Forty Years of Computers and Education

- A Roller-Coaster Relationship

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Abstract For forty years the relationship between computers and education has been engaged in a headlong journey, full of ups and downs, wild swerves to right and left, somehow both exhilarating and frightening, sometimes in tandem but at others barely still holding hands. The engine of the technologies keeps changing while the driver is sometimes a discipline, learners, or the teacher. The landscape passed along the way includes fleeting glimpses of beautiful but unconquerable mountains followed by attractive rivers with treacherous currents. The population is sometimes persuaded by innovators to come along for the ride, and then suddenly they embark on their own journey into an entirely different valley. The paper analyses this journey along the TC3 twin track of education with and about information and communication technologies, using evidence from its publications and debates, organisational structure and the influence of individuals. The presentation, from one who is neither a computer scientist nor mathematician, will aim to portray a particular perspective on this roller-coaster relationship.

1. Introduction

In essence, this paper is a history, specifically about the relationship between computers and education. I am choosing to characterise this historical journey. The decades of travel referred to in the title of this paper are the forty plus years since the establishing of the International Federation for Information Processing's (IFIP) Technical Committee 3 on Education in 1963, through to 2005. Because all history is more than a sequence of dates or facts – the story will be told by the identification of a number of key characteristics, structural, contextual and social that provide a shape to the nature of the journey. The thematic landscape passed along the way includes fleeting glimpses of beautiful but unconquerable mountains followed by attractive rivers with treacherous currents. Some enduring features however remain constant. Overall, this journey can be viewed as a process of innovation and change.

An exploration of the relationship between computers and education over this period is timely for a number of reasons: after forty years, 'folk' memory and knowledge about events and purposes in the early stages of any development fade; archival material may be sparse or relatively buried; and an understanding of history may help inform the future. But over-riding this is the sense that this has been exciting, heady time, during which, it can be argued, that Technical Committee 3 (TC3) has been a significant player. And the direction and speed of change in the information technologies and their relationship with education have been substantial. So I have chosen to characterise this as a roller-coaster relationship.

The evidential base for my research on the history of TC3 has been varied. I have gathered information on the structure and activities of Technical Committee 3, from its inception to its position with seven Working Groups and one Special Interest Group at the end of 2005 (Appendix 1). I have used information on its membership and its means of operation. I have evidence from minutes, but also informal notes and conversations during some meetings. And I have interviewed individuals who have been members of this structure. Analysis of structures provides indicators on why directions have shifted, and the significance of both the organisational context and influence of individuals in shaping events.

In addition there is a complete bibliography of publications for which TC3 and its various working groups have been responsible, mostly proceedings from conferences and working meetings, but also guidelines for curricula and 'good practice' (Appendix 2). The book titles themselves contribute to the charting of directions and are evidence of the interlinking between the activities of working groups and the substantial debates that have flourished, from teaching algorithms to computer scientists to an exploration of the school of the future. Papers in the official TC3 international journal, Education and Information Technologies, currently in its eleventh volume, supplement these debates.

One of the richest sources of evidence, however, for an analysis of the evolution of computers in education lies in the Proceedings of World Conferences on Computers in Education (WCCE), organised roughly every five years by the TC3. Eight such world conferences have been held, from the first in 1970 in Amsterdam, the Netherlands, to the eighth in 2005 in Stellenbosch, South Africa. The sections, papers and panel topics in these conferences reflect the concerns and views of the participants at the time and act as a unique record of debate and change (Appendix 3). The fact that they have been held at intervals enables shifts in the landscape to be noted that might otherwise be lost. From the first, WCCE has identified and addressed the dual concerns of our field; that is, education about computers, and using computers, or more recently, Information and Communications Technologies

(ICT), in education. It is to be expected that during a time-span of over forty years, the balance between these two would alter, and new topics emerge to reflect the changing attributes of the technology and the shifting perceptions about education.

Exploring this history provides challenges not so much because of the nature of the data available, but in finding an organisational modus vivendi. I have applied a style of ethnographic method; that is, I have probed or coded the range of evidence described above to identify themes, and then continually cross-referred between areas of data until I have been satisfied on their strength and validity. I have used this method for a number of reasons: I am familiar with it and it is often used in social science and educational research; it is based on the notion that individuals and structures can be probed for meaning through their written and spoken records; and it enables a variety of opinion and perceptions to emerge. Readers looking for a quantitative or statistical analysis will be disappointed.

Two features influence the story that emerges. The first is that no history can be 'definitive'; any history is but an interpretation of events and this one reflects my analysis of the data I have researched, and my selection of issues to probe. This means some themes may not be discussed, either because I do not feel I have a good enough 'handle' on them, or they are too large and deserve a separate analysis. Specifically this is the case with developing countries. And secondly it is also important to note that I am an insider ('informant') to this history. I presented my first paper at an IFIP TC3 conference at the third WCCE at Lausanne, 1981. I am currently chair of Working Group 3.1 (Informatics and ICT in secondary education) and thus a member of the executive committee of TC3, and editor-in chief of the journal Education and Information Technologies. Research insiders have access to information (such as notes, sometime contemporaneous, of issues at meetings, and informal as well as formal conversations) that is often unique. But they may not be as critical, or fail to see matters that a disinterested historian might consider significant. On the other hand, unlike many members of TC3, I have a humanities background, having studied geography and anthropology at University, and taught geography in schools before becoming involved with ICT in education through curriculum development and research. Although an elected member of the British Computer Society, one of the founding national member associations of IFIP, I am neither a mathematician nor computer scientist.

Analysis enables certain enduring themes such as teacher education to be identified, some such as debates on different programming languages have receded, and yet others such as Logo burst on the scene, briefly flourished and then disappeared. The growth and decline of topics and issues can be charted, from the initial dominance of higher education to the current broad scope of elementary through to higher and further education, and now embracing the community and lifelong learning agenda of the early 21st century. What trends could be, indeed were predicted, and what appear to have taken the community by surprise? What drives patterns of change – increasing technological sophistication, or a growing maturity of education and society in understanding what such technology can offer?

This paper will present a thematic analysis of these forty years, and also attempt a critique of the issues which surround the interaction between computers and the education process, and which might elucidate future debates.

2. Technology and Educational Change

It is obvious that there have been substantial changes, both style and substance of computing power over the last forty years. This section will not include technical details, such as the shift from K to GB of memory, but focus on issues that affected the relationship with education. Six shifts are clear: the ever increasing in the level of computing power, a reduction of physical size, the development of graphical user interfaces, reduction in cost, and common software applications packages, and the growth of the internet and world wide web. All impact upon both the availability and nature of the technologies, with their consequential influence on education and society. I have identified three main time phases significant to education.

2.1 1963-1979

TC3 was established at a time when most computers were physically large - they took up substantial quantities of space. Huge cabinets in computer rooms or laboratories, with air-conditioning to ensure a relatively dust free environment, was the norm. They were expensive and located in universities, major businesses or establishments where automatic computation was a growing necessity. Their computing power was minute compared to today, but substantial compared with the world before computers, that is, of the manual calculator. Data had to be encoded into punched format (on either cards of tape) to reflect the 01 notation.

I first came across this world as a junior scientific officer in 1964 in the Royal Aircraft Establishment in Farnborough, UK. There, after manually recording the results of each wind tunnel trial, I would go to the computer rooms and enter the data by punching line after line of holes and blanks. It was tedious and prone to error, but it provided the aeronautical engineers with a means of fast processing data on air speed pressure and pressure on the shape of a plane as different angles. The computer however could not produce graphical results; I was introduced to the mysteries of using French Curves to manually plot the results.

Between 1963 and 1979, the demands for computers for businesses, local and national governments and agencies, and universities grew, as did the demand for individuals who understood the science of computers, data processing and programming. Equally, the computer industry grew to satisfy these demands. The computer remained a special fixed resource, but data entry shifted to automatic punch card or tape, then to terminals with a qwerty style, noisy keyboard, and finally to terminals that could be at a certain distance from the machine itself, connected by a cable. But for education at this time, this power remained in the hands of a few – computer science or mathematics departments in universities and a few schools.

Nevertheless, some software was being developed for use in departments other than mathematics in schools and higher education, specifically for instance science simulations and data processing. It is important to note that not all classes or lectures at that time were of the 'traditional chalk and talk' mode. Science laboratories had spearheaded a more active learning mode, as had for instance the use of geographical board games. Both these 'tools' facilitated more active discussion on classes. At this time, by a series of coincidences, I became involved in the Computers in the Curriculum project headed by Bob Lewis at Chelsea College, and remember working with geography teachers to develop a database of rain in Wales. Then in the later 70s, this landscape of remote but mostly unattainable mountain peaks changed dramatically.

