Understanding Innovation

Generally, innovation has a bad press. Inventors are often seen as 'cranks' - Sir Clive Sinclair is remembered more for the C5 than his more practical inventions; the Dyson Vacuum Cleaner gets the worst reliability 'star' ratings by Which? Magazine etc. Too many inventions such as Betamax or the Phillips 12" laser-disc or Apricot Computers are remembered as short-lived expensive failures, particularly for those who invested in the leading-edge technologies of the day.

Recently a catalogue arrived through the post entitled "*Expert Verdict – A world of Innovations*". Unfortunately, throughout its 136 pages I could not find one innovative feature, just hundreds of minor cosmetic modifications to existing products with no suggestion as to how they might be applied innovatively.

I prefer to define innovation as '*thinking of the obvious, first*.' Innovation comes about through problem solving or 'needs reduction'. As a teacher of both Technology and Mathematics I see a bit of a conundrum: In Technology if I set a problem to a class of 20 students I expect 20 different solutions. However, if I set a mathematical problem to that same group, I would expect 20 identical answers, unless some have made a mistake in their calculations.

In general, therefore, I do not see 'innovation' as the outcome of a proposition such as, *"Here is a technological device, what can we do with it?"* - although there may be some examples where this may be the actual process or route to innovation.

I give a few selected examples from my own experience:

1956/7
Two 15 yr-old schoolboys with a slight interest in astronomy were asking questions such as, 'Does God exist?' 'Is there life beyond our planet?' etc. We built a series of crude di-pole aerials with gas-valve amplifiers in order to explore inter-stellar noise. We searched inconclusively with our 'radio telescopes' until one day when we got the fright of our lives when we detected the signal from a Russian satellite, later to be identified as the one containing the dog Leila.

Possibly not the most earth-shattering of inventions, but we, as schoolboys, had inadvertently invented a 'domestic' satellite tracking system – but we hadn't the expertise or vision to carry the application further.
[Corollary: A questioning mind can lead to outcomes or conclusions which may not be immediately obvious. However, in order to benefit from such a discovery any application or development of the discovery requires vision, resources (including time, money etc), tenacity and patience.]

1964
As a junior member of staff, I was helping to run an after-school 'Motor-Club' where young would-be mechanics stripped-down and re-built motorbikes and small car engines. (They *were very* simple in those days!) One evening a young lad pushed himself beyond the limits and, in testing out the performance of his bike, crashed, luckily with no bones broken, but with grazes embedded with gravel over almost every part of his body.

The immediate personal outcome, for me, was that I vowed to be as professionally qualified as possible so as to protect myself from potentially angry parents. We were at that time adopting the Schools Traffic Education Program (STEP). However, STEP was following the pragmatic approach of introducing their programme using small light-weight motorbikes (early Honda 90s I think). From this situation, I qualified as a driving instructor etc, and developed what later became innovative 'Pre-Driver Training', teaching youngsters the basis of Roadcraft and vehicle maintenance, using real 4-wheel cars!

[Corollary: Observation and understanding of a critical situation is only the start. Obtaining appropriate qualifications and recognition will enable innovators to have the 'clout' to push the right buttons in order to get the co-operation of others.]

1971
Off ill, in bed, I was watching mid-day TV and saw a documentary about Forestry. I was astounded by how relevant and even exciting the material was for the subjects I was then teaching. From my sick-bed I immediately telephoned ITV and persuaded them to send me a video-tape (Betamax I think) of their programme. I used the material very successfully for several years including transferring it to VHS! Over those early years I also built up a massive tape library of 'Tomorrow's World' and other IT related programmes. My only regret is at that time there was no real means of sharing my 'discovery' with colleagues throughout the UK (or even beyond!) From that time onwards I have always scoured the TV magazines and, more recently, Teachers.tv.com to look out for useful broadcasts worth saving. I now collate collections of topics to DVDs for my own personal archives!
[Corollary: Serendipity has a place, but grabbing the bull by the horns and doing something about it, systematically and over the years, is where the real value then becomes obvious.]

1972-76
Teaching in a residential school for the deaf, I observed an amazing situation which required a realistic solution. Every day, before the evening meal, these profoundly deaf children would sit down in front of the large b/w television sets whilst a teacher would write continuously on a roller-blackboard, writing a simplified commentary on the news for the day. It was difficult to keep up, write simply and clearly at speed and also clean off the previous writing at the same time.

We set up duplicate TV sets alongside the broadcast news and, using a fixed-platen golf-ball typewriter and a small CCTV camera, we managed to display a typewritten commentary which scrolled up the screen. The children found this a vast improvement and actually took more notice of our commentaries to such an extent that, at the end of term, we would run a long 'James Bond' type of movie with a continuous commentary provided by a team of teacher-typists.

