DR. HALL'S
COMPUTER COMMENTS

A Quarterly Commentary by
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Some Editorial Notes

Our Managing Editor's contacts in the UK are abundantly reflected in the present pages. However, despite the large amount of material from British sources, we haven't forgotten Australia. Some of our previous contributors have had more to say.

Geography Software for Secondary Education

The paper by Mr Van de Kuyt (of Boronia High School, Vic.) evaluating Geography software packages is representative of the kind of comparative reviews of software we hope to publish in each issue. If anyone else wants to submit this kind of paper covering another area of educational software, we would welcome the chance to publish it.

School Computerisation in the UK

However, our main emphasis for this issue is the UK, and I hope our readers will be interested to see how our British colleagues are coping with the microelectronics revolution. On the average, thanks to the efforts of the BBC, the Microelectronics Education Programme (MEP) and other major institutional support, it seems their schools are somewhat ahead of ours in the process of installing computers and writing software. Yet, similarities between our two countries are much more remarkable than any differences I have seen.

For instance, where sufficient local resources and enthusiasm have been available, on an individual basis it seems some Australian schools have succeeded in integrating the new technology into the educational process at least as well as any of the British schools.

Murray Luke Wins a Prize

An example of this successful integration is Murray Luke's (Bemboka Primary School) "Country Area Programme", as described in our previous edition. I was most impressed with its structure and execution — and apparently I was not the only person to be impressed.

Out of hundreds of entries submitted for the First Annual Dick Smith Electronics "Computer Educator of the Year" Award, second place went to Mr Luke. (First place went to Brother Vin Hawley, of St Edmonds School for the Blind and Visually Handicapped, Wahroonga, NSW for developing computerised aids that help integrate blind and partially blind students into regular schools.)

Further information on the Dick Smith awards and competition can be obtained from Harold Ellison, Public Relations Manager, Dick Smith Electronics (Phone 02 888 3200).

Intriguing Similarities UK/Australia

My reading of the British material, and comparing this with what we have already heard from our Australian contributors, greatly reinforces certain impressions that I gained from helping to put together our inaugural edition.

First, there seems to be a radical difference between primary and secondary schools in the ways computers are incorporated in the educational process. These differences seem to be reflected in the childrens' responses to their educational circumstances.

In many primary schools it seems the children quickly learn to use their computers very innovatively as general purpose tools in improving their problem solving and language abilities. Primary teachers from both countries tell their own stories about how the computers are very much **controlled** by the children to aid in developing and extending their means of communication and self expression — resulting in powerful impacts on self development and the educational process.

In high schools the computers seem to be submerged in conservative curricula, where they contribute comparatively little to extending the students' cognitive abilities or self development. Here it seems to me that the students are all too often programmed by the computers according to the dictates of some programmers' conceptions of what they should learn.

Secondly, in both countries, it also seems that computers have had the greatest impact on education in the humanities, rather than in the sciences or maths as one might naively expect. And within the humanities this impact seems to be greatest in the areas of access to data and the development of English language usage. With the facility that word processing programs offer for correcting and revising, the computer removes most students' inhibitions about experimenting with language and the expression of their thoughts. Also, in using the computer as a word processor, students are using the technology as a general purpose tool to extend cognitive and communications abilities.

These observations encourage me to explore some ideas about the future and our roles as educators in preparing our charges for this. My ideas are also undoubtedly at least partially based on my own experiences in the school of "hard knocks" over the last four years.

The continuing avalanche of advances in micro-electronics technology has already begun a process which will completely redefine each individual human's social, economic and ecological relationships to his/her world.

Too many educators and academics writing gee-whiz views of the future tend towards glib and sweeping statements like that of the previous paragraph. What does such a gas-baggy statement really mean.

Updating Rates of Technological Change

Two bench-marks will give some measure of the technological avalanche.

