Computers and Education – a landscape

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Abstract This history of Technical Committee 3 is an exploration of the shifting landscape of the relationship between computers and education. Analysis focuses on its characteristics of context, structure, themes and society, and uses four time periods to frame the landscape of innovation and change. These characteristics have acted as a bedrock for scientific debates to flourish and attract the engagement of the significant stakeholders of practitioners, researchers and decision-makers.

1 Introduction

In essence this paper is a history of the exploration by IFIP's Technical Committee on Education (TC3) of the relationship between computers and education. It is an updated version of the address I gave to the WCC congress in Santiago, Chile 2005 [1]. I characterise this history as a journey, starting with the establishment TC3 in 1963, through to 2010 celebrating the Golden Jubilee of IFIP. As all history is more than a sequence of dates or facts, the analysis will identify characteristics - contextual, structural, thematic and social - that shape the journey. This has been exciting heady time; the direction and speed of change in information technologies and their relationship with education have been substantial.

For historical evidence, I have analysed the structure and activities of Technical Committee 3, explored how directions have shifted, and interviewed some members. A complete bibliography of publications has been probed; a rich source of evidence lies in the nine Proceedings of World Conferences on Computers in Education (WCCE) and the official TC3 international journal, Education and Information Technologies (EAIT), currently in its fifteenth volume. A Bibliography Appendix it will be located in IFIP/TC3 archives. From the first, TC3 has identified and addressed the dual concerns of our field, that is *education about computers, and using computers in education*. Any history is but an interpretation of events, and this one reflects my analysis of the data and selection of issues. Some large themes, such as developing countries, may be missing because they deserve a separate analysis. This history is presentated as periods of change, from initial dominance of higher education to the broad scope of an educational community and lifelong learning agenda of the early 21st century. The landscape of this journey starts with mountains, moves into hills where progress is eased, into large plains offering tracks in multiple directions.

2 Technology and educational change

It is obvious that there have been substantial changes in 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 focuses on contextual issues affecting the relationship with education. Six shifts in four periods are clear: the ever increasing level of computing power, a reduction of physical size, the development of graphical user interfaces, reduction in cost, common applications packages, and the growth of the internet, world wide web and 'explosion' into a digital world.

2.1 1963-1979

TC3 was established when computers were physically large. Huge cabinets in computer rooms, with air-conditioning for relatively dust free environment, were the norm. Expensive, they were 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 was encoded and input in punched paper format. And with computers grew demands for those who understood the science of computers, data processing and programming. For education, this power remained in the hands of very few – computer science or mathematics departments in universities and a few schools. And then in the late 70s, this landscape changed dramatically.

2.2 1980-1989

The advent of silicon technology, 'the chip', was a bench mark. By the start of the 1980s micro-computers had emerged, although usually in the hands of the specialist few. By the end of the decade, computing power was available for a range of school disciplines and administration, and was penetrating elementary and vocational education. It was still a relatively fixed resource, whether as stand-alone or a networked room. Networks opened the vista for distance education, via phone lines, rapidly taken up by countries with remote populations such as the Inuit in Canada and outback in North Australia. Additional devices to keyboards were developed - floor turtles, robots and science laboratory controls. With the Apple Macintosh, a graphical user interface emerged; the development of specialist authoring languages contrasted with general purpose business applications for word processing, spreadsheets and data handling. By the end of this decade, we had laptops and mobility.

Thus for education the availability of computing power became a reality, mountains had been replaced by hills negotiated with relative ease. Governments promoted the development of national computer industries, but by the end of the decade, such machines became clones of international companies with a few standard application packages. Computer science flourished, the term sometimes replaced by Informatics. Educational computing, computer assisted instruction and learning, and computer managed learning declined with the rise of the more general purpose term IT; and computer or IT awareness moved to the centre ground. Nevertheless the eighties were a heady time for curriculum development using computers, with attention to issues such interactivity in the classroom. Once micros with graphical interfaces arrived, the possibility incremental steps for geography, the humanities and languages became apparent. The landscape provided greater choice of direction; TC3 flourished.

2.3 1990-2005

This period is characterised by the flowering of global communications with the internet and world wide web. Satellite availability provided shifts from local and national to international and global networks. Now communications technologies impinged upon the perception of networks, and the nature and availability of information. In the late 1990s small mobile phones swept the world. The term Computer was coined to reflect to its original calculation function; it now changed to ICT to reflect the dominant function of providing Information and Communications. And a change occurred with which education still grapples, that is the penetration of computers into the social world. Personal computers (PCs) came within the reach of many households and students. Society was attracted by the availability of global personal communication, accessible information, and universal applications. Commercial organisations for shopping, financial services, travel and entertainment readily adapted. ICT, common in educational institutions, was also in community centres, libraries and internet cafés

ICT in education was no longer specialist or unique; the challenge for education was to use the technologies for learning and teaching, within this different inclusive environment. So how much is it used in communities, classrooms, lecture rooms, or online to teach and learn the concepts and knowledge that still lie at the heart of education, and to support process and styles of learning such as collaboration and debate? 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, became a cause of substantial concern that TC3 among others sought to address.

