The Impact of New Digital Technologies on Training in the 21st Century

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Acknowledgements:

I would like to thank Dr Ben Williams, Dr Jason Skues, Dr Martin Andrews, Dr Carolyn Beasley and Dr Helen Pongracic for helpful comments on earlier drafts of this report. This work was supported by DSTO funding to Swinburne University, under Research Agreement 2010/1129425/1
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Executive Summary

Overview

This report considers the effect of new digital technologies and advances in eLearning on Instructional Methods and Media used in Australian Defence Force (ADF) flying training. The report does not aim to map specific training tasks to specific new digital technologies. Rather, it aims to provide an overview of a selection of new digital technologies and a discussion of the implications for military pilot training in the context of a new generation of recruits who have grown up in the digital age.

Digital Culture

The report begins with a socio-cultural analysis of the Net Generation and the effects of “growing up digital”. The popularist claims that (1) “digital natives” think differently and process information differently from their digital immigrant parents; and (2) their brains are now fundamentally different as a consequence; is not based on empirical evidence from the cognitive and brain sciences. Thinking processes themselves do not appear to have changed – digital technologies have instead changed the content available for thinking about. Growing up digital means that many children will have spent as much time interacting with digital technologies and virtual worlds as with the real world, and because of this, their skills and knowledge may be different through greater exposure to virtual, rather than real, experiences.

These differences may result in changes to the type of knowledge encoded and the degree of attention paid to different types of information. Automated responses learned through repeated exposure to video games and virtual worlds may become more deeply embedded than responses to real world stimuli. Digital natives may end up with more information and less knowledge than previous generations, more capabilities but fewer skills, less social interaction but more sense of community. They will need different training from previous digital immigrant students because there will be different gaps in their training.

The most significant change arising from new digital technologies is the release from constraints of time and space in terms of communication and interaction. Yet a rigorous adherence to the constraints of time and space remains critical to military operations. The differences between cultures based on polychronicity (preference for task-switching between multiple tasks, a sense that time is continuous and with no particular structure) versus monochronicity (preference for completing tasks sequentially, a sense that time is discrete and comprises distinct elements in a structured sequence) need to be considered. Digital technologies may precipitate changes in the
dominant culture with respect to polychronicity, and such changes may in turn affect the type of training required by new recruits to enculturate them to the military context.

The use of portable digital devices for texting and sending images and the rapid adoption of social media such as Facebook and Twitter provide myriad opportunities and challenges through release from the spatio-temporal constraints of face-to-face communication. Opportunities abound for innovative training such as supplementing pre-deployment language and culture training with mobile versions or even undertaking language training programs in-theatre. On the flip-side is the unprecedented challenge to operational security and personal privacy through the rapid dissemination of information through use of social media, particularly in combination with geotagging of communications and social use of location-aware applications.

**Instructional Methods**

There have been significant advances in the cognitive sciences, which serve to provide scientific support for the way that current training methods develop military flying expertise. This evidence suggests caution in adopting strict competency-based approaches to flying training and introducing new digital technologies into training environments.

In military flying training, it is important to be able to perform at a high skill level, but it is also important to be able to perform under pressure. The literature on learning provides guidance in terms of what training environment promotes best early versus later learning for specific tasks, what form of learning produces the best performance under pressure, and what amount of repetition and feedback should be used at different stages of learning, consolidation and maintenance of skilled performance.

**New Technologies**

The new technology landscape in 2011 provides a host of opportunities and challenges for the ADF training environment. What counts as new technology may change rapidly over the next ten years, so the content of this report will only serve as a snapshot of particular technologies that are “trending” now. The report attempts to highlight the specifics of the media being discussed, as well as the logic of the analysis framework used, so that the implications of future technology developments may be also be understood. The report does not intend to provide instructional design guidance for specific types of interactive multimedia learning modules. The report discusses some of the considerations relating to using newer forms of interactive multimedia such as games, virtual environments and simulations, with the main focus being on analysis of the internet as an information repository, and on Web 2.0 and social media as communication tools and vehicles for information diffusion.
Recommendations

The recommendations arising from this overview of the effect of new digital technologies on training are:

1. There is a need to identify training gaps arising from the effect of growing up immersed in digital culture.
   - It cannot be assumed that the psychomotor skills of digital generation recruits will be of the same form as those of previous generations. Many recruits will have developed their psychomotor skills in virtual rather than real environments. The implications of this are hard to predict given the increasing reliance on technology in 5th generation aircraft but training programs must consider remediation or adjustment of training programs to accommodate different skill bases.
   - The degree to which the digital generation prefers multitasking to focusing on individual tasks sequentially may lead to the development of implicit knowledge rather than explicit knowledge as the primary input into decision-making. Automated information integration and communication skills may be built without a platform of conscious and explicit information processing. If this is the case, critical thinking skills and the development of metacognitive awareness will be compromised, and it will be important to develop a curriculum that is able train to explicit attentional focus.

2. New digital literacies need to be added to the training curriculum (not necessarily specifically in the Pilot Training System), particularly new media literacies, including training that addresses security, privacy, communication protocols, and legal, moral and ethical responsibilities in real world and in cyberspace.
Overview and Purpose of the Report

The purpose of this report is to consider the effect of new digital technologies and advances in eLearning on Instructional Methods and Media used in Australian Defence Force (ADF) flying training. Not only do new technologies provide opportunities for improved content delivery and instructional efficiency, but they also provide the potential for new genres of information and communication that might change the nature of current instructional practice.

• If new technologies give rise to new ways of interacting, will new technologies require different consideration of types of learning content?

Keeping pace with the rate of change of technology, there have also been rapid advances in the cognitive sciences, particularly in cognitive neuroscience.

• In the light of new research findings, do we need to reconsider the boundaries between psychomotor, cognitive and affective\(^1\) domains of learning to see if our understanding of them has changed in significant ways?

The report considers the role of the instructor, the methods of teaching and learning employed in flying training, and the characteristics of future cohorts of students and new digital technologies.

• Will a cohort of “digital natives”\(^2\) dictate changes in methods and media used for instruction?
• Will “digital natives” require formal instruction in some areas of previously-assumed knowledge?
• What are the digital literacies required for instructors and trainees, over and above traditional literacy, numeracy, critical thinking and information literacy skills?
• How do these fits with current instructional practices in flying training?

Although it is important to address complex issues such as those above, there is a need for practical advice, specifically in the context of evaluating responses to the AIR 5428 Request For Tender (RFT) for the Pilot Training System (PTS). To this end, for each section of the report, there will be a summary matrix listing Advantages, Disadvantages, Issues to Consider, and Areas for Future Research. It should be noted that this report does not aim to specify the appropriate methods and media for specific teaching activities. That is a role for subject matter experts in

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\(^1\) Affect refers to the experience of emotions and feelings. The affective domain includes feelings, moods and attitudes.

\(^2\) The terms “digital native” and “digital immigrant” were coined by Mark Prensky (Prensky, 2001a) to describe those brought up in the digital age versus those who were educated prior to ubiquitous use of the internet. The terms have become part of the vernacular in discussing digital technologies and instructional methods for the digital age.
conjunction with educational designers and technology experts in the context of a curriculum and a known training context.

**Educating the ‘Digital Native’ Net Generation**

**Growing up “digital”**

Before discussing the impact of different digital technologies on instructional practice, it is worth considering what is meant by the idea of growing up ‘digital’. In 1995, Negroponte introduced the concept of ‘being digital’:

   “Being digital … is here. It is now. It is almost genetic in its nature\(^3\), in that each generation will become more digital than the preceding one”. (Negroponte, 1995, p231).

As with many aspects of the emerging digital age, there has been widespread speculation about the social, cultural, economic and educational consequences of growing up digital, but until recently, there has been little systematic empirical research. For many researchers, a major concern is the potential for a digital divide separating those with and without access to digital technologies (e.g., Black & Atkinson, 2007; Livingstone & Bobet, 2004; Snyder, Wise, North & Bulfin, 2008). By 2006, the vast majority of households with school-age children in Australia had access to computers and other digital technologies (Snyder et al, 2008). Ownership of technology does not by itself, lead to effective use of that technology, nor does it confer any level of understanding of how the technology operates. And it almost certainly does not incur genetic changes on people owning it. The digital divide, if it exists, is far more about digital literacies and digital technology practices rather than access to technology per se.

The following paragraphs aim to capture some of the major issues concerning “growing up digital” before discussing the literature on digital natives and the Net generation. The aim of this section is to consider hypothetical effects on potential future recruits of growing up digital in a changing technology landscape. What impact do digital technologies have in terms of risky behaviour, privacy and personal security? How will digital technologies affect the knowledge, skills and attitudes of potential future recruits? How will digital technology practices contribute to the sense of personal identity and communication capabilities of future recruits? What

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\(^3\) The reference to being ‘almost genetic’ suggests a degree of inevitability about the effects of technological change, through invoking a genetic/evolutionary metaphor. However, genetic traits are passed by parents to their children, which is in direct contradiction to the argument is that the new generation is fundamentally different from their parents. Things that are ‘genetic’ are seen to be pre-determined and unchangeable, whereas things that are cultural can be modified by training. Hyperbole aside, the evidence strongly points to any generational change being cultural, not genetic or biological.
expectations will future recruits have in terms of their relationship with technology, and the role that digital technologies will play in mediating their military training experience?

**Communication in the Digital Age**

Personal digital devices such as computers, laptops, smartphones and gaming devices have altered the communication space of young people and changed their patterns of social interaction (Ito, Okabe & Matsuda, 2005; Livingston & Bober, 2004; Snyder et al., 2008; Rheingold, 2002). Social interactivity can no longer be visually monitored by parents and caregivers. On the other hand, casual and transient social interactions now leave a permanent record on social networking sites, or in smartphone message banks, and can be scrutinised in more detail than was previously possible and with far less reference to social context than was previously the norm. Old style parenting monitored social interactions through listening to snippets of language in the context of body language, eye contact, physical demeanour, social space etc. Monitoring of electronic communications can capture traffic patterns (who people interact with) and content, but often does so with limited social context and without explicit knowledge of, or access to, other participants.

The ability to communicate with, and interact in real time with, people in remote locations subtly alters the sense of ‘ownership’ of personal space, and the discourse around being at home. Parents and caregivers can no longer act as gatekeepers who control entry to into the communication space of the home. With the advent of the home telephone, it became possible to communicate with ease across physical space, but the fixed location of the telephone provided at least some level of control over presence, both at the proximal and distal end of the communication channel. In most home configurations, answering the telephone removed the receiver of the call from their proximal social space (they went to the location of the telephone to take the call). Mobile handsets now allow people to take telephone calls without leaving their current location, and, in the other direction, the use of speakerphone allows shared conversations with multiple people. Handsets and personal mobile phones bring outsiders (from a distal social space) directly into the proximal social space in the home. Being “grounded” or sent to one’s room as a teenager placed physical and temporal constraints on communication space and social interaction. With the aid of digital technologies, teenagers now control their own communication space and can “withdraw” to a distal space.

The blurring of spatio-temporal communication boundaries so that the “engagement zone” in terms of social communication does not rely on physical proximity (or even temporal co-presence) is something new to contend with particularly when considered in the context of enculturating

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4 In contrast to the point being made here, the use of location-aware social media can add a different kind of contextual information to the communication stream in the form of metadata regarding location, time and co-participants) as will be discussed in the New Social Media section of this report.
new recruits to a military culture, chain of command, and discipline. Now from an early age, children can actively engage in a distal social engagement (and pass data in real time) to distal locations through any number of personal digital devices.