2.2 1980-1989

The advent of silicon technology, 'the chip' was clearly a benchmark in the nature of computing power. By the start of the 1980s microcomputers were ubiquitous, although usually still in the hands of the specialist few. By the end of the decade, computing power was available for a range of disciplines and administration, had begun to penetrate elementary and vocational education, and been subject to wild swerves according to each new development. For instance, the flexibility of locating a stand-alone micro in any room – whether a university library, school classroom, or administrator's office, suddenly became curtailed with the growth of networks located in special rooms to increase the number of stations (terminals) with shared power and printer facilities. On the other hand, networks opened the vista for distance education, rapidly taken up for education by countries with remote populations such as the Inuit in Canada and outback in North Australia.

Alternative devices to keyboards were developed, floor turtles, robots and science laboratory controls and other peripherals emerged and the term multimedia emerged. With the development of the Apple Mackintosh, a benchmark of the graphical user interface was set; the need to program special applications led to specialist authoring languages, while general-purpose business applications for word processing, spreadsheets and data handling, such as Claris and Microsoft took hold. By the end of the decade, laptops were in evidence - I do still have a copy of an early information leaflet referring to a 'kneetop'.

Thus for all branches of education the availability and use of computing power became a possibility, mountains had been replaced by hills that could be scaled with relative ease. Governments began paying attention to fostering, and promoting the development of national computer industries geared to providing computers for business and micros for education. By the end of the decade, individual national machines with their own architecture and programming language only survived by becoming clones of major international companies with the ability to run a few standard application packages. The term computer science was often replaced by Informatics; the terms educational computing, computer assisted instruction and learning, and computer managed learning declined with the rise of the more general Information Technology; and computer or IT awareness moved to the centre ground.

It is not clear how much the world of TC3 anticipated the growth of standard application packages with the concomitant reduction of software development for specific disciplines and curricula purposes. Ironically after the gains of a decade of CAL, the growth of computer awareness for all led to a swerving away from the educational purpose of using computers for learning. Nevertheless, the eighties were an equally heady time for curriculum development, with attention to issues such as teacher style and interactivity in the classroom. As soon as micros with graphical interfaces arrived, the possibility for an incremental step for geography (and other humanities) became apparent, with the ability to turn the geographical board games into interactive simulations. One of the reasons some schools were in advance of using computers for learning, was because they could envisage it supporting the more open, discursive and active lessons that were becoming more frequent, and subject to much discussion at other educational fora. But these were not the norm. In universities interestingly, computers were used in laboratories for the processing and analysis of data, but they hardly penetrated the lecture or seminar room.

2.3 1990-2005

This period can be characterised by the flowering of global communications with the internet and world wide web, and finally digital mobility. The growth of satellite availability from specialist defence to generalist purposes provided a shift from local and national to international and indeed global networks. Previous networks replied upon telephonic cables; now the communications technologies began to impinge upon the perception of networks, and the nature and availability of information. The term computer was coined to reflect to its original calculation function. The term then changed to ICT to reflect the dominant the functions of information and communications; in turn this is now being replaced by digital technologies.

At first this affected more substantially business, administrative, and educational enterprises. But a change occurred that education is still grappling with, that of the penetration of computers into the social world. Some parents would have been using computers for work for a long time. Now with the further growth of the industry and subsequent reduction of price, personal computers (PCs) came within the reach of many households and students. Society was attracted in by the availability of global personal communication, accessibility of information, and substantial processing power through ubiquitous business applications of Microsoft.

In the developed world, computers have increasingly become a part of the equipment of a household, along with such items as a washing machine. And the commercial organisations of society have reacted swiftly; shopping, financial services, travel and entertainment. ICT also became common in all educational institutions, and also in community centre, further education college, and libraries. For those without personal access to a computer, libraries, community centres and an internet café is commonly available in urban streets.

The role and function of Information and Communication Technologies in schools is no longer specialist or unique; the challenge is to ensure that educational organisations use the technologies for the purpose of learning and teaching within this different inclusive environment. It is not clear how much TC3 can fully comprehend and explore this world without an influx of social scientists. Teachers, lecturers, administrators and students use the internet to communicate and the web to search for information. They use ICT to organise and manage their work. The real question is how much is it used in classrooms, lecture rooms, or online to teach and learn the concepts and disciplines that still lie at the heart of education, and to support process and styles of learning such as collaboration and debate?

So now the landscape of computing power has become the equivalent of a flat plain, with no difficult terrain of accessibility to negotiate. Flowing across this plain however is a wide river, which affects developing countries and those who are socially and economically deprived anywhere. Bridging this river, or overcoming the digital divide, is a cause of substantial concern that TC3 among others is seeking to address. However the ubiquity of the global digital technology has further issues worth noting here.

Because of the open nature of the global web, the river current is dangerous but which may not be apparent on the surface. And information of itself is not knowledge, but a means towards developing knowledge. And developing knowledge is the business of education – educare, to draw out knowledge and experience. Society needs education to grasp the complex issues about veracity, security, surveillance, legality and ethics now posed by global information networks.

The second issue to note had been the growth of mobile technologies, and particularly the use by the young. At the sixth WCCE in Birmingham, 1995, no mention was made of the growth of mobile phones. Yet by the late nineties the use of this technology already had a profound effect on the ready availability and form of communication. The young were the first to adopt the mobile (or cell phone) as an essential communication device; they use text messaging as often as voice and have developed a shorthand 4 speed. A new language of communication, incorporating graphical functions, has developed fast and is now penetrating formal structures. The educational world of language and communication specialists is studying this change, but it has as yet had little impact on topics debated inTC3.

And this is particularly important because this digital mobile world enables the incorporation of picture, music, film, and broadcast. This is in 2005 the current world of the young; it dominates their culture, interests, aspirations, and increasingly employment. This illustrates the new move to way beyond an information device. It is this digital culture that members of TC3 need to understand and embrace. And unlike previous waves of technology, it is not embedded in institutions and established professions where the power of understanding the technology and its use dominated. It has shifted to society; it is as if the population that has been persuaded by innovators to come along for the ride, then suddenly embarks on their own journey into an entirely different valley.

3. Technical Committee 3 - Its Evolution and Structures

3.1 A new IFIP technical committee

In 1959, a conference was held in Paris on computers and computing, under the auspices of UNESCO. At that meeting, representatives of the main computer societies active at that time decided to explore ways of building on that conference. Subsequently, with the support of UNESCO, thirteen national computer associations agreed in 1960 to found an International Federation of Information Processing [1].

IFIP Council formally decided in 1962 to establish a new Technical Committee for Education (TC3). Richard Buckingham (UK) took over as chair for the establishment of TC3 in 1963. This early establishment of a Technical Committee for Education is historically significant, both as the first international committee on computers and education, and secondly that an organisation dedicated to computers and computing recognised in its earliest days, the fundamental role of education. It is true that the then prime concern was the growth of the training of professionals in data processing, both for educational institutions and the world of business and management. Nevertheless, many educationalists will have reason to thank IFIP for not calling their new Technical Committee 'Training'.

"It was inevitable that education should come to the fore early in the development of IFIP" avowed Buckingham [1]. In essence, he reports that in the early 1960s most educational efforts were focused on the use of computers for numerical computation, under the aegis of university mathematics departments, teaching programming and developing high-level languages. There was however little formal education concerned with information processing, a significant issue for business and administration.

The first formal meeting of TC3 was held in Paris, France in February 1964, followed in the same year by ones in Liblice, Czechoslovakia and Rome, Italy. By the end of that year, 14 members had been appointed, and a series of activities were planned to establish programmes for training and curriculum development in the science of information processing.

Three concerns characterised the early period in the 1960s, and laid the foundations for the development of the Working Groups of TC3. The first was a determination to engage with directly and support the needs of professionals in the field. This was characterised by the production of a series of guidelines for using computers in education that have continued at various intervals to this day. The second was to explore every avenue for collaboration with other groups, both national and within the fledgling IFIP, so as to draw on the early work of all to form an international corpus of understanding of issues and how to address them. Key individuals from new computing societies and organisations including Belgium, Denmark, France, Israel, Italy, Mexico, The Netherlands, Sweden, UK and the USA, led these activities. A third characteristic was the devising and running of training seminars for advanced data processing, with full accreditation and certification - the first in collaboration with the International Computing Centre in Rome, and the second with the IFIP Administrative Data Group.

