



CREATIVE SCIENCE
FOUNDATION

Creative Science 2013 (CS'13)

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How Might Future Technologies Change the Nature of Education?

Creative Science 2013 (CS'13) is the *third* in a series of workshops that have explored the use of science fiction to motivate and direct research into new high-tech products, environments and lifestyles. In particular these workshops have sought to apply a methodology called *Science-Fiction Prototyping (SFP)*, a practice developed by the Intel Futurist Brian Johnson, to serve as prototypes to explore a wide variety of possible futures. This workshop differs to earlier workshops in that it has sought to use SFPs as a means to *explore, inform, and influence future scientific research and development in education*, with a *special emphasis on immersive education* (the focus of the host conference). The workshop was structured around a series of presentations and discussions, the first being a welcome by Professor Callaghan who explained the ideas underpinning SFPs and paraphrased the aim of the workshop in somewhat stark terms as, “*can we identify what technologies might spell the end of schools and universities as we know them?*”! He motivated this theme by pointing back at different moments in history where various major organisations and companies seemed unassailable only to eventually fall (or, at least, lose their dominance) by the advent of new and disruptive technologies. A few notable examples were cited, such as the role of microcomputers in unseating IBM & DEC, how digital photonics took Kodak by surprise, the way the Internet obsoleted the business plans of Blockbuster and Borders, how smart-phones wrong-footed Nokia” and noted that current industry giants, such as Microsoft, struggle to survive the effects of technology and societal changes. *Could the same happen to education, and where might those threats come from?* In effect, this is what the CS'13 workshop is considering. Of course, online immersive reality technologies (the focus of the host conference) are, potentially, one such disruptive technology! The organisers would have been happy for this workshop to provide a comprehensive insight to such questions but they are pragmatists and know that, from such a small workshop (and with such a variety of SFP aims and styles), that this was unrealistic, so the aims were more modest, simply to begin a conversation and, perhaps, decide whether future events based on SFP would be useful as a language and mechanism to discuss (and take a hand in) the future direction of education.

Towards those ends the workshop consisted of *one* keynote talk and *six* peer-reviewed Science Fiction prototypes (SFPs). The keynote talk was delivered by *Brian David Johnson*, a Futurist and Principal Engineer at Intel Labs, who devised the *Science Fiction Prototyping* methodology. Brian's talk "*How to build the future?*" explained how futurecasting works; using social science, technical research, statistical data and fiction can be used to create pragmatic models for a future that he said he hoped researchers would be able to start building today. Brian also introduced innovations to education based on the “*Maker Movement*”, a new type of crowd driven education (that combines students, educators and companies); see an introduction in an earlier SFP [http://victor.callaghan.info/publications/2013_CoT13\(MakerFables\).pdf](http://victor.callaghan.info/publications/2013_CoT13(MakerFables).pdf). Following Brian's talk a set of six peer-reviewed SFPs were presented by authors drawn from a diverse set of disciplines including education, computing and business. The first presentation, “*The Turing Shroud*” was from Jim Hensman (Coventry University) and

Ian Upton (*Get-Real Solutions Ltd*) and considered how technology, in the form of a concept called “SurroundMind” (which could be regarded as equivalent to a very sophisticated brain interface) can be used to enable the internal mental configurations of individuals to be externalised and communicated so as to allow collective intelligence, perception and consciousness to be realised in a group setting that could, in turn, have dramatic impacts on the nature of education. The second presentation, *Stories of the Virtual Mind*, from Anasol Pena-Rios (Essex University), Emmanuel Ferreyra-Olivares (Fundación Universitaria) and Alejandra Pena-Rios (Universidad del Valle de México) explored the use of technology implanted into a person’s brain to capture, preserve and transfer knowledge, in the form of experiences, from one individual to another creating the possibility for “programming human brains” in an accelerated manner using mixed reality environments. The third presentation, “*Storyweavers*”, by Carlos Sanchez-Lozano (Freelance Designer) imagined that nanobots, implanted in people’s bodies, might enable the modification of brain and body signals, creating virtual worlds that would blend with or entirely replace reality requiring teachers to translate knowledge, experience and expertise into fully immersive stories. The fourth presentation, “*Ureka Potential*” by Paul McCullagh (University of Ulster) explored the possibility that advanced technologies, such as electrophysiology and brain interfaces, could be used to monitor and signal cognition and acquisition of knowledge or understanding thereby, for example, ushering in some radically new ways of assessment in education. The fifth presentation, “*Science Fiction Prototypes in Educational and Business Settings*”, by Gordon Fletcher (University of Salford), Anita Greenhill (Manchester Business School), Marie Griffiths (University of Salford), Rachel McLean (Liverpool John Moores University)” examined the workings of Science Fiction Prototypes (SFP) in business education, which they explained has been largely delivered within classroom style workshops, and proposed a modified form called “*an expansion event*” that would seek to reach out to issues and roots beyond the academic classroom, thereby creating a more pragmatic and effective business innovation and planning tool. The final SFP presentation, “*The Dream Machine*” was from Victor Callaghan (Essex University) and included two fictional scenarios, “*The Education Pill*” and “*Plug and Learn*” that explored a post singularity world where brain augmentation enabled “learning free, education”.

Given the central role of the human brain as a repository of knowledge and sensory experience it is, perhaps, not surprising to discover that five of the six SFPs in this workshop concerned storylines describing technology that operated on student’s brains (if only that was available now, we hear some of the teachers amongst you shouting!)

Finally, it remains only to thank all those that have contributed to the success of this workshop. Firstly, we would like to acknowledge the valuable contribution of the host conference team whose support and advice throughout the year has contributed greatly to the success of this event. Most importantly, we want to thank the authors as, without their outstanding work, imagination, and commitment to writing these visionary SFPs, there would be no workshop. Thus, on behalf of the organisers and all those people who have enjoyed reading these SFPs, thank you!

16th November 2013

PS If these science fiction prototypes have inspired you, why not write one yourself and join us at our next Creative Science event (see creative-science.org for details)

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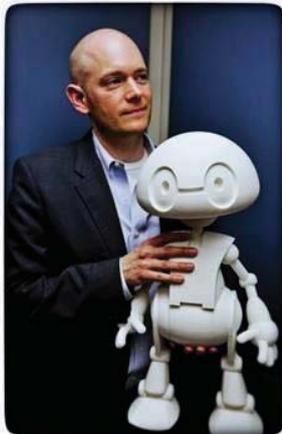
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Creative-Science 2013 KEYNOTE

Brian David Johnson
Intel Corporation



How to build the future?



Brief Biography:

The future is Brian David Johnson's business. As a futurist at Intel Corporation, his charter is to develop an actionable 10 -15 year vision for the future of technology. His work is called "futurecasting"-using ethnographic field studies, technology research, trend data, and even science fiction to provide Intel with a pragmatic vision of consumers and computing. Along with reinventing TV, Johnson has been pioneering development in artificial intelligence, robotics, and using science fiction as a design tool. He speaks and writes extensively about future technologies in articles (The Wall Street Journal, Slate, IEEE Computer) and both science fiction and fact books (Vintage Tomorrows, Science Fiction Prototyping: Designing the Future with

Science Fiction, Screen Future: The Future of Entertainment Computing and the Devices we Love, and Fake Plastic Love). Johnson lectures around the world and teaches as a professor at The University of Washington and The California College of the Arts MBA program. He appears regularly on Bloomberg TV, PBS, FOX News, and the Discovery Channel and has been featured in Scientific American, The Technology Review, Forbes, INC, and Popular Science. He has directed two feature films and is an illustrator and commissioned painter.

Synopsis of Talk:

What kind of future do you want to live in? What futures should we avoid? What will it feel like to be a human in the year 2020 and beyond? Intel's Futurist Brian David Johnson explores his futurecasting work; using social science, technical research, statistical data and even science fiction to create pragmatic models for a future that we can start building today. In the next decade it will be possible to turn anything into a computer and participate in truly immersive education experiences. We will be living in a world where we are surrounded by computational intelligence. Join Johnson as he explores what that means for the future and how can we envision our tomorrows so that we can start building them today. It is possible to change the future and it's simpler than you might think.

The Turing Shroud

Jim HENSMAN^{1,a} and Ian UPTON^{2,b}

^a *Serious Games Institute, Coventry University*

^b *Get-Real Solutions Ltd.*

Abstract. Immersive environments, by merging physical and virtual experiences, allow both local and online participants to meet and collaborate, as well as allowing thoughts and ideas to be collaboratively viewed, discussed and interacted with. Current developments make possible the extending of these environments to incorporate all the senses and increasingly include the use of direct interfaces to the brain. The Science Fiction Prototype uses a story about an attempt to explore the life of the scientist, Alan Turing, to envisage a future where developments of these techniques allows the implementation of systems that can create and recreate past and present reality as authentic collective experiences that can transform the nature of learning, research and life generally.

Keywords. Science fiction, Immersive environments, Virtual worlds, Collective intelligence, Brain computer interface, Interdisciplinary research, Alan Turing

1. Introduction

“The Turing Shroud” explores the possibilities that could arise in the future in learning and other areas through collective intelligence and the contribution of immersive environments and experiences to this. Attention is often focused on the potential of computers and other technologies. The intention is not to ignore this, but to consider their impact together with and in the facilitation of people thinking, learning and working together. Specialisation and its attendant knowledge and organisational silos and barriers, whether it is related to learning, research or work, often limits and restricts our potential. Technology and technique can however be used to help overcome these limitations and barriers as well, facilitating collaborative activity and work across disciplinary boundaries. In the same way that a brain is more than the sum of its individual neurons, so too the collective brain has enormous potential if its power can be harnessed. This Science Fiction Prototype is about some of these possibilities, illustrated and explored in a rather unusual context.

2. Background

2.1. Current Systems

Work by the authors relating to the theme of the story was carried out under several projects over a number of years, both individually and together. Virtual worlds have

¹ Jim Hensman (Corresponding Author), E-mail: j.hensman@coventry.ac.uk

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recognition in some cases, together with information from text messages and social media. Some of the tools mentioned earlier and others interface to the visualisation system through web services to generate new concepts based on the expertise of the participants, visually linking similar concepts together, and allowing collective filtering of ideas through user interaction. A video of the system in operation is available⁶.

Immersive space techniques like this have been used for many different purposes. One system⁷ using a variation of the technology was used for crowdsourcing, in particular for obtaining public feedback about a major activity being developed for the 2012 Olympics. It was part of a physical event held over three days and provided a visualisation, in a virtual space that mirrored the physical surroundings, of a word cloud - including texts from mobile phones, Twitter and e-mail contributions that people made locally, as well as allowing similar contributions remotely. Another system, called Insert/Extract⁸ (see Figure 2), was part of a 3-D immersive installation set up in a Museum, that allowed users to interact with avatars in a very natural way, with added facilities for people in the physical world to appear in the virtual world and vice versa. Many thousands of members of the public participated in this and it demonstrated how easily people, particularly children, adapted to this environment, with important lessons for its potential use in learning.

2.2. *The Future - SurroundMind*

Immersive systems such as the ones described here to facilitate collective thinking are intended to form a small part of a very general and long-term objective to consider how the internal mental configurations of individuals can be externalised and communicated using all the senses to allow collective intelligence, perception and consciousness to be realised in a group setting. This concept, which has been given the title "SurroundMind" in an allusion to the audio system called SurroundSound, in its widest sense is what the story which is part of this Science Fiction prototype aims to depict. It is obviously something that can only be realistically considered very much in the future. However, a number of aspects of it can be seen at the present time, even if in rudimentary form.