**Identity**

Consideration of what constitutes personal identity in the digital age provides insight into what we learn informally from social interaction, and what is taught formally in terms of protocols and etiquette. The protocols governing a range of different social and interpersonal interactions mediated by digital technologies have yet to be clearly articulated. Most young people will have used social networking sites, networked gaming environments, and will have interacted with a range of websites including search engines, online stores, music download sites, etc. Through these activities, they have created a large digital footprint even before they reach adulthood. Many of the digital identities they assume are passing phases in the course of their development, but leave an indelible imprint in cyberspace. Young people will need to consider the boundaries of digital identities versus real identities, and to understand the implications of digital identities and their histories in terms of future responsibilities and security.

In terms of issues relating to future military training, educators may wish to consider how constructed identities in cyberspace relate to fashion and clothing in real life, and how seriously to take the online identities and social interactions of recruits. In military culture, military personnel accept that rank and protocol are indicated by clothing. Maybe in the 21st century, some level of external control over digital identity through prescribing standards of social networking behaviour and digital literacy practices more strict than the prevailing standards of civilian society can be seen as similar to the requirement for military haircuts in terms of identifying with, and deferring to, the military culture and discipline. Along similar lines, Stricker, McCrocklin, Calongne, Scribner and Holm advocate the use of 3D immersive environments and avatars designed to express a desired “in-world persona” to build cognitive skills, to introduce new recruits to military culture, and “to engage individuals in social networks in continued and situated ways for developing strengths of character” (Stricker et al., 2010, p7).

**Privacy / Security and Risk**

Maintenance of privacy and security is always at the expense of ease of use (Vicente, 2004). Young people bound for service with the Australian Defence Force need to understand the securities and risks relating to participation in the online and virtual world, as well as to the real world.

Bruce Schneier (2000) contends that most computer users do not understand security and risk, and as a result, both individuals and organisations allocate security resources to the wrong things. The weakest links in the security chain need to be identified, and usually, these weak links relate to
human factors not technology. For example, there is little utility in spending large sums of money on complex firewalls on the main access to the computer network, if it is possible to gain access by going around the firewall, often through “backdoors” left open for recreational or other purposes (e.g., communication ports left open for seemingly harmless extracurricular activities of system administrators). ‘Security by obscurity’ may work on a small scale in non-networked environments, but will not withstand high-level automated computer attacks. Similarly extremely strong encryption is not useful if the password to access the encrypted information is weak, or the password is written on a piece of paper left next to computer. Although digital signatures and biometrics promise higher levels of personalised digital security, security will be compromised if stored comparison files are stolen. It is important to secure the correct aspects of the system.

As will be discussed later in this report, the other big risk to privacy and security is the trading of personal and corporate information between organisations. Search engines, portals, ecommerce sites, and social networking sites collect information on what sites people visit, what physical locations they visit, what things they search for, what purchases they make, who they communicate with, what their profile is, who their friends and associates are etc., and all this information can be linked back to a person’s true identity. Personal information is owned by the companies collecting it and can be bought, sold, stolen, manipulated etc without the perpetrator leaving home, and warehousing of personal data proliferates in a way that cannot be easily be stopped. Despite the grave threat to privacy and security from this proliferation of personal data, people still willingly give away their data often for seemingly small benefits. Geo-tagging of communication (automatic embedding of information about the geographic location and time that an image was taken or a text-message was sent) and location-based social networking applications link online identities with real-world people and places, adding an extra order of magnitude to the security implications (Social Media Division, n.d.).

Privacy, confidentiality and security of information are of paramount importance in the ADF context, and minor security breaches no longer pose a threat only to local operations. Inadvertent and deliberate breaches of privacy, confidentiality and security can have global effects as Wikileaks amply demonstrates.

**Trust**

Trust is given to people, to information, and to organisations based on social heuristics and assessment of risk (Twyman, Harries & Harvey, 2006). Pre-internet social practices are still the major influence in how parents assign trust (and therefore teach the concept of trust) to young people, but how long will this remain the case, particularly in the context of children being actively encouraged to hide aspects of their true identity (e.g., age, gender, location) when venturing into cyberspace? Identity *(who do you say you are?)*, authentication *(are you actually who you say you are?)*
and trust (can your identity be trusted? can your identity be authenticated? is your authenticated identity trustworthy?) are all inter-related questions and need to be considered together (Downes, 2005). The degree of trust in an entity is inversely related to the perceived risk of interacting with that entity.

Different sources of information are traditionally associated with different levels of trust. For example, news and weather information is deemed to be true if it comes from an authoritative source such as a regularly viewed television channel. The Encyclopaedia Britannica is full of factual (therefore true) information, personal diaries are deemed to be honest (but potentially biased, and therefore the truth is less certain), video and images are deemed to be true by virtue of the fact that seeing something with your own eyes gives rise to a sense of personal validation. Vision is our primary sense, and accordingly in most situations, trust is given to things we see (as per the adage “seeing is believing”).

An important question regarding growing up digital will be whether our cognitive systems internalise visual inputs as valid and validating experience, irrespective of whether they come from a simulation, a movie, an interactive game, or the real world. The nature of experiential learning, and the patterns of sensory and motor information accumulated over a lifetime of experience may be subtly skewed by vast amounts of visual data impinging on our cognition from screen-based activities. Growing up digital may result in automated responses learned through video games and virtual worlds becoming more deeply embedded than responses to real-world stimuli (Gee, 2009). Automated responses are based on trust in the anticipatory cues embedded in information being processed, and we extract anticipatory cues implicitly and without conscious awareness (e.g., Starkes & Ericsson, 2003; Bruya, 2010). Since we have no conscious awareness of the origins of our reflexes and automated behaviours, and we have limited control over how automatic behaviours are selected and activated, it will be difficult to remediate responses that are dangerous when real-world risks are involved.

Digital Culture

The preceding paragraphs raise questions about the hypothetical long-term effects on young people of “growing up digital”. Some of the questions raised give rise to concerns that we will need to modify our training systems to ensure that future trainees receive training appropriate to their training needs. Potential gaps in knowledge and experience may arise from the possibility of greater exposure to virtual, rather than real, experiences. The potential issues with respect to growing up digital are hypothesised to arise from different experiences (virtual content rather than real content) providing the input to normal thought processes operating within normal brains. As will be discussed further in the next section, there is no empirical evidence from the literature to
support the contention that digital natives have undergone changes to their neural processing or brain structure based on growing up digital\(^5\).

**Digital Natives, Digital Immigrants**

The following paragraphs discuss some popularist claims about the new generation of students about to engage in tertiary studies – the first wave of young people who have grown up digital. Rather than hypothesise about the potential effects on young people of new content and new opportunities for interaction, some commentators have proclaimed that there is now a generationally-based digital divide between (young) digital natives and (older) digital immigrants. Their claim is young digital natives use a broader range of technologies more effectively than their digital immigrant parents, and that digital natives are fundamentally different from digital immigrants (in the evolutionary sense) in terms of their information processing capabilities and brain structure. These claims have been used to fuel a technology-driven agenda to transform education and training, and to undermine any resistance to change as coming from digital immigrants who are outdated and do not understand the new technologies.

The term digital native was popularised by Marc Prensky (2001a, 2001b)\(^6\), who asserts that:

1) Digital natives “are no longer the people our educational system was designed to teach” (Prensky, 2001a, p1, emphasis in the original);

2) Digital natives “think and process information fundamentally differently from their predecessors” (Prensky, 2001a, p1, emphasis in the original);

3) It “is very likely that our students’ brains have physically changed – and are different from ours as a result of how they grew up” (Prensky, 2001a, p1, emphasis in the original);

4) “Our students today are all ‘native speakers’ of the digital language of computers, videogames and the Internet” (Prensky, 2001a, p1).

These claims have been quoted with the emphasis present in Prensky’s original work, to highlight the hyperbole and rhetorical style of his assertions. The papers were first published in *On the*

\(^5\) Claims of fundamental changes in the nature of neural processing and brain structure as a result of growing up digital are being strongly contested in this report. The less contentious claim, that brain activity or patterns of neural activation will be different as a result of growing up digital, is not being contested at all. It is assumed in this report that any learning results in new patterns of brain activation, but this is not the same as a change in brain structure.

\(^6\) The collected works of Marc Prensky are available via http://www.marcprensky.com/writing. The digital native versus digital immigrant concept, and use of social media has also been developed and popularised by Tapscott (Tapscott, 1999; Tapscott & Williams, 2008), Palfrey and Gasser (2008), Keen (2007), Veen and Vrakking (2006) among others.
Horizon, a journal aiming to provide strategic planning resources for educational professionals rather than being an academic journal.

**Is the Net Generation really different?**

Although the main focus of this report is on the impact of different digital technologies on instructional practice, it is worthwhile examining the various claims around digital natives and digital immigrants (Brown, 2000; Prensky, 2001a; 2001b; Tapscott, 1999) to see if they have any empirical support. The overall impression from reading the popular press is that educating this Net Generation will be compromised by the lack of understanding of digital culture by instructors and administrators. However, this is now a highly contested position in the academic literature on education and training (Helsper & Eynon, 2009; Kennedy, Delgarno, Bennett, Gray et al., 2009; Selwyn, 2009). As noted by Bennett, Maton and Kervin (2008), the debate around digital natives is couched in emotive terms relating to personal beliefs and personal anecdotes, rather than deriving from empirical evidence, and only recently has the debate begun to be informed by data rather than rhetoric. These data do not support Prensky’s claims.

Bennett et al. (2008) identify the two main assumptions derived from Prensky’s writing:

1. that ‘digital natives’ form a distinct, and fundamentally different, generation from digital immigrants; and
2. that instructional methods and media must change in order to meet the needs of so-called digital natives.

Critical reviews of the literature on digital natives (Bennett et al., 2008; Kennedy et al., 2009; Selwyn, 2009) have found little empirical evidence for the claim that digital natives are all “native speakers of the digital language of computers, videos and the internet” and spend their time immersed in technology. As described by Selwyn,

> “young people’s engagements with digital technologies are varied and often unspectacular – in stark contrast to popular portrayals of the digital native … (which) challenges the popular assumption that the current generations of children and young people are innate, talented users of digital technologies.” (Selwyn, 2009, p364).

Kennedy et al. (2009) also found diversity in technology ownership in a sample of first year Australian university students. A survey of Australian high school students conducted in 2006 (Snyder et al., 2008) found that there is not a digital divide in terms of access to technology, but there are differences between different sub-groups with respect to functional use of digital technology, and digital literacy practices.
Prensky and others laud the digital skills of young people (not a bad thing on its own), but simultaneously, they deride the technological capabilities of older people, notwithstanding the obvious fact that it was people in the digital immigrant age bracket, not the digital natives, who developed digital technologies in the first place. The spurious corollary of digital natives having different brains wired for digital, is that digital immigrants do not have brains capable of dealing with the digital world.

Prensky pokes fun at the “accent” of the digital immigrant, as exemplified by the “Did you get my email” phonecall which is said to occur shortly after a digital immigrant sends their email to check that it arrived (Prensky, 2001a). According to Prensky, the question betrays a lack of trust in new technologies, and represents a cautious, anxious “digital accent” that will not go away.