1. Ten months ago, when I wrote my editorial for the Inaugural Edition of this magazine, the 256 K bit memory chips (i.e., chips with a capacity to store 256,000 individual items of information) were just beginning to be fabricated in commercial quantities). As I write this article in August/September, 85, I have been reading the latest issue of the US Publication, **High Technology**, which features several stories on the Megabit memory chips (chips with a capacity to store more than a million bits of information) are just beginning to be fabricated in commercial quantities. These contain over 2,000,000 transistor elements on the one sliver of silicon. In quantity the megabit chip will sell for approximately what the 256 K chip cost some months ago at a similar time in its maturation.

   The continuing increase in information storage power per dollar applies across the board: According to the August 27 **Australian**, last year 64 K memory chips were selling in quantity for $3.00 to $4.00 each. Today they are selling for $0.40 each.

2. My 8-bit Kaypro-2, with 64 KB total memory working at 2 megahertz (using 16 K chips — if I am not mistaken) and two 200 KB diskette drives retailed for about $3,200 with a full set of software when I bought it two years ago. This machine offered no provision for expansion. When our last issue went to press in October/November, the Kaypro retailed for about $2,500. In the August 27 **Australian,** it was advertised at $1,695. Although my Kaypro still handles many of my word processing needs, it now is sadly obsolete. When it was assembled its memory chips would have approached $100 in cost. If made today, it would use only 8 of the 64 K chips — for a total memory cost of $3.60!.

   Last night I went to the Pan Pacific Computer Conference and Exhibition here in Melbourne (Sept. 10-14) and found that Kaypro is now importing the Kaypro-2000, a 16-bit IBM-PC compatible battery-driven portable. It uses 256 K chips working at 4.7 megahertz and offers an 80 character x 25 line flat-screen display, 256 KB memory (expandible to 768 KB) and a 720 KB micro-diskette drive. This machine, also provided with a full set of software, sells for $3265. The Kaypro-2000 also offers for expansion through the addition of additional disk drives, maths processor chip, plug-in circuit boards for special functions, modular telephone attachment, and an automobile power adapter.

   Using Kaypro as an indicator, on a per dollar basis — personal computer power has more than quadrupled over a two year period. Since the Kaypro-2000 is less than half the weight of the Kaypro-2, the power per Kg will have increased by more than 8 times in two years, with the power per volume having increased even more than the power per weight.

The Human Implications of Technological Change

This kind of technological change cannot help but have a direct effect on any individual confronting it. Certainly I have already seen the beginning of this technological revolution myself, in my own personal history. Starting four years ago as an ivory tower academic with no significant computer or business experience, I:

1) purchased and learned to use a computer to assist my academic writing,
2) supplemented my income through running a part-time word processing bureau,
3) helped to establish and run computer training camps for unemployed people,
4) provided free-lance consultancy services to help small businesses select and/or train new staff in the use of microcomputer systems,
5) helped to establish and promote the present publications.

And, since the Inaugural Editions of our journals went to press, I have become fully established with well-paid full time employment in the computer industry. My job includes the nitty-gritty commercial tasks of writing users' manuals for powerful business software and complete responsibility for the software house's written communications. (I have described what my word processing does for the software house more fully in the business journal accompanying this issue.)

I am one of ten full-time staff in the business. Four other staff are dedicated to sales and customer service. Three people plus outside contractors write software, and our management traces directly from corporate management levels in the multi-national automotive industry and the military. In this active, competitive, hard-headed and actively expanding business — not only do I "type" every written word that leaves the premises through my own keyboard, but I personally write over half of it myself and edit the rest.

With all of this, I still have time and energy left to help with the present publications, work in my garden, entertain friends and enjoy life with my wife.

This is by way of illustrating with the individual case history I know best, just how profoundly assimilation of the new technology can change one's economic relationships to the world. The previous secretary of the company (who never dominated the potential of word processing) has now cleared the typewriter from her desk and is fully involved with customer support services. I have taken on the typing tasks as a fractional part of my job, while at the same time, I have increased the company's output of personalised and individualised correspondence many fold. Most of the increase has been in the sales and support areas, and is resulting in a significantly favourable effect on the company's sales and profits.

As great as these changes in my life have been, based on technology I can already see coming down the pipe-line, my current area of largely clerical employment will be even more profoundly affected over the next five years than it has been over the last five.