This proved so successful that I obtained a 'mixer-box' to insert the two signals onto one screen, inserting 3 lines of scrolling text at the bottom of the screen. I then moved to acquiring a simple teletype signal generator to insert the text directly instead of using the type-writer and CCTV combination.

This again worked so well that my Headmaster invited the RNID and BBC to observe our 'invention' which was eventually adopted and became the CEEFAX subtitling commentaries for the Deaf. It was new, different and a genuine solution to a problem – this is what I understand to be 'innovation'.
[Corollary: Observation of an immediate and practical problem will force an enquiring mind to explore all avenues. Possibly Heath Robinson approaches may be the only way to get started. Repeated consumer trials and improvements may eventually lead to a solution. But again, this needs tenacity, technical skill, adequate resources and encouragement.]

1974-77
At the same time as working in the school above I was also asked to investigate 'Teaching Machines', servo-mechanical devices asking responses to programmed questions on 35mm tape projectors. It was a long hard struggle. The setting of multiple-choice questions and planning not only to jump to the next question if the answer was right but also, on an incorrect answer, to jump back to a relevant section of information was a tedious task. If only I knew then what we can now do with computer software – I would have waited another 20 years!
[Corollary: Sometimes the effort involved in developing a good idea far outweighs the immediate benefits. But who can tell if waiting will supply the right equipment and resources?]

1979
As a young Head of Department in a large comprehensive school I was keen to 'do things properly'. One of our regular tasks was to produce manually written lists of examination results – a tedious and error-prone occupation. At that time some of us were 'playing' with Acorn Atoms and Commodor Pets – tape-loaded and with 8K memory – exploring what they could do. What with my tidy mathematical mind and my concern over 'exam lists' it soon became obvious that I needed to create a simple system of data entry and some effective layout skills in order to produce lists of which I could be proud – especially when I was able to get 'my' perfect lists on the Head's desk first!

Working with a colleague we soon developed a system which was relatively user-friendly, and, once adopted, saved considerable time and did all the extra rank ordering and analyses like 'semi-interquartile ranges' – all neatly and uniformly printed out.
[Corollary: Recognition of a problem is not enough. The understanding that a technical device might be applied in order to produce an appropriate output is not serendipity but a combination of vision and creativity. What was a series of logical steps to me, was just plain 'innovation' to my colleagues. Some saw the value and grasped the technology, some were wary and others just plain resistant to change!]

1981
Learning the mysteries of basic applications such as the arcane WordStar wordprocessor or the cumbersome Multiplan spreadsheet, I soon realised that children found the plain 'boring' output to be a bit of a turn-off. Writing simple routines in BASIC I managed to develop techniques for exporting Multiplan data into simple graphical converters and importing the graphics into basic wordprocessing documents. This added a 'professional' quality to the students' work which neither they nor their teachers had done before.
[Corollary: The challenge to do 'something new' takes hours of exasperation and perspiration, even if the outcome is 'cool'. The fact that commercial systems, using mini- or main-frame computers, could produce similar results did not matter. For our students and their teachers this was new and 'innovative'.]

1984-86
During this time I had become highly involved as an essayist, writing articles for newspapers, magazines and special studies etc. I was using a BBC Micro with a large Juki daisy-wheel printer. The only problem was that to my tidy mind I wanted both justified text and a proportional typeface. 'Not possible.' was the response to my queries – that was not an acceptable answer for me. I therefore found a technical expert who understood my problem and between us we developed some software which, by a second-pass from any WordWise document, would re-calculate the micro-spacing for every character on every line. The product was advertised and a small number of discs were sold over a period of some 5 years. Despite my 'brainwave' my royalties were small and not concomitant to the amount of effort put in. Before long other wordprocessing packages came onto the market which had more bells and whistles – including proportional spacing – and soon my innovation was no longer needed!
[Corollary (1): Input rarely compares with output. (2) Tempus Fugit – some innovations are short-lived and no longer meet a need.]

1986
Electronics and Technology was being introduced into schools – but it was very expensive. The TVEI poured millions of pounds into schools where they could show evidence of some initiative or vision to get 'stuck in'. Sadly, many thousands of schools failed to recognise the challenge or hadn't the necessary motivation. In several schools in one Local Authority that I was working in at that time, they were each given four industrial-standard CNC lathes at £12,500 each. Yes, they had the 'technology' but did not know what to do with the lathes and could not afford the materials that the students would need!

Recognising this problem and being in an opportune situation I was able to make some considerable progress. I approached three UK manufacturers of CNC equipment who were attempting to engage the education market. I spent much time in trying to understand their design and production methods and marketing strategies before approaching them with my ideas for low-cost machines working with cheaper consumable materials which would still deliver the required educational outcomes.