However, an alternative explanation is that the so-called digital immigrants actually understand the inherently uncertain quality of email as a mode of communication. Although there is a high likelihood of correct arrival of an email message, there is no guarantee of delivery, and little chance that an incorrectly addressed email will arrive at its correct destination. Although the same may true of the postal service, the intervention of a human postal worker increases the chance of dealing with error. It may be that the difference between digital natives and digital immigrants is that the older digital immigrants are more mature and trustworthy, and are on this basis are more likely to check the outcomes of their endeavours in the digital world much as they would in the real world. Checking and attention to detail are of paramount importance in flying training, so the so-called “digital accent” may be something to encourage!

The most striking aspect of Prensky’s claims is that digital natives think and process information differently from their predecessors and that their brains have changed as a result of this. Bennett et al., (2008) critically evaluate these claims, noting that there is little more than rhetoric to support them. It is actually more likely that digital natives think about different things, and process different information from their predecessors, but that the actual thought processes and information processing is the same as it has been for many generations. The differences in content of thought and the amount and quality of available information may well have consequences for education in terms of the type of knowledge encoded and the degree of attention paid to different types of information. However, this does not necessarily lead to a conclusion that different instructional methods and media will be required. Rather, it leads to a need for careful consideration of gaps in previously assumed prior knowledge for recruits, in addition to a consideration of whether some instruction is obsolete in terms of content or relevance. Despite being widely quoted in the

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7 As noted elsewhere, evolutionary processes leading to different neural processing and different brain structures occur over many generations, not during the maturation of a single generation.
academic literature and the terms digital native and digital immigrant becoming firmly ensconced
within the discourse, Prensky’s claims do not seem to be based on substantive empirical evidence
from the cognitive or brain sciences.

**Digital Culture**

The Digital Native / Digital Immigrant debate is couched in somewhat ageist terminology, but
Toledo (2007), in a slight twist on the Native – Immigrant metaphor, recognises two different
cultures in terms of technology, a digital culture and a non-digital culture, rather than two
different generations. She identifies digital tourists in addition to digital immigrants, identifying
tourists as those who attempt to interact in culturally appropriate ways when no other non-digital
option is available, but revert to their previous behaviour as soon as possible. Although the
reframing as digital culture rather than digital generation makes good sense, she fails to recognise
(or at least to emphasise) that cultural understanding is a two-way street. It may be the case that
digital immigrants and digital tourists do not understand the new digital culture, but it is equally
true that the digital natives do not understand the culture of their predecessors. Education has
always been about imposing formal constraints on language and behaviour as a first step in the
process of enculturation to a discipline (Stricker et al., 2010). Legitimate peripheral participation
(such as that of an apprentice in a community of practice) provides an opportunity to negotiate
membership and understand what being a practitioner means to the community (Lave & Wenger,
1991). Although it is true that sheer weight of numbers in a large cohort of incoming members can
change the nature of the community, it is generally the case that the learner comes to a community
of practice to learn from its current members, and tries to adopt the prevailing culture rather than
demanding that the culture change to embrace the newcomer.

The push to make tertiary education available to all comers has coincided with the increased
availability of digital technologies. Education is no longer seen as a privilege, but is now seen as a
right, despite the fact that many people see little use for the academic knowledge they are gaining,
other than it being a factor in getting them a job in the future. Students forming part of this long
tail (Brown & Adler, 2008) have little motivation to engage with their studies, are not motivated to
join communities of practice, and often do not have the pre-requisite knowledge, skills and
attitudes to develop self-directed learning skills.

The digital natives have more information and less knowledge than previous generations, more
capabilities but fewer skills, less social interaction but more sense of community. They need
different training from previous digital immigrant students because there are different gaps in
their training.
Instructional Methods and Learning

ADF Training Environment

The defence environment offers its own unique challenges compared with other learning environments in terms of security of information and communications. The effect of new digital technologies, the rapid adoption of personal digital devices and ubiquitous wireless internet connectivity presents opportunities and challenges in terms of instructional methods and media but also in terms of digital literacy practices of new recruits and their instructors.

The Military Flying Instructor Role

The Military Flying Instructor role is a critical path in the development of ADF flying expertise as needed in the military context. Military Flying Instructors not only build the skills of the trainees they instruct, but also build their own flying skills and airmanship through the act of instructing. Flying training is not just about delivering the flying curriculum as a commodity item. It is also about establishing and communicating the expertise and knowledge of the instructors to their students and building relationships based on mutual trust and respect. In adopting new technologies for training, it is important to maintain the integrity of the Military Flying Instructor role. Some new technologies such as computer based flight simulators, virtual reality games, and new communication tools begin to blur the traditional boundaries between Ground School, Simulator Training and Flying School. It is easy to allow inadvertent fracturing of the instructional role if technologies are introduced without contextual consideration of which part of the curriculum they address, and what platform is delivering them.

Learning Theories supporting Instructional Practice

The ADF approach to training is articulated in the Defence Training Model (DTM - Doctrine and Training Series ADDP 7.0). All other ADF training materials are based on the DTM, and contain an explicit outline of the learning theories underpinning the training methods used (see Appendix A for more details). Practical guides for instructors, such as the ADF’s Central Flying School Instructor Manual section on Airborne Instructional Technique, provide a detailed method for instructing in specific contexts. Implicit in the description of instructional methods is a detailed explication of the way in which teaching of cognitive and affective (attitudinal) skills are embedded within the flying training instructional practice. A detailed academic discussion of learning theories is beyond the technology-focused scope of this report; however there have been

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8 More detailed description of ADF training and Airborne Instructional Technique is provided in Appendix A of this report. Appendix B provides a brief sketch of guidance provided on Instructional Methods and Media (from DI (AF) AAP2002.001 Chapter 10).
significant advances in the cognitive sciences that can update the theoretical support for the extant ADF instructional practices. It is important to stress that the advances in cognitive sciences serve to provide scientific support for way that current training methods develop military flying expertise, (e.g., Williams, Ericsson, Ward, & Eccles, 2008) and suggest caution in adopting strict competency-based approaches to flying training and careful consideration when introducing new digital technologies into training environments.

**Near and Far Transfer**

The Cognitive Sciences provide the basic research into cognitive processing (including learning, memory, perception, motor skills, attentional processes). The Learning Sciences involve applying cognitive science research to training. Because of the significant obstacles in the way of measuring the far transfer of training programs, most of the research in the Learning Sciences looks at training outcomes in terms of near transfer despite the known differences between conditions that promote near and far transfer (Ghodsian, Bjork & Benjamin, 1997). The precise conditions for far transfer are difficult to demonstrate experimentally because of the many intervening factors contributing to learning and a range of contextual factors affecting performance.

Given the difficulty in designing studies to test far transfer or training, it would seem timely for the Learning Sciences to be informed by more recent advances in Cognitive Sciences. There is new evidence on engagement of attentional systems during learning (Bruya, 2010), different types of memory systems for different types of material (Ashby, Turner & Horvitz, 2010; Awh, Vogel & Oh, 2006; Repovs & Baddeley, 2010) and effect of repetition in developing basic building blocks (in both Knowledge and Skills) used in putting more complex skills together (Bompa & Carrera, 2005; Bruya, 2010; Ericsson, 2009; Simon & Bjork, 2002).

In military flying training, it is important to be able to perform at a high skill level, but it is also important to be able to perform under pressure. The literature on learning needs careful analysis in terms of what training environment promotes best early versus later learning, what form of learning produces the best performance under pressure, and what amount of repetition and feedback should be used at different stages of learning, consolidation and maintenance of skilled performance. Training within the Pilot Training System needs to be focussed on far transfer of skills (developing skills for future operational platforms rather than for the training aircraft).

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9 Issues concerning competency-based training versus training for mastery and expertise have been discussed at length by Wise and Quealy in a series of DSTO Client Reports for AIR 5428, collectively referred to as the BASE studies.
New Technology Landscape

This section begins by presenting an account of how information is organised into knowledge – that is, how we manage and integrate information from multiple sources to make sense of the world. Information integration is a key digital literacy, and new technologies disrupt traditional ways of encoding, storing and retrieving information used to create knowledge.

Technological determinism and new cultural forms

Technological determinism incorporates a belief that the introduction of new technologies into a society has a determining influence on how that society is organized, how its members perceive the world around them and how knowledge is stored and shared (McLuhan, 1967). McLuhan’s signature expression “the medium is the message” challenges the notion that content has meaning independent of its context. Bellamy (2006) suggests that narratives or stories as the basic way of organising human experience form such an integral part of our culture that we are no longer explicitly aware of their significance for the way we interpret and interact with the world. However new media such as interactive multimedia, the internet and virtual reality, are built around databases of structured data which can be searched, navigated and viewed in a variety of ways. The contrast of database logic with narrative logic as a form of cultural expression and way of interpreting the world has been discussed by a number of authors (e.g., Manovich, 2001; Bellamy, 2006; Snyder, 2008). The essence of a strong narrative in print-based media combines linearity, plot, characterisation, textual coherence, resolution and closure (Bellamy, 2006). On the other hand, electronic narratives (DVDs, games, websites) can challenge the linearity, sense of coherence and closure of a narrative experience. In contrast to the notion of electronic narrative, Manovich (2001) argues that narratives within the new media are based on the construction of an interface to a database of electronic resources.

“After the novel, and subsequently cinema privileged narrative as the key form of cultural expression of the modern age, the computer age introduces its correlate – the database. Many new media objects do not tell stories; they don’t have a beginning or end; in fact, they don’t have any development, thematically, formally or otherwise which would organize their elements into a sequence. Instead, they are collections of individual items, where every item has the same significance as any other.”

(Manovich, n.d.)

Walton (2004) points out that although the classification and categorisation underlying database search and retrieval may not be as immediately engaging as narrative, underlying database logic structures the information landscape in significant ways. For example, many frustrating
interactions with service providers (such as telcos, banks, utility providers) arise from the fact that information must be provided to human operators in a structured sequence determined by the database logic inherent the screens they use to access relevant information.

More importantly in the context of education and training, the logic governing the retrieval of information from a database is usually hidden from the user (e.g., Google’s page rank algorithm governing the return of Google searches), rendering any narrative structure connecting the retrieved information implicit at best. It is an open question as to whether we implicitly impose a narrative structure on streams of information irrespective of how it became available to us, and if so, whether the narrative structure is biologically or culturally determined. The implicit nature of information integration relating to database search and retrieval, particularly in systems using natural language search terms, means that the ability to identify the underpinning logic and assumptions represent new key information literacies for the 21st century.

At the same time, Walton (2004) emphasises that the database as a cultural form gives rise to reduced and simplified models of reality, which tend to homogenise and classify what they represent. This reduction and simplification of reality can be masked by the attractive appeal of “naïve realism” (Smallman & St John, 2005), which refers to our tendency to assume that the more visually realistic an interface appears to be, the more likely we are to presume that it is a good interface, irrespective of its effect on performance. A preference for natural language search terms may be another form of naïve realism, in that, while it ‘feels more natural’ to the user, it leaves the logic of the search to a search algorithm. Boolean search, in contrast, requires the information seeker to match their search strategy to their understanding of the database structure and search logic. This does not seem to come naturally to humans, but does allow a better understanding of the reasons why each piece of information was retrieved.