By then, many of us will have clip-board sized flat-screen computers that need no keyboards because they are controlled by pointing and speaking. These will be equipped with 8 or more megabytes of memory with a wider range of much more powrful and better integrated software than we find on today's machines. Because the software is vastly more powerful, people will require much less training to use them. Such machines will probably sell for less than $1,000.00

With such technology in hand, we should then be nearing a peak in the changing structure of employment — when the jobs today's students are being trained for will be diseappearing at a maximum rate. Ten years from now, today's jobs simply won't exist in their present forms.

What does this kind of revolution mean for today's school children, those of you who are responsible for helping them face this unforeseeable future, and society in general?

I don't have a crystal ball, but I do have some ideas and a philosophical understanding of change and education that might be worth exploring.

Primacy of the Primary School

A striking anomaly I have seen in helping to assemble our publications is the general paucity of interesting papers from secondary schools — whether the sources were British or Australian. Admittedly, in a quantitative sense, there are more primary schools than secondary.

However, I would have expected that the generally longer experience high school teachers have had with computers, combined with their presumably better preparation would have resulted in some strikingly creative uses of computer systems to assist education.

Perhaps also my view is biased and jaundiced by my impression that computer use in the secondary schools is tightly constrained within existing curricula. In many cases the curricula seem to be designed for a world looking towards the past, which almost certainly will no longer exist by the time today's secondary students find and establish their professions in society.

By contrast, it seems that many primary school administrators, teachers and students are accepting the available computers with a far more open mind. All three levels of the social hierarchy are experimenting with the educational possibilities offered by the machines in a very open-ended way. Computers seem to be bringing a ferment of enthusiasm and interest into primary teaching, such that I would not be surprised to see the whole educational process revolutionised over the next five to ten years.

(I hope some secondary teachers disagree strongly enough to challenge my assertions by sending us their publishable reports on some exciting initiatives or at least some contrary opinions and arguments!)

Resource material

The following part of Dr Hall's quarterly commentary could form excellent resource material for use in the instruction of senior students, quite apart from providing most stimulating reading for all teachers.

An Evolutionary Argument

I guess I should begin by considering just what factors success in computerisation should be measured by. The argument begins by considering some definitions which may seem trivial until one begins to think seriously about the actual realities they attempt to encompass.

Given my many years training as an evolutionary biologist, it is unavoidable that I will see computerisation in an evolutionary framework. The following argument is highly condensed, but I think its logic and the justification for its premises should not be too difficult to follow or accept on the basis of general knowledge available to most educated people.

Evolutionary change is a natural process, driven inevitably by the metabolic demands of living organisms for supplies of energy and other resources (e.g., shelter) required for the preservation and maintenance of life:

The primary requirement for any living organism is to regulate and control its external and internal environments (= homeostasis). This control must be maintained in the face of random events and events resulting from competition with other life forms. Death is the direct consequence of a loss of the ability to regulate. The unavoidable consequences of the physical laws of thermodynamics (i.e., "natural law") is that energy supplies are limited. Similar physical realities limit the availability of other necessary resources. Thus, as a consequence of their competition, all life forms face an imperative to increase their powers to control limited resources.

Information is the ability to respond differently to differences in the state of a particular phenomenon — and hence, in its most basic meaning refers to knowledge of and ability to interfere with or **control** the phenomenon.

Due to passage of inherited information down lineages, progeny tend to resemble their parents more than they resemble less closely related individuals.

Small random changes in the hereditary transmission of information guarantees a range of largely heritable variation in each generation.

Individuals expressing heredity that enables them to achieve a higher level of control over limited supplies of those resources required for the maintenance of life, growth and reproduction will increase that heredity at the expense of those individuals whose heredity makes them less well equipped to control the limited resources.

Thus, so long as living organisms compete for limited resources (whether for energy, protection from harmful circumstances like bad weather, etc.), and their competitive success is to any degree determined by the expression of lineally transmitted information, the shaping processes of selection impels the lineages to extend their control over essential resources to maximise their success in transmitting that information.