Membership of TC3 therefore grew by the initiative of keen committed individuals from a number of countries, who spearheaded activities, which triggered a number of meetings. Many were employed in higher education, others in the computer hardware and software industry. In effect, these individuals formed a committed club of innovators, who were collecting information about activities and sharing developments between themselves and others at a series of meetings in their different countries. The initial membership of 14 grew to 23 by the early seventies. These individuals represented their national associations (which they themselves had often had a hand in establishing) that formed the bedrock of the subscribing membership of IFIP. The basis of membership of any Technical Committee is still this representation, although this has been modified in later years, the implications of which will be discussed later. And the practice of moving meetings to an ever-increasing circuit of locations has continued to this day. Apart from the personal joy at travelling to many diverse locations, such meetings are stimulating as they enable the exploration of the national activities at each location, and they can trigger new membership. On the other hand, there are substantial cost implications, which shall also be discussed later. For the purposes of this paper, the most significant of these meetings was the first World Conference on Computers in Education (WCCE) in Amsterdam, 1970. This conference was attended by many who were not then in the IFIP or TC3 'family', and provides by its scope and scale a benchmark for addressing the relationship between computers and education.

At the first formal meeting of TC3 in 1964 [1], the following aims were agreed:

a) to establish guidelines for comprehensive training programmes and curricula in the science of information processing, with special consideration for the needs of developing countries and to encourage the implementation of these programmes;

b) to generate material to acquaint the general public with the computer and its impact on various aspects of society;

c) to serve as a central clearing house for all educational material pertaining to the science of information processing.

Compare this with the current aims of TC3 in 2005 [2]:

- to provide an international forum for educators to discuss research and practice in;
  - teaching informatics
  - educational uses of communication and information technologies (ICDT;
- to establish models for informatics curricula, training programs and teaching methodologies;
- to consider the relationship of informatics and other curriculum areas;
- to promote on-going education of ICT professionals and those in the workforce whose employment involves the use of information and communication technologies;
- to examine the impact of information and communication technologies on the whole educational environment:
  -teaching and learning
  -administration and management of the educational enterprise
  -local, national and regional policy-making and collaboration

An understanding of the growth and expansion of these aims can be gleaned in part from analysing the intertwining of the organisational structure of TC3, its membership and activities, and in particular the Workings Groups.

3.2 The growth and activities of Working Groups

In an analysis similar to and entwined with that of technological change, the growth of Working Groups can be charted in the same three distinct phases.

3.2.1 The early period – 1966-1979

As the name suggests, Working Groups (WGs) are designed to take forward specific areas of interest within a Technical Committee. Working Group 3.1 was established in 1966 to reflect the question of how best to extend education about computers into secondary schools. Imaginatively, the remit considered the use of computers in all aspects of secondary education, and not simply the teaching of programming. Thus both Computer Assisted Instruction/Learning in the disciplines and teacher training were the dual concerns that remain to this day. Many of the members of this working group were nominated by national association members of the of the pioneering TC3 countries – Austria, Canada, France, Denmark, Israel, The Netherlands, Sweden, UK, US, and Yugoslavia. Others were 'known' about; at that time, a few individuals were pioneering using computers in schools. For instance, David Tinsley [3] reports that in around 1997/8 he was drawn in by Dick Buckingham to the schools committee of a new British Computer Society (founded 1967). There the over-riding concern was that "youngsters should be acquainted with the needs of industry and so understand computers and programming".

Through Dick, he was invited to join the new WG 3.1and attended his first working meeting in Paris in 1979. "The idea was simple really, the most sensible thing in the current climate of what's it all about was to sit down and write advice for schools. So that's what we did." He also suggested that under the chairmanship of Dick Buckingham, anyone who dared to publish anything (such as David Johnson in Minnesota or Hank Wolbers from the Netherlands) was perceived to have 'put their head' above the parapet, and would invited into the new working group.

This first working group met regularly between the late sixties to mid-seventies often in association with invitations to mount workshops on computer education for teachers in secondary education. Tinsley [3] remembers that at these meetings the members took the opportunity to work on writing the advisory guidelines. The first of these, Computer Education in secondary school – an outline guide for teachers [4] (known as the Red Book), was available at WCCE Amsterdam in 1970, with a revised version, the Blue Book, available in 1971 and subsequently translated into a number of languages. This developed with three further topic books, produced at a series of meetings funded by CERI (OECD), thus establishing the primacy of the notion of producing guidelines for the profession. All guidelines from WGs are noted in the Bibliography (Appendix2).

In the meantime, one of the three initial activities of TC3 noted earlier, that is the devising and running of professional training seminars in ADP, was devolved to a new Working Group 3.2, with the original title of Organising Educational Seminars. First came the expansion into seminars for Information Systems design, resulting in the publication of an international curriculum for information systems designers [5]. Later, to reflect the continuous concern for the nature of the curriculum for teaching computer science in universities, the name of WG 3.2 was changed to Informatics and ICT in Higher Education.

Bob Aiken [6] attended the first WCCE at the recommendation of his PhD supervisor, who was aware of the work ongoing with respect to the computer science curriculum. He welcomed the chance to visit Europe for personal reasons, but became "drawn into the debate – well arguments - between mathematicians and electrical engineers about the foundations of the science of computing" on both sides of the Atlantic. Having become a friend and colleague of Bernard Levrat, taking a sabbatical to work in Geneva, consolidated his commitment to IFIP, membership of WGs 3.1 and 3.2, national representative on TC3 and then GA.

Two further working groups were established in 1971. WG 3.3 was for Instructional Uses of Computers, which produced a further booklet on computers in learning and teaching. The remit of this working group however changed, in part because it was perceived to overlap with the existing groups, and was moved first to consider 'futures', especially with respect to new technologies, and now is identified as Research on Educational Applications of Information Technologies. And in a logical extension to the work of 3.2, but also to distinguish it from the higher education sector, WG 3.4 took on the more specific vocational education mantle, and is now called IT-Professional and Vocational Education in Information

Technology. Similar to the brief of 3.2, it is concerned with devising of curriculum and related accreditation. It is notable that in this early period, the emphasis on producing curricula and guidance for professionals in the workplace of the computing industry, business, universities and schools dominated the activities of these initial working groups.

Thus by 1979 and after 16 years, four working groups of TC3 had been established, and two world conferences (Amsterdam, The Netherlands 1970 and Marseilles, France, 1975) held. For these WCCEs, TC3 relied upon the efforts of the fledgeling WGs for their planning and execution. Guidelines and curricula for professionals had been published by WGs 3.1 and 3.2, and in addition WGs 3.1, 3.2 and 3.4 had each held their own first individual conferences from which 3 books were published.

3.2.2 An established pattern – 1980-1989

In the 1980s a substantial shift in activities occurred, best characterised by an increase in their number and scale and the consolidation of an establishing pattern. The third and fourth WCCEs were held in Lausanne, Switzerland in 1981 and Norfolk, Virginia USA in 1985. Two more working groups were set up, in 1983 WG 3.5 on Informatics in Elementary Education and in 1987 WG 3.6 on Distance Learning. Throughout the decade working groups held a number of conferences that dominated their energy and attracted new membership. In addition in the 1980s,TC3 through its WGs held two regional conferences, one in Japan (1986) and one in Europe that also coincided with celebrating 25 years of TC3 (1988). Two reasons appear to have triggered such regional conferences, which have so far not been repeated. The first was with WCCE 1985 in the USA, and WCCE 1990 in Australia, there was concern that the momentum of European involvement that characterised the first three WCCEs might be lost. Secondly, TC3, and indeed IFIP in general appeared to be having difficulty in attracting interest and membership from the Far East. There is in fact an ongoing discussion about whether IFIP is too 'Eurocentric'.

No guidelines were produced in the 1980s; no clear evidence explains this. Establishing guidelines and developing curricula were very much the raison d'etre of the first working groups [3]. In the 1980s, the focus shifted to mounting a series of international conferences to reflect the flowering of interest and activity in schools, further and higher education – and that of governments. Conferences reflected a different mutual relationship with the professional community. This was after all the first decade of micros, and the journey of exploration was fast, multi-facetted and optimistic. The WG conferences provided venues for the expanding university computer science departments, faculties of education and teacher training colleges, local and regional education boards, and government departments to explore the use this new, small and flexible resource, and discuss the issues that came with it. These might be open with an international call for papers, or working group conferences with attendance by invitation, and often limited to around 100. This latter style of conference have become an established feature; many consider them to be the ideal means of generating real debate, exploring change in perceptions, and a defining characteristic of working group membership.

Bernard Cornu [7] became involved in this period, being invited to attend the working conference on ICT and mathematics in secondary school, on behalf of ICME. So why did he continue and remain involved? "First the international context of IFIP – many, many different countries; then I wanted the topic computers in education, ICME was more about the didactics of mathematics; and of course I met good friends there….this is important , not a detail…it's a friendly way we work in IFIP."

In addition to classic paper and panel sessions, workshops were a substantial part of conference structure. They may have been on particular software designed to support the use of computers for subject learning, whether computer science, mathematics, or even occasionally for humanities and languages. And others might feature a particular programming language for computer science teaching. And a further feature of the three world conferences of 1981, 1985 and 1990 was the substantial exhibitions of hardware and software manufacturers, and the level of computer business sponsorship that underpinned these events. I attended my first IFIP event, at the suggestion of Bob Lewis, my project director, at WCCE 1981 in Lausanne – the scale of the programme and exhibition remain a vivid experience, despite the fact that I had been involved in software development for a number of years. I had no sense of the internal IFIP community however until my first WG 3.1 event the following year, at which firm friendships were formed; I became a member in 1990.