The VRE work carried out by the authors described above falls broadly into the category known as knowledge visualisation [2], which is related to but can be distinguished from information visualisation. Other senses in addition to the visual need to be included and integrated to provide additional sensory inputs and outputs. For example, music and sound can have a powerful effect on emotional state and thus in conveying emotional information. Considerable research is taking place into algorithmic methods to implement this [3]. Other senses also have a role to play. For instance, the well-known VARK classification of learning styles [4], considers the kinaesthetic sense as being of key relevance to learning. Brain interfaces are of course still at an early stage of development, although some developments referred to in the story, such as controlling the narrative of virtual world based soap operas through a direct brain interface, are factually based [5].

⁶ vimeo.com/49155054

⁷ vimeo.com/15598938

⁸ vimeo.com/58571590

3. The Story

3.1. Prologue

The man in the white coat sounded anxious, “Look, Prof, I know you’ve been given special approval, but we’ve not done anything quite like this before. We don’t know whether we’ll be able to get you back to the way you are now. At least let us keep the emergency emotional level cut-outs on in case we detect something potentially dangerous”.

“No safety nets”, Jeff Lee said firmly, “and if I come back as I was, I probably wouldn’t have learnt anything”.

Today he would get into the mind of Alan Turing. It was a risk worth taking. He smiled at his two younger colleagues, Maria and Cheng. He could see they were nervous, even though they were trying to hide it. What he was doing was a day-to-day part of learning and research, not to mention leisure, using what were generally referred to as “Experiences”. But two things were different.

“It would not normally be allowed with someone who committed suicide”, the ethics adviser had said when he had first raised this.

“That’s disputed”, he had insisted, “and maybe this is the only way to find out”. But Jeff had his misgivings as well.

What was completely unknown though was something else. Two years previously, among some household items being auctioned, some letters had turned up, supposedly written by Alan Turing towards the end of his life. Most mysterious were pages with series of numbers on, that been found together with them. These had been expected to be some sort of encrypted writing, but even the best quantum computer crackers had got nowhere with them. But various analyses established that the numbers were not random, that there was probably meaningful information there. Some scientists speculated that it could be a computer program of some kind, perhaps for some device that had not yet been invented. Of course this had further inflamed the controversy about whether the letters had been genuine or not - and had led to intense media interest around what had been called the “Turing Shroud”, after the crucifixion relic. If this had been anyone else, the number data would have been strong evidence that it had all been a forgery. But this was the man who had invented computing itself. The man some of whose security related papers were considered so far advanced that they were not declassified till over 70 years after he wrote them. He had also worked extensively on biological systems. What if he had discovered some general principles in this area equivalent to the Universal Turing Machine he devised that could carry out any computation? What if he had been able to represent something, perhaps about himself, which could only be implemented in a system in the future and left this for posterity? The trouble was that the only way to really find out was by what Jeff was going to do. And that was something he had to admit to himself, he wasn’t entirely comfortable with. As the final preparations were being made, he thought of how he had got there.

3.2. Jeff’s Story

When Jeff was starting out as a graduate student, there were high expectations of the impending “technological singularity”, when computers would pass the point where they would surpass human intelligence - with consequences difficult to envisage. But

there were sceptics as well, one of whom, Joseph Gratsky, was to become Jeff's mentor and shape his future career. He remembered Gratsky's virtuoso performance in a packed out lecture hall. "This humble device I have here", he said, holding up an antique device few of them had ever seen, "is one of the first pocket calculators". "The chip it uses", he added, opening up the device, "is so simple that it was once issued in a single bit version. So only marginally more intelligent than some of my more vociferous critics". This always went down well - everyone knew who he was talking about. "But it still was faster in what it did than any human past or present. Very significant, but no singularity. Fast forward to 1997 when a computer beats the world chess champion. Still no singularity. Today we have reached computing power difficult to even imagine then. But the principle is the same. The philosopher, Thomas Nagel, wrote a famous paper entitled, 'What is it Like to be a Bat?' With all our intelligence, this is something we cannot know. Similarly computers, for all their intelligence, cannot imagine what it is to be like humans."

Gratsky of course had not been a technological sceptic, far from it. What he had argued for had been the development of collective human intelligence, augmented and facilitated by machines. Was it machines augmenting humans or the other way round? This had been one of the questions often posed. Jeff, as he had continued his own research, had been happy to consider this an open question. He had even entitled one of his courses, "Humans and Computers – Is There a Them and Us?" What was beyond dispute, was that the combined intelligence and creativity of human-kind and machine-kind together, finding the best combinations and synergies to solve problems and expand knowledge, had demonstrated what could certainly be described as a singularity. Jeff wondered whether some of the questions now being answered could have even been imagined a generation earlier.

He began to feel the effect of the equipment taking hold and closed his eyes. Soon he would be in a mental state similar to lucid dreaming, where he would be in a dreamlike state but still be aware of this and with some conscious control over it. Some people had a natural ability to go into this state, but now it was part of education generally from an early age and with suitable equipment very easy to do and used widely in many ways. Jeff felt a sense of extreme anticipation, but also through his detached self knew what he was feeling - a peculiar sensation. He wondered whether Maria and Cheng could see the smile he had on his face in his internal world.

3.3. Cheng's Story

Cheng had been fascinated by the work that Jeff was doing even as a child. When he was given the opportunity to work in one of Jeff's teams, he was very pleased. Developing techniques for collective intelligence and better interfaces between humans and computers had gone hand in hand, each building on the other. In the past, work on virtual environments for learning and research, combined with knowledge about factors in physical spaces that supported creativity, had led to the increased adoption of composite environments that facilitated different aspects of collaborative working. An important part of this related to immersive spaces which merged the physical and the virtual, allowing physical meetings in one or more locations to be enhanced and facilitated through features in virtual space, which used interactions through all the senses to support collective thinking and learning. These multisensory collective

environments had increasingly also utilised brain computer interfaces. The original large and unwieldy FMRI devices for real-time analysis of brain patterns had become increasingly more portable and precise, utilising nanotechnology and related techniques. Together with massively increased computing power, brain activity and corresponding mental states and thoughts could be increasingly analysed and correlated even down to individual neuron levels in some cases.

The other side of the equation, how to directly alter what was happening in the brain, was more difficult, and he was particularly proud of the work he had been able to contribute to in taking this forward. Jeff had explained the principles of this to him the first time they met. "Evolution has developed sophisticated interfaces to our brain over millions of years through our senses. So our five senses and others, such as our kinaesthetic sense, will always be the starting point when we look at how to influence what's going on up here. But we had got an idea of what was possible a long time ago. As you know, individuals who had brain injuries which left them severely disabled in one or more of their faculties have been able to recover them through other parts of the brain taking over the required functions. So we know the brain has a surprising degree of plasticity. It was the work I did on prosthetic devices when I was starting out that made me realise how much further this could go. Some of the pioneers of devices such as cochlear implants didn't initially believe what they were doing would be possible."

"My father was profoundly deaf and had one of those", Cheng interjected, "and I know we took the technology for granted by then. But I can remember being puzzled when I first started thinking about it."

"Yes", Jeff said, "the key question was how electrical signals generated by sound could be connected to the brain's auditory system. In the early days particularly, the resolution of the sensors used was very coarse, and the connections made almost random. Yet the brain was able to adapt and learn over a period of time and users were able to recover surprisingly sophisticated powers of hearing. As devices and our ability to monitor the brain got better we were able to improve the quality and the learning process dramatically to what we have today, where we can effectively restore normal hearing as well as sight and other senses. Of course that work was just a start in a way, because we also wanted to be able to connect to higher order mechanisms - thoughts, feelings and emotions."

Since Cheng had started working with Jeff, things had moved a lot further. Wearing comprehensive augmented sensory interfaces, such as active contact lenses for vision, was now as normal as wearing clothes. In fact a common product slogan was "I feel naked without my ...", for whatever device was being promoted. A brain interface was now an easily attachable external device, normally hidden under the hair - although also available as a fashion accessory. All the interfaces were seamlessly integrated to provide an experience that could blend the physical with the virtual to the requisite degree depending on the particular requirement. You could have your normal physical experience subtly augmented with appropriate information, or have an experience that was effectively completely virtual, using different states suitable for what was required. This could be anything from what would seem to be a dream, through lucid dreams, to one's where you were fully awake but all your sensory interfaces controlled virtually. The direct brain interface could also be used in different ways depending on the requirement. This could be from selecting options and controlling communication and other devices, to facilitating complex collective

experiences. Cheng was an extreme sports enthusiast and in developments he had been involved with in this area was able to combine both his work and leisure interests. Using smart reactive clothing together with the sensory and brain interfaces, it was possible to simulate these experiences to a high degree. This meant, for instance, that the friends he went skydiving with could each experience in their own location all the interactions of a group skydive. Of course, although this was an exciting experience in its own right, they used it primarily to develop their skills for when they came together to do it in real life. Where some of these new developments really came into their own was in learning, and this was an area Cheng felt that had been most transformed by the work he was part of.

3.4. Maria's Story

Maria had started working as a teacher in her own country and been sent on a course to learn about some of the new techniques being introduced. As part of this, there had been a special lecture on the future of learning. That was where she met Jeff Lee and got fascinated in what he was doing. Experiential learning, aiming to provide learning experiences in as authentic real-world settings as possible, was the norm at all levels of education. This used the kinds of technology Jeff was working on to augment the experience and support learning. As the technology advanced, virtual experiences, including using brain interfaces and dreamlike states, were also increasingly used. But from her own use of these in teaching, Maria wasn't sure whether they were always as effective as intended. She quizzed Jeff about this after his talk.

"Even with all the personalisation features, the systems seem to work better with some kids than others. Sometimes it's not just about ability, more about interest and motivation."

Jeff nodded his head. "You have hit on one of the key areas we're trying to address. As you know, game-based learning is a key element in all education now. This uses the fact that gameplay is instinctive and one of the key ways we learn from birth. There was a time when some people seemed to believe that there was some kind of cut-off point after which it was no longer important for learning, but of course it is important at any age and now a key part of education at every level. But we acquire other motivations and interests as we grow up, which associate emotions with different activities, including learning. This can be negative or positive in various degrees, and is affected by a whole raft of things, cultural, familial, peer influenced, and so on. How we can use some of the new brain interface developments to work with this is a key focus area for us."

"It also seems easier to apply the systems to some subjects compared to others", Maria continued.

"You're also right there", Jeff added, "we would love to be able to help create a few new Shakespeares or Mozarts for instance, but we're not as far advanced in areas like that."

This had got Maria thinking, and led eventually to the path which would take her to where she was now, working with Jeff in this area. There had been work going back many years which had identified emotional states based on brain monitoring in real time which had been used to modify user experiences. Maria smiled when she thought of early experiments she had read about that controlled the narrative of virtual world-based soap operas this way. But it worked, and further developments had led to

increasingly sophisticated applications, including in learning. Live action role play, where participants enacted different scenarios had become very popular in both entertainment and learning and newly developing combinations of virtual and physical experiences were able to take this further. Advances in interfaces to directly influence the brain could enhance what was done through sensory input, but also go in new directions. One of these was in influencing emotional state, which had become a major field of work with applications in every area from medicine to entertainment. Some of the work in the earlier days was inevitably controversial, and Maria remembered the heated discussions she had with her flat mate at that time, Sophia.

“So let me get this straight, you want to reinforce positive emotions associated with learning. Isn't that very ... behaviourist. You know, you give the rat an electric shock if it's doing it wrong and a piece of cheese if it gets it right.”