At this point the argument extends to our own human species:

Man is the first species which has brought together in the one lineage, both an effective use of tools, and the cultural transmission of hereditary information.

Tools are inanimate devices, usually the products of technology, used by people to extend the distance, quantity or quality of their personal control over their external environments.

Information concerning the construction and uses of tools is culturally transmitted from one generation to the next via writing (in the broad sense) and teaching, and thus represents a non-genetic ("extracorporeal") form of hereditary information transmitted lineally within families, cultures and the human species as a whole — all unavoidably competing with other entities at the same level. Variation in the transmitted information results from accident, experiment and innovation. As a consequence, the same unavoidable evolutionary imperatives impel families, cultures and the species to extend with the aid of their tools their control over their environments.

As an aside, please note that **control** is not synonymous with exploitation. By controlling a limited resource of the environment, the entity doing the controlling may choose **to exploit the resource at less than a maximum extent** so long as it is able to prevent (through its control) others from doing the exploiting.

The most fundamental and rapid change in the **process** of evolution since the origin of life itself is occurring within the span of the presently living generation of man. Until this century hereditary information was processed only by living organisms.

Scientific studies of the fossil record have revealed information concerning more than three billion years of organic evolution. Only within the last million years have the one species, man, evolved the capacity to transmit a significant fraction of his hereditary information non-genetically (e.g., via writing, teaching and learning). Once this capacity was assimilated, the extent of our control over the environment of the entire planet Earth quickly grew out of any bounds reflected in previous evolutionary history. Yet, until this century — no matter however information was transmitted from one generation to the next — it was still processed, interpreted and acted on by our own organic brains.

This century has seen the invention of incredibly and increasingly powerful tools for the automatic processing of information. We call these tools computers.

Automatic (related to autonomous) refers to processes which occur independently of the direct intervention of a human being.

I will clarify what I do not mean in this definition with two examples: Guard dogs are used by people to process and transmit information for the protection of their premises, and have probably served in this capacity for many thousands of years. However, dogs evolved their information processing capacities through many millions of years of independent evolution paralleling human evolution. The abacus is a tool used for some two millenia to assist rapid calculation. However, it has no autonomous abilities to process information. It works primarily as an aid to memory in focusing the arithmetic powers of the human brain.

For millenia, man has made comparatively trivial mechanical feed-back devices for automatically processing information to control the environment. One example is the dead-fall trap used by hunters as remote "processing" devices to detect and capture prey. Another class of devices is the more recent centrifugal governors used to regulate windmills, clocks, steam engines and the like. Although autonomous, such mechanical devices could process only limited amounts of a predetermined kind of information in a predetermined way.

The first general purpose systems for the practical and autonomous processing of information were the mechanical calculators developed in the last century. The idea of the external storage of information for the control of industrial processes was first applied to power looms early in the last century. The power loom's punched cards were then adopted by Herman Hollerith in the 1890s for the development of mechanical sorting and tabulating systems for processing and storing US Census data. (Hollerith's company grew into IBM.) These two avenues of development (automatic calculation and the external storage of data used in the calculation) were combined in the 1940s by the massive and expensive electromechanical or electronic digital "computers" (using vacuum tube valves or mechanical relays) developed during the 1940s for ballistics calculations and cracking codes. (This history is summarised in the article "A Review of Computation (Mathematical Calculation) Equipment from about 1000 BC to Today" in our Inaugural Edition of International Computer Literacy.)

It is only a few decades since transistors were invented in 1948 and subsequently applied to computers (only in 1959!). Today the largest solid-state computers have already expanded **more than a billion**-fold in their power from the first "flip-flop" chips, to store and autonomously process information. What the creation of such power will mean to man in an evolutionary sense is still solidly within the realm of science fiction. Yet almost anyone in the developed world can now afford the purchase price of a completely functional and quite powerful general purpose computer of a power unimagined 30 years ago.

