DELIVERING THE POWER OF COMPUTERS TO CHILDREN, WITHOUT HARMING THEIR HEALTH

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The increased interaction with information and communication technologies (ICTs) has created a major change in the lives of children in industrially advanced countries. This change offers potential opportunities and threats to the cognitive, social, physical and visual development of children. These impacts are reviewed to emphasise the importance of optimising the interaction between children and ICTs. The change in children's use of technology also poses opportunities and threats for ergonomics that we should note if our profession is to continue being relevant and useful into this century. A pathway to the development and implementation of guidelines about child ICT use for different groups of guideline users is presented.

INTRODUCTION

The ICT Revolution of Childhood

The capabilities of information and communication technologies (ICTs) are creating a revolution in education and in other aspects of children's lives. Foremost amongst the current generation of ICTs are personal computers, either desktop or laptop, with internet connectivity. Other common ICTs are palmtop computers, mobile phones, TV, video, console and hand-held electronic games. Children are using computers to perform tasks related to their occupation as a school student, to support their hobbies and leisure interests and to enhance their daily living. Toffler (1980) described an information based 'third wave' of human society following on from the agricultural and industrial societies. The magnitude of this change in society is only now becoming apparent, with the change in the lives of children a stark example.

For children in industrially advanced countries today, powerful ICTs are widely available, frequently used and used for long periods of time

For example, USA census data figures indicate that 71% of USA households with children aged 8-17 had a computer at home in 1999 (Turow and Nir 2000). In the UK, recent figures show that 77% of 14 year olds (Harris 1999) and 89% of a sample of 360 8 and 10 year old children from three UK schools (Mumtaz 2001) had access to a computer at home. And in Australia, an Australian Bureau of Statistics (ABS) (2000) report found that in the 12 months to April 2000, 95% of children aged 5-14 years used a computer at some time.

Children do not only have computers around them at home, but are using them frequently. The ABS study referred to above found that 85% of 12-14 year olds and 76% of 9-11 year olds used computers at least twice a week. Even children in the younger age ranges were frequent users, with 63% of 5-8 year olds using a computer at least twice a week. Recently figures from a survey of a random sample of 1600 Western Australian children that have been tracked from birth (the RASCALS study) showed that at five years of age, 56% of them use computers each week (Straker 2001). In the study of UK children by Mumtaz (2001), 39% of 8 and 10 year old children were using the computer at home every day.

For some children, their frequent use of computers at home means that they spend a considerable proportion of their free time doing this single activity. The ABS reports that in the two weeks leading up to the 2000 survey, 13.6% of boys and 4.2% of girls aged 9-11 years spent more than 20 hours over those two weeks playing computer games. In Hong Kong, Ho and Lee (2001) found that 12-14 year olds were spending, on average, 137 minutes using a computer every day. In the USA, Turow and Nir (2000) found that 2-17 year olds with access to a computer at home spent, on average, 97 minutes on a computer or related technology each day.

The above figures indicate that our children today are faced with such changes to their daily activities compared with previous generations that we must seriously assess the impact on their health and wellbeing. This change in our children's lives also provides challenges for our profession.

Opportunity and threat for ergonomics

This revolution in ICT use by children provides an opportunity for ergonomics to become a significant part of the knowledge and skills of the next generation. However there is also a threat that ergonomics will not be able to adequately meet the needs of this generation.

Ergonomics will need to change and adapt to meet these new needs. For example, in the 20th century ergonomics assisted technological developments to reduce the heavy physical exertions and thus helped ameliorate negative health and productivity outcomes for heavy industry. However, in the 21st century the major musculoskeletal disorder risk may be postural monotony

from seated operation of computers. The provision of mechanical power rather than human power will not reduce these risks (in fact that approach has increased the risks) and other approaches will be needed.

It may also be a mistake for ergonomics to presume that the knowledge developed in the 20th century about adults using computers in offices can be applied to children using computers in the current decade. Much of that knowledge, and the standards and guidelines based on that knowledge, are now obsolete, as the computer hardware and software technology has changed, and as the way people use computers has changed. Further, children may use computers differently to adults. In fact the way children use computers may be our best prediction of how adults will use technology in the future.