Maria laughed, “If only it was as simple as that. Emotion got bound up with thinking very early in evolutionary history. Emotional correlates with things like learning are incredibly complex and learning itself has many different aspects. The overall aim is to get the student to want to learn, to find what they associate with a good experience and then work on linking that to what they feel about learning.”

Maria had been originally teaching in the area of the humanities and this now also formed a focus for her research. Because work in this area concentrated on generic factors, such as creativity, this also had a major impact on learning experiences in other disciplines, as well as in environments for research and more generally. Distinctions between different disciplines were increasingly blurred as concepts and methods that went beyond traditional boundaries increasingly became the focus for learning and research. The distinctions between learning and life generally also had changed dramatically. For a long time most learning had to take place after anyone's formal period of education, but now the concept of lifelong learning had an even more fundamental importance and learning had to be intimately integrated into work and all aspects of living. This was not a passive process - the aim was that people would contribute to the creation of new knowledge. Every stage of learning was linked to the real world and real problems, so that the transition from formal education to work was mainly a change in emphasis rather than a structural break.

This seamless transition was aided by the varieties of experience that were available. Maria's own research itself was increasingly conducted in a collaborative thinking space which used a variety of different types of experience and included other researchers from a wide variety of areas, students and the public. In fact with regard to the development of knowledge generally, research, learning and public involvement had increasingly merged, with aspects distinct to each, but also many environments where interactions took place between them, which she found very stimulating. Maria particularly liked the free-flowing collective dream experiences where new ideas could be formulated, modified and connected - and using the rapid prototyping facilities integrated into it, tested and evaluated, sometimes all within the same session. Particularly exciting were the new connections that could be made during these activities, often from researchers, research and other areas that would seem to initially have no apparent connection to the subject under discussion. Links could be created which could then sometimes re-divide and redefine the whole topic in a dynamic and developing ecosystem of knowledge. Her own work had often made dramatic changes in direction and scope through this process, and had been enormously aided and

enriched because of it. She also enjoyed participating in sessions of this type initiated by others, which her brain interface would connect her with when she wanted to. These excursions could not just involve thinking and discussion but any area of creative activity - collective art, music, writing or media production, for instance, aided by the wide variety of brain controlled devices that existed.

One area which she had originally got involved with in this way appeared to be a diversion - albeit an interesting one. This was digital biography, which was to have some surprising repercussions for her work. This had originated as just a means of including digital materials within the biographical field, but increasingly the emphasis was not just on finding out about somebody, but getting to know them, and with the development of experiences, this began to include being able to meet them, even if they were no longer alive. This work intersected with role-play gaming where real or hypothetical situations were recreated for players to interact in, with the biographical subject effectively being a simulated non-player character in this genre. But one factor, which affected a wide range of other experiences as well, always acted as a limitation. How could we know what they felt like? If we were part of an experience where we were in the role of someone from that time, it would not be authentic for us to feel, believe and understand like someone from today. This was where some of the more recent work in directly influencing the brain came in. Maria had appeared on a media program, called "Inside the Minds of the Past" explaining this.

"Tell me how I can feel like someone else?", the interviewer asked.

"If I was deaf and used a hearing prosthetic device, it would have simulated what a person without that disability could hear. Now consider what would happen if a spider was put in front of me. I have no problem with spiders, so my emotional arousal signal in relation to fear would be small. But supposing we amplified that signal greatly and stimulated the locations in my brain which aroused fear with it. I would then feel like someone who had a phobia for spiders", Maria replied.

"I presume the aim of this work isn't just to find ways of making us scared."

"In practice, quite the opposite of course. This kind of technique is extensively used in treating phobias. And we can't usually just increase or decrease certain emotions. Sometimes we need very complex translations between different emotions combined with other stimuli", Maria answered.

"What about people from the past. You can't go and stick one of your monitoring devices on Alexander the Great can you?"

"This relies on building up a model based on historical materials and analysis. Of course people had significantly different attitudes and beliefs then, but also similarities. We still read and use the works of Aristotle, who tutored Alexander. We still laugh at the humour of Aristophanes."

The experiences that were now available made learning about the past and across cultures and languages much more authentic and were also extensively used across disciplines. In the sciences it allowed students to take part in the experience of some of the great discoveries and inventions of the past. In geography and related areas, historic explorations could be relived, and so on similarly for other subjects. Experiences could be personalised to fit the prior knowledge, interests and motivation of the students, but were also usually collective. Maria explained this to a group of research students who were about to do their internship as part of her team.

“Our activities, whether at work, at school or at home, are predominantly carried out with other people, so it is sensible that we learn that way as well. We can still tailor things to individuals, but construct collective experiences around these. It’s all part of making the learning experience authentic. But it also teaches students about the mutual benefits they get through learning interactively and collectively with others.”

“What about evaluating individual work?”, someone asked.

“What individuals do within collective experiences are an ideal way to gauge their level of understanding and expertise in real situations. We can design special experiences to evaluate individuals more comprehensively if necessary and even use certain experiences where all the other participants are non-player characters if we need to compare people”, Maria replied.

“How do the experiences take into account people learning at different rates?”, someone queried.

“This is where the techniques we have learnt from games and related areas allow us to dynamically modify scenarios and different individual’s paths through them. Our ability to use feedback from brain interfaces, so that we have independent information about engagement, arousal levels and so on, also means we can adapt various characteristics of situations and environments to optimise learning as we go along. We also include a lot of sophisticated monitoring of various indicators that the individual will not be aware of, but which we as designers can later use to improve the overall system”, Maria answered. Some people also raised ethical concerns. With the increasing power of the devices and techniques being used, many ethical and related questions arose. With the enormous beneficial potential also came it’s obverse. Even with the many safety mechanisms and techniques that existed, there were dangers. Dreamlike experiences were usually restricted to having some kind of lucid constraint, so the subject could exit the experience if they needed to. Getting into the mental state of people with certain disorders or who had exhibited certain behaviours was controlled as far as possible, although doing this with special constraints and safety provisions had also led to major therapeutic advances.

3.5. The Turing Experience

When the news about the Turing find became known, Jeff had been very excited. He had always been fascinated by Turing and his work and had published papers about aspects of Turing’s research - including his famous Turing test to define thinking like a human. Jeff got together with Cheng and Maria to discuss what they would do.

“We don’t even know what the numbers mean”, Cheng said, “there is a risk involved.”

“I don’t mean to pull rank”, said Jeff, “ but because of the risk I can’t allow anyone else in the team to do it first. If it’s OK, then others can try it out.”

“But what if it’s not OK?”, Maria queried.

“Nothing ventured”, Jeff said, trying to sound unconcerned. “This is a unique opportunity. If Turing actually did figure out something, this might dramatically advance the whole area.”

Faced with the challenge, the team had focused on enhancing and extending their systems. The challenge had caught the imagination of some of the best minds around the world and the multidisciplinary team that had been working on the problem had made some key breakthroughs recently which made Jeff feel they were ready to try things out. The fundamental problem was that brains had many similarities but also

major differences, especially at a detailed level. What was needed was a way of detecting the high-level thought patterns from one brain and translating these appropriately for another. Sophisticated techniques based on algebraic topology had been developed that could take into account both the spatial configuration and connectivity of any specific brain as well as information from its neuronal state. This was then abstracted into a form which could be translated, using some of the most powerful processing devices yet devised, to stimulate another brain for which a similar analysis had been carried out. This work already had been responsible for dramatic improvements in experiences used in every field. But Jeff felt this was going to be the crucial test. They didn't have Turing himself there so that they could analyse his brain, so they would have to assume that the numbers in the letters was already in some abstracted form that could be interpreted by Jeff's brain interface. He was sure that the systems they had developed were so powerful that any discernible patterns there would be identified and translated sufficiently for him to understand.

Jeff was now deep into his experience. Both the preparation he had done beforehand as well as the sensory stimuli that had been provided as he went into this state allowed him to move easily - first into the setting of Bletchley Park during World War II and then into the post-World War II world. He knew that the brain detectors would not be using the special data as yet, they would wait till they detected he had reached a suitable point, which he could also influence from his lucid state. He was now in Manchester and visiting Turing in a University building. He felt incredibly intellectually stimulated, with many new ideas coming into his head which he was discussing with Turing. He could also sense a feeling of sadness, although the system had been set to influence his moods as little as possible. Now he was entering a house in Cheshire, which he recognised as where Turing lived. Suddenly he knew the time was right and instinctively felt the change as the data started kicking in. He could see Turing beckoning him into a room. He followed. Suddenly he saw it. For a moment he stood there in amazement, feeling as if everything was real, that he was no longer in a dream and in control. Then the lucid dreaming mechanism re-established itself. He had seen what he needed to see. He started pulling himself out. His surroundings seemed to shrink into the distance. He opened his eyes.

"I don't understand." Cheng scratched his head. "How come we never figured that out?"

"Because we were looking for things like text or program codes", replied Jeff, "we didn't think of images. It also used a type of data compression different to ones we use today, but with some similarities. If Turing was responsible, he probably invented that as well. My brain picked it up immediately of course because it was visual."

"I appreciate the significance of an apple", said Maria, "because that was found by Turing's bed and we know he was fascinated by the story of Snow White and all that. But it wasn't an ordinary apple was it?"

"No", said Jeff, "it filled the whole room. It was like that picture you may have come across by the surrealist, Magritte."

"Where has all of this got us then?", mused Cheng. "We still don't really know whether the data was a forgery or not. And we haven't really got into Turing's mind, have we?"

"Maybe not, but if it was him, he certainly lived up to the sense of humour we know he had," said Jeff laughing.

“But wait a minute”, said Maria, “we might not have found out a lot about Turing, but as a by-product of doing the work triggered off by all this, we have made very significant advances in brain interface systems, which particularly will help us in some of our historical investigations, including undoubtedly understanding Turing better. It’s, as if somehow, he realised that this was the best way to help us. To make a contribution to the knowledge of the future.”

“I certainly wouldn’t put that past him”, said Jeff. They all nodded in agreement.

4. Conclusion

The story has been used to explore how the development of technologies to facilitate and enhance collective experiences and intelligence could transform the nature of learning and other aspects of life - which would be increasingly integrated with learning. There are dangers and challenges associated with these developments which the story also aims to raise. Using a science-fiction scenario is an ideal way to explore possible future developments. Of course things we do today will be part of creating that future, but it is also useful to consider what might be possible, to help determine some of the directions we take now. Developments around the concept of what has been called “SurroundMind” it is felt could act as a bridge from current technologies to the future. Beyond this, exploring and working towards a Science/(Art) of Knowledge, which integrates the different aspects of this area in the way that is projected for the future in the story, would be an important endeavour. The story is set in a time around the last decades of the 21st century. Some of the possibilities presented might seem to stretch what could be achievable by then, but it is only necessary to go the equivalent length of time backwards, to a period when computers didn’t even exist, to sense what could be possible in the future. And of course even envisaging the possibility of computers, which the object of the story, Alan Turing, figured importantly in, was key to their future development. Similarly it is hoped that some of the musings about the future we make now can contribute in some way to their achievement.

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Stories of the virtual mind

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Abstract. The use of virtual worlds and immersive technologies have brought many possibilities for experiencing alternative realities, as some has been used in gaming, medicine or learning. We used this Science Fiction Prototype (SFP) to present a fictitious use of immersive technologies and virtual reality, exploring a futuristic method to learn, described in the story as the concept of “programming information directly into the brain”. In the story the main character explores the idea of using the human senses as input/output devices to exchange information with the world, collecting information from our everyday life (life logging); preserving knowledge and creating a way for accelerated learning through programmed physical experiences created within a mixed reality environment.