Control and regulation of external circumstances are possible only through the acquisition, processing and application of information about these circumstances. Computers now exist as a completely new universe of tools for gaining and processing information. Today, for the price of a few international telephone connections and plausible service fees, any individual person who masters even a comparatively puny personal computer like the BBC can gain virtually instant access to a substantial fraction of the totality of human knowledge about the world. Easily learned and used query languages exploit the host computer's tremendous processing power to filter millions or perhaps even hundreds of millions of references to find the one, the few or the many that contain the desired information.

As yet computers do not offer an individual the same degree of scope in applying the information to control his circumstances — but through advances in robotics this power wll also come into existence within an instant of evolution. However, even now, many kinds of control may be effected simply through the ability to transmit information to other receivers.

Given the evolutionary imperative which we have no power to change, I see no way to put the computer genie back into its bottle — even if we wanted to. However, while we are learning how to effectively command the genie's powers in the service of man there are some choices which can be made to control the direction of its growth.

On one hand there is the very real risk that effective command of computerised tools will fall into the hands of a few despots, transmitting their knowledge about the means of control lineally within their "families" (e.g., the Mafia, a military dictatorship, tiny elite minorities like the Communist Party within Russia or the NAZIs in Germany, corrupt businesses like the Krupps and I. G. Farbens of the world, etc). Such "families" could easily use their extended powers over the acquisition and processing information to rigidly control the circumstances of the individual person.

On the other hand cultures, or even humanity as a whole, can communicate the knowledge of how to command the computerised tools horizontally across lineages rather than vertically along them. With widespread horizontal communication of information, a population can gain sufficient democratic power to prevent or at least contain the growth of despotism. With democratic control over tendencies towards despotism, individuals who understand how to use their personal tools for accessing the much greater power provided by public information networks should then be able to maintain some degree of control and regulation over their personal environments.

Another alternative I intend to explore from an evolutionary point of view in a later issue is that we are subtantially along the way to creating — not autonomous tools for collecting and processing information — but rather autonomous life forms able to use their powers for collecting, processing and transmitting information to control and regulate their own fabrication.

As yet, computer technology is so new and so rapidly evolving that none of these alternatives is inevitable. As long as the evolutionary system is not destroyed in a catastrophe (nuclear or otherwise), the evolutionary imperative requires that control over the gathering, processing and application of information will contiue to increase over time. Whether the computerised control over information evolves towards despotism, democracy and individual freedom, or autonomous independence of the computers themselves, depends on the depth of understanding we gain of the new technology and on the degree to which this understanding is transmitted horizontally across lineages versus vertically down them.

In this framework, schools offer a critically important institutional means of horizontal communication to equip people with the information they require to make use of the technology.

Back to School

In an evolutionary framework, my yardstick for measuring the success of computerisation in the schools relates very fundamentally to the degree of control the individual student is given over the technology.

Thus, I would regard most programmed learning or drill and practice programs as fundamentally ill-advised. A preprogrammed computer is used to shape a student's knowledge according to the pre-determined content of the program. In other words, the students' "correct" responses are determined in advance by the programmer, and the computer's processing power is used to control information feedback given to the student until these responses are achieved. The tendency in such uses of the computer programmer's power over information is that of a despot extending control over many — with the student being processed by the computer. The student is forced to accept the programmer's view of the world.

On the other hand, where the student is allowed to use the computer for word processing, for access to data bases (especially public ones), for graphics, for the construction of their own data bases, or for programming — the relationship can be completely different. Here the **individual** student quickly learns to use the computer as his/her own tool to extend his/her control over information: for self-expression, for enquiry or for play. The computer extends the individual's powers to relate to and control the world.

Most education at secondary school levels aims towards preparing students for jobs or for tertiary education. Those of us who can see the growing tidal wave of technological change ask: What point is there in training people for jobs that will not exist when today's students are ready to take them? Tertiary education for jobs in the commercial area faces an even greater problem, as all too often the departments providing the education are even farther removed from a world where the students must find the jobs.