2.4 2006-2010

These last five years has seen a further name shift to Digital Technologies, now embedded into everyday life – mobile/cell phones and laptops are ubiquitous, global positioning systems are routine, and integrated digital technology has changed the photographic, art, music and communication environment. Large multiple display devices in business, education and entertainment have strenghthened the role of live and graphical images as a means of presentation. The advent of wifi has released the technology train from any sense of fixed track, and iPhones lead the way providing mobile integrated functionality for personal digital environments, encompassing simple graphics representing 'Apps'. Devices are small, light weight and relatively inexpensive. Society is still enjoying the impact of such intergated and instantaneous communication, with access to almost unlimited information, available in graphical, visual and vocal forms as well as numerical and written. In roughly fifty years, the world has experienced a technology revolution similar in impact as the shift from a small propellor driven aircraft to the development of the jet engine, wide bodied aeroplanes and universal flight.

However this ubiquity of the global digital technology has implications. First, a new language and style of communication has developed. Does its instantaneous communication masks the educational role of considered thought, reflection and the development of knowledge? Secondly, this is the world of the young; it dominates their culture, interests, aspirations, and increasingly employment. Their landscape may not include conventions and norms of the recent past. And finally, because of the open nature of the global web, the river current is dangerous but this may not be apparent on the surface. Society needs education to grasp the complex social and political issues about veracity, security, protection, surveillance, legality, responsibility and ethics now posed. As, 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 1963, three years after its foundation, IFIP Council formally established a new Technical Committee for Education (TC3) . "It was inevitable that education should come to the fore early in the development of IFIP" avowed the first TC3 chair, Richard Buckingham [2]. He reported that in the early 1960s most educational efforts focused on using computers for numerical computation in university mathematics departments, teaching programming and developing high level languages. Little education concerned with information processing was a significant issue for business and administration. At the first TC3 meeting in Paris in 1964, supported by UNESCO, 14 members were appointed from 10 countries, many from higher education but others in the computer hardware and software industry. In effect *these individuals formed a committed club of innovators*. Membership grew to 23 by the early seventies, meeting in a circuit of locations. They often represented their national associations that formed the bedrock of the subscribing membership of IFIP.

At the first meeting, TC3 [2] agreed the following aims:

> 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 these with the current aims of TC3 (2009) [3]:

• to provide an international forum for educators to discuss research and practice in
- teaching informatics
- educational uses of communication and information technologies;

• 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.

Understanding the growth and scope of this TC3 journey, requires an exploration of its working structures.

3.2 The growth and activities of Working Groups

This analysis is inevitably entwined with the four distinct phases of technological change.

3.2.1 The early period – 1966-1979

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 explore how best to extend education about computers into secondary schools. Imaginatively, the remit considered the use of computers in all aspects of secondary education, not just the teaching of programming. Thus both Computer Assisted Instruction/Learning in the disciplines and teacher training became concerns that endure to this day. Some members were nominated by the pioneering IFIP countries. Others were 'known' about; at that time a few individuals were pioneering using computers in schools. For instance David Tinsley [4] reports that around 1967/8 he was invited by Dick Buckingham to attended a WG 3.1 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 stated that 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 be invited to join.

Meeting regularly, WG 3.1 members wrote advisory guidelines. The first, 'Computer Education in secondary school – an outline guide for teachers' [5] (known as the Red Book), was available at WCCE Amsterdam in 1970. The revised version, translated into various languages, and three further topic books established the primacy of producing guidelines for the profession. Devising and running professional training seminars in ADP for system designers, was devolved to a new Working Group 3.2 [6], later, called Informatics and ICT in Higher Education. Bob Aiken [7] attended the first WCCE at theon hearing of their work on the computer science curriculum. Through Bernard Levrat he 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.

Two further working groups were established in 1971. WG 3.3, Instructional Uses of Computers, later turned into Research on Educational Applications of Information Technologies. And in a logical extension of 3.2, but to distinguish it from higher education, WG 3.4 covered IT-Professional and Vocational Education in Information Technology, and focused on curriculum and related accreditation. Indeed discussing and *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. By 1979 and after 16 years, four working groups had been established, and two World conferences (Amsterdam, The Netherlands 1970 and Marseilles, France, 1975) held. 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 the number and scale of activities increased. The third and fourth WCCEs were held in Lausanne, Switzerland in 1981 and Norfolk, Virginia USA in 1985. A feature of these world conferences of 1981 and 1985 (and later that in 1990) was the substantial exhibitions of hardware and software manufacturers, and the level of computer business sponsorship that underpinned these events. 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, reflecting the broadening educational base and concerns of members. Working groups conferences attracted new membership. In addition in the 1980s,TC3 held two regional conferences, one in Japan (1986) and one in Europe that coincided with celebrating 25 years of TC3 (1988).