Thus by the end of the 1980s, 6 WGs had now been established, two WCCEs held, and 19 books published. Conference activity dominated agenda of the working groups

3.3 A shift in profile – 1990-2005

In the1990s, two further world conferences, the fifth and sixth WCCEs were held in Sydney, Australia in 1990, and Birmingham, UK in 1995. WG 3.7 on Information Technology and Educational Management was formed in 1996. And then into the new century the seventh and eighth WCCEs were held in Copenhagen, Denmark in 1991 and Stellenbosch, South Africa in 2005. The established pattern of WG conferences thrived, with 37 books produced. In addition, in 2005, a new Special Interest Group, was established on Lifelong learning (SIG LLL). An interesting development has been a revival of working meetings to produce Guidelines. These significantly have been funded by UNESCO and revived a relationship with the founding organisation. Involvement with UNESCO has led to two further activities. TC3 taken an active part of the UNESCO/IFIP world forum on IT for developing nations (WITFOR); two events, in Vilnius Lithuania 2003 and Botswana 2005 have been held. And TC3 was equally active, through UNESCO and the Swiss Academy of Technical Sciences in the United Nations World Symposium on the Information Society, Geneva 2004.

During conferences in the early 1990s, an additional element was developed to ensure the maximum interaction between all participants. Themed topical discussion (or focus) groups would be timetabled to meet regularly during the event. Attendees would select or be allocated to a focus group – and they would present the result of their deliberations to the collected conference in the last session, often with key recommendations. These reports and recommendations began to feature in the published books, and the style was adopted in both 1995 and 2001 world conferences, with well over a thousand participants all joining focus groups. This engendered a sense of inclusion; the collegiality generated amongst participants should not be underestimated. Post conference publication of the discussions meant that they were available to a wider readership. On the other hand no mechanism was in place, and it is still a challenge, to ensure that these debates and recommendations are communicated with policy-makers and practitioners.

3.3.1 Until 2005

At WCCE in Stellenbosch all participants at the event were invited to write down three key points they wished to communicate about 'what works' re ICT and education. Chairs of sessions also wrote three points down to reflect discussions following papers. Post conference these were collated to form a declaration by the IFIP Technical Committee community, entitled ICT in education – make it work. Its conclusions will be discussed later. This is known as The Stellenbosch Declaration- make it work [8], and has been distributed electronically to all the WCCE attendees with a request to distribute it further.

Unfortunately, in parallel, conference exhibitions and sponsorship has been in decline. It is possible to infer that the dominance of large multinational computer producers, the decline of national machines geared to local schools, and the reduction in investment in computer assisted learning that characterised the third technological phase has made the educational market less significant and relatively indistinguishable from that of society in general. The impact is substantial. First in the absence of the computer industry sponsorship, mounting conferences carries an increased financial concern for the host institution and TC3/WGs. Secondly, the overall financial climate in educational institutions makes it harder for individuals to get support to attend, particularly the young. Although IFIP does fund a small number bursaries for attendees from developing countries, this problem is affecting the ability of TC3/WG and Programme Chairs to mount events, in part because of the extra burden such financial pressure causes in addition to the already busy agenda of organisation.

Then another stream of conferences emerged. Since the early days of IFIP, the General Assembly (GA) has mounted a biennial World Computer Congress. These Congresses functioned as binding for the community of the enthusiastic committed pioneers in the development of the new Federation. Congresses maintained a bond during the expansion and rapid development of the constituent Technical Committees in the early period. Note that 9 of the 12 current Technical Committees were established between 1962 and 1976. Meeting at a biennial Congress helped keeping the original community together and sharing what were some substantial commonalities, such as software theory and practice and computer applications in technology. Only very occasionally was a paper presented at Congress on an educational topic. Indeed Peter Bollerslev [9] is of the opinion that TC3 became strong because "there was no competition from Congresses", which may also explain how TC3 was able to establish such a strong pattern of its own quinquennial WCCEs and sense of community.

In 1992 however, a substantial shift occurred. Congress was always designed around themes presented and organised by some of the TCs. TC3 was first invited to take part in WCC Madrid and was represented by Education and Society. Further thematic involvement of TC3 has occurred in every Congress since 1996. This involvement has been significant politically by raising the profile of TC3 and its educational themes within IFIP. Hitherto Education, though highly active within its own frame, had a lower profile overall within the GA. On the other hand, it has sometimes created a crowded events agenda, forcing members to make choices between attendance at working group events or WCC.

Another feature in these sixteen years was the number of times working groups collaborated to mount joint conferences, for example 3.1 and 3.5 on supporting change through teacher education, 3.1 and 3.2 on informatics teaching, cognition and social and ethical issues. Such joint events are increasing. There are practical advantages in association with the cost structures and organisation involved in mounting events. They have increased the sense of community between working groups, extending the collaboration developed during WCCE planning. But it also illustrates the relative arbitrariness of the particularities of the current working groups, that is the mix of sectors and activities, based on their historical development outlined above.

During this period, members of TC3 have discussed the strengths and limitations of the current WG structure. The debates have centred on crosscutting themes. Research is one example. WG 3.3 has had a chequered history and found it less easy to sustain a regular and coherent series of events. This is in part because research is a basis for many conference presentations and debates in the other working groups, and also because the group has had difficulty in sustaining a substantial membership of individuals who are often equally committed to reporting research in the contexts of other WG events. Other themes such as tele-learning illustrate the cross-cutting matrix whereby working groups operate, even though the structure of the seven groups may appear linear. Thus under the aegis of WG 3.6

Distance Learning, but sometimes independently as part of TC3, tele-learning/teaching conferences were mounted throughout the 1990s, and contributed to the revival of TC3 activity in Congresses. But of course tele-learning has changed in the last ten years to be associated with the impact of the web and e-learning; thus elearning is a now substantial feature across the WG events. Similarly, life-long learning embraces all elements of schooling, university and vocational education, as well as learning at a distance and learning in communities throughout life. On the other hand, WG 3.7 has operated very effectively since its inception as a relatively closed community, with its own biennial working conferences, with fewer cross-links. This suits the nature of the community. In effect WGs operate in a number of dimensions, but a matrix of activities, between the contexts and themes more truly reflect the way the structure and activities work in reality. Indeed, in more recent years, the WG chairs and TC officers have held an executive meeting before the formal AGM to discuss themes and plans of the WGs to ensure that this virtual matrix of connectivity operates as effectively as possible.

3.4 Other features

The section above has focussed on three time phases of structural development of the working groups and their main activities, writing guidelines and mounting conferences. There are however other features that I consider worth noting.

3.4.1 Camaraderie

A feature of the initial TC3 and its first two working groups is that initial membership was basically a group of committed individuals with common interests in this new field. The meetings in the first period were mainly internal working events of often no more than 10-12 people where the members produced guidelines, and planned the first two world conferences. Such intensive activity clearly fostered a camaraderie; the sense of a collaborative team, with common interests and concerns is an enduring trait of the TC3 working groups that is frequently mentioned, both formally and informally by its members. As Tinsley [3] said "really we were just a group of friends – but a powerhouse too". The sense of a working collective of individuals from many different contexts and countries has not only underpinned the growth of activities since the start, but enduring friendships have developed. When asked how they continued to be involved after their first contact, Tinsley [3], Aiken [6], Bollerslev [9] and Cornu [7] all commented on the friendship embedded within the community. Each returned to this point, ensuring that I took it seriously. Aiken [6] called it a "nice confluence of the professional and personal aspects" of life. This certainly reflects my experience as a member. Meetings are relaxed and we always socialise in the evenings. My children grew up with a range of visiting 'friends for IFIP' passing through. Indeed the fact that all interviewed agreed to a telephone interview with me was in part because we are friends and colleagues, but it also meant I could understand their tone and reflect on the meaning they were imparting. In addition, I could not simply ask questions about their views, but also explore my tentative analysis with them, which drew out further opinion.

One means whereby this camaraderie has continued is because, as can be seen from a scrutiny of working group chairs and book editorship, the initial group of individuals were active in establishing all the subsequent working groups. So the style of operating, and the social agenda, was perpetuated. In the same way, the strategies for organising a conference and producing proceedings have been passed on to newer members from the pioneers. It is only in the last few years that TC3 has felt the need to capture such information in guidelines for members' use.

