teacher or computer aided learning than with a book or television program but the principle still applies in a modified form.

The model case is a control system designed by an engineer. He knows that there is a control system and knows what it controls. Moreover, he knows that the controlled system can be controlled because of the way it is designed. In other words, the controller must operate according to principles that do not apply to the system being controlled (*cf.* Powers, 1973). While this may be appropriate for inanimate systems, how useful is it when considering humans? Are we justified in using two models of human behaviour, one for those who control and one for the persons being controlled?

In most educational technology research and practice this seems to be exactly what happens. Perhaps this trap is a legacy from psychological research where the experimenter is presumed to be controlling the organism's behaviour (despite the dim awareness, albeit in cartoons, that the rat pressing a lever is controlling the food-givingbehaviour of the psychologist). Or perhaps it is a legacy from the days of birch and leather teaching aids. Control theory offers an escape from this trap.

Control System Theory

Control theory seems to have originated four decades ago though its roots are ancient. Norbert Wiener's (1948) seminal work on cybernetics introduced a new paradigm for understanding human nature, indeed all organisms, whether we view them as agents or objects of control. Cybernetics, he showed, was concerned with control *in* , not control of, the organism or machine. Because "control" sounds manipulative, even authoritarian, we may wish to substitute "regulation" for it. But control theory has emerged as the theory of systems which control rather than a theory of how to control other systems. The distinction is not as subtle as the wording might suggest. Indeed the fundamental ideas ofcontrol theory have the potential to produce the transformation in our thinking about education, indeed of society, that Beckwith insists is needed. More important it can alter our own perspective on education.

In the first place, if we begin to take into account the controlling behaviour of the people previously thought of only as objects to be controlled, whether in experiments, in the classroom or by a computer tutor, we immediately can see that learners'ability to control themselves is essential to education. Moreover, the fundamental observable is not the simple cause-effect sequence initiated by the controller but the reciprocal control of each by the other,

This reciprocal communication and control "dialogue" may be verbal or mediated in some way but as long as it continues we can think of the two persons as coupled together to form a new system which develops its own characteristic behaviour. Whether or not this resembles the intended outcome of either controlling subsystem is problematical.

Let me illustrate. If you were asked by someone to explain or teach something to him, what would you do? Would you establish performance objective, devise a special sequence of statements to make to him, or insist on special audiovisual displays? What would you look for in order to infer that he understands you?

I conjecture that you might ask him to explain, evaluate or use the relevant knowledge or perhaps to criticize it. You might ask if he has any questions. I doubt if your conversation would be punctuated by multiple choice questions or monosyllabilic responses. I suspect you would probe for evidence of his grasping related concepts or principles. In short, you would function as a supportive conversational system, building on this student's strengths, clarifying misconceptions and linking it into a rich, intricately connected conceptual structure. In the end, both you and the learner have learned something about one another and the subject.

Why do designers of so-called interactive video/CAL systems seldom address these fundamental issues? They proceed instead to present more and more information based on an exceedingly crude inference system that seldom constructs a model of the learner's understanding or permits dialogue. "Right" and "wrong" responses often determine what happens next. But knowledge is more than information. It is complex, relativistic and open to interpretation.

The act of reaching a shared understanding involves agreement (e.g., on explanations, derivations) that one's perception of what the other is saying is an adequate representation of one's own concepts. In short, the structure of knowledge represented by the subject matter expert (as presented through verbal or other media) appears to be congruent with the learner's knowledge structure insofar as they both can perform similar operations of derivation, explanation, identification of counter-examples, application, etc. This dialogue demonstrates reciprocal control by two yoked systems. Such reproducible conceptual representations may be called understanding; a sequence of understandings defines a conversation or, in an educational context, a tutorial (*cf.* Pask, 1976). Our computer-based tutoring systems have yet to achieve this level of dialogue but eventually may approximate it (Mitchell, 1988).

Now consider the possibility that an instructional system is intended to control or regulate the (educational) behaviour of a large number of students simultaneously. One model case is the teacher in a classroom discussion with 25 or more students, each of whom may attempt to control the behaviour of others (as well as themselves). Except under very special circumstances the teacher cannot control the verbal, not to mention the internal behaviour of her students; each responds to others as well as to internal factors. Another model case is the provincial education system which stipulates a set of intended learning outcomes for all students in a particular age group, regardless of individual differences in general or specific knowledge, motivation, etc. and heedless of differences in teachers, learning resources, etc. The typical approach to instructional control is to restrict the student's alternatives (rather than to enhance his possibilities).