Twenty books of selected Proceedings were published in this nine year period, but no guidelines were produced. In the 1980s the focus shifted to mounting international conferences to support the flowering of activity in schools, further and higher education – and that of governments. *These conferences reflected a different mutual relationship with the professional community and interested stakeholders* and workshops and discussions became a substantial part of conference structures. In this first decade of micros, the journey of exploration was fast, multi-facetted and optimistic. Staff from university computer science departments, faculties of education and teacher training colleges, education boards and government departments attended to explore and discuss using this new, small and flexible resource. Some conferences were open with an international call for papers, others were working meetings with attendance by invitation of around a 100. Many insiders consider this latter the ideal means of generating real debate, exploring change in perceptions, and a defining characteristic of working group membership.

3.2.3 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 continuing 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 one sense, the 1990s were a continuation of the successful TC3 pattern of activities.

There are however two developments to note. First, was the revival of working meetings to produce Guidelines for Good Practice; Working Groups produced seven between 1992 and 2002 covering informatics education, secondary education, computer science elementary curriculum and teacher development [8-14]. These were funded by UNESCO, reviving a relationship with IFIP's founding organisation. Second, a new form of publication emerged – the international Declaration. TC3 took an active part in two UNESCO/IFIP events, first at Montreal, Canada resulting in a Youth Declaration [15], followed by a 2003 world forum on IT for developing nations resulting in the Vilnius Declaration [16]. And TC3 was active, through UNESCO and the Swiss Academy of Technical Sciences and Raymond Morel, in the UN World Symposium on the Information Society, Geneva 2004. Then at WCCE in Stellenbosch all participants contributed their views on 'what works' for ICT and education; Post conference these were collated to form The Stellenbosch Declaration [17] by the IFIP TC3 community, entitled 'ICT in education – make it work'. These Guidelines and *Declarations are designed to reach a different audience of national and international stakeholders*, acting as 'Position papers' for those, such as governments who are less likely to read conference books.

Unfortunately in parallel, conference exhibitions and sponsorship were in sharp decline; during the third technological phase the educational market was less significant and relatively indistinguishable from that of society in general. The impact is substantial. First, in the absence of computer industry sponsorship, mounting conferences carried an *increased financial concern* for the host institution and TC3/WGs. And secondly the overall financial climate in educational institutions made it harder for individuals to get support to attend, particularly the young. This problem was affecting the ability of TC3 and WGs to mount events.

3.2.4 2006-2010

The most recent WCCE was held in 2009 in Brazil, and other WG events have been held across the world. But in this most recent phase *the momentum of change has increased*. Two new special interest groups (SIGs) or working groups have been formed, Life Long Learning (2005) and Digital Literacy (2008). Both are devised around an overarching theme rather than a specific topic or constituency. Thus they tend not to mount separate events but contribute streams to other TC/WG meetings, such as WCCE 2009. Unfortunately in parallel the activities of WG 3.2 have been in flux; there has been a divergence of interest between Education and University Computing/Informatics departments, which appears in part to be a reflection of different perspectives in Europe and America, though there was useful colaboration between WG 3.2 and WG 3.4. in The Netherlands 2009. As with all WGs, a corpus of keen individuals is needed ot maintain momentum.