As I understand it, most secondary schools have used their computers primarily in the maths, sciences and in so-called "computer-science" courses. In the past, people teaching maths, science and computer science courses have been required to have a depth of specialist knowledge which has discouraged them from going outside of their subject disciplines. Computer skills that are taught in such environments, are all-too often taught in isolation from the world of the day-to-day business needs and transactions through which humans normally interact with one-another. All too often the skills taught are programming in comparatively low-level languages like Fortran and Basic at a very low level of integration. In the sciences and maths, computing has been discipline oriented and used for drill and practice, simulation and other essentially sterile uses designed to improve the students' understanding of obsolescent disciplines.

What the normal secondary students desperately need in order to prepare them for the peak waves of the technological tidal-wave they will be facing when they leave school, is maximum access to powerful micro-computers equipped with a broad range of general purpose applications packages — word processing, financial spread sheets, communications and database tools, graphics, statistical packages, CAD/CAM systems, robots and the like.

Teachers will answer that they don't know how to use such packages themselves — well, truthfully, no one else does either as far as their long-term social implications are concerned.

My radical suggestion is to put all of the equipment, software, instruction manuals, reference books from the present curricula and students together in a big open barn and let them play and experiment with the gear as they will in terms of setting up their own model economic systems. The students' inquisitiveness and enthusiasm will teach us the possibilities and options. Our jobs as teachers should be to teach them to be critical, along with history, ethics, empathy, responsibility and maturity. At present we have no more idea what their eventual professions will be like than they do. Furthermore, their vested interest in determining what **their** future employment should be will certainly exceed ours. I call this school the Option Barn.

If we do our jobs in the Option Barn well, I have high hopes that the information society, which evolves in the next generation will be an affluent and compassionately democratic one.

If we leave the computers primarily in their present roles in the compartmentalised and economically distant subject disciplines of the maths and sciences, we encourage the evolution of a despotic class of high priests who control the rest of us through their control of information.

Hopeful Signs in Primary Schools and the Humanities

By now it should be clear why the ferment in the humanities and the primary years should so impress me.

The environment of the primary classroom is by its very nature an interdisciplinary one — as most learning occurs in the same room under control of the same people. The primary teacher rarely claims to be a true expert in any of the fields taught — rather he or she must be something of a generalist. Even the chief administrator is more likely to be a generalist by comparison to the situation in the secondary school, where the chief is most likely a trained administrator.

In the primary classroom many teachers and their students are encountering their new computers together on nearly equal terms, and together they have been learning to use them as word processors, to gain access to data bases, and to use a high level language called LOGO to make a robot turtle draw funny pictures on the floor.

Similar types of things, but at a more sophisticated level, are happening at the secondary level when English, history and geography teachers are finally surmounting their fears and getting some equipment out of the clutches of the maths and science teachers. Again no-one knows what should be done with the equipment, so teachers and students experiment with the general purpose tools and learn how to cope together. The trend is still small — but at least it seems to be in the right direction.

We are still a long way from the Option Barn, but as I argued in my editorial section, "Capital Requirements for School Computerisation", in the last edition of this journal — individual Australians could equip the schools their children attend with sufficient equipment for considerably less money than they spend in a year on alcohol, tobacco and home entertainment.

TTNS — The Times Network for Schools

The Times, London, has achieved a significant breakthrough, in terms of scope and cost, with the development of TTNS — The Times Network for Schools.
School children will be able to use their microcomputers for a much wider range of activities with the establishement of the first national electronic information service dedicated exclusively to education.

CENTRAL DATABASE

TTNS has central database built up from educational and outside sources. Schools' usage is being subsidised by sponsors selected from commercial companies as well as trade, professional and industrial associations capable of contributing worthwhile information of relevance to education.

TEACHERS CONTROL DATABASE

The database, being continually developed in close consultation with teachers and local education authorities, contains a variety of information relevant to the curriculum and promoting extra-curricula activities.
Children will be able to initiate research projects, enter competitions, send and receive software programs, pool technical expertise and equipment and find out about national and local events from the noticeboards. Older students will be able to learn about different careers and apply for jobs through the system.

Children at Garth Hill School, UK, are already exploring surprising ways of using TTNS