Even more compelling is the implication of control systems theory that there are fundamental organizing principles in living systems and organizations whereby the observed behaviour is simply the process by which these systems control their sensory input. In other words, the purpose of a system's action is to control the state of its perceived world. This also has some interesting implications for the actions of the researcher as observing system and we must recognize that the observing and the observed system interact; there can be no objective observer.

The Cybernetic Systems Age

The complexity of inter-related systems with many feedback loops requires us to develop new tools to cope with them. Some relevant tools appear to exist within the trans-disciplinary domain of cybernetics and general systems research.

One of the most impressive aspects of conferences about cybernetics and general systems research is that experts from disciplines as diverse as anthropology and economics, engineering and family therapy, medicine and psychology, natural science and philosophy not only share a meta-discipline that amplifies and transcends their own speciality but also "feel no compunction in tackling the most challenging and vital problems of the day. . . believing sincerely that they have, in cybernetics, a powerful inter-disciplinary weapon for solving the most baffling social, economic, and political problems of civilization (Robinson & Knight, 1972, p. 2).

What is the most important attribute of their approach? Central to the cybernetic or systemic approach is that it considers the *total system,* with all its interacting elements, as one inseparable organism. This holistic approach represents a paradigm shift from the reductionistic approach which we have inherited from the logical positivist movement. Though the holistic perspective has a strong intellectual background, the word "holism" was invented only in 1925 by Smuts who wrote, "Instead of the animistic, or the mechanistic, or the mathematical universe, we see the genetic, organic holistic universe" (Smuts, 1925).

Synthetic thinking is needed (in addition to analytic) to explain or understand system behaviour. A system is essentially an observer's model which attempts to link a set ofinter-related entities or their attributes into a coherent pattern, one that is perceived to cohere and to be distinct from other entities. This model can be physical, mathematical, verbal or procedural. And the system represented may be physical or conceptual. Indeed it could be argued that all models are fundamentally conceptual and that epistemological issues (e.g., What shall count as information? How can knowledge be represented most usefully?) are central.

The performance of a system as a whole is different from the performance of all its parts. As Gharajedaghi and Ackoff point out, is a whole that cannot be divided into independent parts; the effects of the behaviour of the parts on the whole depend on the behaviour of other parts. Therefore, the essential properties of a system are lost when it is taken apart. . . and the parts themselves lose their essential properties" (1985, p. 23). Thus analysis cannot lead to understanding of the system as a whole.

Analysis is very useful for revealing its structure, how it works, but not why it works. Systemic thinking is needed to understand why the system functions as it does. Such synthetic thinking means that we must conceptualize a system as part of one or more larger systems. This calls for seeking understanding of the larger system which, in turn, may be explained in terms of its function in yet another system. This expansionist approach, in contradistinction to the reductionist approach, assumes that ultimate understanding can be approached but that it flows from larger systems to smaller rather than the reverse. Obviously, environmental problems frequently are involved. So are systems that may be called purposeful and human.

Wiener's (1948) use of "cybernetics" to denote the science of control and communications in the animal and the machine, can be restated to omit communications because communications is simply the vehicle for control. Moreover we have seen that regulation may be a less offensive and misleading word. Thus cybernetics is concerned with regulation (i.e., the achievement of goals and objectives of some entity>. As Robinson and Knight (1972) conclude "the central problem remains optimization of the organization and operation; of the organism itself to maximize achievement of its goals and objectives" (p. 5). Moreover, "Any lack of understanding of the nature of this total systems approach results in focus on individual parts of the whole, inability to find much new in cybernetics, and skepticism that cybernetics can add anything worthwhile (p. 5).

In considering the total system, with interacting systems and subsystems, as one inseparable organism, cyberneticians deny the validity (for a complete solution) of optimizing a component subsystem separately. "The approach insists that the analysis be *comprehensive* and *simultaneous*. Thus, it considers the total organism . . . maximizing achievement of its goals and objectives in its total environment" (Robinson & Knight, 1972, p. 5). But how do we manage this at the level of society, a university or even a class?