Nevertheless most working groups have a similar sense of purpose. Thus WG 3.1 “tries to identify problems, to document experiences and to find solutions. It does not strive to offer a unique solution to problems, as it is aware that specific circumstances of people and countries must in general be taken into account,” Pieter Hogenbirk. WG 3.2 notes that “in most of the world the enrolment in Informatics is getting smaller, despite the career opportunities that remain significant. …The international community is struggling with the apparent obsolescence of their curriculum,” Deepak Kumar. WG 3.3, following concerns over a perceived lack of theoretical base for research into ICT and Education, has recently published a synthesis of perspectives [18] enabling them to state that the “diverse nature of developments in ICT in education and their far-reaching effects and potential for change mean that whilst it is important for the research community to achieve coherence and identity it is also crucial to draw on research development in other areas”, Mary Webb. WG 3.4, after some years of concerns over diverse computing curricula in education, is now addressing how to make the study of ICT as an academic subject more attractive and how should the ICT sector be addessing the area of global warming?” Barrie Thompson. WG 3.5 aims “to provide an international forum where ideas, practical educational experiences, research and project orientated work can be discussed in a professional way, and ……add new insights for individuals and networks for future research and practice,” Marta Turcssanyi-Szabo. For WG 3.6 “The emphasis on distance education, while still a focus, is shifting towards blended and distributed forms of learning. As technology advances the notion of distance is challenged and re-evaluated, and attention is drawn to multi-user virtual learning environments, collaborative learning spaces and social/psychological persepctives….as well as cultural contexts,” Steve Wheeler. And in WG 3.7, althought the nature of information systems change, “our focus remains under which conditions these sytems and the informatiion they provide will be utilized fully for improving performance, and which effects utilization has on the organsiation using the systems” Adrie Visscher. SIG LLL continues to relate to the interactive role of informatics and resulting technologies on lifelong learning (Mike Kendall), while for the new SIG Digital Literacies, “its mission is to provide an international forum for undertsanding and endorsing research, promoting policy development and improving practice in the challenging area of Digital Literacy and e-inclusion,” Lampros Stergioulas.

The above recent statements of intent show commonn features - an international perspecitve, combining research and practice, engaging in debate, and looking to the future. They all represent a reflective perspective. And the most recent 2009 Bento Gonçalves Declaration for Action [19], following up the Stellenbosch declaration, provides incentives and recommendations for putting the principles of Stellenbosch into action. This reinforces further the attention placed on providing direct links between policy makers and practitioners.

3.2.5 Camaraderie

The initial membership of TC3 and its WGs was of committed individuals with common interests. Meetings were mainly internal working events often of no more than 10-12 people where guidelines were produced and two world conferences planned. This intensive activity clearly fostered camaraderie. The sense of a collaborative team, with common interests and concerns is an enduring trait of the TC3 working groups frequently mentioned, both formally and informally by its members. As Tinsley [4] said "really we were just a group of friends – but a powerhouse too". The sense of a working collective of individuals from diverse contexts and countries has underpinned the growth of activities. When asked why they continued to be involved after their first contact, Tinsley [4], Aiken [7], Bollerslev [20] and Cornu [21] all commented on *the friendship embedded within the community*. Each returned to this point. Aiken [7] called it a "nice confluence of the professional and personal aspects" of life. Bernard Cornu [21] invited to a WG 3.1 conference on ICT and mathematics in secondary school, on behalf of ICME, then stayed. "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." Scrutiny of working group chairs and book editorship shows how the initial group of individuals were active in establishing subsequent working groups. So their style of operating, the social agenda, and establishment of a camraderie was perpetuated

A feature of WGs is that members are invited to join on the basis of their activity and personal interest. Indeed they may be from a country that has no formal affiliation with IFIP. WGs rarely have more than a few members from any one country, and individuals are nominated on how they have interacted with that community. Thus both the international and working nature of the community has been maintained.

3.3 TC3 and its place in IFIP

The place of TC3 within IFIP is wortth exporing to explain the shift and expansion of TC3s activities.

3.3.1 The role of TC3

Members of TC3 represent the educational interest of IFIP national member organisations, and thus the structure of IFIP and the General Assembly (GA). There can be overlap as some individuals are members of both, as National Member representatives on TC3 and members of working groups. From early on, GA mounted a biennial World Computer Congress (WCC), which helped cohesion for the community of enthusiastic pioneers developing the new Federation. Only very occasionally was a paper presented at Congress on an educational topic. Indeed Peter Bollerslev [20] 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 in the 1980s such a strong pattern of its own quinquennial WCCEs and sense of community*. In 1992 however, a substantial shift occurred when TC3 was invited to take part in the Madrid Congress, and TC3 has been involved in most Congresses since 1996. This has been significant politically, raising the profile of TC3 and its educational themes within IFIP. Hitherto Education, though active within its own frame, had a lower profile overall within the GA.

Johnson [22] noted TC chairs hold a unique position in the structure between the GA and working groups. The hierarchical pattern of representation and structures is interesting. WG chairs were not formal members of TC3 unless were national representatives. They were invited to attend TC3 AGMs, but traditionally sat at the rear of the room, only taking part when asked a specific point [20]. This pattern changed in the third period 1990-2005; WG chairs became full members, encouraged to take part in TC3 discussions. Later, an executive was formed of TC3 officers and WG chairs. It was intriguing to realise that a similar structure operated in the General Assembly. GA consists of national member association representatives who embody of the federal structure. Chairs of the TCs were invited to attend, but had no formal constitutional role. Indeed, they sat at a separate table removed from the main body. And yet it was their activities through working groups that made the Federation function. In the early 1990s, by a combination of strong leadership of TC chairs [20] and the IFIP President [22], Technical Committee chairs became active participants of the GA. They now form a Technical Committee, and as a collective provide a powerful voice within the whole [20,22].