Keywords. Science fiction prototype, ubiquitous virtual reality, mixed reality, blended reality, human-machine interface (HMI), experiential learning.

Introduction

Imagine the possibility of learning a different language within minutes or the opportunity of becoming an expert in one subject by loading the information directly into the brain, (similarly to what happens to the protagonist in the film *The Matrix* [1]); or the possibility to capture and preserve all the invaluable untransferable knowledge obtained by experience that specialised professionals, such as surgeons, researchers, etc., possess. This Science Fiction Prototype (SFP) delves into an imaginary world where all the information that goes through the senses is captured by an implant and then it can be recreated using virtual reality and immersive technologies.

1. Background

In this paper we incorporate diverse technologies extending them to a future vision of their possible implementations for learning, using the method of science fiction prototyping [2]. We explore the use of immersive technologies and virtual worlds to propose an unusual method of accelerated learning based on Kolb’s ideas on experiential learning [3]. He suggested that learning can be acquired from grasping concrete experiences in real-world and by creating abstract conceptualization of new

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information, and then transforming this experience using reflective observation and active experimentation. This develops a preferred way of learning, following patterns defined as “learning styles” [4]. Fleming's VARK model extended learning styles based on the channels for input/output information, targeting learning as the final objective. These categories are: visual learners, auditory learners, reading-writing preference learners and kinaesthetic or tactile learners [5]. Based on this, the SFP proposes the use of external stimuli as a way to create physical experiences which accelerate learning by implanting information on the learner's brain. Shibata et al. [6] used “decoded functional magnetic resonance imaging (fMRI) to induce brain activity patterns to match a previously known target state improving performance on visual tasks” [7], inducing “highly selective activity patterns within a brain region, thus allowing the investigator to influence specific functions”. According to them this method “can ‘incept’ one to acquire new learning, skills or memory, or possibly to restore skills or knowledge, which has been damaged through accident, disease or aging, without one's awareness of what is learned or memorized.” [6]. This research explores plasticity in visual areas of the brain generating visual perceptual learning. In our story we extend this to a hypothetical situation where learning can be obtained not only through visual stimulus but using auditory, olfactory and haptic stimuli simultaneously within an immersive environment to acquire learning.

The use of mixed reality virtual environments in education has been implemented in many projects, e.g. [8] [9]. These examples use virtual worlds as an extension of traditional physical classrooms, motivating visual or auditory learners and enabling geographically dispersed students to attend and participate in lectures. In previous works [10] we proposed the use of a blended reality learning environment to perform laboratory activities, using a mixture between tangible user interfaces embodied in real-world objects and virtual devices, enhancing the learning process for kinaesthetic learners. This SFP explores the illusion that virtual worlds can deceive the mind using different stimuli and immersive technology (as presented in videos such as [11]); having as an outcome an enhanced accelerated learning process. Murray et al. [12] presented the use of immersive virtual reality to treat pain, in an experiment similar to the ‘rubber hand illusion’ [13]. They used a virtual world, a Kinect camera and a sensor to track user's head movements to create a virtual image of the patient's amputated arm which was causing him chronic pain. Reportedly, when the user visualized and moved both of his arms in the virtual world using immersive glasses, the pain was reduced [12] [14]. This shows just one of the possibilities of the use of virtual reality and immersive technologies to change brain behaviour and deceive the senses. Some other uses of virtual reality have been related to the treatment of mental disorders such as schizophrenia [15], where avatars used as virtual representations of the voices heard by schizophrenic patients might help them to take control over the hallucinations [16].

Our story delves not only with the possibility of implanting information onto the brain but also with the possibility of recollect information captured by an individual through its senses to then recompose all the elements with the intention of “relive” experiences; capturing valuable information that then could be reused in other persons to transmit and preserve knowledge. A problem described in the story is that people's memory tends to edit, forget or rewrite specific (maybe vital!) details of the lived experiences, in order to reinforce their values and beliefs. To solve these issues in our futuristic world, population have implanted a life logging device which captures every

detail of the life on an individual, similar as the idea showed on the film *The Final Cut* [17]. Life logging is the process that captures every event in a person's life, generally using sensors and wearable devices such as mobile devices [18] or cameras [19] that get information automatically every certain period of time [20]. Besides the many issues on privacy, an interesting challenge is the management and organisation of all the data recollected to provide meaningful information that can be used in diverse applications such as medical monitoring. In [21] the authors proposed a framework to create a story-based visualization of all the recorded data. In our SFP the main character uses a similar organisation system with the information collected not just to preserve certain memories but to reconstruct the experience captured as it was happening again, using immersive technology.

2. Creative Science Prototype (CSP)

*"Most people die before they are fully born.
Creativeness means to be born before one die" - Erich Fromm*

2.1. Sophia

- "What is reality? Reality, like time is just a concept for human beings. Certain situation could be real for you, but not real for everyone else. I mean, you can believe that something is real, like the existence of God, but for others it can be just a concept, an idea. But, when does it become real? When everyone can feel it with their senses?" With these ideas Sophia always started her talk on 'What is reality?'



Figure 1. Sophia working on her virtual environments

She was a neuroscientist and owner of a company focused on creating virtual experiences for people. The company started with multiplayer videogames, and then,

with the boom of augmented reality (AR) - thanks to devices like AR glasses, AR contact lenses, AR helmets, etc.-, just like many other companies it moved to virtual experiences. In these experiences engineers could create almost anything, and then implemented in immersive devices with special audio, video, haptics and even olfactory devices, they could deceive the senses and the mind. Because of the degree of 'reality' in these experiences, some people had been driven to a point really close to madness, especially when they asked for things like to recreate a dead person, or create the perfect partner. To prevent these cases, the government implemented laws classifying the type of experiences, banning most of the direct human-avatar interaction, and limiting the use of these experiences to 20 hours a month. However, in case of using this as a medical treatment for disabled people, the number of hours could be increased, (filling the appropriated forms!). Due to these restrictions, people usually just asked travelling to real or imaginary places in their immersive experiences; the Caribbean, the Mediterranean, even a different planet or imaginary locations described in a book or movie. Sophia always thought that these laws restricted creativity; still she fortunately could find one or two clients willing to try different experiences.

"Imagination is the beginning of creation. You imagine what you desire, you will what you imagine, and at last, you create what you will" – George Bernard Shaw

2.2. Hank

Hank was a rich septuagenarian widower, obsessed with the possibility to live again the happiest moments of his life, rejoicing again with his childhood, memories of his mother –gone long time ago– and the remembrance of his late wife. This was similar to the idea that people can see their life in a flashback when they have near-death experiences; but with the bonus of choosing which memories they wanted to bring back. This was possible because in this era all the memories were recorded from the beginning of the life of an individual. In older times, people did this voluntarily, uploading their photos, achievements, activities and thoughts to social media. But those methods were primitive, people could select what things to upload, creating a different digital persona from the one they really were. This resulted on people looking successful and popular on the recorded data, but with a reality completely different from what they have declared. Early experiments on memory transfer of information from digital media to the brain, ended up with a person completely different from the one scientists were trying to create. Sophia recalled a very unfortunate incident, when a person completely lost his memory in an accident. The family asked Sophia's company to upload into his memory all the data they recollected from the social media. Obviously as it was previously censored by the patient, when they put this data into the memory it resulted in a completely different persona. The family couldn't recognise their relative.

Nowadays to keep a better record of a person's life, hospitals implant a microscopic chip to new-borns, to record everything from the beginning until the end of their lives. The problem with Hank was that because of a human mistake (it seems that humans will never surpass this characteristic!) he got a faulty implant (or maybe is the technology the one that will never surpass this!). Sophia and her team had been working for several months trying to create a virtual experience based only on digital

photos, old emails, digital voice records, etc. This project had been a nightmare to Sophia, because Hank was never satisfied with the quality of the experience. These kinds of projects were difficult even using real data captured with the implanted device. Sophia discovered that people also perform an unconscious selective mechanism to erase memories and some of them, with the time, get mixed with other experiences, own or borrowed, like movies or someone else's stories. Therefore even when she and her colleagues worked with real data obtained from the microchip, people always surprised when they re-experience a particular memory as they didn't recalled as it was. It is an entirely different feeling to experience your born when you are a baby than re-experience it later when you are an adult!

*"Creativity involves breaking out of established patterns
in order to look at things in a different way" - Edward de Bono*

2.3. Clem

Clem was Hank's second child. She grew up in the middle of a successful business family. As far as she remembers, most of her relatives were involved in the family business since the beginning of the company. This company was the largest chain of food pills in the world. Food pills became a successful business a few decades ago, when people were so busy that they didn't had time to do regular stuff, i.e. for shopping, online commerce appeared; for reading, audio books and immersive books appeared; for food, Clem's family created special pills which can transform in a whole meal and send to your brain the best tasting experience ever (even if you repeat the same pill for all your meals!). Clem was in charge of the company's business planning, for that reason she had to travel almost every week to different parts of the world. She was fluent in four languages, and being a very sociable young woman, she had a good relationship with everyone. But she had a secret that lately was giving her many headaches: she always felt as an impostor, as if she was watching all her life through a monitor; a woman looking like her but living, acting, speaking and interacting different with the outside world. Inside her brain she always had contradictory thoughts, and she needed to translate not only her words to different languages, she always felt as if she was also translating her life. But why does she need to translate each word, each action, and each movement before doing it in the 'real' world? She felt like if there were two persons inside her brain. One with the original intentions, thoughts that had different ways and different goals, which were not appropriate to her; and other showing her the behaviour she was expected to do. She always followed the latter, but the original intentions, before the 'translations' were the things she really wanted to do.

Clem's problem was that her brain carried out two types of memories; she could remember what she did but she could also remember her original thoughts, her original intentions, her original words, even the original experiences inside her mind before the translation she performed every time that she acted in the 'real' world. Sophia's company diagnostic was: "The individual records two different memories; one for the acts that she did in the 'real' life and other for the intentions displayed into her mind". She always had control on her acts, she could always differentiate between what she did and what she thought... until now.

Sophia's team found two implants into her brain: one was an old model containing Clem's unreal experiences; the other one was the one that contained 'real' memories, but the team could not remove any of the implants without losing Clem's personality. They didn't know why her brain was always translating all her thoughts and actions, and recording both, 'real' and 'unreal' experiences. Clem wanted to keep the 'unreal' content and remove the other, but this could collapse her 'real' life. The only way to feed those internal 'unreal' experiences was living and acting in the real world, and therefore keep registering real life events, otherwise she could not feed this second life. It was a vicious circle.

*"You see things; and you say, 'Why?'
But I dream things that never were; and I say, 'Why not?'" – George Bernard Shaw*

2.4. Paulo

But besides her everyday work at the company, Sophia was doing some research on her own. She was obsessed trying to find a way to program a human brain without using an implant, based on the idea that human anatomy had already all the chips required for almost any programming goal. She was always avid to learn, and her maxim goal when she was younger was to be able to hold all human knowledge in her brain, in other words to be a 'know-it-all' literally. On her first experiments she tried to create a method to upload the information to the brain. She thought that if a computer can hold immense quantity of information on a hard drive, well, the brain seemed to do the same on humans. She tried first this method, but the result was something like a humanoid robot, he had memories and information in his head but he didn't know how to use it. This resulted in just a method to implant information in the brain, just like the old practices of hypnosis and subliminal advertising.