3.4.2 Membership

Another feature of working groups is that members did not have to be affiliated or part of their national association, but have been invited to take part on the basis of their activity and personal interest. Indeed, they may be from a country that has no formal affiliation with IFIP. TC3 working groups rarely have more than a few members from any one country, as care is taken to ensure country 'blocks' do not form. The way an individual interacts and works with the community at an event is a major point towards nomination. This way both the international and working nature of the community has been maintained. A further feature of working groups is that many members have relatively little to do with TC3. They see themselves as active in support of the practitioner and professional community. Thus David Tinsley [3] was interested in having working meetings with outcomes, not being a committee member.

Members of TC3 represent the educational interest of IFIP national member organisations, and thus the structure of IFIP and the General Assembly. There is substantial overlap as the some individuals are members of both, as national members representatives on TC3 and members of working groups. For example, Peter Bollerslev [9], having met members of WG3.1 at the OECD seminars in Paris in 1971/2, attended the second WCCE in Marseilles, and was invited to join WG 3.1 while attending a conference organised in Lancaster by Bob Lewis. (1977) He says that there "he met Uli Bosler [from Germany] there, and found they got on well and could collaborate, so… that was it". This reflects the similar comments by Tinsley – this was an active group where working and friendship mattered. Then the following year, the Danish Computer Society asked him to be their representative on TC3. In essence, TC3 is the formal committee with responsibilities for the activities it working groups undertake, while also reporting to GA on its undertakings. Johnson [10] notes TC chairs also hold a unique position in the structure between the GA and working groups.

This hierarchical pattern existed until the last period, and manifested itself in an interesting way. Working group chairs were not formal members of TC3 unless they happened to be national representatives. They were invited to attend TC3 AGMs, but traditionally sat at the rear of the room, and only took part when asked a specific point. Not only has this been specifically reported to me by Peter Bollerslev [9], but I happened to experience it myself, when attending a TC meeting in the 1980's on behalf of a colleague who was a national member.

This pattern changed in the early 1990's; working group chairs became full members of TC3 and encouraged to take full part in discussions. By the end of that decade, an executive had been formed specifically of the main officers and working group chairs to plan the forward agenda for activities. This seems to be wholly appropriate as after all it was the working groups who were responsible for devising and organising these activities. It has been intriguing for me to realise during the course of this research that a remarkably similar pattern of structure operated at the General Assembly level. GA consists of national member association representatives who embody of the federal structure and responsibilities to the whole. Chairs of the Technical Committees were invited to attend, but had no formal constitutional role. Indeed, Bollerslev [9] has informed me that they even sat at a separate table removed from the main body, and had little part in discussion. And yet it was their activities through the working groups that made the federation function. In the early 1990s, by a combination of strong leadership of TC chairs [9] and equally strong leadership by the IFIP President [10], the rules were changed and Technical Committee chairs became active full participants of the GA. Indeed the members also form a Technical Committee, and as a collective provide a powerful voice within the whole [9, 10].

This has had interesting consequences. The first has already been noted. It is clear that the timing of the invitation for TC3 to take part in Congress in 1992 was no accident. It was part of a political shift in the roles of TC chairs within GA. It has been clear that some WG chairs dislike their pattern of events, already reported to TC3 and GA, being disrupted by the intervention of WCCs. It is equally clear no TC chair would wish to dilute their influence by refusing to contribute to WCCs. This conundrum was actually debated in TC3 AGM in 2003 in Pori, Finland with the President of IFIP, Klaus Brunstein – who was there to attend the TC3 fortieth birthday celebrations. Johnson [10] suggests that the role of Congress is also under discussion in GA. One issue for TC3 is that WCCs on the whole are structured around a series of mini conferences that are virtually stand-alone. Therefore, there is no particular benefit that distinguishes a WCC from other TC3 events. Indeed, I remember my enormous disappointment at the Madrid 1992 Congress when the education stream and that of TC9 for social and ethical issues ran in parallel rather than being entwined.

A greater intertwining of the relationships between the various stakeholders in the Federation is obviously beneficial. One anomaly remains; the direct links between active members of a working group and the national member organisation may be few – yet the former is central to continuing activities while the latter pays the IFIP fee. Thus, the actual workings tread a careful informal path to ensure that formal relationships remain intact. For instance, as a chair of WG 3.1 and member of TC3; I was aware that there was an IFIP strategy working party, but had seen no report. When interviewing Johnson, [10] it was apparent that some of the issues I was seeking clarity about for this paper were in a draft document of this working party. Good happenstance. Johnson says that "one of the issues under discussion is the links, existing or broken, between the various stakeholders and structures of the organisation". He also reports a desire by the working party to ensure that "a permissive structure" should reflect what is essentially a permissive group of member organisations.

Equally significant is the relationship between IFIP and other international organisations such as UNESCO. Here Bollerslev [9] asserts that the strengthening relationship between IFIP and UNESCO in the last period has benefited IFIP by raising its profile. This has been apparent both in the work with TC9 on WITFOR and also the UN World Summit on the Information Society. Peter Bollerslev [9], being at the same time a member of WG 3,1, TC3, GA and a former President of IFIP, has interesting reflections on the complications of the relationships between the different structures and activities within the Federation. I know he was particularly pleasured that Aicha Bqah Diaqllo of UNESCO addressed the seventh WCCE in Copenhagn in 2001. He thinks that it is now the time to try to formalise more closely the relationship between IFIP and UNESCO, as it was IFIP's founding sponsor in 1960. It has also been reported in GA minutes following the 2003 AGM that this was desirable and I believe it has the attention of the President Klaus Brunnstein. Bernard Cornu [7], of WG 3.1 and TC3, who is also a UNESCO representative of France, thinks that UNESCO could use IFIP more as a group of ICT experts with connections at the policy and practitioner levels.

One last question. How does TC3 maintain it relations with the practitioner community? On the whole they not come to international conferences unless specifically encouraged or sponsored. They may then however be drawn into the community as their career progresses. But it will mainly be through individual contacts. The majority of active members and attendees at events are academics or managers and policy makers in the field. The task for TC3 is to find a means, preferably both electronic and personal to connect more strongly with policy makers and practitioners so that the themes we discuss reach as wide an audience as possible, and they in turn need to influence our debates.

It would appear that the combined efforts of individuals, some with notable leadership skills, and the style of operating as an active community of practice which characterises the nature of Technical Committee 3 and its working groups. These would seem to be the critical factors that have enabled it to thrive and change over forty years and to become one of the most important TCs in IFIP today. However I remind readers that this is an insider perspective.

4. The Main Debates

4.1 A word on data

It was not possible to do any sensible numerical analysis with regard the WCCEs and their publications (Appendix 3), for the following reasons. Each conference selected from submitted papers for presentation on merit. In some conference proceedings, all papers presented were included in the proceedings. In others, a further selection was made from presentations for inclusion. Thus no inference can be made from the different number of papers from each event. Out of curiosity, I counted 65 countries that have been represented by publications from the eight world conferences (Appendix 3). And while you might expect certain English speaking countries to dominate, such as the USA, UK and Australia, others (measured by papers at 6, 7, or 8 WCCEs) have provided consistent presence throughout, notably Brazil, China, Denmark, France, Italy, Japan, The Netherlands, Norway, Sweden, and Switzerland. The range of countries may not represent all attendees, but attendance information is not in any archive. But this range does reinforce the actuality of an international community, and at the same time in part refute the assumption that it is a Eurocentric organisation.

It is a shame that actual attendance data is not available, as there is a general 'feeling' in the community that attendance in general is not holding up, and that from some regions in particularly North America, is on the wane. Aiken [6] supports this, suggesting that it is caused by the growth of other specialist communities that embrace ICT in education. There can be no doubt about the growth of such communities; in one 5 day period in February 2006 I received notification of eleven different such events. Aiken [6] considers that TC3 will have to work hard to ensure that its constituency is not reduced by the attractions of other organisations offering similar debates, in events closer to home and therefore less costly.

Two other matters caught my attention. When reading the 1970 papers, I noted a few female names. I then searched as far as I was able for the number of woman who wrote, or co-authored papers in the conferences. This count is crude because many authors only provide initials for their forenames. Nevertheless, I have recorded it, as the expansion from 6 to 46 reminds us of issues associated with equality over this time. I was also delighted to be reminded of interesting geopolitical changes that have occurred. Thus, the reunification of Germany, the handing back of Hong Kong, the separation of Czechoslovakia and the break up of the USSR all emerged from perusal of the country affiliation of authors.

4.2 Themes

Perusal of the titles of TC3 publications (Appendix 2) indicates the spread and shift of interests. Thus from Large information systems to the virtual campus via Interactive multimedia in university education; from Computer assisted learning: scope progress and limits, to Quality education @ a distance, and Lifelong learning in the digital age. A clearer picture of thematic development can be provided first considering the following.