It is now clear that the timing of the invitation for TC3 to take part in Congress in 1992 was no accident, but part of *a political shift in the roles of TC chairs within GA*. Some WG chairs dislike their pattern of events being disrupted by the intervention of biennial WCCs, though all themes from TC3 have been succesful. It is equally clear that no TC chair would willingly 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 attending the TC3 fortieth birthday celebrations. Johnson [22] told me in 2006 that that the role of Congress was also under discussion in GA.

A greater intertwining of *the relationships between the various stakeholders in the Federation* is obviously beneficial. One anomaly remains; direct links between active members of a working group and national member organisation may be few – yet the former is central to continuing activities while the latter pays the IFIP fee. “One of the issues under discussion is the links, existing or broken, between the various stakeholders and structures of the organisation” [22]. Equally significant is the relationship between IFIP and other international organisations such as UNESCO. Bollerslev [20] asserted that the strengthening relationship between IFIP and UNESCO has benefited IFIP by raising its profile. There is now a signed Memorandum of Understanding between IFIP TC3 and UNESCO’s Institute for Information Technology in Education, where many IFIP TC3/WG experts have participated in seminars and projects. TC3/WG members also have a strong presence in European funded projects.

3.3.2 Collaboration across Working Groups and TC3

Since 1990 WGs have collaborated to mount joint conferences, for example 3.1 and 3.2 on informatics teaching, cognition and social and ethical issues. There are practical advantages with cost structures and organisation, and they reinforce the sense of community between groups. But it also illustrates the relative arbitrariness of the identities of working groups, that is the mix of sectors and activities, based on their historical development previously outlined.

Since the turn of the century, TC3 began discussing the strengths and limitations of WG structure. The debates have centred on cross-cutting themes. Research is one example. WG 3.3 found it less easy to sustain a regular and coherent series of events; research is the basis for many conference debates in the other WGs, and individuals were often committed to reporting research in their contexts, e.g. elementary education. Other themes illustrate the cross-cutting matrix whereby working groups operate. Thus under the aegis of WG 3.6 Distance Learning, tele-learning/teaching conferences were mounted throughout the 1990s. On the other hand, WG 3.7 has operated very effectively since its inception as a relatively closed community. In effect WGs operate in a number of dimensions, but *a co-operative matrix of activities*, between the contexts and themes reflects collaborative working. And importantly for many, the WG is the primary locus of their interests and loyalty. The last five years is notable for further increased collaboration across three or more WGs. For instance, the next calendar event in June 2010 at Amiens is a working conference on ‘New development in ICT and Education’, involving WGs 3.1, 3.3, 3.5, 3.8 and 3.9. This may reflect a maturity of identity with the ability of the broader matrix to explore major cross-cutting themes. In essence, after decades of development within the separately defined roles and structures of TC3 and its Working Groups, *the constituent parts have become a blended community through their common interests*.

Inevitably there are areas for concern. How to integrate and use the national reports from the 37 members countries presented annualy to TC3? How to attract students to Computer Sceince and Informatics? As the era of Congresses and Proceedings is ending, how to find new and effective ways of working? How better to disseminate our outcomes and ourselves use the digital technologies more efffectively? How to engage with the young? For Bernard Cornu, the current chair of TC3, to identify such concerns illustrates *the strength and resilience of this organisation*. What has always made TC3 oustanding is that it is a truly international, closely linked with research and practice in many countries of all continents. TC3 is primarily identified by the activity of its working groups. But the recent years have indicated much commonality; the Declarations have reinfiorced the dominant trend to link research and practice with decision making and policy making. Thus TC3 now serves a stakeholder community both broad and muliti-faceted. This is reflected by the new group activity called AGORA –a market place

3.3.3 AGORA.

The Agora initiaitve, part of a revitalisation startegy of IFIP, intends to reflect the move *from an infornatics society to an information and knowledge society*. Transversal themes are emerging such as Lifelong Learning, Security and Trust, Ethics and Citizen Education – themes all discussed at the UN Summits on the Information Slociety (Geneva 2004 and Tunis 2006). Agora engages with multiple agencies - other international bodies and institutions, industry and business, key decision makers and IFIP member societies - to explore issues and reflect on different perspectives. Lampros Stergioulas reports on the 2008 discussions focussed on digital divides and cultutal understanding, drawing attention to social spaces that can enhance communication between the young, but might endanger culture through homogenisation. Agora could be a powerful resource for various stakeholders, so the TC3 community by drawing on its bedrock of strengths can now present a corpus of expert opinion for engagement at all levels.