The result was a major marketing strategy to introduce CNC lathes and mills into schools at a maximum price of £1,000 each, and thus making CNC slightly more affordable for the National Curriculum. As soon as CNC became recognised as part of the schools' curriculum other commercially viable devices such as plotters, 2½-D mills and the 'Poem' sewing machine began to find their places in schools' workshops.
[Corollary: Problems are sometimes created by the well-intentioned with little anticipation of the possibly dramatic outcomes. It takes someone with the necessary vision and 'language' to relate to both industrialists and educators and mediate appropriate solutions. Even then, it is not until the new artefact is used in realistic applications that 'innovation' can be said to have occurred.]

1987
The computer was rapidly becoming the 'in-thing' in many schools – but what to do with it? Was it a gimmick? Could 'it' be used in subjects other than Maths? Which children would be chosen to use 'the' computer? How could a computer be economically viable? Could it possibly be used by every child – or was it just to demonstrate to whole classes or groups?

As a peripatetic Advisor for Information Technology, it was my responsibility not only to install and configure small networks of computers in schools but also to make sure that they would be used efficiently.

Working closely with Headteachers and curriculum leaders I tried to ensure the maximum usage of the facility, rotating classes and devising activities which would extend children's learning rather than emulating the 'Typing Office' mentality so entrenched in schools at that time. There was also a serious resistance to the take-up of the use of computers – the 'Computers in Cupboards' syndrome – *"I haven't got time to get them all out, set them up, and then lock them away again at the end of the lesson!"*

Rather than 'rewarding' the most able students with access to the computer, I found most benefit and motivation was generated when encouraging the least able and often the most untidy of workers to work on the computers. They could correct and edit their work, producing results that were without all the usual crossings out and spelling mistakes. Particularly those with what we now know as Attention Deficit Syndrome, children could re-visit their work as many times as they wished. For the first time in their lives I saw young ruffians taking a pride in writing beautifully sensitive poetry or producing statistically significant graphs of their research.

Teachers, too, discovered that they could do things with a computer which, before, were impossible. They could access students' work and check progress from the staff-room, they could check mark-books on-line etc and suddenly do a host of things never done before.
[Corollary: Having a vision is one thing, making it happen is another, yet encouraging the unbelievers is really something else! A few may take innovation on board easily, some will listen to reason and take pride in exploring ideas, some need the challenge of recognising that something can actually be done better, faster, more reliably, more attractively etc and yet others need to be taken gently by the hand and told what they must do – which often needs 'clout'!]

1990
As Founder Director of Technology in a brand new City Technology College I had the brief of designing the whole topology and infrastructure of my vision for the computer network. Every classroom, staff-room, office, library, technician's room and display area was cabled with ample data access points. My vision was for an Open Access Policy which would generate the synergy whereby all students, all staff, including the administrators, caretakers, cooks and cleaners would have access to appropriate software and files. Classrooms had to be big enough to take a set of computers AND allow sufficient room for a full set of desks. The DfES objected to the sizes of rooms I needed, they told me to wheel in stand-alone PCs on trolleys from a shareable store. Staff were initially tempted to think that the computers were only to be used if the occasion was right otherwise they could be left, unused.

It needed strong leadership right from the defining issues of hardware and security policies etc. Choices of software, controls of printing, access rights, copyright, libel and pornography were all issues not previously thought through by most staff. I had to insist that the use of such an expensive resource must be maximised – which meant that sometimes classes would have to change rooms and that uses of computer resources should be planned. An Open Access Policy lent itself to the longer working day. A self-generating 'synergy' resulted with all staff and students using the same basic IT skills. Some students were ready to start work at 7.30 in the morning, others stayed on until 6.00 in the evening, yet others came to work on a Saturday morning or during the so-called holidays. Adults and local businesses also used our facilities -staff and students had to get used to the idea of 'strangers' on site.
[Corollary: Leadership must start with a clear, unswerving perception of the task in hand and the goals to be achieved. Once established, innovation evolves and things previously unimaginable become normative.]

1999
Broadband was coming to the big cities and some Local Authorities saw this as a way to link schools' MIS to the main Education Offices and establish some form of order throughout the hundreds of different management systems individual schools were using. Broadband was thus first seen in schools as an administrative device – and not for teachers, and certainly not for children!

In a small rural Comprehensive school, we needed to break down the barriers to learning which our geographical location forced upon us. We had a large contingent of overseas students who were far from home, lonely and missing their home-language, culture and friends. Our Headteacher was also very involved with the Commenius project, getting children from different countries to communicate with each other. Furthermore, as a smaller school we did not have resident teachers for some of the A-level courses, such as Psychology, that we wished to run.