In 1988, TC3 published a book, a selected compilation, celebrating 25 years of TC3 publishing [11] organised in the following sections:

The history of TC3
The impact on Society
Developing Countries
Information Technology Literacy
Computers in support of learning
The impact of computers on the curriculum
The role of programming
Teacher Education
The provision of hardware resources
Computer science curriculum

Compare this with the preamble to the 2005 The Stellenbosch Declaration - ICT in education; make it work [8]

Having reflected on many aspects of Education, and the influence of ICT on education, we recommend that stakeholders and decision-makers in ICT in education focus on six major areas that will shape a beneficial use of ICT in education.

- Digital solidarity
- Learners and lifelong learning
- Decision-making strategies
- Networking
- Research
- Teachers

For each of these 6 areas we formulate recommendations and we propose a set of possible actions in order to put the recommendations in place. These actions address three main levels

L1 Societal Level
L2 Learning and teaching level
L3 Technological and infrastructure level

An understanding of these shifts in foci may be provided by an analysis of the themes that have occupied this community. Taking the main source of the proceedings of the eight world conferences [12, 13, 14, 15, 16, 17, 18, 19], I am highlighting only some areas to illustrate to characteristics of the journeys undertaken. Perusal of other slices indicated by the contents lists of WCCE proceedings, such as distance education, developing countries, elearning or national policies would be equally valid

Computer science, programming, and data processing dominated the papers in the early period, including those in the section entitled use of computers in education, which is in fact mainly about choices of programming language and the structure of computer science courses. Some interesting thoughts emerged. Programming was considered the second literacy, and Ershov [14] claimed made that it would enhance the intellectual power of mankind. All children should be expected to take a course in programming. Indeed Charp [12] starkly stated that all educators must be concerned about computers, must learn about them, and must teach about them. By 1988, however Hebenstreit [11] provides a different perspective on the assumptions that programming teaches people to think logically, formulate solutions and handle detail with care. He says that the truth is that we should like future programmers to have these qualities, but that experience has shown us that the teaching of programming, even intensively, has been unable to develop those qualities for people who did not already have them beforehand. But a substantial interest remains in the computer science curriculum, the role of programming and information literacy courses. Many papers [12,13] replicated their whole course structures and acted as a collective information base where none previously existed. One of the problems underlying the first developments of a computer science curriculum was the competing claims of the electrical engineering perspective and the mathematics perspective. Overall the work at this time reflected the need to establish the science of information and ensure students and professionals have a thorough grounding in its principles and methodologies. A number of branches emerged from this theme.

The computer science curriculum has developed from the reproduction of the timetable for a three years undergraduate course as a means to identify the disputed core components of the nature of computer science, to a debate about the inherent concepts underlying computer science, or Informatics, and whether these concepts are best learnt theoretically or through an examination of their application. This suggests there has been a substantial shift in the articulation on the conceptual of nature of Informatics, in which the role of algorithms has played a part. The role of programming appears to have taken two further branches. One route combined with software development and debates about software production and design. As authoring languages and tools emerged, this stream is appears to have progressed towards object oriented modelling, html, XML and virtuality.

Another route programming took led to Logo [20], the development of a programming language with associated claims that the learning of 'turtle' geometry and programming protocols together were tools for cognitive development of young children. This received substantial attention at the time, but subsequent research into its use in the classroom indicated that the there some major flaws in this proposition; young children were often not yet at the stage of cognitive development to cope with a notion of recursion, they also did not take to these tools without intervention of their teachers, who were themselves not necessarily familiar with the language, and who often later recorded little conviction that this was really helping with mathematical understanding. After a spate of interest fostered by some hype for over a decade, it suddenly disappeared. Nevertheless Cornu [7] on Logo thinks "it was an important step for the teaching of mathematics as it was a time when you could not use the computer in a deep way without programming or a style of programming to think about what an algorithm is". But he considers that this was but a phase, as "we now have sophisticated tools for mathematics, with the capacity to experiment things." In the similar way to Logo, artificial intelligence in education flourished then died when it became apparent that it was an exercise in programming logic that used educational exercises as a mere context for the experiments, and ones that bore little relationship to real learning tasks. But it is equally valid to propose that they lost significance because the nature of technological developments with applications to suit for instance learning in mathematics and science. Indeed, Bentley suggested in 1990 [16] that the use of a computer as communicating device creates a more powerful educational tool than its functions as a delivery mechanism.

A final comment on the computer science and programming papers is that in the earlier years and especially in higher education, they exposed a poor understanding of the nature of educational thinking about teaching and learning. It was some time before the didactics of instruction were replaced by a more active problem solving style of learning activity was employed. In 2005, Cornu [7] noted that there continues a debate in Informatics about the whether we should teach it, or simply ensure we can use it.

The rise of Logo did however have one notable effect, that is increasingly serious attention was paid to the theories of learning and how they may be supported by ICT. This attention to learning theory was not new; previous attention had been paid to active learning and constructivism. For instance, Bewley, Holznagel and Klassen [12] proposed a cognitive development rationale to underpin the instructional use of computer simulations. A shift in perspective emerged however that instead of learning from the use of software, students learned with it, and the computer was referred to as a 'mindtool' [21] in its own right. Applications became categorised by the nature of constructive learning they enabled. Thus for instance applications could be categorised as semantic organisers, dynamic modelling tools and knowledge construction tools. Such tools would represent cognitive scaffolds, engaging learners in critical thinking. Active, constructive, internal and authentic learning theories provided fertile grounds to analyse the potential of the new medium not simply to support learning, but even led to suggestions that applications could possibly reorganise how students think. More attention was paid to this than the actual subject concepts and knowledge as the contexts for learning. This focus on the nature of learning shifted attention towards individual learning, self-directed learning and independent learning.

Problems have arisen as attempts to confirm the efficacy of such an approach. Further results often neither isolate the specific effects of a package, nor confirm that that any effect was sustainable. Attention has returned to the situation in which such learning occurs, in essence the context of both the problem being considered, whether mathematical or geographical, and also the role of the teaching and fellow students in the totality of the learning environment. As Erling [16] stated with respect to elementary school, it is essential that pupils are given real tasks. Situated cognition, collaborative learning, and activity theory have increasingly entered the language to support the use of ICT for learning. Despite many studies undertaken it is not clear what learning gains can be explicitly associated with using ICT, and such lack of clarity remains problematic. The first is that an increasing number of voices are emerging probing the nature of the research undertaken. Broderick, as early as 1970 [12], suggested that the study of the effectiveness of simulation in the classroom is usually difficult to conduct in a scientific manner. And with respect to learning, Cox and Marshall [19] state clearly that despite a plethora of studies on the effects of ICT in education, methodological problems mean that results are not reliable, and those which are tend to be inconclusive. They report that the most robust evidence of ICT use to enhance students' learning comes from studies that focussed only on specific uses of ICT. As Leiblum noted [14] there have been many disappointments due partially to unfulfilled expectations about the development of learning theories to support the medium. And the most recent challenge has been an exploration of the nature of student learning and collaboration online. Studies by Stacey [18] on issues such as the development and maintenance of a social presence online, by Furr and Ragsdale [18] on incidental learning and learner frustration with desk top video conferencing, and Yip [18] on the way students, favour web-based learning but still fail to use the system's full potential for problem based learning – all suggest the exploration of learning with, by or though the technology remains problematic. And how will we explore mobile learning, MP3 systems and broadcasting?

Throughout the forty years teacher education for the use of the computer has been a consistent theme. Teachers have been directed to courses to learn basic programming in order to be able to write their own software packages, provided with an armoury of subject specific software packages, and encouraged to undertake computer awareness/literacy courses. But with respect to awareness courses Ragsdale [22] noted that knowledge of IT skills do not mean that these skills are always applied. Indeed acquiring IT tool skills may be relatively easy, but gaining wisdom to use them effectively is not. General-purpose applications are current, though often designed for business practices, but still the actual use of computers in classrooms to support the curriculum has remained disappointing, even by new teachers who have used ICT in their training. Teachers have been categorised as traditional, conservative, barriers to innovation and reluctant to change, and some teacher education initiatives have been designed on this premise.

Yet, Jones Preece and Wood [15] recommended that teacher education should be based on a question raising technique – so that a balance was found between introducing and discussing educational perspectives (theory) and building on teachers' own experiences (practice). Teachers are returning to the centre stage in the agenda with an acknowledgement that they are both the key to the educational enterprise, and thus to educational change. Thus, a dichotomy is apparent whereby teachers are perceived as both the problem and the key to the solution. Recent studies are acknowledging that the using ICT can be part of the personal and professional expertise and judgement of the teachers, but only when it is embraced within the complex pedagogic model that acknowledges subject expertise, experience of teaching, understanding of learning, and the organisational context. Teachers can be represented as communities of practice. And throughout sits the conundrum that using ICT to support existing professional understanding, knowledge and expertise could reinforce practices and styles that have been fixed and the opposite of intentions. As Argues pointed out [11] the educational advantages of the new information technology can be turned into disadvantages if it is not used according to an explicit and well defined educational philosophy. For this to happen, he asserts that our schools must be turned from 'auditories' of isolated listeners into laboratories of active collaboration. And Knezek and Christensen [18], reporting on a range of studies undertaken over a ten-year period, confirm that the highest stage of integration involves a change in perception of teaching with technology rather than additional training or resources. But they also report that in almost all studies research is far from conclusive.