Whilst some ergonomics approaches and knowledge may be obsolete, conceptually ergonomics is well placed to be of significant use to this generation. The focus on the interaction of people within a sometimes complex system provides a simple yet useful construct around which to develop knowledge of ICT use. Using this basis to direct research, ergonomics can become a significant contributor to the quality of life of the next generation.

Ergonomics research should be targeting the interaction of children and ICT to develop an understanding of the complete system (Straker et al. 2000)

IMPACT OF ICT ON CHILDREN'S DEVELOPMENT

ICT may have a positive impact on outcomes important to cognitive, social, life skills and fine motor development. However other evidence suggests there are real threats to the cognitive, social, physical and visual development of children from increasing ICT interaction by children (Straker & Pollock in press). Table 1 summaries some of these potential opportunities and threats.

Table 1 Potential opportunities and threats for the development of children based on increasing ICT interaction.

Potential Opportunities	Potential Threats
Cognitive Development	
▲ critical thinking	▼ educational attainment
▲ problem solving	▼ teacher motivation
▲ motivation	▼ funds for other education needs
▲ English, maths, science achievement	
Social Development	
▲ social interaction	▼face-to-face interaction
▲ cooperative play	▲ obsession with computer interaction
▲ social problem solving	▲ exposure to unsuitable people and material
▼ social anxiety	
Life Attitude and Skills Development	
▲ positive attitudes to technology	▲ negative attitudes to computers
▲ word processing, data manipulation skills	▲ computer anxiety
▲ information search skills	
▲ technology interaction skills	
Motor Skill Development	
▲ hand-eye coordination	▲ risk of neck and upper limb musculoskeletal disorders
▲ fine motor dexterity	▲ risk of low back pain
	▼ whole body activity
Visual Development	
▲ perception skills	▲ myopia

FACTORS INFLUENCING THE NATURE OF THE ICT –CHILD INTERACTION

An essential aspect of the ergonomics view is that the interaction of humans is complex and multifactorial with many elements within the system influencing the nature of the interactions. Much of the past research on children and ICT has been limited by a focus on single elements in the system and single system outcomes. However there are clear indications of the system elements that may impact on the nature of the interaction. Critical elements include the individual child, their peers, supervising adults, the technology used, the task performed and the context within which it is performed (Harris et al. 2002).

Further, the above elements must also be considered within a temporal context. Children's needs and ways of

interacting with ICT and the relationships between all the system elements will change rapidly as both the child and the technology develops. The way that system elements interact and impact on each other will be very different for a 5 year old child today than for a 5 year old in five years time or for the original 5 year old at age 10.

PATHWAY TO EVIDENCE BASED GUIDELINES

A basic assumption in ergonomics is that knowledge derived from scientific exploration can be used to guide the development of more optimal interactions between people and technology in all its forms, and that this approach is more efficient than trial and error. Thus an important role for ergonomics is the provision of advice to key players in the optimisation of the interaction between children and ICT. Whilst different information may be of use to different players, certain principles may apply whoever the guidance is prepared for.

Principles

We believe that guidelines should be developed using the following principles: transparent supporting evidence, culturally sensitive, not limited to current technology, balance outcomes, living, edited to suit target groups.

Guidelines should be based on the best available evidence to maximise the correctness of the guidelines. There is a threat to ergonomics that it receives widespread publicity for a guideline that subsequent research finds to be incorrect (for example the widely promoted recommendation for computer displays to be at sitting eye height is currently under threat (Pollock and Straker 2003)). The trust the public has in ergonomics would then be shaken, and the uptake of future guidelines diminished as people wonder whether these too will be found to be incorrect. Thus ergonomics needs to be open and honest in the quality of the evidence to support each guideline. There are therefore likely to be guidelines which are supported by a range of good quality research sources, and other guidelines which are only supported by the opinion of some researchers. Guidelines users can then focus their resources knowing the surety of the guidelines.

However being too conservative in describing gained knowledge risks isolating ergonomics to the ivory tower, whilst disciplines willing to sell simplistic messages are more likely to get the media, and thus public and governmental attention. An alternative approach is to be more definite in our uncertainty. The approach taken with the weather forecasts and outlooks in several countries could be fruitfully examined. Weather forecasters recognise that they can never predict the weather exactly, but they can predict the likelihood of rain on a particular day, or over a particular period of time. Similarly, whilst ergonomics cannot be certain about the impact of a particular risk, we can make reasonable estimates of effect sizes and thus be able to offer users information on the relative likelihood of a particular outcome. This would have the double benefit of providing the users with better information, but also of portraying ergonomics in a positive light.