Cybernetics therefore makes possible, explanations of goal-seeking behav- whether in the human or in organizations. It also permits us to investigate how it is that successful complex systems regulate themselves, in the hope that we may discover principles that can be generalized (cf. Beer, 1986). Equally important for educational technology, we can investigate cybernetic systems with a view to finding out what people or computers are good at and what they are not, thus learning more about how to design expert systems or automated teaching/learning aids.

Can We Redesign Societal Cybernetic Systems for Education?

Our problem is not to portray ideal states of man in the manner of Plato's

Republic. The best we can hope for, I suspect, is to find out how to regulate a system, in which we are interested, by holding it within its natural boundaries. That is, by monitoring the system's own changes of state as it responds automatically to environmental disturbances, we may be able to control it. On the other hand, if we try to monitor environmental changes we shall fail. Thus the input-output model is obsolescent.

As for our own organizations, Warfield offers this conclusion, "What is needed is the redesign of the decision-making, consensus-building machinery itself, deliberately and carefully employing cybernetic system principles and practices" (1985, p. 80). To do so requires that we design self-correcting cybernetic feedback loops into the structure itself if we wish to produce or manage a viable system (i.e., one that will survive). Beer (1986) offers a model.

Finally we need to recognize that the Conant-Ashby theorem states that the controlling system has to have (e.g., to contain or simulate) a model of the controlled system in order to be able to exert any regulatory control. In the context of educational technology, we must be able to have workable model of our students, the organizations within which we work (or install our solutions), indeed, of our society within the global community. This is a mind-boggling task and our collective failure to do it is one of the reasons for the fatal illness of educational technology.

Perhaps some of us are predisposed to accepting a cybernetic or systemic world view; others may not be. But if educational technology is to become a viable enterprise, I think we will need a massive shift in this direction. Are we prepared? How can any of us acquire this new paradigm if we are not already part of it?

Interaction Within and Between Complex Systems

Beckwith's insistence on a systemic perspective is not misplaced even though his optimism may be. When dealing with systems as complex as human systems at a global, or even an institutional level we must recognize and cope with the fact that everything interacts with everything else (at least in principle), thus invalidating the traditional analysis and reduction ofproblems into isolated subproblems. This is not meant to be a banal statement.

C. West Churchman, a philosopher of science, expressed it thus:

> When we are dealing with systems as complex as human ones, we need to consider: That everythinginteracts with everything else, thus invalidating the traditional reduction of problems into separate subproblems;
> That the observer cannot be objective, thus necessitating the development and utilization of an observer-inclusive epistemology;
> That ethical and aesthetic variables must be explicitly and effectively integrated into the analysis, design, and decision-making process;
> That use of only quantitative data and model-based modes of inquiry is not satisfactory in analyzing and designing human systems; and
> That current cross-cultural and culturally specific measures of performance are semantically impoverished.

> In order to develop inquiring systems which will produce results that help to improve the human condition, new approaches, rather than mere extensions and refinements of old ones, are needed. We are convinced such approaches are now available and should be applied to the urgent problems we face (Churchman, n. d.).

Restated, we have to recognize that we cannot describe (e.g., in a mathematical model) any system whose behaviour we wish to regulate because the value of each component's contribution to the overall performance is a function of the current and past activities of all other components as well as of other systems in the environment. If we alter only one factor (or even several) to which the system responds, we may not be able to predict or regulate the outcome. At the cognitive level, virtually every concept is related to others which, in turn, are linked more. But these may be influenced by quite unrelated events.

To illustrate, the academic performance of students may be influenced not only be what the educational technologist does but also by many other factors, (e.g., their genetic endowment, early nutrition and environmental stimulation, previous exposure to information and opportunities to learn and solve problems, psychological stress at home or with peers, blood sugar level, TV viewing, whether or not the nation is at war or experiencing a depression, perception of the subject matter and fellow students – or even of school itself – study skills and decision to select and deploy them, proximity of exams, current events in the community, or the presence and arrangement of specific textual and pictorial messages embedded in salient media). Can we develop an explanatory model to portray this?