There have been a number of sociological studies on the identification of stages in the process of innovation in education, and in particular of planned innovation during times of curriculum innovation or changes in government policy. Some take a top-down management approach; others focus on the role of a change agent as a catalyst within the innovation process. And the anthropologist Katz [23], as early as 1961, discussed the social itinerary of technical change. Using studies of technology change in medicine and farming, he advocated the notion of studying the process of diffusion by tracing a) the movement of a given new practice, b) over time, c) through specific channels of communication and d) within a social structure. Using such method provided the opportunity to understand the social characteristics of innovators, how they adopt the change, and the strong interpersonal influence in the diffusion process within communities of practice.

And research, such as that done by Gross et al [24] indicated that there was no resistance to planned change, on the part of teachers. On the contrary, they were receptive to educational innovation, but the strategies for implementation were deficient in two respects – failure to identify and bring into the open various difficulties teachers were liable to encounter in their implementation effects, and failure to establish and use feedback mechanisms to uncover barriers that arose during the period of attempted implementation. Some more recent papers

[17,18,19] use the notion of affordances, activity and transformation theories as means to explain and explore how teachers may negotiate organisational barriers.

Indeed the implementation of organisational change in education is central to our concerns. Kozma [25] reports from the substantial SITES2 study of 174 cases across the world that a number of the positive messages about what can happen are true – but these depend on a complex set of variables being a necessary pre-condition. In particular, coordinated strategies for change and more models of technology intensive learning are needed. He indicates that all forms of societal institutions even schools are altering slowly but radically. Yet he asserts we are already inhabiting a profoundly interconnected, knowledge based, global market place. A further conundrum is posed when he argues that the complexity of this innovation has been seriously underestimated. It is clear from this study, and a seeming increasing consensus in 2005 [19] noted by Cornu [7] that the role of pedagogy is a third critical variable.

It is clear that publications from the eight WCCEs reflect a community of innovators, who are confident about the value of information and communication technologies and who spend much time espousing the possibilities and opportunities for education. Statements about the efficacy of learning a particular programme, or curricula design for training IT professionals have been gradually superceded by reports of how an application or training programme has actually been used and the apparent effects. Sometimes these effects or outcomes are measured; on occasion unexpected issues are reported. But on the whole this is a community committed to the innovation and concerned to explore how to get it used. They are convinced change will happen.

Many would say this is a problem, suggesting that unabased enthusiasm of authors such as Papert [20] and Gates [26] has presented an imagery or new positive change and renewal for learning. This presents confused notions of a technocentric society [27, 28, 29]. Evaluation studies by Cuban [30] suggest that unreflective and unabashed enthusiasm about the necessarily transformative nature of new information technologies is both naïve and historically unfounded. He has written that in the battle between classrooms and computers, the classroom wins. Indeed Miller and Olson [31] have pointed out that "the history of innovation in education should teach us to be cautious about predictions associated with new technologies. However, there is something about computers that negate this caution. Whenever computers are discussed, words such as revolution, powerful ideas, microworlds, and student empowerment occur frequently".

And so after forty years of endeavour, perhaps it is less surprising that we see from a number of national and international reports that the classic curve of innovation has still not progressed beyond the initial stages of the classic S curve of innovation diffusion [23]. There is no doubt that change is happening in our environment, but the change is mainly the rapid advances of the technology, thus change in the shape, character and attributes of the innovation itself. Indeed Baron and Bruillard [19] suggest that one of the problems is that educational technology appears to be under a curse of cyclical unfinished business. And I propose that this cycle could be characterised as a headlong journey from the didactics of certainty to an the uncertainty of complexity.

There are for me some black holes in the themes explored at WCCEs. In subject terms, where is an exploration of creativity? In the Arts, there is a whole new world supported by the technology, from new computer generated installations to the impact of graphical design perceptions, concepts and capabilities. Vast new applications dominate the world of students and practitioners in this area. Similarly, the digital world has had a profound effect on music and film, its creation, its production and influence in society. The young use the technology in the home, in schools and university departments and digital music and film studios are a feature of new employment. Finally where are the papers and discussions on the creative change to language, both in form and style, introduced by the technology and now a feature if society?

It is in part not surprising that creative subject disciplines have not featured – the community of TC3 has been founded on, and to some extent still substantially reflects the disciplines of mathematics and science. But there is a danger that TC3 could become fossilised, fixed by the science of information. It has already become obvious that we must engage with and incorporate expertise from the social sciences. After all education is defined as a social science and professionals within social science bring a different style and set of ontologies to bear. Understanding communities and communication, the fears and role of stakeholders, the influence of decision-makers and politics, the power of position and knowledge lie at the heart of many sociologists working within education. After producing the Strellenbosch declaration, Cornu [7] suggests "that future conferences must include the social dimension". The significant topics of security, surveillance, ethics and legality must play a part in the educational scenarios of the future; at the societal level these are major concerns in association with the digital world. We have started to touch on these topics in TC3 but fresh perspectives from others would seem to be pressing.

5. Reflections

I have no intention to summarize or repeat argument here. This paper could be unpicked to form a SWOT (strength, weaknesses, opportunities, costs) analysis of TC3. But I will leave that to others. My intention has been, ever the geographer, to explore rather than conclude, as there are always further places to go. Indeed I could describe in greater detail the landscape of the last forty plus years, to include where analogous deserts and ice, weather systems, or modes of transport from canals and railways, to motorways and Concorde. Instead, I will simply record my expectation that the next forty years will be as full of excitement, change, dichotomies and the unexpected as the first.

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Appendix 1
Technical Committee 3

Technical Committee 3
Established 1963

Chairs

Neils Ivar Bech	1962 initiating chair
Richard A.Buckingham	1963-1972
D. Henk Wolbers	1972-1978
Jacques Hebenstreit	1979-1984
Wilfred Brauer	1985-1990
Peter Bollerslev	1991-1996
Brian Samways	1997-2002
Jan Wibe	2003-

The seven working groups of Technical Committee 3 as of December 2005, following 43rd AGM, Stellenbosch 2005.

WG 3.1
Informatics and ICT in secondary education
established. 1966

Chairs

William F. Atchison	1966-1977
Frank. B. Lovis	1978-1983
Peter Bollerslev	1984-1989
Tom van Weert	1990-1994
Bernard Cornu	1995-2000
Deryn Watson	2001-

WG 3.2

Informatics and ICT in higher education
established 1968 as Organising Educational Seminars.
Re-named late 1970s.

Chairs

Richard A. Buckingham	1968-1979
Not recorded	1980-1982
William F. Atchison	1983-1989
Bernard Levrat	1990-1995
A. Joe Turner	2002-2005
John Hughes	2006-

WG 3.3

Research on education applications of information technologies
eststablished1971, as Instructional Uses of Computers
re-est. and re-named 1988

Chairs

Sylvia Charp	1971-1979
Robert E. Lewis	1980-1994
Betty Collis	1995-1996
John Tiffin	1997
Jari Multisilta	1998-2001
Niki E. Davies	2002-2004
Paul Nicholson	2005-

WG 3.4

IT-Professional and vocational education in information technology
Established 1971

Chairs

A. Berger	1971-1977
Patrick G. Raymont	1978-1984
Ben Zion Barta	1985-1994
Peter Juliff	1995-1998
Mikko Ruohonen	1999-2004
Barrie Thompson	2005-

WG 3.5
Informatics in elementary education
established 1983

Chairs

Frank. B. Lovis	1984-1989
Erling Schmidt	1990-1995
Anton Knierzinger	1996-2000
Sindre Rosvik	2001-

WG 3.6
Distance learning
established 1987

Chairs

G.Kovacs	1987-1992
Jan Wibe	1993-1999
Gordon Davies	2000-2005
Elizabeth Stacey	2006-

WG 3.7
Information Technology in educational management
Established 1996

Chairs

Ben Zion Barta	1996-1998
Alex Fung	1999-2004
Adrie Visscher	2005-

Special Interest Group on Lifelong Learning
Established 2005

Convenors
Brian Samways and Tom van Weert

Appendix 2
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- in date order

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- Outline guide " the Blue book" (1971),
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TC3 The Stellenbosch Declaration (WCCE 2006)
www.ifip.or.ac/

Education and Information Technologies Volumes **1** to **10** (Springer, Boston, US, 1996-2005)

Appendix 3
World Conferences on Computers in Education

1st WCCE – Amsterdam, The Netherlands 1970

Total - 148 papers, from 23 countries
6 women among authors

Papers typed.