To me it was obvious that we were in a unique position to fight for Broadband as the solution to the difficulties we were experiencing. After much research and tendering I won the opportunity to run a pilot study for the LEA and specialist contractors were brought in to cable our school at a time when there was no broadband for the local rural community.

Once set up we suddenly discovered a wonderfully satisfying ethos whereby children were able to read their local newspapers, on-line, in Polish, Scandinavian, Romanian and a whole host of other languages. We established regular contacts with other schools through the Commenius project and, most successfully, set up a professional quality distance learning video-conferencing system so that students could take up A-level Psychology.
[Corollary: 2+2=6. Seeing a set of problems that can benefit from the introduction of a technology is fine. Fighting bureaucracy, lack of vision and miserly accountants is another! Any one of several 'problems' could have been technically resolved using broadband, the innovation was about the natural take-up across a number of platforms with an acceptance which was quite seemless. A synergy came

about creating a mental attitude that had never existed before, that, from our isolate rural environment we could contact anyone, anywhere, anywhen – that, for us, was innovation.]

2000
The problem of Internet Security soon arose. Students were reading on-line newspapers from several mid-European and Asian sources, of which some of the content was not acceptable. Similarly, e-mail messages for our students were an important part of their life away from home but we had a responsibility to protect from inappropriate content. Broadband had made the frequency, speed and size of file transmissions increasingly of concern.

Upon investigation, most of the school-based filtering systems were not flexible enough to provide the security we required, and the commercial systems were far too expensive. Upon further investigation I found a young forward-thinking company who specialised in broadband security for banking. Upon explaining my problem to them they listened intelligently and tailored their package to my needs, allowing me to set up my own 'white-lists' and 'black-lists' along with their own standardised set of known 'offenders'.
[Corollary: Thinking 'outside the box' is not that painful – it just needs the ability to believe that the 'impossible' can be done, and to go out and find someone who will take the trouble to listen.]

2001
Interactive Whiteboards (IWBs) were the latest new toy – but too expensive – and anyway, "What could the do that we didn't do already?" was the outcry.

Seeing something of the dramatic potential for my own teaching, I had my first IWB installed and began developing my own set of techniques. Visiting other schools and commercial training courses I soon had a whole armoury of teaching styles and resources with which to encourage my colleagues. Knowing the colleagues who had some motivation to develop their own skills, I was then able to strategically install another half-dozen boards.

Firstly, I was surprised by how many different techniques the different subject specialists had between them. I identified 11 differing practices, all of which individually justified their use of the IWB for their purpose. However, the commonality of the medium was such that soon I was able to encourage colleagues to try teaching styles or techniques 'borrowed' from their colleagues. We eventually had every classroom in the school fitted with IWBs all being used to match and expand upon the various teachers' teaching styles. This was, to my mind, real innovation!
[Corollary: To use a new technology to do 'the-same-as-before' is not innovation. When a new technology comes about which enhances a conventional process (possibly to our surprise) we can say that innovation has occurred.]

An Analysis of Conditions Amenable to Innovation

1. A questioning mind is not always sufficient – innovation requires vision, resources (including time, money etc), tenacity and patience along with a wisdom that comes with experience.

2. Innovators often need the 'clout' of qualifications or authority to push the right buttons in order to get the co-operation of others.

3. Observation of an immediate problem still needs tenacity, technical skill, adequate resources and encouragement to reach an acceptable solution.

4. Serendipity may have a place, but grabbing the bull by the horns and doing something about it, systematically and over the years, is where the real value then becomes obvious.

5. Innovators need the 'language' skills of an intermediary to mediate appropriate solutions particularly when third-parties such as industrialists or sponsors are involved.

6. Vision is the essential driving force – it keeps the developer working towards a solution – whether or not the profit margins are realistic.

7. Sometimes an innovation might be short-lived – but the establishment of a principle may lead on to the acceptance of a norm applicable to other developments.

8. Innovators require not only vision, leadership, motivation but also tact, diplomacy and patience if a majority are to be convinced.

9. Innovators must have a clear perception of the goal to be achieved, the strategy to get there and the sensibility to know whether to stop or go further.

10. Innovation can often work better when one individual does not have the sole control of an outcome. An innovator can get valuable support from kindred spirits. Innovators need to be ready for their 'discovery' to lead into new areas of application and to recognise and build upon the contributions of others.

11. Innovation can occur when we least expect it, but rather than being 'serendipitous', it starts with an enquiring mind. It is the nature of an innovator to recognise and promote any such discovery using the skills as listed above.