To complicate matters, control system theory (Powers, 1973) shows that even when we can relate observed behaviour to observed stimuli, we must expect to be wrong most of the time! Yet our dominant research paradigm (and that of psychology) shows no sign of change.

CONTROL THEORY ANEW PARADIGM FOR BEHAVIOURAL RESEARCH

Suppose that a visiting scientist from Mars observes an earthling driving a car and decides to investigate the relationship between driving behaviour and the complex pattern of stimuli coming from a twisting, hilly road that is subject to gusts of wind and snow. Suppose moreover, that with his sophisticated methods he found that the stimulus pattern predicted the rate and amount of angular rotation of the steering wheel. Would you be comfortable with this as an explanation of driving behaviour? Or would you, as the driver, insist that in fact it was your intention to drive in the centre of your lane and, because you were successful at it, the visiting scientist failed to notice that there was no deviation of the car's position from this reference trajectory. And if we accept your operational definition of driving behaviour, controlling the perceived deviation from the centre of the lane, then we should expect no relationship between this essentially unobservable behaviour and the complex pattern of stimuli.

What is controlled then is controlled only because it is detected by a control system, compared with a goal or reference, and affected by compensatory behaviour based on the perceived discrepancy, Thus a control system controls only its own sensory representation. In this case the control system is controlling an internal representation of the position of the moving vehicle. But note that what is controlled is defined strictly by the behaving system's perception and sensory representation; it may or may not be identifiable as an entity in the external milieu (cf. Powers, 1973). Therefore it may not be identifiable by an observer, especially if it is a perceived discrepancy.

As Powers shows, "In general an observer will *not*. . . . be able to see what a control system is controlling. Rather, he will see an environment composed of various levels of perceptual objects reflecting his own perceptual organization" and point of view (p. 233). What will he observe? "He will see events taking place, including those he causes, and he will see the behaving organism acting to cause changes in the environment and (his) relationship to the environment. The organism's activities will cause many changes the observer can notice, but what is controlled will only occasionally prove to be identical" with any of them (p. 233).

COMPLEXITY OF GOALS AND NORMS

To complicate matters for the observer (alias researcher or instructor), human behaviour is not confined to one controlled quantity nor is a fixed reference level the norm. A person, indeed any system, can have multiple objectives and variable reference levels, changing from one to another without warning.

Education, according to philosophers, is concerned with initiating students into instrumentally and intrinsically worthwhile activities. Embedded in this statement is the hint of a narrowly interpreted means-ends concept that seems to permeate educational technology. Let me explain.

We usually think of an end or objective as apositivelyvalued outcome likely to result from some means selected with the intention of producing it. In educational technology the value of a means (e.g., teaching/learningmethod A or B) generally is equated with the probability of its producing an end. Criteria for selection are based on instrumental and cost/benefit decisions. On the other hand, the value of an end is taken to be intrinsic, rather than instrumental. Thus completing my degree may be an end and an educational technologist may use instrumental, extrinsic means to help me to achieve it. But for me, being graduated may be a means to a new job or higher income. And for the educational technologist, the selection of means may be related to personal ends (i.e., intrinsic value for him). In short, every end is also a means and vice versa; they are relative concepts.

Note that preferences amongst means may not be based on efficiency but on intrinsic values of the educational technologist. Equally this is true of the student. Each may select means because they are satisfying. Now what if there exists a persistent preference for a particular kind of activity? (Anyone familiar with video game players has seen such behaviour.) Psychologists refer to these as traits. Half a century ago, Gordon Allport identified nearly 18,000 traits. So it is apparent that we can expect to find an exceedingly high variety of ends in any observation of human behaviour except where nearly all of them are eliminated by virtue of the artificial environment of an experiment.

A final note. If we accept that every consequence to some activity is in turn -a means to additional consequences, continuingto some ultimate consequence, then we might find an end that is intrinsically worthwhile. This is essentially a theoretical definition of an ideal. But it is likely that there are many routes to a given ideal and, equally, that a given means-ends activity could eventually be linked to more than one ideal. Given the complexity of human traits and the possibility of many ideals, it is no wonder that observers have considerable difficulty making sense of empirical observations of students' behaviour.

Thus the concept of behaviour as a feedback control process organized around one's perceptions has to be extended to include those perceptions that pertain to ends and means thought likely to maintain one's ideals.