Section headings, substantial number of papers per section.

I Education about computers
- Computer education in secondary schools: Teacher training
- National schemes for computer education and governmental responses
- The place of computer and informatics sciences in higher education
- Education (Data Processing) and Management
- National and international efforts to develop computer education
- The planning and execution of programs for computer specialists in Universities
- Professional training (programmers and systems analysts

II Use of computers in education
- Strategies for development and presentation of computer based learning exercises
- Practice of computer based learning
- Languages for education
- Simulation

2nd WCCE – Marseilles, France 1975

Total – 179 papers from 33 countries
13 women among authors

"…. produced typed on special paper for off-set printing" Lecarme and Lewis (eds.)

Sections reflect session order

Education and management
Computers and Physics education I
Reports on CMI (computer managed instruction) projects

Teaching programming I
National and international planning for Informatics Education I
Curricula for management education
Computers and Physics education II
Computer managed learning: case studies
Computer education in developing countries
National and international planning for Informatics Education II
Large scale experiences in computer assisted instruction
Computer education for all teachers
Computer aided teaching of programming
Computer education in developing countries: case studies
Informatics in universities I
Informatics in secondary schools I
Theoretical aspects of computer assisted instruction (CAI) I
UNESCO involvement in the use of computers in developing countries.
Computer aided evaluation of students work
Informatics in Universities II
Informatics in secondary schools II
Theoretical aspects of CAI II
How can we transfer experience on computer education from developed countries to developing countries?
On teaching computer application for commerce, industry and administration
The use of computers in university science teaching
Teaching school mathematics I
Making CAI economical
Directions of research in developing countries
Informatics in the learning process
Teaching humanities at school
Special applications of CAI: Medical sciences
Teaching operations research
Teaching advanced concepts of - Informatics learning with data bases
Computers in Education – hardware resources
Informatics systems for management
Applied mathematics
Science teaching in schools
Teaching school mathematics II
Special applications of CAI: Language applications
Education for management II – using gaming and simulation in management and social science education
Computer assisted test construction
Management of education
Computer literacy I
Computers and fine Arts

Economics teaching
Teaching mathematical concepts
Software resources for computers in education
Computer literacy
Computers and the teaching of engineering science I
Guidelines for the training teachers for secondary schools
Models for CAI
Economics and Social Sciences
Computers and the teaching of engineering science II
Exchange of material in CAI I
The impact on society of computers in education
Which programming languages for an introductory course on informatics
Computers in the teaching of engineering science III
Exchange of material in CAI II
Change of the role and behaviour of teachers and students when
involved with CAI – 1 paper
Teaching Programming II – 1 paper

3rd WCCE – Lausanne, Switzerland 1981

Camera-ready copy, produced by mix of golf ball and other typewriters.

Total - 114 papers from 30 countries
9 women among authors

6 general sections, and then grouped according to the sessions of the conference.

1. Information and various disciplines
   - Social and environment issues
   - Teaching programming
   - Informatics and Science I
   - Informatics and Science II
   - Informatics and Language
   - Informatics and engineering design
   - Informatics and mathematics I
   - Information and mathematics II
   - Informatics and Art/Design
   - Informatics and Music
   - Informatics and Medicine

2. Computer assisted learning and other direct uses of the computer in education
    - CAL systems
    - Improving CAL
    - Language skills through CAL
    - CAL in schools

3. The impact of new technologies
    - Audio-visual developments
    - Special applications in computer aided education
    - Microcomputer systems
    - Education and Professional People

4. Social impacts including changing role of teachers
    - Education for the disabled and disadvantaged I
    - Education for the disabled and disadvantaged II
    - Education for techniques
    - Education for an Informatics Society I
    - Education for an Informatics Society II

5. National policies and models for computer education with special reference to the needs of developing countries
    - National policies in developing countries I
    - National policies in developing countries II
    - National policies in secondary education
    - National policies in university education

6. Aims, policies and curricula for informatics education
    - Informatics in secondary education I
    - Informatics in secondary education II\
    - Teacher training in Informatics
    - Topics in computer science teaching
    - Advanced techniques in Informatics teaching
    - Mathematics in computer science curricula
    - Experiences in computer science teaching

4th WCCE – Norfolk, Virginia, USA 1985

Camera-ready copy, produced by mix of golf ball and other typewriters.

Total - 226 papers, from 30 countries
33 women among authors

Sections are session themes in order

Across the curriculum
Design and development of CAL
Pedagogical tools and techniques
Mathematics, science and engineering education
Humanities
New teach, high tech, and using tech
Computer languages, problem solving and programming
LOGO
Graphics
Course and curricula recommendations
Computer literacy
Non-traditional education
Teacher training
Issues and ethics
National systems and policies
Non-curricula aspects of computing and education
Computers and research
Future of computing and education

5th WCCE – Sydney, Australia 2000

Camera-ready copy, produced by mix of golf ball and other typewriters.

Total – 143 papers from 29 countries
36 women among authors

Large sections – which reflect the working group titles

Informatics education at secondary level
Informatics education at the university level
Research on educational applications of information technologies
Vocational training and education
Informatics in education

Rainbow Stream elementary

Also 3 Mini conferences held within

Computers in education – national perspectives
CBT 90
Teleteaching 90
PEG 90 (Prolog in Education Group)

6th WCCE – Birmingham, UK 1995
First with subtitle: **Liberating the learner**

Note, here only six WGs are recorded – Distance 3.6, has re-absorbed Tele-teaching

Produced in Word - copy was sent to publisher in electronic format;
includes a list of keywords
Was also available also as a CD.

Total – 104 papers, from 30 countries
24 women among authors

The sections follow the main conference themes

Artificial intelligence
Costing (one paper)
Developing Countries
Distance learning
Equity issues (2 papers)
Evaluation (2 papers)
Flexible learning
Implications
Informatics as study topic
Information Technology
Infrastructure
Integration
Knowledge as a resource (1 paper)
Learner centred learning
Methodologies
National Policies
Resources
Social Issues
Software

Teacher education
Tutoring (2 papers)
Visions (1 paper)

7th WCCE – Copenhagen, Denmark 2001
subtitle **Networking the learner**

Produced in Word sent to publisher in electronic format; includes list of keywords.

Total - 84 papers from 22 countries
37 women among authors

Open and distance learning
ICT in learning
New pedagogic ideas
Teaching maths
Teaching computer science
Forms of assessment
Management and resource
Teacher education
National initiatives

Also
13 professional groups discussion reports
12 panel reports

8th WCCE – Stellenbosch, South Africa 2005
subtitle: **What works?**

Total – 165 papers, from 25 countries
46 women authors/joint authors

Output not a book, but CD of papers

Sections organise by session

Pre-service teacher education
The future of lifelong learning
HE: distance education
Collaboration and interaction
Management of learning

Learning environments
In-service teacher education
LLL: dealing with special students
HE theory and practice
What works in the classroom?
Analysis of what is successful
Enhancing interaction between students
E-communities and learning theory
Learning with networks
HE: ICT is everywhere
Information, learning and thinking
Teacher education: Theory and practice
Broadband, virtual experts and XML
E-inclusion
LLL: ICT and the learner
HE: creativity and learning
Teaching and learning with ICT
Case studies in using ICT in teacher education
Digital learning resources
HE: what can we learn from history
Online learning environments
LLL: the way ahead
HE: professional training
Technology enhanced learning for the future
National and local approaches
Research and formative assessment
Computer science and the setting of standards
HE: on-line learning
Technology and learning activities
National success stories
Tools for tutoring
Informatics, computer toys and drop-out rate
Disseminating ICT skills in higher ed
Learning materials and pedagogic practices
Quality and values
Capturing the opportunities now available
Teaching modelling
E-learning in higher ed
Examples of teachers learning
Culture and learning
Collaboration and learning
Courses in programming
National and local policies

The professional development of teachers
Content policy
Research and collaborative learning
Important influences in our school
Professional competence
Net-learning for teachers
Management and partnership

Note: 65 countries have been represented by the publications from these eight conferences.

Algeria, Argentina, Australia, Austria, Belarus, Belgium, Botswana, Brazil, Bulgaria, Canada, Chile, China, Czechoslovakia, Denmark, Egypt, Ethiopia, Finland, France, Germany (both GFR and GDR before unification), Greece, Hong Kong (before reunification), Hungary, India, Iran, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Kuwait, Lithuania, Malaysia, Mexico, the Netherlands, New Zealand, Nigeria, Norway, Oman, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Singapore, Slovak Republic, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Tanzania, Turkey, United Kingdom, United States, United Soviet Socialist Republic, Venezuela, Yugoslavia, Zimbabwe.