Even subtle changes in media can lead to surprisingly insidious changes in existing forms of cultural expression. For example, up until recently, “the news” was available on the radio, in the newspapers, and on television. Each of these media outlets only released news bulletins at set times. With the advent of news via the internet and social media, formal media outlets have lost control over information release, and no longer control what is “new” news. The media have also lost editorial control over news, and are struggling to maintain their relevance and to understand how to operate in the changing environment. Only recently have they started to consider that, since they can’t be first, their major role may be in packaging information for their audience and in analysis of newsworthy events.

A similar search for relevance is perhaps overdue in the educational design arena. Rather than generating hype about each new technology’s capacity to transform education as we know it, educational designers may be better served by focussing on understanding pedagogy for the
digital age, particularly with respect to how vast amounts of information can be harnessed into accessible forms of knowledge. While it is tempting to use readily available new technology to create educational material in the form of Discovery Channel edutainment, educational designers should not lose sight of their primary focus, of providing learning environments that promote deep learning in the specific domain of expertise, rather than just providing greater engagement at a more superficial level of learning.

New Digital Technologies and Training

The new technology landscape in 2011 provides a host of opportunities and challenges for the ADF training environment. What counts as new technology may change rapidly over the next ten years, so the content of this report will only serve as a snapshot of particular technologies that are “trending” now. The report attempts to highlight not only the specifics of the media being discussed, but the logic of the analysis framework used, so that the implications of future technology developments may be also be understood. Although the focus of the report is on new digital technologies, this section begins with very familiar digital technologies currently used in training. The aim of beginning with familiar technology is to situate the relationship between technology and cultural form (discussed above) in the educational context of this report.

Powerpoint slides for lecture presentations and Computer Based Training modules based around interactive multimedia are part of the mainstream instructional media, and have been substituted for many of the instructional media listed in Appendix B (such as, video cassette, 35 mm film, overhead projector, audio cassette, interactive video). The degree to which the substituted medium (the new technology) has subtly transformed our interpretation of the instructional method is considered, using Powerpoint as the case in point. The focus of the remainder of the report is on an analysis of the internet as an information repository, and on Web 2.0 and social media as communication tools and vehicles for information diffusion.

Powerpoint Slides and Lectures

Powerpoint Slides

Although eLearning has been touted as offering a whole new way of teaching and learning, the most common format for eLearning material is in the form of basic Powerpoint slide shows. In this basic form, Powerpoint offers the capability of presenting bullet point notes and graphics as visual aids in face-to-face lectures, enhanced by more detailed written notes for each slide in a “Notes” page. Although Powerpoint is not a new technology, there two reasons for including Powerpoint in this report.
Powerpoint as lecture replacements

Firstly, Powerpoint presentations are the *de facto* standard presentation medium supporting face-to-face lectures. As a consequence of the ready availability and easy distribution of such presentations, the easiest first step in transforming a training module to “new technology” is to replace face-to-face lectures (an instructional method) with Powerpoint slides (an instructional medium). Sometimes the Powerpoint summary slides serve as the replacement ‘lecture’, but more often the slides are embellished with additional notes presented in a separate window. The pedagogical\(^\text{10}\) aim of a lecture (its role in instructional practice) needs to be carefully considered before such a path of action (replacing a method with a medium) is taken. As noted by many educational designers, lectures are not a good method for transmitting large volumes of content (e.g., Bligh, 2000). The purpose of the lecture may be better construed as the opportunity “to disambiguate difficult concepts, and to provide a narrative framework for the information provided in readings and as part of the course content”\(^\text{11}\) (B. Williams, personal communication). When construed in this way, lectures also become an effective method for ensuring that a large cohort of students is aware of what they are expected to know, and simultaneously, provide a framework for students to develop an understanding and respect for the level of knowledge and expertise of the instructor presenting the lecture. The level of interaction within a lecture is not well-measured by the number of direct dialogues between instructor and trainees. Better measures would be the degree to which the instructor has facilitated understanding of context (have trainees developed more complete mental models of the area being taught?), and the degree to which the instructor has developed a better understanding of the learning needs of the cohort (does the instructor understand what sort of mental models the students are currently working with?). These interactions occur at a subjective, intuitive level rather than an explicit level, and as such, they are difficult to document. The important point is that the lecture as an instructional method is selected for reasons other than pure content transmission, but Powerpoint, initially designed as a *medium* to support lecture presentations, has become synonymous with a “lecture as content transmission” *method*.

Before face-to-face lectures are replaced, it is important to ensure that the informal learning associated with the lecture format (e.g., the narrative structure relating information to course aims, the contextual awareness surrounding relative knowledge of student and instructor and student and cohort) is understood and recreated elsewhere in the training program. Educators considering

\(^{10}\) Although many educators make a distinction between pedagogy and androgogy (adult learning), this report uses the term pedagogy to cover both terms.

\(^{11}\) Even in mathematical and scientific domains, lectures serve to disambiguate, and to identify assumptions and constraints implicit in the material, which could be construed as the “narrative” around the content.
instructional methods and media in a new technology landscape need to overcome their fear of addressing deep issues of epistemology (the nature of knowledge) and critical discourse analysis to best fulfil their role in designing new learning environments.

**Powerpoint as eLearning module**

The second reason for including Powerpoint, notwithstanding the points made in the previous section, is that it is readily available to everyone, and thus offers an opportunity for any instructor to construct their own interactive learning modules on a low budget. Used to its full potential, Powerpoint can offer the capability to develop interactive multimedia presentations or stand-alone eLearning modules incorporating animations, videos and hypertext links to other resources (Bozarth, 2008). Given the wide availability of snippets of multimedia content, Powerpoint allows the opportunity for rapid development of targeted learning content.

**Design considerations for Powerpoint**

When Powerpoint is used as the vehicle for delivering important information, whether as lecture or as an eLearning module, it worth considering the issues raised by Edward Tufte (Tufte, 2005) in his essay on the Cognitive Style of Powerpoint. Tufte’s thesis is that the structured presentation format of Powerpoint is not suitable for the presentation of technical and scientific information. He traces the space shuttle disaster caused by faulty O rings to the use of Powerpoint in technical briefings during the design phase of the shuttle. As argued in more detail in later work (Tufte, 2006), the screen-based structured templates and hierarchical presentation style inherent in Powerpoint distorts weighting of content by confounding conceptual hierarchies with aesthetically pleasing presentation. Tufte (2005; 2006) highlights the limited amount of information available in a Powerpoint slide compared with a page of a Word document. He is particularly disturbed by the difficulty in presenting numerical information accurately in Powerpoint slides. When important information is conveyed through presentation templates designed for visual effect, the design imperatives often override the logical flow or accuracy of presented information. Words are abbreviated, or logical flow is interrupted in order to accommodate information within a single screen. Powerpoint is primarily a presentation toolkit rather than desktop publishing software so if lecture content is delivered as stand-alone study notes rather than as a summary of a live presentation, the use of Powerpoint as a legacy development tool may need to be re-evaluated, due to the low density of information inherent in its design.

**Lecture Notes and the Expertise Reversal Effect**

When designing written notes or multimedia incorporating text-based explanations of concepts, it is important to understand the type of learner in the audience. Oska and Kalyuga (2010) found that
Instructional effectiveness of lecture notes depended on the expertise level of the learner. Guided explanations aid those with low prior knowledge, but surprisingly, the same explanations have been shown to interfere with interpretation for those with higher levels of expertise. This expertise reversal effect has also been found in other learning contexts (Kalyuga, Ayres, Chandler & Sweller, 2003; Koch, Seufert & Brunken, 2008).

An important aspect of learning that should be kept in mind when designing lectures and lecture replacements is the fact that, when students take their own notes, they learn more. Active note-taking rather than passive exposure to information is important. Peverly, Ramaswamy, Brown, Sumowski, Alidoost & Garner (2007) found that transcription fluency, the rate of written word production, rather than verbal working memory or the ability to identify main ideas, was the only predictor of quality of lecture notes, and quality of notes was the only predictor of test performance, suggesting that digital technologies that improve transcription fluency may enhance learning more so than the provision of prepared lecture notes. The current obsession with objective measures over subjective measures, irrespective of what is being measured, generates a false impression that if students have good notes (the educator’s prepared notes), educators have done their job. The more challenging task is to provide interactive learning designs to facilitate student recreation of course content, which serves as the foundation for building the mental models that allow their active use of that knowledge in authentic training tasks which prepare them for future operational performance. In this context, Huxham (2010) identifies the importance of providing appropriate cues to students as to when to take notes. In designing digital media and preparing notes for students, via Powerpoint or otherwise, it must be remembered that the active cognitive processing by the student in order to develop mental models is the intended outcome, not the visual appeal or neatness of the notes as a stand-alone artefact.

Morrow, Ridolfo, Menard, Sanborn, Stine-Morrow et al. (2003) found that note-taking is related to expertise, and supports the maintenance of expertise over time. Using a task of read-back in a simulated air traffic control task, they found that note-taking improved performance for older pilots, but not for older non-pilots. Accuracy in answering probe questions (used as a secondary task) was improved by expertise, younger age and note-taking, but note-taking did not mitigate against age-related decline. These findings suggest that note-taking provides environmental support to maintain expert performance in complex environments such as air traffic control despite typical age-related declines in cognitive ability that interfere with other non-expert cognitive tasks.
### POWERPOINT

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>ISSUES TO CONSIDER</th>
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<tr>
<td>• ubiquitous</td>
<td>• Are the slides a printable summary of the lecture or are they supplementary?</td>
</tr>
<tr>
<td>• no extra software or training required</td>
<td>• Is the instructor delivering the content or do the slides serve to illustrate a message?</td>
</tr>
<tr>
<td>• can use advanced features to build stand-alone eLearning modules</td>
<td>• format of PowerPoint slides may affect presentation style (too many words) and may affect student learning by constraining their own note-taking</td>
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<thead>
<tr>
<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
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<tbody>
<tr>
<td>• tends to promote bullet-point style of thinking</td>
<td>• Do PowerPoint lecture summaries aid in retention of important information OR is it better for future understanding that students to take their own notes?</td>
</tr>
<tr>
<td>• Provides less information than written notes (See Tufte, 2005)</td>
<td></td>
</tr>
<tr>
<td>• PowerPoint templates “reduce analytic quality, weaken verbal and spatial reasoning … and almost always corrupt statistical analyses” (Tufte, 2005).</td>
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### Interactive Multimedia, Virtual Reality and Simulation

**Interactive Multimedia**

An age-old problem in instructional settings is how to maintain student attention and interest, or in modern parlance, how to “engage” students. Student engagement is considered to be central to learner-focused instruction, although there is little empirical support that a sense of engagement has long term learning outcomes in terms of depth of learning and transfer of learning to new contexts (as distinct from student engagement or student satisfaction). In fact the bulk of research comparing the learning outcomes of different media points to “no significant difference” and where differences are found, it is not clear how generalisable those results would be to other learning contexts (Clark, 1983).