How do we deal with the behaviour of a learner, whether in the laboratory or in the classroom? Are we to conclude that what is observed may not count, that the learner is behaving to reduce a discrepancy perceived by him -not by us-to exist between his current state and some desired state? If so, then it may be incumbent upon educational technologists not merely to have educational (or, more narrowly, behavioural) objectives but to attempt to share responsibility for these with the learner as a control system. More importantly, if we can ascertain the learner's objective we may be able to adapt our instructional activities to support him or her. Truly individualized instruction now might be possible.

SELF-REGULATION FOR SELF-INSTRUCTION

A closed chain of causal relationships may characterize the learner who is actively studying some subject. Control theory suggests that the learner's behaviour (of attending to and interacting with images and semantic information that may be perceived in the external or internal reference. Any discrepancy "produces" further behaviour intended to reduce this discrepancy, either by re-structuring knowledge and images or by altering the goal. Such control cycles tend to continue until a limiting resource (e.g., time) is used up.

A profound insight reveals the most powerful aspect of feedback: the organism actually "causes" its own behaviour. Sometimes it does so in an environment designed to promote such learning, but educational technology lacks the sophistication needed to develop them. Moreover, the absence of universal reinforcers in educational settings underscores the observation (of such investigators as Kelly, Rogers or Snygg & Combs) that behaviour is a function of individuals' personal frame of reference, their perception of themselves and their environment and the meanings they attribute to them. In cybernetic terms, the person's behaviour controls their perception in relation to their intentions.

Tutoring

Thus tutoring educational technology can shift from an input-output model to a control theory model dominated by feedback which the observing system uses to control its own behaviour and thereby to attempt to control the behaviour of another system. Note that feedback monitors goal-directed behaviour (i.e., the system begins with some desired state or goal which is compared with its perception of the actual state during or following a behaviour episode). In effect, environment is what the receptors and brain perceive (i.e., an internal representation). Not only objects and events, but also symbols and relations may be represented by these internal models. Internal events probably are represented in the same way and we assume that behaviour (overt or covert) acts on the inner as well as the outer environment.

Powers (1973) demonstrated that what we control is our own input; our behaviour is the means of control and the purpose of our students' action is to control their internal models of the perceived world. This is a powerful insight for educational technologists to exploit. It opens the door not only to design of intelligent CAL but also to the design of new organizational structures for education.

In a tutorial conversation, two cybernetic systems become coupled (until a resource, e.g., time or attention, is used up) to form a new interacting system in which each begins with goals that it attempts to satisfy by monitoring the effects of its own behaviour on the other. Similarly, an adaptive equilibrium occurs between a nation and its education system.

Instead of the input-output model, educational technology could conclude that behaviour is not so much a function of the environmental input as of a self-conscious "I" of each person in interplay not with his environment per se but with his perceptual model of that environment. The would-be regulator of all this, a human or an intelligent CAL system, mirrors the same process; the instructional system must have minimally a model of the subject matter, a model of the student's knowledge and conceptual style, and a model of communications and control strategies to respond to the student's behaviour (Mitchell, 1982).

What are the implications for educational technology if it's to be rejuvenated? If one's perceptual field determines his behaviour, it seems reasonable to conclude that educational technology has two options. We can continue to implement schemes that limit opportunities for individual differences, developing representations of knowledge that omit much of the richness of a subject in their emphasis on achievement of specifiable objectives in a limited time. Or we can recognize individual differences and attempt to promote the optimal development of each person, providing opportunities to extend the self-regulatory capacity of the person both within a subject domain and in general.

To do this, the regulatory system itself will need training. Thus each person, and educational technologists, must learn how to express models of their own activities that have sufficient alternative courses of action from which to choose. Once again I wonder if educational technology has the capacity to do this.

A cybernetic model of the learner, based on Stafford Beer's (1982; 1983; 1984) pioneering work, may prove useful. This model is consistent with research in psychology and education, but begins with a different perspective. At its heart is a perceptual field or set of relationships which determines that this is "Oneself." Beer identifies the intrinsic regulatory mechanism that holds everything together, maintaining one's identity, and suggests that Education should enhance the regulatory variety of each person rather than delimit it (as often occurs). This injunction applies equally at the level of the person and society. Therefore, it may have resuscitating powers for educational technology.