Then she discovered that the key to program a brain was the experiences that the person feels when a particular event happens. She read many theories of learning (Pavlov, Skinner, Piaget, Papert, etc.) and she agreed with Fleming's VARK model [5]; in which a person can learn through his/her input devices: the senses (visual, auditory, kinaesthetic, etc.) and this happens when learners are willing to digest and accept the information provided by the senses. This was the moment when she thought of reusing experiences from her clients, preserving memories and specialised knowledge, and transferring it to a different individual. Imagine that you could transfer the experience of a skilled surgeon, or the genius of a musician, or... well the possibilities could be unlimited! This was her main motivation to work every day at the company; she wanted to focus on constructing immersive environments where all the senses could be deceived, allowing users to enter in a different reality, and experience virtual as real to transfer and collect information. She started with visual environments and augmented reality; in these initial environments people were deceived only on their sight but the experience although very realistic wasn't described by her users as complete. The next step was to include more senses to create a real immersive experience. She realised that the mind can be completely abstracted and focus on one environment at a time (what Lifton [22] defined as 'vacancy problem'), just like when people concentrate on their screens watching a movie or having a videoconference and forget time or situations happening around.

Then the first step was to create an environment able to provide external stimulus to human I/O devices (aka senses). She knew that certain sounds change human behaviour, like music, since a tune can change people's mood and make them feel better... or worst. And what is music after all? Is it just a sequence of sounds? Almost all music is written under mathematic measures and certain combinations of volume, timbre, and harmonic patterns which might lead people to a certain mood [23]. For example she recalled reading about the work of John Sloboda [24], which analysed human reaction to certain musical constructions. For example, he discovered that a particular construction called 'appoggiatura' creates sadness on listeners. She also knew about the so-called 'Mozart effect', which seemed to show short-term improvement on the performance of spatial-temporal reasoning [25] as a consequence of arousal or mood [26]. Levitin [27] says that 'musical memories intermingle with events, emotions and other information about the context of the experience of the music' giving it an evocative capacity. For the stimulus of the other senses she studied colour psychology and its relation with human behaviour, physical reactions and its influence on learning [28] [29]; she also studied olfactory memory [30] and stimulus over anthropological comportment as it was reflected on Patrick Süskind's book 'The perfume' [31]; one of her favourite novels.

After years and years of research she created a test environment, but the simple suggestion of the experimentation was a very big problem for the authorities. How could they know that she would not harm the subjects on the test? And also what kind of programed information she could insert into their 'guinea pigs'? Finally after many paperwork and many problems, she was ready to try her environment in a volunteer: Paulo. He was a middle-aged gamer who spent most of his time (and money) betting on illegal 3D casinos, where people can only play if they bet huge amounts of electronic money, and if they do not have money then the owner can lend it to them with the highest rates. In many countries it was illegal of course, as in those cases lender's gains are higher and the probability of win is low (e-money tracking in this business is a real challenge for authorities). Paulo just loved the excitement and intensity of these games and as an optimist at heart; he always thought the next game would be his lucky game. Sometimes he gained enough money to pay the bills, buy food pills and holographic clothes, but most of the time he was in bankrupt. Sophia had chosen Paulo because as an experienced 3D gambler, he had many hours of training using virtual worlds and particularly immersive videogames where the gamer participate on mixed reality tasks to achieve a goal. Paulo accepted because he really needed the money, he had many debts and due to this he had been suffering of anxiety. He just wanted to end this problem and then go to a gambler's rehabilitation clinic.

The test was designed to program Paulo's brain to understand Spanish, (he only knew English and some words in German as he used to have a German girlfriend in college). She collected the data from the chip of many Spanish speaker subjects; creating a repository of the language an educated 30-years-old would possess. She turned on the machine, and set the knowledge to a B2 level, which represents an intermediate level (around 500-600 hours of study [32]); she was calculating a feasible amount of information in order not to overcharge Paulo's brain. After a moment of doubt she started the process. The machine started to recreate an incredible cocktail of sounds, visual images and colours and olfactory inducements along with other

electrical stimuli for skin. Paulo had many sensors attached to his skin to measure his heart rate and body temperature. The machine went on for the first hour, and she felt confident about the process, Paulo's sensors indicated that he was having an experience similar to deep sleep (REM frequency). By the second hour she started to get nervous but she tried to calm down and think that everything was calculated thoroughly. The third and fourth hours were a really painful process for her; Paulo's heart rate had increased as if he was running on maximum speed. She was not sure if she wanted to continue with the process but she was even more afraid of stopping the process and leaving Paulo in the middle. As she didn't know what could be the consequences she decided to wait. The machine stopped at the fifth hour. To be more precise, it took 5 hours 19 minutes and 27 seconds according to Sophia's chronometer. Her heartbeat was so fast that she took a minute to breathe. She checked Paulo's vital signals. They looked fine; his heart rate was decreasing slowly, but he was still, with his eyes closed...



Figure 2. Paulo inside the environment.

3. Reflections

In this CSP we proposed the use of technology to capture, preserve and transfer knowledge, in the form of experiences, from one individual to another. In particular, our stories proposed a fictional scenario using virtual worlds and immersive technology as key elements in the learning process. We described a relation between collecting and storing data using devices implanted in the human brain and transferring this information to a different individual, enabling an imaginary possibility of programming human brains in an accelerated manner using mixed reality environments.

The story superficially touches issues such as free will and human ambition, the role of life logging in an individual's life, and some risks and ethical problems of

capturing, managing, classifying and preserving information. We left our story without a defined end in purpose; with the intention of generate discussion about the benefits and problems of these methods, having in mind all the elements described in the story. What could it be the positive and negative effects on people's lives if everyone could have access through this sort of learning to any subject they would want to learn? Has the human brain the capacity to hold unlimited knowledge? Would it be any side effects? What kind of laws would be necessary to implement in order to regulate this imaginary scenario? What impact would that cause in the world? Would that completely modify for good the present educational model?

We are aware that this SFP do not offer answers to these questions but we hope that it will raise ideas that might identify solutions towards the construction of a new enhanced learning era.

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Storyweavers

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Abstract. This Creative Science paper reviews critical thinking and suggests that rather than a purely mental construct, good thinking is embodied and situational. The concept of embodied expertise is presented, followed by a story in a not so distant future when nanobots implanted in people's bodies will allow us to modify brain and body signals, creating virtual worlds that will blend with or entirely replace reality. This paper argues that the challenges that we currently face require educators not only to teach skills but also to help people find their path in life. Beyond delivering information, it is speculated that teachers will be asked to translate knowledge, experience and expertise into fully immersive stories.

Keywords. Science fiction, critical thinking, embodied cognition, embodied expertise, immersive worlds, storytelling

Introduction

Our society faces difficult challenges, with a growing number of individuals suffering from depression, neurosis, alcoholism, and drug addiction. Suicide rates at global level have increased by 60% in the last 45 years, according to Suicide.org. We are seeing a considerable number of teenagers who are victims of bullying and harassment and reach the unfortunate conclusion that death is better than life. We are also witnessing increased violence and rage in young people that have lost hope in the future.

The educational system spends considerable time delivering information but in many cases, as young students, we are not taught how to face deeper issues. In school we learn mathematics, chemistry and physics, but we receive little help regarding how to go about life, which is what most of us focus on throughout the rest of our existence.

After decades of promoting rote learning and unquestioned premises, we have arrived to a point where we may have to conclude that our model is not working. As Facione mentions, "the eighties witnessed a growing accord that the heart of education lies exactly where traditional advocates of a liberal education always said it was – in the processes of inquiry, learning and thinking rather than in the accumulation of disjointed skills and senescent information" [1]. The eighties are long gone, but education has kept the desire to help people think better.

How feasible is it to teach critical thinking? Imagine for a moment that you are a prisoner in a cave where the rays of the sun can never reach you. You, however, lead an unquestioned existence, since you have never been aware that you are a prisoner. You know there are others like you, because you can hear their voices and you can talk to them. All of you spend your time pondering the shapes that are projected on the wall by a fire you cannot see, shadows to which you give different names, like

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“mountain” and “tree”. That constitutes “reality” for you and your fellow prisoners, even though it’s just a reflection. Suddenly one day you manage to escape from the cave following a rough and steep path. Reaching the outside world you are able to see for the first time the real mountains and trees, the lakes and oceans. Thrilled with your new understanding, you pity those you left behind in the cave, for what they consider reality is not more than a shadow of the world. So you decide to go back and ‘enlighten’ those who are still in the cave, but what you say sounds incoherent to them, and finally they conclude you must be mad, a menace to their well-preserved status-quo, and kill you.

You probably recognized in this previous tale a short unorthodox summary of Plato’s Myth of the Cave. In my opinion, it summarizes how difficult it is to change thinking patterns in individuals. We resist change and anyone who tries to change us. We normally go about our business unaware of our beliefs, content with our realities, until a crisis forces us to check our assumptions. Can we teach how to think better before we reach a crisis? Could the solution to teaching critical thinking skills be the words of Cicero? "If you wish to persuade me, you must think my thoughts, feel my feelings, and speak my words." This Creative Science paper explores this possibility.

1. Thinking Critically

What is critical thinking? Since critical thinking is commonly confused with problem-solving and decision-making, the American Psychological Association decided to create a panel of experts, their objective to systematically arrive to a definition [1]. The consensus was that critical thinking is a “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. As such, critical thinking is a liberating force in education and a powerful resource in one’s personal and civic life.” The definition goes on to describe the critical thinker, cognitive skills and sub-skills involved, and affective dispositions. Even though this definition is certainly valid and encompasses the many variations of critical thinking, I would like to focus on more practical versions, which are essential for everyday living.

In educational gerontology and adult education, critical thinking is related to challenging long-held beliefs and judging how efficient they are in the context of a new reality. In this situation, critical thinking (CT) can be considered a tool to find the meaning of one’s existence [2].

In a ground-breaking work in the field of adult education, Brookfield proposed that critical thinking involves two processes: identifying assumptions, and exploring and imagining alternatives [3]. The purpose of identifying one’s assumptions is to uncover strategies that were acquired in childhood without much evaluation, and challenging their validity and applicability to one’s current situation. Usually, though not always, a difficult situation or crisis triggers this process. The second part of CT takes care of producing new alternative paths or ways of thinking that will agree more with reality.

In the same line, Mezirow’s perspective transformation deals with the process of reflecting on perspectives culturally acquired, and how they impact us and our relationships [4]. Mezirow agrees with Brookfield in identifying ‘life dilemmas’ as the triggering events of transformation, and also in that this process cannot be carried out

in an individual vacuum but requires a social dimension that will allow discussion and validation of new paradigms.

The emancipatory nature of CT is shared by Paul, who divided the construct into macro-logical skills (of emancipatory nature) and micro-skills (technical) [5]. As a guiding force, it is seen by Ennis as “reasonable reflective thinking focused on deciding what to believe or do” [6]. CT as a means to free oneself from unchallenged paradigms is the process that underlies the search for meaning in a specific situation –and at a larger scale of one’s existence– in order to efficiently deal with it.

In this emancipatory definition of critical thinking the underlying assumption is that thinking is a purely mental process, disconnected from our bodies. However, there has been a relatively recent shift in the way we view cognition, from considering it a purely internal process to being situated, distributed and embodied.