It is not the aim of this report to provide instructional design guidance for interactive multimedia learning modules. There are already good guidelines for consumers and developers of multimedia available from Mayer and Clark (Clark & Mayer, 2008; Mayer, 2005) and a range of books describing methods and media for eLearning (e.g, Clark & Mayer, 2008; Kearns, 2010; Rosenberg, 2006). The report will instead discuss some of the considerations relating to using newer forms of interactive multimedia such as games, virtual environments and simulations.
Serious Gaming, Virtual Worlds and Augmented Reality

Serious gaming in virtual environments generally involves adopting an online avatar that mediates interactions with the virtual world, with its automated agents, and with other real people, via their online avatars. Virtual environments can be constructed as simulations of scenarios and exercises based on tactical or strategic decision-making, as first-person-shooter games focusing on psychomotor skills, response times, and tactical thinking, as real-time strategy games or role-playing games that combine different elements of other genres.

Gee (2005) articulates a set of 36 learning principles built into good video games, and discusses three areas of current research underpinning the understanding of how serious gaming might be used in training: situated cognition; New Literacy Studies; and connectivism (a framework mirrored by research in the cognitive neurosciences that emphasises the human capacity for pattern recognition). These three strands of research relate the way we experience and understand the world to our situated context. Our interactions with the material, social and cultural world provide that context, which in turn shape the patterns of information we extract from any given situation. Gee discusses the way that we learn from video games and how video games could be designed for learning. His approach is from the socio-cultural perspective, so rather than beginning with the technology and its possibilities, he considers the implicit and explicit discourse and the other semiotic cues involved in sense-making and creating meaning from interactions with video games. From the perspective of using serious gaming as a form of instructional method or as a medium in military training, the socio-cultural and semiotic aspects of gaming and virtual environments are the areas that require deeper analysis. It will also be important to consider the nature of information literacies required for generating and interpreting meaning from new media (Gurri, Denny & Harms, 2010).

Digital natives have been described as having had extensive interaction with video games and virtual worlds. A number of issues focusing on the digital generation are highlighted. How does selection of an avatar affect our cognition and social interactions? Should students have a role in designing their avatars, or should the learning design generate avatars for the learning context? Does the use of avatar promote a distinction between different roles, and serve as the new medium for understanding role-based protocols and procedures (e.g., see Stricker et al., 2010). There is a large literature on role-play in education that is noted in terms of its existence, but is not referenced or reviewed here. At a basic level of understanding, role-play can be used effectively to

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12 Semiotics can be defined as the study of signs, or ways of signalling meaning. For a basic introduction to semiotics, see http://www.aber.ac.uk/media/Documents/S4B/sem01.html
elicit affective/emotional reactions, to demonstrate emotive aspects inherent in tasks, and to
demonstrate timeframes and the effect of temporal compression on task performance. Part of the
attractiveness of “gaming” in the educational context is based on a naïve realism (Smallman & St
John, 2005) that supposes that things that “feel real” (cause engagement and emotional reactions)
must be more like the real environment. It is important to understand the educational aim of a
virtual environment rather than take a simplistic view that all forms of active engagement will
promote “better learning”. The important issue is what is learned. Much of what is learned will
depend on an interaction between the learning goals and the fidelity of the learning environment
in terms of achieving those goals. A much-overlooked issue for the military training environment
is that training fidelity of any medium depends on the learning goals of the training task. No
training device or training environment can be certified in terms of training fidelity without
knowing the specific training task for which it is being proposed. A corollary of this is that the
same training medium will have different training fidelity depending on the context of its use.

At the opposite end of the scale from virtual reality is augmented reality, where digital
technologies are used to enhance information from the real world. There are many examples of
augmented reality or assistive technology in common use, such as reflective markers on obstacles
to highlight their existence in poor lighting, or electronic devices to assist in locating studs in the
wall of a house. There are also sensory substitution devices such as proximity detectors, in
common use in newer cars that produce audible alarms that increase in frequency as proximity
increases. Augmented reality aids for military operational use utilise advanced technology to
highlight cues from the environment, or to overlay additional information onto real world
environmental cues. Although augmented reality devices can differ greatly in their level of
sophistication, the basic questions in terms of training are the same. While augmented cues may be
shown to deliver improved performance, do they enhance or inhibit early learning? The optimal
use of trainer wheels on a bicycle, or proximity detectors on a car, or subtitles on a foreign
language film may assist the learner in abstracting relevant patterns of information, but if not used
optimally, may result in learners relying on the augmented cues rather than learning to abstract
the relevant environmental information.
## SERIOUS GAMING, VIRTUAL WORLDS, AUGMENTED REALITY

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<tr>
<th>ADVANTAGES</th>
<th>ISSUES TO CONSIDER</th>
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<tr>
<td>• can explore different environments and situations</td>
<td>• Are we responsible for the actions of our avatar?</td>
</tr>
<tr>
<td>• Allows role-playing</td>
<td>• Can we be assessed on actions undertaken in simulated worlds?</td>
</tr>
<tr>
<td>• Augmented reality allows integration of simulation with real-world information</td>
<td>• What is the cross-over between activity in virtual and real worlds? (e.g., it is possible to buy virtual goods with real money in Second Life; online worlds have forums where people can interact as their real self as well as via an avatar)</td>
</tr>
<tr>
<td>• Can play out scenarios that cannot be played out in real life (e.g., setting up conflicts, exploring different physical or social environments, modeling aftermath of disaster)</td>
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<thead>
<tr>
<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
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<tbody>
<tr>
<td>• Virtual is not real</td>
<td>• Is an avatar an extension of self or an external entity we control? (internal versus external locus of control)</td>
</tr>
<tr>
<td>• Motivations and risks not real</td>
<td>• What factors contribute to transfer of learning to real world situations?</td>
</tr>
<tr>
<td>• Role-play changes sense of ownership and responsibility</td>
<td>• Is augmented reality better than virtual worlds for fast-tracking pattern extraction for learning complex skills?</td>
</tr>
<tr>
<td>• Cues not real</td>
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### Flight Training Devices and Simulators

Flight Training Devices (FTDs) and Flight Simulators have been used extensively in military flying training from as early as the 1930s with the Link trainer (Roberson Museum and Science Centre, 2000). A common view in the discussion of future flying training is that new generation aircraft with advanced avionics systems will change the nature of flying from a predominantly psychomotor skill set to one requiring greater emphasis on cognitive skills. The need to train pilots in managing information from a vast array of sensors and sources is one of the great challenges in military flying training, and one where virtual environments and simulation should play an increasingly important role. The aim of this report is to highlight issues that must be carefully considered when designing training environments based on new technologies. While there are many exciting opportunities, there are also a number of serious challenges that need to be addressed.

Issues relating to fidelity of FTDs and simulators have been the subject of much debate, particularly between engineers and psychologists. The question of realism (perceptual fidelity...
rather than physical / engineering fidelity) and the relative weight to place on subject matter expertise, empirical scientific data and scientific theory, in providing guidance on virtual training environments, is a vexed issue. The impressive level of visual realism provided by even the more modestly priced FTDs only serves to obscure the fact that “realistic” simulations by definition do not present exactly the same stimulus cues as the actual environment. The greater the perceived realism, the more subtle the perceptual deception, and the less easy it is to recognise that the simulation may not actually be providing the appropriate discovery environment for trainees to learn to extract task-relevant cues.

Issues with the contextual aspects of fidelity (functional fidelity) call into question the opinion of domain experts regarding the training potential of a virtual environment. The mental model of the domain expert is different from that of the trainee and, similarly to the expertise reversal effect described by Kalyuga et al. (2003), it may be that a given virtual environment does not operate in the same way psychologically for experts and non-experts. It may be safe to trust a domain expert’s assertion that a simulator lacks “realism” or “feels wrong”, but it may require closer scrutiny to trust their claim of appropriate realism with respect to training potential. The degree of realism for experts may result from their own internal “filling in” of cues that should be present but are not. This filling-in is performed implicitly and experts are not consciously aware of what is real and what is not. It is a matter for further research as to how real and virtual information sources are weighted as part of the implicit process of information integration. More importantly, is the weighting information retained in a form available for post-hoc analysis or verification, implicitly or explicitly. As has been emphasised, the whole aim of a virtual reality environment is to ensure that immersion in the environment is complete as possible, and as a consequence, it is desirable that the boundary between real and virtual is as blurred as much as possible. Although immersion is important in terms of face validity and engagement, it may not be quite so desirable in terms of training outcomes.

The issues relating to training fidelity and the appropriate representation of perceptual cues are inherent in the generation of simulations and cannot easily be resolved. The single most important point to be made about simulations used in training contexts is that simulation, by its very nature, does not contain the same cues as the real authentic environment. Gee (2009) amplifies this point in discussing the concept of dual perspectives in virtual worlds. The perspective from inside the model generating the virtual world provides a first-person, situated, egocentric view. In contrast, the perspective from outside the model is a God’s eye, global, allocentric view. Learning in the real world involve extracting domain-specific patterns of information from the environment, whereas learning in a game involves acquiring the parameters of the model of the environment (the virtual world) rather than parameters of the real world itself. Gee (2009) makes a further distinction about games in a social context, such that there is an internal grammar for the game itself (the rules and
protocols governing the game world), but there is also an external grammar of the game within a social context (the rules and protocols governing playing of games). This distinction draws attention to the fact that a simulation has its own internal grammar in terms of training (allowing for engagement with the simulated environment as if it were real) but it also has an external grammar governing its overall role within the training program and how it is used therein.

It is during ab initio pilot training that fundamental mental models of the flying domain are being formed through extracting cues from the environment. Virtual reality simulations do not provide the same cues as the airborne environment. The basic mental models laid down in ab initio training serve as the foundation for all future flying training and may be very hard to modify in later training. In this light, it is recommended that fundamental flying skills should be trained in real aircraft to build appropriate mental models of the military flying domain. This recommendation does not preclude the use of new digital technologies in early training, so long as the aim of training is to support the construction of appropriate mental models for the real flying environment.

### FLIGHT TRAINING DEVICES AND SIMULATORS

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<tr>
<th>ADVANTAGES</th>
<th>ISSUES TO CONSIDER</th>
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<tr>
<td>• Can use a lower cost alternative for high cost, high risk training</td>
<td>• There are a raft of issues relating to training fidelity and appropriate representation of perceptual cues for different types of training</td>
</tr>
<tr>
<td>• Can provide opportunities to experience low probability events</td>
<td>• Metrics relating to training efficiency are based on short term training outcomes and cost of training (number of sorties to criterion) rather than on longer term learning and performance (including development of appropriate mental models for future expertise)</td>
</tr>
<tr>
<td>• Can experience situations that would be too risky in real life (including practice of emergency procedures and system failures)</td>
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<tr>
<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Need to ensure that simulators have appropriate levels of engineering, psychological, and functional fidelity (not well-understood by engineers and educational designers)</td>
<td>• What constitutes training fidelity?</td>
</tr>
<tr>
<td></td>
<td>• How does simulation training affect the development of mental models and risk assessment?</td>
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</table>

### Training Management Systems

Although Training Management Systems (TMSs) are not the focus of this report, there is a strong need to clearly define the role of any TMS in the training continuum. A TMS operating across the whole training continuum has implications for training practice at each level of the system,
depending on specific choices in terms of implementation. For example, the way in which audit trails of instructor input are implemented (e.g., notes on a student file) will affect the whole training culture of what is recorded (e.g., instructor suspicions that will be noted at the time and removed if proven unnecessary or wrongly based will never be entered if there is no capacity for legitimate complete removal). A TMS across the whole training continuum will necessarily begin to codify flexible practices.