ONESELF, SELF – CONTROL AND THE ENHANCEMENT OF HUMAN POTENTIAL

If the purpose of one's action is to control the perceived world, a cybernetic model of oneself as learner deserves scrutiny. At its heart is a perceptual field or set of relationships which determines that this is "oneself." Think of a human being not as mind, body, spirit or social unit but as "an entire and interactive system." Oneself is an exceedingly complex, probabilistic system that maintains stability and integrity by virtue of an organizing principle, a set of relationships which determine that this is Oneself, not another self. Beer labels the intrinsic regulator which holds invariant the set of internal relationships that maintains the identity of Oneself, cybercyte.

Goals and Their Achievement

The self-regulatory capacity of the body seems automatic but what if one aspires to be different (e.g., run amarathon, read 5,000 words per minute, solve a complex problem)? As Beer shows, such pursuits require extending the self-regulatory capacity of both body and mind (i.e., of the cybercyte). Thus I may have the potential to run a marathon or to read at 5,000 wpm or to solve that problem, but I lack the regulatory model required. If Oneself sets goals and aspires to achieve them, then Oneselfmust change one's model ofoneself. Why? Because things one is only potentially capable of doing are not initially included in one's regulatory model. There is a spectrum of options from which to choose (e.g., actions, models, beliefs and aspirations).

Recall that the purpose of human action is to control the perceived world by comparing this model with an internal model of a desired end-state. It is essential therefore, that the person (whether learner, researcher, planner or educational technologist) establish a goal-state, believe it can be achieved and will be achieved, and visualize oneself already in the goal state – and then to act accordingly. At this point the regulatory system should respond to perceived deviations from that goal.

Beer's concept of selfhood thus advocates self-improvement – and, by extension, education and societal improvement – based on the existence of autonomous regulatory mechanisms that permit self-control. However, the rules which govern the effectiveness of this self-control require the regulatory process to generate new states and detect and store patterns that can reduce discrepancies. Another principle is that "the recognized self exists within a potential self, the realization of which constitutes its fulfillment" (Beer, 1982, p. 20).

Beer (1984) has tested this model at various recursive levels of selfhood within the context of corporations, society and religion. Surely these principles both address the enhancement of human potential and lie at the core of learning and therefore educational technology. As Beer suggests, Education should enhance the student's regulatory capacity rather than delimit it. But educational technology traditionally has restricted students'regulatory capacity -And our own.

THE DEATH OF EDUCATIONAL TECHNOLOGY

The preceding discussion of our self-regulatory capacity is central to my analysis of why educational technology cannot escape Beckwith's traps and the major reason for its demise.

Despite Beckwith's (and others') visions of educational technology's potential, the field itself is not a cybercyte and cannot have goals. Individuals can; so can organizations that are established for that purpose. But despite the existence of professional associations, there is no organizing principle that binds and regulates the research, practice and theory development which we identify as educational technology.

Therefore, Beckwith's insistence that educational technology transform itself is misplaced. We who think of ourselves as educational technologists may choose to transform ourselves and even attempt to transform others (e.g., students or colleagues). But even then we may need assistance, perhaps of a kind that does not now exist. We know little of control theory's regulatory models and how to alter the self-regulatory capacity of ourselves or others. Research is needed but who is capable of carrying it out? It may even be that this is one of the most crucial areas for instructional design if we wish to enhance human potential for learning how the world works and how to get along in it.

Graduate programmes in educational technology, too, need to be able to communicate relevant insights and research findings to students and, through continuing education and publications, to others. But how can they communicate what they know little about, especially when so many courses address tactical issues at the level of instructional design and media production? Can graduate programmes be transformed along the lines suggested by Beckwith or any other way?

At the same time we function in collaboration with other systems whose perception of educational technology regulates their interaction with us. Do they perceive us to be competent?

NEEDED: ARE-ORIENTATION OF FOCUS

What stands in our way? Walt Kelly, the creator of the comic strip Pogo, had the main character say: We have met the enemy and he is us."