2. Critical Embodiment

Cognitive, perceptual, and motor operations cannot be seen as separate as it is frequently the case. Memory-based and perceptual-motor strategies act together to influence the way the individual interacts with the environment. It can be said that cognition encompasses not only formal operations ‘in-the-head’ but also the situation the individual is in, the physical properties of the environment he/she is acting on and the body used to act upon the environment. The environmental context provides opportunities for action (affordances) which our bodies are designed to detect and act upon, creating a cycle of action and feedback [7]. Learning is defined then as the “education of intention and attention” [8].

Embodied cognition is not a clear-cut construct. Simple embodiment sees the body as a constraint on the internal processes and representations [9]. The flow of information from the environment through the body and to the mind is what Clark considers cognition. A more radical approach is that of Chemero which directly stems from Gibson’s ecological psychology and abandons mental representations entirely, what Chemero calls ‘cognitive science without mental gymnastics’ [10].

If we adopt an embodied perspective, then rather than using logic and other purely rational tools to teach critical thinking, we need to make the individual aware of the possibilities for action afforded by the current situation, mindful of how the body is reacting and how it is influencing, and how in turn it is influenced by thoughts and mental images. I suggest that critical thinking goes beyond mental models and is more in line with what Suwa calls ‘embodied expertise’ [11]. I would summarize embodied expertise as the optimal balance between mental processes, sensory and perceptual information, body skills and the surrounding environment.

Embodied expertise would be applicable to all levels of what we define as critical thinking, from the skills required to play an instrument or dance, all the way up to the process of giving direction and meaning to our lives. Immersive technologies are starting to offer us the possibility of ‘living’ knowledge rather than understanding it at a purely conceptual level.

3. Storyweavers

3.1. Zara

Zara was not looking at the vast ocean in front of her. Her eyes were focusing on empty space while in her mind she revisited the path she had followed to reach the top floor of the Observatory, the massive structure on the artificial island of Miura. The memory of sneaking through forbidden corridors and doors made her fair skin redden slightly. Her hands were still shaking and her heart was beating fast. She bit her lower lip and raising her hands to the top of her head, she undid her ponytail and run her fingers through her hair. Her silky black hair framed her delicate features and contrasted with her big turquoise eyes. Gently she massaged the stiff neck and shoulders.

She sat on the wide fence bordering the building's roof. Was there any way to fix this mess? She thought about this old song from years ago. Immediately the nanobots inside her body lit up and began sending neural impulses that resulted in a high-definition three-dimensional hologram of a song retrieved from her memory right in front of her eyes. The sound enveloped her entire body.

"Whenever something is too unpleasant, too shameful for us to entertain, we reject it. We erase it from our memories. But the imprint is always there", said the face in front of her.

Her thoughts switched to the days and hours that had led to that moment. The holographic image in front of her eyes receded in space and was replaced by images of her body and her most inner thoughts and desires paraded all over the global stream for everyone to see. Her profile holograms were all vandalized with obscene drawings and hurtful insults. Some went as far as encouraging her to 'just die'. However, she realized that being physically naked in front of everybody was not as painful as being ridiculed for her adolescent dreams. Because she fell in love, she was accused of being easy. Because she dared to explore, she was accused of being an ugly whore. Everything she had thought of becoming was trampled on viciously. Even her music.

Music moved her and took her to places she could not reach any other way. Shyness turned into wizardry when she played the violin. Before she had to carry the instrument wherever she wanted to play it, but all that changed when she met Iain. She did not know where he came from but she was fascinated by him. It was her birthday and she received this strange card from him: "Open me and what you love will always be close to your heart". She thought he was referring to himself, except for the use of 'what'. She opened the file and felt a strange tingling sensation. She recognized that her system had installed something that modified her nanobots. After a few seconds the centuries-old Alard violin, one of Stradivarius' finest creations, materialized in front of her eyes. She had smiled thinking it was a common hologram but then he heard Iain's voice saying: "Come on, play it!"

First generation nanobots, like the ones she used to carry, were only allowed to modify an individual's perception system up to a certain point, for fear that their capacity to influence sensory and neural signals could be misused. Humans could interact with holograms and they could feel almost like the real thing but playing a holographic instrument had remained a challenge because it required modifying brain and body signals in a way that was strictly forbidden. It was not just about touching the instrument. It was about the precise texture, its response, the acoustics, even how it felt in one's hands and how it influenced one's body. Iain had told her about second

generation nanobots that could emulate these experiences and more, but he had been very secretive about it.

She felt silly but grasped the bow with her left hand and with her right hand rotated the instrument to place it on her collarbone, finally resting her jaw on the chin rest. She propelled the bow and music flowed as if she were playing the real thing. She felt a strange sensation, as if someone was driving her execution, but she was soon carried away by the sounds of the instruments and her own mind.

After that day she started feeling music in a completely new way. Her body moved as if she were a different person, in a manner that she could not understand but felt just right. After that day she could not say no to Iain.

“We can be connected now, you and me. We can share our thoughts and desires. We can be one, never mind where we are!” Back on the roof of the Observatorium she remembered she had indeed shared everything, much more than she should have.

She thought of the violin and the nanobots created the illusion of the playable instrument in front of her once again. She stood on the edge of the fence, two kilometers away from the ground, and started playing. The sound of the violin followed the ethereal voice of the song she was listening to.

“Can't fight it all away, Can't hope it all away, Can't scream it all away, It just won't fade away.”

Tears fell down her face, her eyes closed. The nanobots, still reacting to her thoughts, surrounded her with holograms of her parents listening to her play, and her sister that used to tease her calling her ‘creepy ghost’ because of her pale complexion. Completely immersed in the music she felt weightless. She played for a long time not noticing the cold wind against her skin. Suddenly she stopped, breathed deeply and opened her eyes.

“God, please don't hate me.”

3.2. Ailsa

“I hope I won't get into trouble”, thought Ailsa. The web of messages danced in a three-dimensional mesh in front of her eyes, reconfiguring themselves according to the way she wanted to search. She found the one she was looking for and isolated it with her mind. After struggling with herself for a while, she unwrapped the content: the MeridianMod in all its glory, and a modified dance environment to go with it –courtesy of Zara's mystery boyfriend– were ready for her.

She held the files and opened her hands. She felt the code modifying her nanobots and once the process was over, she checked her body to see if she felt any different. Nothing. She opened the dance mod and chose a song. A hologram appeared in front of her, ready to demonstrate the routine. Ailsa started moving her body slowly following the music. She knew this routine well. Suddenly, she felt a gentle twist of her leg moving it in a slightly different manner from the way she normally did.

“You've got to be kidding me...”

Great dancing did not come just from the brain but from the understanding of the music piece and the interpretation the dancer created about what that music meant emotionally. It naturally depended on the motion of different body parts and where those movements were taking place. The environment, other dancers, the energy of the music and audience, delivered cues that the expert was able to decode but the novice overlooked. Of great importance was the dancer's awareness of his/her own body through the proprioceptive system. Apart from augmenting all these elements and

delivering real-time information to the prospective dancer, as first generation nanobots did, second generation nanobots went further by modifying the information between the brain, the body and the holographic and real environments around the individual.

So with first-generation nanobots, a person could see a holographic teacher, imitate its form and superimpose his or her own hologram to see where the differences were in real time, striving to match the correct technique. Color codes, plan-like lines and highlighted symbols quickly indicated the areas where everything was working well and those that needed improvement.

In contrast, second-generation nanobots, which were created by Professor Ethan Suk to enhance learning, added emotion and embodiment. They modified sensory and perceptual information in order to reach the perfect level of training. Thinking about moving a hand in a specific way was not the same as actually moving it that way. The dancer could attempt to do the exact motion of the model, but lack of training or physiological constraints could result in the wrong movement. Or the technique would be perfect but performed without emotion or expression.

Here is where the new nanobots would kick in. Coded within the example offered by the experienced dancer were the levels of emotion translated into brain chemicals, and the exact muscle and joint motions that were necessary to achieve that specific level of proficiency. Nanobots would induce the same emotional states by modifying the levels of brain chemicals and would send signals to muscles and joints to replicate the exact same motion.

The trainee would at the beginning be almost like a puppet, but as the dancer's body became closer to the target, nanobots reduced their influence. Dancers would no longer go through long hours of training without having a clue about what it really felt to be a great dancer.

Second generation nanobots were at research stage and faced a steep path to being approved because of the potential control nanobots could have over physical and emotional states. What Ailsa was experiencing was a modified version created by hackers.

Ailsa quickly chose a difficult song, one that she called her 'nemesis'. Whenever she danced that routine, the teacher's hologram and her own would engage in what tended to look more like a Sumo wrestling match than a coordinated dance. Watching the reviews made her sometimes wonder if she should have been better off doing something else.

She was ready. A sudden energy flow went through her body. She felt the nanobots gently sending sensory information to her muscles and joints. She felt a bit like invisible hands twisted her limbs gently correcting her moves and getting them closer to the expert's. Her skin felt almost like touched by the music, her face reacting to every single nuance in the musical piece. She thought of visualizing herself and she appeared as a hologram right next to the trainer. But this time it was different, she moved gracefully and for the first time she really felt that song and understood what it meant to move her body to that tune. She continued dancing with herself, her body sensually flowing as carried by invisible guides. Nanobots released the right chemical soup to reach a state of pure emotional flow with the music.

Suddenly, one of the nanobots' state changed and started to release an increased dose of epinephrine. Ailsa started feeling a sense of exhilaration and her heart started pounding. A few seconds later, the nanobot induced the release of phenylethylamine, which in turn triggered dopamine. She felt attractive and sexual. She smiled at her holographic self, flirting a bit like she would with a real partner. It was then that the

nanobot started to broadcast an encrypted holographic signal of her sensual dancing. She was enjoying herself very much. And so was Iain.

3.3. *Chief Inspector Kinlan*

Chief Inspector Cerys Kinlan sat in front of a long table. Rather than each individual being physically present in the room, each chair was filled by a hologram, an immediate transmission of the actual person located somewhere else on the planet. The table and chairs, except for hers, were of course the product of her own nanobots recreating the necessary space for the meeting.

The Web 4.0 was now standard across the entire globe. People could access information and get it directly delivered to their brains. Humans did not just visualize information. They were immersed in streams of data. Advanced artificial intelligence delivered the right content at the right moment. Anyone could access any information resource and learn anything they wanted. Education had become widespread even in the poorest areas of the world. Nevertheless, depression had become the number one global disease followed closely by other mental diseases. Stress and anxiety dominated a society of overpopulated cities with hundreds of millions of people and scarce resources.

“Where is she?”, asked Cerys.

“We don’t know, ma’am. The last satellite transmission of her position indicated that she was moving towards the outskirts of the city but we lost her after a while. She has activated her firewall and we have not been able to trace her.”

The hologram in front of them showed a 3d map of the city with an orange path glowing through the transparent-blue buildings and stopping in the Nova district.

“We are the police department and we cannot track a teenager, is that what I am hearing?”

“Ma’am, we have 300 million people in this city, almost 100 artificial islands surround it with roughly the same population. Also, she is not a regular teenager. She is highly intelligent and she has upgraded her nanobots to second generation. We are only experimenting with them so far. She has applied the MeridianMod patch to her system.”

Second generation nanobots were not available to the public but hackers had been quick to create a patch, the MeridianMod 1.0, its name based on the autonomous sensory meridian response, which was defined on the global stream as a “perceptual phenomenon characterized as a distinct, pleasurable tingling sensation in the head, scalp, back, or peripheral regions of the body in response to visual, auditory, olfactory, and/or cognitive stimuli.” The patch was a modification of Professor Ethan Suk’s work.