Guidelines should be culturally sensitive. Ergonomics has tended to be ethnocentric in the past, with little consideration of the physical, mental and social diversity of humans outside major European and North American groups. (For example the ergonomics literature on seating consistently assumes that chair sitting rather than floor sitting is the norm (Gurr et al. 1998)).

Guidelines should try to be based on general principles rather than current technology. The development of ICTs is likely to continue to be rapid, making technology-based research obsolete before it can be promoted as guidelines. Principle-based guidelines can also help technology developers to develop new technologies better suited to human needs.

The multiple areas of impact ICTs have on children suggest that there will be trade-offs between the benefits and losses associated with ICT use. For example there may be a broad trade-off between cognitive development and gross motor development, with better learning outcomes coming at the cost of poorer skeletal development. Thus the guidelines should assist users in balancing the outcomes.

As the knowledge base will never be perfect, and new technologies may create new interactions not adequately predicted by current knowledge, there will be a need for ongoing research and a need for the guidelines to be continually reviewed and renewed based on available evidence. A useful approach could be that used by the Australian Department of Foreign Affairs and Trade when issuing travel advices. Advices are supplied with the information that they are "current for (today's date)", when they were last reviewed and when they were last changed.

Finally the guidelines should be developed for different users and be prepared with content and style appropriate to the user. As the needs of a furniture manufacturer, early childhood teacher and teenager are different, guidelines need to be targeted for each specific group.

Development Process

A process for the development of evidence-based guidelines should begin with basic principles and specific guidelines developed based on quality research and be peer reviewed and discussed within the scientific community. Following the achievement of some consensus, draft guidelines should be prepared and reviewed by the various target audience groups. This audience/user review should cover both content and style. Once developed the guidelines should be widely promulgated. Given the broad community interest in this area already demonstrated, ergonomics may be more successful than previously in using the mass media together with interactive ICTs to promote and distribute this knowledge. Alongside the promulgation there should be a strategy for the education of critical players: children, responsible adults, ICT industry and education authorities.

Finally, there needs to be a monitoring of the nature of ICT use and key outcomes. Currently very little is known

about how children use ICT. We also need to better understand what ICT use means to children and what factors influence children's use of ICT. Ergonomics research should be monitoring technology trends to try to predict changes in use and monitoring actual usage patterns. Further, leading indicators of cognitive, social, physical and visual development should be developed and consistently evaluated across diverse populations to improve our understanding and be early indicators of trends which need to be addressed.

Implementation

Whilst there are considerable scientific hurdles to the development of guidelines supported by good levels of evidence, such guidelines will be of little value to people unless they are implemented. Again this is a threat to ergonomics; not only must the science be good, but so too must the translation of the acquired knowledge into practice. A systems approach suggests all elements in a system are important and thus guidance to equipment designers, education authorities, children etc. may be useful to optimise the interaction The essential question is, How to get audience groups to follow guidance?

The optimisation of the interaction between children and ICTs will depend on various groups.

Awareness of the importance of the interaction between children and ICT, education about the effects of the interaction, development of education policies, codes of practice, standards and legislation need to be developed to ensure ICT producers, schools, teachers, parents and children themselves are working towards the harmonious use of technology for the children's future well being.

CONCLUSION

The increasing use of ICT by children in industrially advanced countries offers an unprecedented opportunity for ergonomics to become a central part of life skills for the next generation. It offers the opportunity for ergonomics to escape from its conventional constrains of being focussed on adults in occupational settings. It offers the opportunity for ergonomics to engage with people and become a part of their daily lives. This major change in society also carries a threat to ergonomics. If the ergonomics knowledge base is not updated to the new situation, if obsolete information is used and poor outcomes result, there may be a societal disenchantment with ergonomics resulting in it being marginalised.

Whilst a failure to adequately optimise the interaction between children and ICT may signal the failure of ergonomics, more importantly it may result in a major lost of quality of life for many of this generation of young people. The resulting individual and community mental, social and physical health costs may be crippling to industrially developed countries. However, if ergonomics can conduct good science and aid in translating the gained knowledge into widespread practice, the interaction of ICTs and children could be well managed thus enabling the realisation of opportunity for improvement in quality of life that this major change creates.

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