I would argue that it is the combined efforts of individuals and the style of operating as an active community of practice, which characterises the dynamic nature of Technical Committee 3.

4. Significant scientific debates

The relationship of TC3 with UNESCO, the sales and digital downloads of its publications, and the citation status of its journal, all attest to the scientific status of TC3 within the international community of ICT and Education.

4.1 Themes of debate

Perusal of the titles of TC3 publications 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’. In 1988 TC3 published a book celebrating 25 years of TC3 [22] organised in sections including information technology literacy, the impact of computers on the curriculum, the role of programming and the provision of hardware resources. Compare these with the preamble to the 2005 ‘The Stellenbosch Declaration - ICT in education; make it work’ [17]:

> 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 6 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

In effect over the last twenty-five years, the technology itself has receded to be replaced by a more educational structure, that now embraces a societal level. An understanding of this shift in foci may be provided by analysis of themes that have occupied this community. Taking as a main source the proceedings of the nine world conferences [23 - 32], and some special issues of the Journal of Education and Information Technologies [33-36], I highlight issues to illustrate to characteristics of the journeys undertaken. Perusal of other content slices 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. Programming was considered the second literacy, and Ershov [26] claimed that it would enhance the intellectual power of mankind. Indeed Charp [24] starkly stated that all educators must be concerned about computers, must learn about them, and must teach about them. By 1988 however Hebenstreit [23] questions the assumptions that programming teaches people to think logically, formulate solutions and handle detail with care. He says that in truth we should like future programmers to have these qualities, but that experience tells us that the teaching of programming, even intensively, has been unable to develop those qualities for people who did not already have them beforehand. Many papers [24,25] 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 and mathematics perspectives. 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.

The computer science curriculum developed from a timetable for an undergraduate course identifying the disputed core components of the nature of computer science, to debates 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* [37], 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, but subsequent research into its use in the classroom indicated 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. Nevetheless, Cornu [21] 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 learning in mathematics and science. Indeed, Bentley suggested in 1990 [28] that the use of a computer as a communicating device creates a more powerful educational tool than its functions as a delivery mechanism.

The computer science and programming papers in the earlier years and especially in higher education, 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. In 2005, Cornu [21] noted that there continues a debate in Informatics about the whether we should teach it, or simply ensure we can use it. These debates have more recently come to a head – note current interests or divisions with 3.2 and 3.4. Problems also emerged with the inadequacy of trying to evaluate what was happening in educational settings without taking sufficient account of the new technological settings. Visshser and Wild [33] made a strong case for re-thinking the evaluation of computers that included a new taxonomy for IT supporting teachers and educational managers. Passey [34] used evidence to indicate that *past evaluation practices are simply not comprehensive enough* to cover the mix of issues raised when techology is introduced into schools.

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 [24] proposed a cognitive development rationale to underpin the instructional use of computer simulations. A shift in perspective emerged that instead of learning from the use of software, students learned with it, and the computer was referred to as a 'mindtool' [38] 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 technologies 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 and independent learning.

Problems have arisen with 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, geographical or music, and also the role of the teaching and fellow students in the totality of the learning environment. As Erling [28] 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 for some 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 [24], 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 [31] 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 [26] 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 on-line. Studies by Stacey [30] on issues such as the development and maintenance of a social presence online, by Furr and Ragsdale [30] on incidental learning and learner frustration with desk top video conferencing, and Yip [30] 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. More recently however, it has become clear that there is a large body of evidence using a range of research methods that has resulted in some common understandings of *the affordances*, which different types of ICT can provide for students' learning [22].

Throughout *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 [39] 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 [27] 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 [36]. 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. Indeed some recent papers [35] focusssed on the Art of of practice, of schooling and of emergence to reinforce a lesss mechanistic perspective of such communities. 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 [23], 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 [30], 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. More recenlty it has become apparent that the role of teachers, and thus teacher education, in ICT and education represents a multi-faceted and complex relationship, with attention on how teachers negotiate organisational barriers [36].

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 [40], 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 [41] 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 [29-32] 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 [42] reports from the substantial SITES2 study of 174 cases across the world, many involving TC3 people, 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 [31] noted by Cornu [21] that the role of pedagogy is a third critical variable. Erstad [36] explores how policy makers have used the terms information society or knowledge society to argue for implementing new technologiues in education for improving learning. He suggests these views have been highly problematic, in part because they do not take into consideration how new technologies are used by young people, or how schools work as social practices. And Krumsvik [36] suggests the implementation of ICT has been more strongly anchored rhetorically than in practice.

On the whole this is a community committed to the innovation and concerned to explore how to get it used, convinced change will happen. Many would say this is a problem, suggesting that unabased enthusiasm of authors such as Papert [37] and Gates [43] has presented an imagery of new positive change and renewal for learning. This presents *confused notions of a technocentric society* [44,45,46]. Evaluation studies by Cuban [47] 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 [48] 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". The work of TC3 has increasingly exposed and explored these contradictions.