The mod allowed direct sensory and perceptual information in the brain and body to be modified. It made possible to mix the virtual world with the real one in an almost indistinguishable manner. It also allowed full access to the individual’s system.

“And where is he?”

“He is under custody, ma’am”.

“Good, we are not as ineffective as certain people claim. And what do we know about him?”

“He is a sort of regular kid, relatively social. He moved out of his parent’s place a couple of months ago, because according to him they were just too stupid to understand him.”

Cerys nodded and a new hologram materialized in the centre of the room. She carefully observed the athletic man staring directly into her eyes. She did not expect him to have glowing glyphs tattooed on his scalp and his neck. Cerys' younger sister was considering getting them but she thought they looked weird on a man. She noticed Iain kept one eyebrow raised and his lips slightly pursed as if he was the one analyzing her.

"I want you to hack into her system and stop her from doing something stupid. Now."

"She gave me access to all the information I posted. Now she is making a big deal out of it."

"She trusted you and you took advantage of her."

"She was the one complaining about not being able to play her stupid violin everywhere."

"You accessed private thoughts and sensory information that did not belong to you, and made them public. You broke the law and you could be held responsible if anything happens to her".

"She should have read the fine print", answered Iain with a grin.

Cerys wished at that moment she also had second generation nanobots so she could slap him and make him feel at least some degree of pain.

"I will make sure you don't enjoy one more day of freedom if you don't help us."

"What freedom?", he yelled back. "You mean the freedom to roam the streets? The freedom to see people starve to death? I don't care about your stupid freedom. People die every day. She will be just one more."

Chief Inspector Kinlan stayed quiet for a moment and then, using the same tone of voice she had used all along, said: "You will help me find my sister or I will make you suffer beyond anything your mind considers possible in this world".

3.4. Ethan Suk

From the messy white hair, unshaved face and wrinkled clothes one could conclude that Ethan Suk had been hiding in some dark corner of the planet, alone with his computer, for the past two centuries. An emeritus professor at one of the leading global universities, he had created the original code on which the MeridianMod was based.

"As you well know, Chief Inspector Kinlan, I created this code with the idea of going one step further. Just sharing information is not enough for humanity. For far too long we have lived in our heads. Our bodies need to be incorporated into the equation. Our mental, sensory and perceptual systems are important parts of what makes us human, and they are involved in how we apprehend knowledge, in how we interact with the world. My idea was simply to take human learning to the next level. I have conceived a way where essentially you can perceive what I perceive and interpret it in the way I do, generate your own concepts or share mine, and follow my body response or chose your own. So far we have augmented all physical places on Earth. I can go to Stonehenge and see with my own eyes what happened there centuries ago, explore and even play a role in that society. But this is still purely a mental exercise. I have no idea about how they perceived their world, or why they reacted the way they did, or how their bodies behaved in that world in response to that specific environment."

"That's all very good, but your code allowed this hacker to steal images, thoughts and sensations from my sister and post them all over the stream. I need to find her before she does something foolish. And you will help me".

Professor Suk took a deep breath. "I would not call Iain a hacker. Old school hackers have ethics. For them, the goal is to create art and beauty using a computer. We may disagree with their concept of art and beauty, but they do believe computers can change life for the better, even though they reject authority."

"Iain seems to be the destructive type", he continued. "Highly intelligent, he gets easily bored with what regular people term 'education'."

"Spare me the psychological profiling. Can you get into his system?"

"He has a solid firewall but I am confident I can see what he is up to". Professor Suk proceeded to work with his holographic computer. He did not need to type code as his thoughts were transcribed directly into the compiling console. Eye-motion determined the steps he wished to follow. After a couple of minutes he stopped.

"Ok, I am in. But you will not like what he is doing."

With a swift gesture, he shared his holographic display with Cerys. Ailsa was dancing almost naked in front of them. "I have severed the communication, she will be ok now. I think I have an idea. Maybe now is time to test my theories, if you allow me to do so. We might need permission to run this procedure."

"Forget permissions, I will deal with that later", Cerys said. "Just get my sister back."

3.5. *Iain*

"Hello, Iain. I am Ethan Suk." Professor Suk's hologram appeared in front of Iain's field of vision.

"How did you bypass my firewall?"

"Let's say I have a more refined version of your mod. Like a 1.5 sort of thing".

"Your code was junk. I just made it better", replied Iain.

"I am a messy coder, you are right, but I learned from my mistakes. But you know I am not here to talk code. I severed your communication link with Ailsa because it was active. You have cut all communication with Zara, why?"

"I could not stand her whining. So people have seen her naked. Big deal!"

"I think you went further than that. You stole her thoughts and desires, a whole bunch of private information that was not yours to share." Suk paused for a moment and then added in a calm voice: "Iain, a girl is about to die if you don't stop her."

Iain looked at Suk for a moment and then asked: "What kind of upgrades have you made?". Suk looked puzzled for a moment but answered the question. "My nanobots are able to control lower versions of nanobots at all levels. I can present myself at will, like I just did. I can create illusions for other people. I can write their realities if so I wish."

"Is it even legal?"

"Coming from you, Iain, that is a very strange question to ask."

A second later Suk knew his strategy had succeeded. By taking advantage of a vulnerability planted in the code, Iain was hacking Suk's system and had downloaded the upgrade.

"As I said, your code is still junk. Now let's see what this can do", said Iain with a proud face.

Professor Suk's holographic projection appeared to be affected by static. "You see, Iain, it is time for me to try a little trick of mine. I designed this program to help people understand anything at a very profound level, not just in their heads. I lied when I told you that I could create any reality I wanted. In fact, I needed a tiny piece of code in

your system, the one that you have just kindly installed. I have written a new reality for you.”

Iain was no longer in his cell with Suk. He was in a black and white world, one step beyond redemption. He saw the crumbling roofs and towers of gothic cathedrals, ruins of magnificent buildings hidden by a dense forest of dead trees. He tried to scream and cursed Suk but the only sound was that of death. He felt the cold wind burning his skin. Following the dry bed of a river covered with ice, he ran for what seemed like hours, falling again and again. Out of breath, dark gray blood covering his face, he reached a cliff and fell to his knees. He faced distant colorless memories, broken promises, and un-lived dreams, creating a phantasmagoria of emotions he could barely handle. All of a sudden everything stopped and what he saw in front of him was the view from the Observatorium. He then heard his own voice: “Zara, stop!”

4. Conclusion

While the literary merit of the previous somewhat dark story is highly questionable, I wanted to present a perhaps naïve view of what technology might one day enable us to do with respect to what we currently call teaching and learning.

If we conceive experience as embodied, then better thinking will really mean better perceiving, feeling and acting, within the specific reality we face. In general, the tools we use in educational institutions, at least beyond a certain age, teach the mind only. We sit for hours and listen, when perhaps we should be moving, talking and acting.

As educators we are in charge of teaching different kinds of skills but I believe that as our world changes, we will also be more in charge of helping people live. Whenever someone says the word ‘education’, images of formality, boredom and stillness fill people’s minds. Nevertheless, in essence what we do in life is to learn and most of us don’t find that particularly dull.

Immersive technology can bring a level of embodiment to learning beyond anything we have seen so far. Naturally there will be risks, and we will have to debate how far we can go. In this new environment, we will be asked to move beyond the delivery of information and create realities that will help us learn and safely make mistakes. We will no longer be able to compartmentalize knowledge. Instead we will be required to string together skills, domain-specific facts, competencies, attitudes, motivations, emotions and all the components that allow us to apprehend reality, be it playing an instrument, building a rocket or understanding the reason why we are here. Through technology, educators will create immersive stories where people will experience and appropriate our collective wisdom.

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Ureka Potential

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Abstract. This fictional prototype appraises recent advances in the fields of intelligent glasses and brain computer interface technology to address possible impact on a more immersive style of teaching and learning. The former advance can be used to measure eye gaze and hence to assess whether a student is at least looking in the correct place and possibly attending to lecturer or computer screen; the latter can measure and quantify changes in brain activity. Could changes in brain activity be used to signal cognition and acquisition of knowledge or understanding? This is a much more ambitious goal and the prototype extends current achievements in electrophysiology to unearth an 'understanding' component, termed here the 'Eureka Potential'. Two exhibitions which ran concurrently over the summer in London at the Victoria and Albert museum, "David Bowie Is" and "The Memory Palace" provide the inspiration for the piece. The motivation for this work is that assistive technology could encourage our students to become more 'active' learners.

Keywords. Brain computer interface, intelligent glasses, teaching, learning, "David Bowie Is", "The Memory Palace".

1. Introduction

The backdrop to this work is the serendipitous collocation of two exhibitions at the V&A during June 2013. The first "David Bowie Is" was a retrospective testimony to musical and artistic genius. This is a subjective experience, in the eye of the beholder. The second, "The Memory Palace" warns of the danger to future digital society of loss of technology. In the Orwellian society that emerged, at an individual level a citizen's memory was controlled. Memory of course underpins all cognition, understanding and creative thinking, even genius.

The paper uses a water metaphor, which flows through the different sections, in search of a potential, until the author declares, "I have found (it)".

Of course the focus of the work is immersive education, and technology that supports it. Intelligent glasses can provide an objective measure of engagement. But how do we as teachers know that a student has understood a topic?

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2. Discussion

The paper addresses education and the problem of assessment. For example, in an examination, if a student replays a 'stock' answer to a question, have they really understood the topic? This is manifest to the author in the discipline of Computing and Mathematics. In this subject problems that have been previously seen can normally be solved by students, but performance falls off for questions which require 'problem solving' skills. In programming for example we try to teach core problem solving skills from the bottom up in year one of an undergraduate degree, but sometimes a weaker student simply searches the Internet for solutions to problems, often tweaking variables without really understanding the consequence, sometimes even by trial and error.

To engage the students many departments have used exciting interactive technologies such as Mindstorm's Lego robots, Robosapien and novel input mechanisms such as Nintendo Wii motion plus and Microsoft Connect. Indeed working in multimedia design or in game design is often the expectation of the student and motivation for the course in the first place. Novel use of technology can have beneficial engagement effects over the standard integrated development environment (IDE) for learning programming skills, particularly in a team environment. Yet most of our employers still seek students who can 'program', often for the financial sector, with commensurate rewards. This really means students who can problem solve.

However technology continues to improve and throw up unanticipated consequences for its application. This prototype addresses such technology for application in immersive education.

3. Fictional Story

3.1 Lecture Theatre May 2014

As I finished my final lecture of the semester to the normal hub-hub of relief for all concerned and looked up to my audience, now paying customers, a door at the back of the theatre opened purposefully, a burly customer entered the lecture theatre and descended towards me. His eyes were transfixed on mine, as he made his way down the stairs, seemingly oblivious to the tide of final year students leaving. I knew why he was here. He was a first year student from my computer networks class, indeed by all accounts a particularly good student².

3.2 Two faces of life: 22 June 2013

I had just left the "David Bowie Is" exhibition at the Victoria & Albert (V&A) Museum. Most V&A exhibits portrayed long deceased characters taken from a dour fourth form history, art or music lesson – Archimedes, Van Gough, Mozart and many more of our forebears touched by genius; Bowie was

² The scenario was inspired by colleagues at an evening meeting in Colchester, Sept 2013

an exception to this, as befitted his esoteric music career, the “Is” was crucially important, he is still alive³. The trivia and memorabilia were encased in glass and the vivid stage costumes on display conjured up Bowie’s stage and screen personae, a series of iconic instantiations from the David Jones⁴ template, each with a distinctive look, like a Japanese kabuki [1] character’s mask. The popularity of the exhibition⁵ cascaded the visitor along a current of people, old and young, flowing from entrance to exit, accompanied by a whirlpool of sound and vision, an immersive ‘mash-up’ of his 70’s and 80’s songs. Bowie’s songs acted like a switch and instantly ignited my memories of the fourth form disco, shoulder length hair and blue jeans, riots on the streets of Belfast, and the imminent arrival of aliens from space; definitely no school lesson in this museum. The ‘David Bowie Is’ experience kindled my optimism.