The TMS must be structured in a way that ensures the training records from each level can be recorded in the manner appropriate for that level, and that access to private or confidential information is protected appropriately. If the TMS is not sufficiently sensitive to local practice, practice will “go underground” and what is entered into the TMS will reflect “what the organisation wants to hear” rather than what the local areas are actually doing, thereby defeating the purpose of the TMS in offering better information in a complex organisation.

The requirements for the TMS as a training management system (focused on the training needs of individuals and areas) versus a personnel management system (focused on the capabilities and readiness of ADF forces) need to be clarified, along with the requirements for the TMS in terms of evaluating training outcomes.

A number of questions arise regarding the role of the TMS. Is the TMS primarily an enterprise-resource planning tool, or does it also serve a pedagogical function? Will it be used to manage personal learning, course delivery, or will it only be used for overall administration and management of training? If a TMS or Learning Management System (LMS) is used for course delivery, will it aim to promote standardisation or innovation? Will it have the capacity to support niche training tools? Who will be responsible for authoring training materials and how will quality assurance requirements be balanced against flexibility and adaptability for instructors? How does the TMS or LMS support version control and sharing of site content between courses? Who controls access rights to different sections of system and will the technological architecture inadvertently result in changes to responsibilities and job roles?

The issue of eLearning content (what learning resources might be delivered by a TMS or LMS) is covered in other sections of the report dealing with new technologies. Kearns (2010) also provides guidance on ways to construct eLearning for aviation.
TRAINING MANAGEMENT SYSTEMS

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>ISSUES TO CONSIDER</th>
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<tbody>
<tr>
<td>• Central repository for training information</td>
<td>• Identify differences between Learning Management and Training Management Systems</td>
</tr>
<tr>
<td>• Can manage training materials and version control</td>
<td>• Understand the difference between Virtual Learning Environments compared with</td>
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<tr>
<td>• Can manage training histories across the organisation</td>
<td>tools that manage training programs (i.e., record who has completed training and</td>
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<tr>
<td>• Allows audit trails for all training interactions</td>
<td>accreditation)</td>
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<tr>
<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
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<tbody>
<tr>
<td>• Can disrupt Instructor-Student relationship</td>
<td>• Governance issues (who owns the content? who owns the data? what is being managed</td>
</tr>
<tr>
<td>• Can change Instructor role due to mismatch with permission settings in</td>
<td>(learning or program)</td>
</tr>
<tr>
<td>the system</td>
<td></td>
</tr>
<tr>
<td>• Constrains feedback and instructor comments due to audit trails (can’t</td>
<td></td>
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<td>remove comments so less comments are made)</td>
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</tr>
<tr>
<td>• Privacy and confidentiality issues</td>
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Web 2.0 and Social Media

Google and Wikipedia sit as the current symbols of the internet as a global repository of knowledge. The Google search engine not only uses powerful and innovative search algorithms, but, more importantly, Google was one of the first companies to use low-cost commodity boxes (off-the-shelf computers) to build extremely powerful parallel processing capability previously only available using super-computers. This innovative approach provided high level processing capacity that had been the domain of large organisations and consortia (such as governments, academic institutions, defence and multinational corporations, who owned supercomputers or controlled access to them).

The second innovation was to focus on search algorithms based on natural language search rather than on structured search such as Boolean combinations of search terms (relying on information seekers having domain knowledge regarding stems of distinctive words and metadata structures). The large amount of computing power from commodity boxes was paralleled by unrivalled storage space using similar principles of robustness of storage through redundancy rather than through elite engineering. The larger the Google database, the more complete the indexing of sites, and the data available on search terms, search history, relationships between searches and outcomes, and the more successful the search capability. Google’s extra tools also ensure its continued relevance. Google Images and Google Video not only provide access to images, but
provide a huge amount of data to test theories of how image search might be achieved without recourse to text-based metadata. Google Maps provides a huge database of information that is sufficiently useful that people put aside concerns about security and privacy. Although there was much public consternation about the invasion of privacy caused by Google Streetview cameras, many people are willing to provide private information about location and browsing history in order to gain access to location-aware services. Social media such as Facebook and Twitter add another dimension to the amount of private personal data voluntarily placed in the hands of private companies in foreign countries.

Google and Wikipedia

Google

As noted above, Google search provides access to vast quantities of information, but at a price of the loss of context of returned information and issues surrounding the authority and authenticity of the information. Page rank (the order in which page links are returned from a search) has become a proxy for authority, and popularity is becoming more important than expertise in determining what links are followed.

Prior to the advent of the internet, the first step in teaching a course was to provide access to the required domain-specific content. Such content was in books and other resources that were in limited supply and costly to reproduce. Much of the educational design effort was devoted to generating enough information to stimulate enquiring minds. Students need to have access to a broad range of information to be able to begin the process of constructing domain-specific knowledge. Now that such access to information is ubiquitous, the problem is reducing the information load, not increasing it. Education is about learning to allocate attention to the relevant information, learning to prioritise and manage information, and learning to construct meaning that is situationally relevant. More than ever before, educators need a good understanding of epistemology (theorising about the origins of knowledge) to guide the process of turning information into knowledge.

As has been proposed by Manovich (2001), many new digital media rely on database logic rather than narrative logic to create meaning. Google epitomises the concept of database logic in the way that it provides information. Wikipedia, by way of contrast, is a vast internet repository of information that provides narrative as a major feature of its genre. Each page is a narrative text about the particular topic but the underlying technology is a database of content retrieved in a non-linear fashion via hypertext (Snyder, 1997). Although all good reference books index words and ideas using a range of cross-referencing devices (such as a table of contents, an index of terminology, a glossary, footnotes, end-notes and reference lists) generating such cross-references
was a specialist and labour-intensive process, and following up on such cross-references took much time and energy of the reader. Cross-referencing using a hypertext medium allows an interesting mix of narrative and database logic, and gives rise to questions about discontinuities in contextual relationships among narratives that have been hyperlinked by automated processes. Following links takes little physical or organisational effort, but raises serious issues in terms of navigation, and conceptual learning. The medium of the internet has changed the way that information is selected, with ease of access rather than specific relevance being a critical factor in what is chosen. Anecdotal evidence from a number of scientific researchers is that, much as they hate to admit it, it is often as true for them as it is for their students.

In the context of learning, it is of great concern that associations and associative networks thought to be the foundation of human learning now reside in Google (the machine), and not necessarily in the mind of the human accessing the machine. There is a growing literature on distributed cognition, which understands that technological systems can serve as the memory for some forms of cognitive interactions in complex systems (e.g., Hutchins, 1995).

“Distributed cognition is a hybrid approach to studying all aspects of cognition, from a cognitive, social and organisational perspective. The most well known level of analysis is to account for complex socially distributed cognitive activities, of which a diversity of technological artefacts and other tools and representations are an indispensable part” (Rogers, 1997, p1).

Many new technologies can be understood as part of distributed cognitive systems operating across large organisations, and it is important to consider that the distributed cognition research agenda began in the area of human-computer interaction in workplace settings involving complex technology. The broader consideration of distributed cognition as part of the fabric of human cognitive activity and social networks has many far-reaching implications both for education and for society. At the heart of the debate about 21st century technology is whether we are now so intrinsically entwined with technology that we are willing to devolve our collective knowledge to external technology-based databases rather than to human-centred narratives. In the context of military flying training, there has been much debate over whether trainee pilots need to be able navigate without GPS, or a host of other sensors and technology-based enhancements, since all future aircraft will be equipped with advanced avionics. In the event of systems failure, they will just go home. The resolution of such debate rests on deep epistemological questions about the nature of knowledge and expertise. The effect of using GPS on the development of navigation skills will be explored in greater detail later in this report.

At a more accessible and practical level, when we pit database logic against narrative logic, how do we make sense and meaning from the patterns of results from a search engine? How is sense-
making altered when we are browsing for knowledge versus seeking specific information or completing a specific task? Information-seeking behaviour is not just about outcomes (finding the answer) but also about understanding contexts and relationships. In the past, information-seeking required effort, and the process, not the outcome, resulted in deeper learning. If we can fulfil the requirement of our search without any need to form a representation of context, have important opportunities for informal learning been badly compromised? How does the outcomes-oriented perspective (implicit in competency-based training) in a context of easy access to information, shape our ability to build future domain-based expertise?

**Wikipedia**

Wikipedia is a great source of first level information about a topic. Information retrieved from Wikipedia should be filtered by an understanding of the motive of the author who contributed content, which in turn serves to moderate the level of authority attributed to the content. The essence of the Wiki genre is to privilege content over author, and the underlying philosophy is that shared authorship will improve quality (Surowieki, 2004). Many highly specialised areas attract dedicated contributors who want to share their detailed and arcane knowledge and demonstrate their expertise to their fellow aficionados. Some areas are controversial and entries are used to proliferate a preferred position. Political entries or entries relating to historical events may be skewed towards spreading polarised views or as marketing. The ability to understand information in context and to make judgements about the authenticity of information is an information literacy skill. Information literacy skills as part of the digital technology literacies for the 21st centuries need to be clearly defined.

Google and Wikipedia may remain the premiere search engine and information repository for the foreseeable future, or may be replaced in pre-eminence by other search engines and repositories. Either way, the issues outlined in this report apply to search engines as interfaces to databases, and content repositories as hybrid database and narrative entities. The issues relate to the availability and access to information, and how we make sense of, and integrate information from multiple sources.
### GOOGLE and WIKIPEDIA

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<th>ADVANTAGES</th>
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<tr>
<td>• Instantaneous access to vast quantities of information</td>
<td>• Confusion of information with knowledge</td>
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<tr>
<td>• Easy to use, easy to search</td>
<td>• Privacy issues and trust in Google tools, data warehousing</td>
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<td></td>
<td>• Loss of semantic information conveyed by context and culture</td>
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<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
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<tr>
<td>• Reliance on proprietary search algorithms for finding data</td>
<td>• Effect of access to information on level of understanding (data versus knowledge)</td>
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<td>• Paid page rank (not easy to identify)</td>
<td>• How is information filtered for sense-making?</td>
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<tr>
<td>• Recording of search histories and ability to link information and information-seeking behaviour of individuals (privacy, security, trust)</td>
<td>• How does finding information through search (rather than browsing) allow for pattern recognition, associative learning and prioritisation or weighting of information?</td>
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<td>• Difficulty of ascertaining origin and validity of information</td>
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**GoogleMaps and GPS Navigation**

Google Search Engine comes with a vast range of additional tools, such as Google Translate, Google Maps, Google Images and Google Video. There are also many competing search engines and web services that have not been mentioned specifically. The decision on which technologies and services to discuss in detail is somewhat arbitrary and the selection has been made in terms of which tools are currently popular. The rapid growth of Facebook and Twitter (to be discussed in the next section of this report) illustrates how quickly the technology landscape can change, and serves to emphasise the arbitrariness of choice.

Navigation capability is critical for military flying training, and there are many relatively recent technological developments supporting navigation. Geospatial Information Systems (GIS) are databases of geographical location data, and Global Positioning Systems (GPS) allow identification of relative locations via a global satellite navigation system maintained by the United States government. The combination of geospatial information and global positioning allows for satellite navigation systems that can provide directions and location-aware maps based on current and desired locations.