Has the classic curve of innovation [40] taken off? There is no doubt that change continues, but mainly in the rapid advances of the technology, thus in the shape, character and attributes of the innovation itself. Indeed Baron and Bruillard [31] 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. Nevertheless two final points are worth noting. First, education is defined as a social science and after producing the Stellenbosch declaration, Cornu [21] suggested "that future conferences must include the social dimension". The more recent concerns of working groups acknowledge the social and cultural dimensions of digital environments. And secondly, technological penetration is now such that the digital world could be recast as a tool to re-think education, with its past constructs and canon of disciplines [49]. Moran has identified new knowledges for the 21st century; his multidiscipinary approach, focusing on relevant knowledge, teaching comprehension, understanding complexity, and recognising local and global identities will suit education for a digital society. Indeed, TC3 will be well placed to contribute to a re-thinking of our current construct of disciplines, and repositon our sense of the 'known' to consider relevent knowledge in times of change and uncertainty in our digital world.

As part of the IFIP Golden Jubilee celebrations, an IFIP Computer Pioneer has been identified as "one who, through active participation in IFIP Technical Committees or related IFIP groups, has made outstanding contributions to the theoretical, technical, commercial or professional aspects of computing." On behalf of TC3, the executive committee has proposed 5 names, which have been submitted to the IFIP Committee for Pioneer experience. The 5 names are: Jacques Hebenstreit (France), Tom van Weert (The Netherlands), Deryn Watson (UK), Peter Bollerslev (Denmark), Raymond Morel (Switzerland). The next milestone for TC3 will be its own birthday celebrations in 2013.

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, ever the geographer, has been 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-seven 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 our current pre-occupations suggest that the future will be as full of excitement, change, dichotomies and the unexpected, as the past.

References

1. Watson, D. *Forty years of computers and education – a roller-coaster relationship*. In History of Computing and Education 2, Impagliazzo, J. (Ed.) (Springer, Boston 2006)
2. Buckingham, R.A. TC3 – The first ten years. In Zemanek, H. (ed.) A quarter century of IFIP. (North Holland, Amsterdam, 1986)
3. IFIP *IFIP Bulletin No 36* (IFIP Secretariat, Austria, 2006)
4. Tinsley, David *Interview* 11th April 2006
5. WG 3.1 *Computer Education for teachers in Secondary Schools*:
   - *Outline guide* " the Blue book" (1971),
   - *Aims and Objectives in teacher training*(1972),
   - *Elements of information and information processing* (1976)
   - *Analysis of algorithms* (1977). WG 3.1 IFIP, Geneva.
6. Brittain, J.N.G. (ed.) *An international curriculum for information system designers* (WG 3.2 IFIP, Geneva, 1974)
7. Aiken, Robert *Interview* (6th April 2006)
8. Taylor, H.G., Aiken, R.M. and van Weert, T.J. *Informatics education in secondary schools*. Guidelines of good practice, IFIP WG 3.1 (IFIP, Geneva, 1992)
9. Ruiz I Tarrago, F.R. *Integration of Information Technology into Secondary Education: main issues and perspectives*. IFIP WG 3.1 (IFIP, Geneva, 1993)
10. Tinsley, J.D. and van Weert, T.J. (eds.) *A modular Informatics curriculum for secondary schools*. IFIP 3.1 (UNESCO/IFIP, Paris, 1994)
11. IFIP WG 3.2 *A modular curriculum in computer science* (UNESCO/IFIP Paris 1994)
12. Tinsley, J.D. *Tele-learning in secondary education*. IFIP WG 3.1/3.6 (IFIP, Geneva, 1994)