Educational technology had a short life. By the 70's it had gained academic respectability and widespread acceptance in training circles. As with another new, transdisciplinary field, operational research, "Survival, stability and respectability took precedence over development" (Ackoff, 1979, p. 242). And following Ackoff, I, too, hold academic educational technology and the relevant professional societies responsible for the decline and fall of educational technology. I hasten to point out that I have been involved in both and therefore share this responsibility.

Consider'for a moment what educational technology has contributed to ameliorating existing messes.

Which educational technologists or educational technology programmes have attempted to solve these common problems? (I omit the more complicating systemic implications here.) Reports abound of illiterate and innumerate students graduating from high school. Half the world's children do not go to school. One third of the adult population in the USA (and nearly as many in Canada) is functionally illiterate. Most schools teach children to use computers but not to touch-type so that they can use them more efficiently. Neither teachers nor schools nor ministries of education insist on improved methods of teaching and learning, to say nothing of radical transformation of the curriculum. Our socioeconomic future will require a massive shift in education (and training) just for survival. Atypical educational technology course differs little (except in content) from other courses on campus.

Are educational technology professors or research students tackling such problems? What are the burning issues in educational technology graduate programmes?

Suppose a school of educational technology to be a system organized to produce practitioners for this field. If we were to analyze such a professional school using control theory, what might it look like? Recall that in ordinary behavioural situations the controlled quantity is not immediately obvious and that in a system that operates with the complexity and time span of a graduate programme we can expect a very large number of intended outcomes or reference trajectories. Some of these might even be considered to be ideals. Moreover the professional school may attempt simultaneously to contribute to several related goals: to improve society (though its graduates' efforts to improve education); to improve educational systems; to help individuals to increase their knowledge and understanding; to excite in their students a desire and ability to learn and to solve problems.

To the external observer, all that is obvious is the relationship between various "disturbances" applied to the learners and some output of their reorganizing systems. Clearly we should expect to see a shared vision (amongst faculty if not students) of what is desirable but reports from several such programmes suggest that this is not always the case. Then, too, we might expect some creative approaches to the problems of teaching and learning.

For instance, one might test the hypothesis that, "An educational system should (1) facilitate students' learning what they want and need to learn, (2) enable them to learn how to learn more efficiently, (3) motivate them to want to learn" (Gharajedaghi & Ackoff, 1985, p. 24). One approach may be to assume that the best way to understand a system is to design it (or at least a model of it). To do so, students will need to learn how to solve problems, how to identify what they do not know, how to acquire what they need to know, how to use what they know.

Gharajedaghi and Ackoff suggest a radical departure from standard course-based graduate programmes: their principal instruments are learning cells and research cells which integrate faculty members and students who work jointly to integrate and extend theoretical themes and to design systems or to work on general theoretical, conceptual or methodological problems related to practical problems. The fundamental assumption is that graduate students do not need to be taught but may need guides and mentors. Such an approach clearly permits, indeed encourages, a systemic approach to identifying solving problems. Are we, in educational technology, willing to design radically different approaches to our curriculum and instruction system?

Though I may be mistaken, I think it is fair to say that most educational technology courses are taught by faculty members who have never, or hardly, practiced as educational technologists, except for occasional consulting. They – more accurately, we – and our students are textbook-bound and use the language but not the experiences of dealing with real educational problems, whether we consider complex design problems or simple concepts. By real educational problems I refer not to needs analysis or product development for corporate training (which may indeed be important to the company) but to fundamental problems such as illiteracy, innumeracy, intolerance or lack of caring. To illustrate, I am struck by the blind faith which most of my students have placed in textbook definitions of central concepts, including, for example, "learning." I refer to books which repeat the silly statement that learning is a relatively permanent change in behaviour (as if behaviour of a complex organism is confined to what the observer noted, and – moreover – remains static after learning, thus prohibiting further learning). When asked about their own learning experiences such students invariably discuss the concept from a very different perspective, one that is conceptually more useful and defensible. I detect a similar withholding of common sense too frequently in journal articles and textbooks. Something is wrong.

Perhaps because of our being trapped in a state of emulation of an out-of-date model of science borrowed from psychology, our journals and professional meetings fail, too, to come to grips with very real educational problems. Who is writing (in the educational technology literature) about the messes which we find all about us in the vast domain of education and training?

Is there any hope? Where can we go from here? I am tempted to liken our situation to that of the traveller who asked a farmer how to get to his destination; the farmer replied, "If I were you, I wouldn't start from here." But where can we start from?