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13 The author does not have appropriate domain-specific expertise to discuss the application of specific GIS/GPS systems to military flying. The discussion is about the cognitive effect of use of navigation aids during *ab initio* training on the development of mental models of the spatiotemporal domain.
A number of issues arise from reliance on satellite navigation systems (e.g., GPS and GIS like GoogleMaps) as navigation aids during training. For example, learning navigational skills is labour intensive, and 21st century aircraft will all have GIS/GPS navigation systems. Should valuable time be spent in basic flying training on a legacy skill that is unlikely to be used in operational flying roles?

In terms of training efficiency, teaching traditional navigation skills appears to be a luxury that takes time away from more important training issues. However, a deeper cognitive question in terms of training is the extent to which traditional navigation skills help to build appropriate mental models of terrain and positioning. Spatial mental models may prove to be critical to future flying expertise. Does reliance on GPS affect the development of map reading skills, and constrain the ability to build appropriate spatial mental models of the flying domain?

Aporto and Higgs (2005) undertook an anthropological study on the use of GPS navigation in Inuit hunters of the Igloolik region in Canada. This study illustrates the apprenticeship model of learning, and also highlights differences in the underlying navigational model in traditional navigation versus GPS navigation that have important consequences in terms of risk. The Igloolik region is an area characterised by moving snowdrifts, ice floes, and other complex navigational factors resulting in a terrain that is constantly changing. According to Aporto and Higgs (2005), traditional wayfinding is based on many years of training on how to interpret wind patterns, snow drifts (shaped by the wind patterns), tidal cycles, currents and astronomical phenomena.

Navigation in uncertain conditions (changing winds, low visibility, presence of ice floes) requires caution and Inuit elders rarely take straight routes from point to point. Their wayfinding techniques involve a dynamic understanding of the terrain, and a strategy of minimising the risk of losing one’s way at the expense of taking longer routes. Wayfinding is taught from an early age, and wayfinding techniques are explained by Elders during the course of travels. Since the introduction of GPS units to the Inuit, young people have begun to lose the traditional wayfinding skills and rely more heavily on GPS. It seems that the cognitive effort involved in learning traditional skills makes use of the GPS more attractive. Moreover, the GPS provides direct routes to destinations rather than the more circuitous, but often less risky, routes chosen by elders.

It would be easy to conclude that use of GPS results in deskillling, and undermines the development of spatial mental models. However Aporto and Higgs identify a number of other factors at play. Snowmobiles have all but replaced dogsleds as the preferred mode of transport for Inuit hunters. Snowmobiles travel faster than dogsleds and are very much more noisy, thereby severely restricting the opportunity for Elders to discuss wayfinding while travelling (shorter available time, unsuitable conditions for conversing). Most experienced Inuit hunters who use traditional wayfinding methods have GPS for emergency use (e.g., in fog, when traditional
methods would require a halt in the journey). A combination of GPS plus traditional knowledge allows for the best outcomes because the GPS data is superimposed on a robust mental model of the terrain.

The effect of cognitive processing and sense-making is that young people using GPS for navigation learn to extract meaning from the patterns of information from the GPS, i.e., they learn to abstract patterns of information that suggest uncertainty or poor advice. Rather than building implicit mental models of the real terrain, young people are constructing mental models of the GPS data. This finding is mirrored in studies of taxi drivers using GPS (Girardin & Blat, 2010), who found that use of the GPS seemed motivated by a desire to reduce stress rather than to improve efficiency – people like to know where they are in relation to a known destination. The GPS provides that information with the least cognitive effort, despite sometimes offering less efficient routes than someone with local knowledge would select. If training efficiency dictates that traditional map-reading and navigation skills are no longer taught, it will be important to develop the capability to interpret the quality and reliability of GPS data in order to anticipate and avoid risks.

Girardin and Blat (2010) note that, in addition to effects on navigation skill, the use of GPS alters the social dynamics for taxi drivers as there is less interaction with other people with respect to route information or navigational advice, so the opportunities for social and informal learning are reduced by technology. These effects are similar to those observed in the Innuit snowmobiles, and parallel different affordances for instructional interactions in tandem versus side-by-side training aircraft and in simulators.

Leshed, Velden, Rieger, Kot and Sengers (2008) studied the effect of GPS use on the level of engagement with the environment, noting that

“GPS units … demand less skill and attention by providing orientation and navigation as a commodity, with instant availability, ubiquity, safety and ease of use, resulting in loss of engagement with the environment and others” (Leshed et al., 2008, p1675)

However, they also note a range of design principles for GPS navigation devices that would facilitate engagement with the environment and support informal learning about the spatial layout and social meaning of the environment (for example, giving directions in terms of visual landmarks rather than street names). They also note that GPS systems should provide some indication of the quality of GIS data used in providing directions (Leshed et al., 2008). GPS data are usually fairly accurate, but can be inaccurate due to outdated GIS information, blocked reception, or transient local conditions (roadworks, flood damage etc). GPS systems integrate information from a variety of sources to provide the best possible navigation assistance.
“GPS systems should reveal rather than hide error-prone or outdated information to reduce overreliance. If navigation is not always presented in an authoritative manner, users may be better prepared to handle unexpected changes to their routes.” (Leshed et al., 2008).

There are also many exciting opportunities for social learning afforded by use of GIS/GPS such as smartphone applications that interact with GoogleMaps. For example, many cyclists and runners share their favourite training routes via websites such as http://www.bikely.com/. Recently, an Australian archaeologist discovered dig sites in Saudi Arabia by looking at GoogleMaps14. By the same token, there are also serious pitfalls in terms of operational security in using location-aware applications.

The discussion of GPS navigation systems above speaks to the issue of how an early reliance on technology may alter the development of mental models of the spatiotemporal domain. This aspect of new technologies, the effect on mental models supporting future domain expertise, is critical in terms of the development of training systems such as the Pilot Training System for military pilots. The important point is that early reliance on GPS navigation results in primary mental models of the patterns of information displayed by the GPS, and secondary mental models of the environment.

“Borgman [argues that] technological devices … exhibit a characteristic internal division between a machinery and a commodity generated by this machinery. To obtain this commodity no skilled engagement with the environment is need anymore, replacing satisfaction that comes with an expertly exercised skill with the comfort of effortless consumption.” (Leshed et al., 2008).

There is reduced motivation to expend the cognitive effort required to build primary mental models of the spatiotemporal domain if the same output can be acquired effortlessly. The challenge for educational designers and instructors is how to build a training curriculum that supports development of primary mental models of the spatiotemporal domain by requiring engagement with the environment when using GPS navigation. It should be noted that, while students and instructors may have the best intentions to “do the hard yards”, humans are very good at finding short-cuts. This is the strength and the weakness of pattern-extraction by the human cognitive system – if patterns of information give reliable results, they will be used as cues. Effortful versus effortless attention (Bruya, 2010) relates to which cognitive pathways are involved in maintaining attention, not whether or not people have a good work ethic.

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### GPS and GOOGLE MAPS

#### ADVANTAGES
- Can scan GoogleEarth for all sorts of information previously only available via aerial reconnaissance
- GPS provides maps and point-to-point navigational information

#### ISSUES TO CONSIDER
- Timestamp of information important (updating of mapping data is not instantaneous, unlike many other Google functions)
- Possible to insert false information

#### DISADVANTAGES
- Images of private land (or areas previously protected by national borders) available for all to see
- GPS promotes navigation by landmark rather than understanding geographic layout
- Disconnection of internet, jamming of satellites, susceptibility to cyber warfare

#### AREAS FOR FUTURE RESEARCH
- Does reliance on GPS lead to loss of map-reading ability and knowledge of terrain?
- Do map reading skills from virtual worlds and games transfer into the real world?

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### Facebook and Social Network Sites

There are many social networking sites on the Internet, with current popular instances including Facebook, MySpace, Tumblr and Twitter\(^ {15}\). Facebook is currently the predominant social networking site, with more than 500 million active users (http://www.facebook.com/press/info.php?statistics). Typical Facebook users will spend from 10 minutes to more than two hours per day on Facebook (Ryan & Xenos, 2011, Skues, Williams & Wise, 2011 unpublished data). Individuals sign up for a Facebook account and create their own profile, in which they have the option to include a range of personal information including: basic identity and demographic information (e.g., name, residence, gender, date of birth), people with whom they have close relationships (e.g., formal relationship status, family members), educational and work history (e.g., linking to their school, university and places of employment), philosophy (e.g., religion, political views), information about their interests in the arts/entertainment, sports or other activities, and their contact details (e.g., address, phone number). McGannon and Hurley (2009) found that more than half of United States Air Force personnel posting to MySpace in 2007 (before the advent of location-aware tools) gave away enough information about themselves in their public profile to make themselves vulnerable in terms of being targeted for attack.

\(^ {15}\) Many other social networking sites revolving around specific interests and hobbies, or around dating exist but have not been considered as part of this report.
Users also have the option to request and accept friendships of other users, to join interest groups or networks, and to communicate with others by sending messages to their mailbox, utilising instant messaging, ‘poking’ other users (interacting with them without specific semantic content to convey), and commenting on others’ profiles. Until recently, there has been limited research on social networking sites such as Facebook. However, over the past 12 months there has been increase in the number of peer-reviewed articles appearing in the literature (ScienceDirect returned 65 hits for 2006 versus almost 900 for 2010, using the search term “Facebook”). These studies have examined a broad range of topics including how individuals use Facebook (Chung, Chui & Lee, 2010; Ryan & Xenos, 2011), what their motivations are for engaging with others online (Ross, Orr, Sisic, Arsenault, Simmering & Orr, 2011), and what psychological factors influence their style of Facebook usage (Amichai-Hamburger & Vinitzky, 2010; Carpenter, Green & LaFlamm, 2011; Ryan & Xenos, 2011; Zhong, Hardin & Sun, 2011). While there have been mixed results in terms of personality factors relating to Facebook use, preliminary data from a study at Swinburne University (Skues et al., 2010) suggest that the Facebook Wall (a personalised profile area, which is usually made accessible to friends for an individual to share messages and information) is the preferred Facebook tool, and that Narcissism is the main personality variable that differentiates people reporting high use of Facebook from those reporting low use. People scoring higher on extraversion had more Facebook ‘friends’ and were in more groups than others, but extraversion was not associated with more time spent on Facebook (Skues et al., 2010).

Factors governing the use of Facebook and other social networking sites are the subject of much current research, and there is a strong need for guidance on protocols for use of social media. The United States Army’s Online and Social Media division has published a comprehensive guide to social media best practices (Online and Social Media Division, 2009).

While Facebook is predominantly a site for personal interaction with friends, it is also increasingly used for marketing and information dissemination through Fan pages. Janson Communications (2010) undertook a study to evaluate the content of military Facebook pages, noting that while many military organisations have Facebook Fan pages, the majority of these have no interactions with their fans. The study found uptake of Facebook within the military is high, but administrators need to make more effort to “interact with their fans, answer questions in a timely manner and use the pages to build advocacy for their missions” (Janson Communications, 2010, p15).