13. Knierzinger, A., Rosvik, S. and Schmit, E. (Eds.) *Elementary ICT curriculum for teacher training*. IFIP WG 3.5 (UNESCO Paris, 2001)
14. Anderson, J. and van Weert, T. J. (Eds.) *Information and Communication Technology in education: a curriculum for schools and programme for teacher development* (UNESCO/IFIP, Paris, 2002)
15. IFIP/UNESCO *Youth Declaration* (2002) www.ifip-tc3.net/
16. IFIP/UNESCO *Vilnius Declaration* (2003) www.ifip.tc3.net/
17. IFIP/TC3 *Stellenbosch Declaration – make IT work* (WCCE 2006) www.ifip-tc3.net/
18. McDougall, A., Murnane, J., Jones, A. and Reynolds. N. (Eds.) *Researching IT in Education: theory practice and future directions* (Routledge, London and New York, 2010)
19. IFIP/TC3 *Bento Gonçalves Declaration for Action* (2009) www.ifif-tc3.net/
20. Bollerslev, Peter *Interview* (8th April 2006)
21. Cornu, Bernard *Interview* (12th April 2006)
22. Johnson, Roger *Interview* (10th April 2006)
23. Lewis, R. and Tagg, E.D. (eds.) *Informatics and Education: An anthology of 25 years of TC3 publications* (North Holland: Amsterdam, 1988).
24. Scheepmaker, B. (ed.) *1st IFIP World Conference on Computer Education* (IFIP: Amsterdam, 1970).
25. Lecarme, O. and Lewis, R. (eds.) *Computers in Education; 2nd IFIP World Conference on Computers in Education*. (North Holland/American Elsevier: Amsterdam/New York, 1975)
26. Lewis, R. and Tagg, E.D. (eds.) *Computers in Education; Proceedings of 3rd IFIP World Conference on Computers in Education – WCCE 81* (North Holland: Amsterdam, 1981).
27. Duncan, K. and Harris, D. (eds.) *Proceedings 4th IFIP World Conference on Computers in Education – WCCE 85* (North Holland: Amsterdam, 1985)
28. McDougall, A. and Dowling, C. (eds.) *Computers in Education, 5th IFIP World Conference on Computers in Education - WCCE 90* (Elsevier Science, Amsterdam, 1990).
29. Tinsley, D. and van Weert, T.J. (eds.) *Liberating the Learner, 6th IFIP World Conference on Computers in Education - WCCE 95* (Chapman and Hall: London, 1995).
30. Watson, D. and Andersen, J. (eds.) *Networking the Learner: Computers in Education. 7th IFIP World Conference on Computers in Education – WCCE 2001* (Kluwer Academic: Boston, 2002).
31. *8th IFIP World Conference on Computers in Education - WCCE 2005.* (University of Stellenbosch, South Africa. CD DTT2103 Document Transformation Technologies, South Africa, 2005). And Education and Information Technologies**12** (1&2) 2007)
32. Tatnall, A. and Jones, A. (eds.) *Education and Technology for a Better World. 9th IFIP World Conference on Computers in Education – WCCE 2009* (Springer, Boston 2009)
33. Special Issue on: *Information Technologies and Educational Management*. Visscher, A. and Wild, P. (Eds.) Education and Information Technologies **2** 4 pp261-371 1997)
34. Special issue on: *Evaluation.* Somekh, B. and Watson, D. (eds.) Journal of Education and Information Technologies, **4** 3 pp215-341 (1999)
35. Special issue on: *Learning for the twenty-first century: what really matters?* Somekh, B. and Watson, D. (eds.) Journal of Education and Information Technologies, **10** 3 pp103-296 (2005)
36. Special Issue on: *Imaging the future for ICT and Education*. Munro, B. and Watson. D. (Eds.) Education and Information Technologies **11** 3-4 pp197-149 2006)
37. Papert, S. *Mindstorms: children, computers and powerful ideas* (Harvester Press, Brighton, UK, 1980)
38. Jonassen, D. H. *Computers as mindtools for schools: engaging critical thinking* (Prentice Hall, Ohio, 2000)
39. Ragsdale, R. G. *Permissable computing in education: values, assumptions and needs* (Praeger Press, New York, 1988).
40. Katz, E. *The social itinerary of technical change: two studies on the diffusion of innovation*. Human Organization XX (2) (The Society for Applied Anthropology, 1961).
41. Gross, N., Giacquinta, J.B. and Berstein, M. *Implementing Organisational Innovations: a sociological analysis of planned educational change* (Basic Books, New York, 1971)

42. Kozma, R. (ed.) *Technology, innovation and educational change: a global perspective* (International Society for Technology in Education, Oregan, 2003)
43. Gates, B. *The road ahead*. (Viking, London, 1996)
44. Mackenzie, D. and Wajcman, J. (eds.) *The social shaping of technology* (Open University Press, Milton Keynes, 1985).
45. Turkle, S. *Life on the screen: Indentity in the age if the internet* (Weidenfeld and Nicholson, London, 1996)
46. Finnegan, R., Salaman, G. and Thompson, K. (eds.) *Information Technology: social issues* (Hodder and Stoughton, London, 1991)
47. Cuban, L. *Oversold and underused; computers in the classroom* (Harvard University Press, Cambridge, Mass., 2001)
48. Miller, L. and Olson, J. *Putting the computer in its place: a study of teaching with technology*. Journal of Curriculum Studies **26** (2) p121 (1994)
49. Watson, D. *Pedagogy before Technology: re-thinking the relationship between ICT and teaching.* Education and Information Technologies **6** (4) p251-266 (2001)