FUTURE PLANNING

Some of us in this disparate field have attempted to act and write as if it were possible to predict future behaviour of a system if only we knew all the cause-effect relations that apply to it. Then, according to this viewpoint, we can design, produce and install some instructional system or materials in such a way as to produce the intended behaviour. Aside from the lack of insight into control system theory which this paradigm reflects, it also fails to take into account the fundamental fact that we operate within constraints that limit our choice just as our clients' choices are limited. Perhaps the most constraining of all is the system within which we function as critical components.

For those in academic educational technology, George Grant warns, **We** are unable seriously to judge the university without judging its essence, the curriculum; but since we are educated in terms of that curriculum it is guaranteed that most of us will judge it as good. The criteria by which we could judge it as inadequate in principle can only be reached by those who through some chance have moved outside society. . . (but then) one's criticisms will not be taken seriously" (Grant, 1968, p. 67). Surely it is this curriculum which has schooled us to believe that certain kinds of theses, publications or papers are somehow more acceptable (albeit to promotion and tenure committees) than others. Research productivity is an ambiguous concept. What counts as research?

The research required to ameliorate some of the pressing educational messes will take many years with little to show for it. What university would give tenure to the modern equivalent of the young Isaac Newton? "To arrive at the simplest truth, as Newton knew and practised, requires years of contemplation. Not activity. Not reasoning. Not calculating. Not busy behaviour of any kind. Not reading. Not talking. Not making an effort. Not thinking. Simply bearing *in mind* what one needs to know (Brown, 1969, p. 110). For tackling complex educational problems such "bearing in mind" certainly is consistent with control system theory even if it is not with contemporary education or our universities. I suspect that this applies to training departments also.

How can those of us who prepare future educational technologists do what is necessary to support these learners in more sustained groping, exploration, synthesis and evaluation as part of their attempts to identify and solve important educational problems? What do we need to contemplate ourselves in order to provide such support? Is research and development in the area of intelligent tutoring systems a useful direction or a dead end? How can we even identify what we need to know so that we may bear it in mind? And how to help our students to do likewise?

One thing is clear to this observer; the corpse called educational technology appears to have died because it lacked a cybernetic systemic paradigm and an organizing principle to give it life as a viable system dedicated to improving education. And even though this field cannot itself easily be a viable system it can contain many viable systems which could even cohere to form such a metasystem. One such component system could be you; I could be another. If we all work together we may just be able to save educational technology and thereby education. But we shall all have to struggle with our regulatory systems. This will require allocation of scarce resources to do the job – resources such as care, creativity, commitment and love. Perhaps these are the only assets educational technology has left.

CONCLUSION

We may be able to revive the corpse of educational technology but not without a radical transformation in a number of inter-related domains: our professional associations; our graduate programmes preparing future practitioners; our schools, colleges, universities and ministries of education; our media of mass communication; our governments; our corporations; our society and – most important – ourselves.

Albert Rosenfeld expressed our educational need thus: "In any planning of society, the structure and function of educational institutions (with education soon to encompass a lifetime) will be at the heart of it; and we are less likely to go wrong in our choices if we keep in mind what it is all to be designed for: the whole human being and his fulfillment in a regulated but free society."

"The educational establishment's major challenge will be to turn out people of high quality; people capable of constantly improving the quality of their own lives and interested in improving the lives of others; people who possess the necessary technical know-how, intellectual prowess, sensory awareness, personal and social responsibility to face cheerfully the unending ambiguities of the new age; people who are incapable of bestiality toward their fellow men, who have no use for personal power unless it offers an opportunity to enhance the quality of life on earth for all mankind" (Rosenfeld, 1969, p. 311-312).

To this I would add that these paragons will need a solid foundation in cybernetics and system thinking as well as in the relevant design sciences. Such educational engineers are likely to become very valuable members of society – if we are able to help prepare them.

If our graduate programmes in educational technology, inter alia, can turn out such men and women then we shall realize Kenneth Richmond's prediction (that this will become the central humane discipline of the future) and Beckwith's dream that we will help "to create health, ideal space and peace." The last reported resurrection required only three days. How long will it take to resuscitate and transform educational technology?

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