**Twitter**

Twitter is a microblogging service that offers a different type of social network service from Facebook and MySpace, somewhere between a social network and a news service (Kwak, Kee, Park & Moon, 2010). As of July 2009, it boasts more than 41 million users (Kwak et al., 2010), who can tweet about any topic, so long as they remain within the 140-character tweet length limit.
Tweets are designed to be brief and topical, and people can follow other people (have their tweets sent to them) or can interact via the Twitter website. Twitter tracks phrases, words and “hashtags” (a hash followed by a brief topic label e.g., #topic) to identify Twitter topics, and keeps a list of the top ten “Trending Topics” on the default user home page. Twitter users keep brief profiles about themselves (including full name, location, webpage and a short biography), the number of tweets, and network links (people they follow, people who follow them). In addition to tweeting their own messages, Twitter users can also retweet messages from someone they follow to their own followers. In this way, Twitter allows for rapid information diffusion through a social network. The concept of microblogging (pushing out small amounts of information with transient temporal relevance) uses the social network as a vehicle for information flow, rather than as a vehicle for strengthening interpersonal bonds, although anecdotal evidence through conversations with colleagues is that some use Twitter in preference to other forms of communication as a channel for conversations with friends. Kwak et al. (2010) have explored the nature of relationships and the rate of information diffusion through the “Twittersphere” and note that there will be much further research on using Twitter to explore the nature of information cascade and information diffusion through different types of social networks.

**FACEBOOK AND TWITTER**

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<th>ADVANTAGES</th>
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<td>• Ubiquitous instantaneous access to vast network of people</td>
<td>• What is the role of social media in a training context?</td>
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<tr>
<td>• Instant access to breaking news and conditions “on the ground”</td>
<td>• How will social media impact on the future work environment?</td>
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<tr>
<td>• Lack of verification of information</td>
<td>• What forms of border security will be needed when secure perimeters cannot be</td>
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<td>• Often very low signal-to-noise ratio</td>
<td>readily defined and patrolled in spatial terms (e.g., virtual presence of</td>
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<td>• Blurred boundaries between social, educational, family, work and</td>
<td>unauthorised personnel)</td>
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<td>entertainment contexts.</td>
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<th>DISADVANTAGES</th>
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<tr>
<td>• Ubiquitous instantaneous access to vast network of people</td>
<td>• How does co-presence versus co-location and synchronous versus asynchronous</td>
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<tr>
<td>• Lack of verification of information</td>
<td>communication impact on social, educational and work interactions?</td>
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<tr>
<td>• Often very low signal-to-noise ratio</td>
<td>• What is the difference between social interaction and information flow?</td>
</tr>
<tr>
<td>• Blurred boundaries between social, educational, family, work and</td>
<td>• How and why do people engage with social media, and with people via social media?</td>
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<td>entertainment contexts.</td>
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iPhones, iPads, Kindles, Handheld Games

Portable Digital Devices (PDDs) cover a broad spectrum of devices ranging from mobile phones, through music players, digital cameras, GPS and maps, eBook readers, to a suite of multipurpose devices such as computers, iPads and smartphones. The rapid rate of improvement in technology and capability is nothing short of astonishing, and it is not useful to discuss specific devices in any detail, as they are likely to have become outdated within the next five years. Key considerations regarding PDDs in the context of military flying training relate to: (1) issues of portability versus robustness; and (2) data security and integrity versus ease of use. For many devices, there are deep-seated security issues relating to reliance on access to networked information and location-based services (e.g., Social Media Division, OCPAP, n.d.). There are also issues relating to the quality of information integrated from multiple sources, particularly when algorithms used to fill in missing data are not made visible to the user. The pros and cons of single-purpose dedicated devices compared with multipurpose flexible devices need also to be considered.

As has been discussed at length elsewhere in this report, digital natives have grown up surrounded by technology and the majority of young Australian teenagers own PDDs such as mobile phones, music players and digital cameras (Snyder et al., 2008). Given the ubiquity of PDDs in their lives, the expectations of students regarding use of portable and personal technology need to be managed appropriately. This is not to say that student expectations should be met as a matter of course, but rather, that students should be adequately prepared for the availability or restriction on PDD use during training, operations, and in social contexts.

PDDs offer a range of opportunities for training innovation. Quinn (2011) describes the use of iPods and iPads as platforms for delivering language and cultural training to troops both pre-deployment and in theatre. The mobile device tends to be used differently from PC-based training using the same training package, in that trainees are much more inclined to use mobile devices intermittently when they have time, rather than needing to be tied to the computer for a set period of time. Factors deserving further study are the effect of more limited software interfaces (e.g., at the time of writing, the mobile devices did not have speech recognition interfaces for some of the training exercises and used video clips instead) versus easier access in terms of place and time of training using mobile platforms. One point to note is that soldiers expressed a wish that they could have the training materials on their personal iPods (rather than on army-issued iPods used exclusively for training), emphasising the sense of personal ownership invested in PDDs and the need to be clear about boundaries between work and play. Another point warranting closer examination is the fact that mobile devices are used intermittently when there is time between other tasks. Does this mean that learning is being undertaken in inherently dual-task or multitask
conditions? Such conditions are known to promote learning at a more implicit and automated level, which may be optimal for language learning, but less optimal for some other tasks.

The use of personal digital devices in training contexts and social contexts deserves closer examination, in terms of how attentional resources are allocated to information, navigation and information processing via small screens, and how the use of multiple digital devices in the workplace interacts with multitasking capabilities and preferences. For example, Bowman, Levine, Waite and Gendron (2010) report that, while students who multitask while undertaking an academic task perform as well as those who focus only on the task at hand, they do so at the cost of taking longer. The literature on polychronicity (preference for interleaving multiple tasks over completing tasks sequentially, Kaufman-Scarborough & Lindquist, 1999; Poposki & Oswald, 2010) and cultural influences on allocation of attention (e.g., Nisbett, 2003; Nisbett & Masuda, 2003) deserves closer examination (Konig, Buhner & Murling, 2005). Given the suggested influence of portable digital devices on our sense of space and time, cross-cultural studies of polychronic versus monochronic cultures provide an evidence base to inform us on the projected effects of the new digital culture in predominantly monochronic societies such as Australia. Military flying training involves integrating information from many digital sensors and devices, and communication across a range of co-located and remote channels. Situational awareness may rest on a capacity for polychronic behaviour within an intrinsically monochronic context.

There is a wide variety of PDDs available and a major attraction is that they allow access to capabilities and services irrespective of location. The downside of PDDs, particularly when combined with access to social media and geotagging, is that in as many ways as they can be used, they can also be misused. Media reports in recent weeks have demonstrated some of the serious issues for security and privacy posed by the combination of PDDs and social media. For example, a young Air Force cadet was broadcast via Skype engaging in compromising behaviours, and still images of the same incident were distributed to third parties via the internet (http://www.theage.com.au/national/defence-in-sexweb-scandal-20110405-1d2wu.html). A youngster was retaliating against a bully in a video that went viral on YouTube (http://www.abc.net.au/news/stories/2011/03/16/3165182.htm). While these incidents relate to social behaviours, they could just as easily have related to matters of security – the overriding issue is that once information is released into cyberspace, it is beyond the direct control of individuals or organisations, irrespective of their claims to ownership of the information. Dauber (2009) evaluates the role PDDs such as smart phones with built-in video cameras connected to YouTube and other forms of social media in changing the nature of warfare. The YouTube War allows rapid and widespread dissemination of information (such as publicising terrorist propaganda and terrorist attacks, with or without additional Photoshop effects) without any dependence on the traditional media organisations.
At the more personal level, McGannon and Hurley (2009) discuss the “dark side of social media”, and the Social Media Division at the Pentagon offer guidelines to avoid some of the pitfalls of using PDDs in combination with social media.

### SMART PHONES, iPADS, PSPs

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<tr>
<th>ADVANTAGES</th>
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<td>• Portable and personal digital devices</td>
<td>• Many functions available on devices but security and privacy implications not fully understood by users</td>
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<td>• Large quantity of searchable information locally</td>
<td>• Are COTS or MOTS portable devices robust enough to be Electronic Flight Bags?</td>
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<td>• Access to information networks wirelessly and through 3G</td>
<td>• Swiss Army knife versus dedicated tools?</td>
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<td>• Synchronisation and updating of data</td>
<td>• Proprietary, commodity, specialist – is there a need for certification</td>
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<th>DISADVANTAGES</th>
<th>AREAS FOR FUTURE RESEARCH</th>
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<td>• Lack of security of devices and of network access</td>
<td>• How do people identify “work tools” from “entertainment tools”?</td>
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<td>• Provides a lot of traceable data</td>
<td>• Are there any problems with the blurring of contextual boundaries and social spaces?</td>
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<td></td>
<td>• What are the attentional resources required for use of different types of interfaces?</td>
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<td>• What is the physical robustness of different types of interfaces?</td>
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Conclusions

Concluding remarks

The most significant change arising from new digital technologies is the release from constraints of time and space in terms of communication and interaction. Yet a rigorous adherence to the constraints of time and space remains critical to military operations. The interplay between cultures based on polychronicity (preference for task-switching between multiple tasks, a sense that time is continuous and with no particular structure) versus monochronicity (preference for completing tasks sequentially, a sense that time is discrete and comprises distinct elements in a structured sequence) may be an important area for future study. Digital technology may precipitate a change in the dominant culture with respect to polychronicity. From a military perspective, Sheffer (2007) notes that, like the teenage digital culture, terrorist and guerrilla tactics are agile with respect to communications over time and space. Sheffer proposes that a study of teenage communication culture may inform an understanding of how terrorists gain and maintain situational awareness.

The use of portable digital devices for texting and sending images challenge traditional views of language and communication. An increased use of images suggests that visual literacies (learning to extract meaning from images) will have a part to play in future training. Facebook, Twitter and mobile phone messages provide a vast amount of data for analysing changes in language and culture, especially in terms of their capacity to capture transient conversations in a static form and to use visual images in communication. The effects of digital technologies on language and culture help explain the focus of the report.

Future research

The research team at Swinburne University of Technology\(^{16}\) have identified three of the most pressing areas of research to inform a training and education agenda in the 21st century. This overall program of research is in the cognitive sciences and focuses on attentional processes and learning strategies for a digital culture. The underlying theme across the three research projects is the study effortful and effortless attention, spatial and temporal aspects of communication and interaction, and learning strategies for mastery and the development of domain specific expertise.

\(^{16}\) Researchers include Dr Lisa Wise, Dr Ben Williams, Dr Jason Skues and Dr Lorraine Fleckhammer, from the Psychology discipline area.
Literacies and learning strategies for the digital age

The main aim of this research is to identify learning strategies to support people from a diverse range of socio-economic and educational backgrounds to learn within a digital culture. In particular, the aim is to identify the nature of literacies for the 21st century and provide a program of training to provide people with appropriate learning skills before they progress to discipline-specific studies. There are two projects currently underway:

- Identifying information literacy, multimedia literacies, numeracy, critical thinking, discipline-specific literacies for the digital generation
- Feedforward versus feedback in assessment.

Attentional processes and training strategies to develop expert skilled performance

- Studies of instrument scanning to examine perceptual learning effects and their potential in terms of designing efficient training tools17
- Martial arts as a model system for the study of effects of cueing, repetition, development of spatio-temporal awareness and focal versus peripheral attention

Psychological and social factors affecting use of social media

- Facebook study, looking at personality factors affecting Facebook use.

17 This research is being undertaken in collaboration with Dr Greg McLean from DSTO Fisherman’s Bend.
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Monash University.


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