*“I’m not a prophet or a stone age man, just a mortal with
potential of a superman” [2]*

These lyrics resonated around and around in my head, swirling in a continuous loop. I had long since believed that Bowie was indeed a latter day prophet, and it goes without saying, a superman. He was a creative genius, often blazing a path where his peers, some mere mortals, others definitely from the Neanderthal side of the spectrum, meekly followed, often releasing pale imitations of the master’s work, like fake Van Gough’s paintings. Where did this creativity come from? The exhibition portrayed his upbringing in Brixton, an unremarkable youth, no Mozart child genius, somewhat overwhelmed by the intelligentsia and artisan ‘in-crowds’ of Soho’s swinging 60’s. Then it all changed as he grew to a twenty-something, like a switch. What if we all had this potential for creative thought, I pondered? It may just be a matter of flicking the switch.

My research had centered on ‘potentials’, electrical ones from the brain, so I tried to decipher the deeper meaning in the lyric. I was sure the ‘prophet’ has a message for me.

As I was about to leave the V&A to meet up with a group of similarly minded Bowie followers, I noticed a disturbing image in my peripheral vision. It was a display banner advertising a “Memory Palace” [3]. It provided a “dramatic vision of the future through an immersive exhibition experience”. I assumed it was co-located by chance. The title intrigued me – I decided to go in to experience the author, Hari Kunzru’s future vision [4]. The first poster in the exhibition confirmed my curiosity.

*“Hari Kunzru's story is set in a future London, hundreds of years
after the world's information infrastructure was wiped out by an
immense magnetic storm. Technology and knowledge have been
lost, and a dark age prevails. Nature has taken over the ruins of*

³ David Bowie’s latest album “The Next Day” has been nominated for the 2013 Mercury Music Prize

⁴ David Robert Jones was born in Brixton (8 January 1947), he is better known by his stage name David Bowie

⁵ ‘David Bowie Is’ was the most popular V&A exhibition ever, with reserved tickets completely sold out, night-time slots and long morning queues for the remaining day tickets

the old city and power has been seized by a group who enforce a life of extreme simplicity on all citizens. Recording, writing, collecting and art are outlawed.” [3]

By contrast there was no tide of people in this room, a still silent V&A backwater, where the few visitors meandered from station to station. This Palace was not a happy place. The narrator of the story, a dissident in the Palace, was trying to hold onto his memory. It presented a dystopian view of the future, where society dictated that citizens were ‘programmed’ to conform, a subject coincidentally envisioned by Bowie in his ‘Future Legend’, a version of ‘Metropolis’ [5].

“If you could keep only one memory, what would it be?”

This was a tag line for the exhibition. My thoughts lingered on our recent Alzheimer’s assistive technology research work, a depressing proposition indeed, if all our citizens suffered these symptoms of memory loss [6], destined to repeat some small set of meaningless phrases, before they too faded. Some dissidents in this future world did what they could to retain their free thoughts and save their memories; but the narrator of the Palace ended up in prison.

“..accused of being a member of a banned sect, who has revived the ancient ‘art of memory’. The narrator uses his prison cell as his ‘memory palace’, the location for the things he has remembered: corrupted fragments and misunderstood details of things we may recognise from our time. He clings to his belief that without memory, civilisation is doomed.” [3]

The Palace provided an antidote to my Bowie induced ‘high’, no creativity, society in a downward spiral, a Tower of Babel [7] in the digital age, yet to come.

I pondered on the education process, and reflected that nowadays students were being similarly programmed, fed information which they would duly regurgitate to show they had ‘understood’, but I doubted it. New tasks would often initiate a quick surrender; problem solving and creativity were being stifled. Information was now disposable, to be consumed, filed away in the cloud, then seemingly forgotten. Were we in danger of taking a step closer to this future legend? Of course I blamed the ‘system’, which absolved me. This tempered my optimism, a little, until I left to meet my colleagues in a nearby pub and my memory dwindled, aided by a relay of ‘Metropolis’⁶ real ale.

But I was left with a question. How could teachers inspire students to be more creative, like Bowie’s lyrics had inspired me? At least students could still write down to help them remember (or download,hmmm!) but how could

⁶ Metropolis, “A superb golden session beer, with enormous balance and depth of flavour and a long floral, spicy finish.”

we know that they understood the subject? How could they put the fragments together? I was in danger of becoming a Palace dissident.

3.3 A perfect storm: May 2014

My London trip was filed in my own Memory Palace (for later regurgitation, of course), I was back in my day job end of semester; sometimes a teacher, sometimes a researcher, a confused academic struggling with the paperwork in my paperless office. I filled in my Higher Education Statistics Agency transparency return form which detailed my effort: 50% time on teaching, 50% time on research, not too hard, although increasingly it seemed that much of my time was spent on filling in forms.

However, my research had gathered new impetus this year. As a post-doc researcher I had been involved in the investigation of brain electrical signals, the electroencephalogram known as the EEG. The EEG had been first recorded by Hans Berger [8] in the 1924, a scientist, prone to bouts of depression, but undeniably touched by creativity⁷. By using various sound and vision stimuli a class of diagnostic brain electrical signals known as event-related potentials could be generated for subsequent analysis. These potentials were powerful indices of the function of the brain; some could be used to objectively assess sensory function such as hearing and sight, others were diagnostic for degenerative neural conditions such as multiple sclerosis, epilepsy, even brain death. My own research focus had been into the cognitive potentials. Some excellent work had been done by to identify the various important cognitive 'waves': the P300⁸, the N400, the mismatch negativity (MMN), the contingent negative variation (CNV); all useful to psycho-physiologists in the study of memory, attention, and even the understanding of language.

In the 'noughties', the fusion of Human Computer Interaction with recorded EEG spawned the area of brain computer interface (BCI); I duly got involved in this research stream, as befitted my teaching role in Computer Science. BCI was set to be the next 'big thing' for accessing computers by thought alone, but the research had stalled for some years, leaving those involved to devise ever more complex signal processing algorithms to show modest increases in classification accuracy for one or other classification model, using well-worn datasets.

But in Sept 2013 came a disruptive change, a new headset designed by Tan Le and funded by a Kickstarter crowd source project changed everything [9] – the 'Insight' would provide a paradigm shift. EEG caps were now designated as brainwear!

“A sleek, multi-channel, wireless headset that monitors your brain activity and translates EEG into meaningful data you can understand.”

⁷ Berger eventually succumbed to suicide like many touched by genius

⁸ The labelling implies a positive peak 300 msec after a stimulus to the subject; P300 is important in memory update

The headset was technically limited by neurophysiological laboratory standards; it had only 5 EEG channels; but multimodal add-ons included a 6 axis inertial sensor (gyroscope and accelerometer) and 3-axis magnetometer. As it cost only a couple of hundred dollars; it could be treated as a computer peripheral, a bit like a 'souped up' mouse. The headset could be applied in seconds. Indeed I had dreamed of such a device [10].

Better still my research group had found a way to solve the tricky problem of electrode reuse. With the advent of 'dry'⁹ electrodes, it was possible to make disposable electrodes from plastic, of all things. The electrodes had to replicate the intricate shape to fit the headset. But of course this could now be done cheaply with a 3D printer, giving a potentially unlimited supply, for extensive reuse. The 3D printer provided a new way to make things that could be drawn on a computer cheaply.

These technology advances had come hot on the heels of 'intelligent glasses' [11] These glasses could be programmed to measure eye gaze, meaning that when a student looked at a computer screen, it was possible to track the areas that he/she was attending to.

For my research area, this was a perfect technological storm.

BCI could be enhanced by this technology. This was really exciting. By combining eye gaze and BCI our lab had already built a 'hybrid BCI' that outperformed our previous BCI systems, and in addition, the hybrid technology was robust, reliable and easier to use [12]. With the addition of the Insight headset it could be aesthetically pleasing, even cool. The eye gaze was measured unobtrusively by the glasses and linked with the BCI allowing menu selections on a computer interface to be made using BCI, eye gaze or both in collaboration.

3.4 Another Brick in the Wall

How can we be sure that the students attend to our lectures? How can we be sure that the student has understood a topic? These two questions were the holy grail of pedagogic research.

The first question had become easy to answer.

If student wore the intelligent glasses then it was straightforward to work out if the student attended to the lecturer (in the seminar) and the computer screen (in the lab). At the end of a class the lecturer could view summary data pinpointing any students that tended to stray 'too much'. Feedback to the student¹⁰ could be instant, initially causing a fair degree of alarm – 'big brother' [13] had arrived in the classroom. I had used the system throughout the semester and I was surprised how quickly the students accepted it, but of course students of computing are early adopters of 'cool' technology. I felt that the technology was having a positive effect and this spurred me on.

⁹ Previous electrodes required gel

¹⁰ A student was now of course a paying customer demanding value for money

The second question was a little more complex.

For the last 20 years in cognitive research, neurophysiological researchers had been looking for the 'next' event related potential wave; something that demonstrated cognition. There were many such candidate waves distributed all over the scalp, but their patterns were illusive, not reproducible. We had got lost in the laboratories; too many electrodes, algorithms that indeed were too sophisticated, a feature set that had exploded. We were a victim of BIG data, drowning in the deluge. We had been looking for the 'needle in a hay stack'. There were just too many needles.

But over the last couple of weeks in the BCI we had been recording with our PhD students, a clever bunch. We devised a set of problem solving questions and monitored the brain activity, using our newly acquired Insight headset.

The years of toil were about to pay-off. Little did we know that the answer to our understanding process was there all the time, but occurring much later in time than researchers had been observing. It was very easy to miss. When a test subject solved a particular problem, an event was embedded with the raw EEG data, and an off-line algorithm mined the EEG channels for discernible features. The peaks and troughs in the EEG came and went. We needed a way to visualise the activity, so we hooked up the analysis software to large display screen and pondered, numbers were translated to colours, and we waited for patterns to emerge in space and time. This was 'CSI - Jordanstown'¹¹. We could see some classic waves ebb and flow. We stopped the analysis after about 2 seconds and the EEG had returned to background levels.

Coincidentally we had just taken on a sixth form student, to give him some experience as part of a STEM¹² placement. On first impression the student, Archie, was the typical 'geek' programmer, good with computers – less so with people, really a young version of 'Brains' from Thunderbirds [14]. One afternoon we demonstrated the hybrid BCI system, to give him a project to present for his presentation day, a requirement of the placement. He was very enthusiastic and could program, but he didn't have our expertise and experience of course. He duly underwent the recording procedure and I left him to analyse his own data using a simple MATLAB routine. Later I returned to the lab to help him. It was a bit of a mess, not unexpected of course, 'rookie' mistakes. "The magnetometer and inertial data are completely different from the EEG, why did you subtract the vectors?", I queried using my authoritative, academic kabuki mask. "The evoked potentials finish after 2 seconds post-stimulus, I continued, there's no need to continue..." He wasn't attending to my comments, but excitedly showed me the pictures of his brain wave on the screen. Initially I wasn't attending to his comments. It would probably suffice for his project, I reassured myself. Then I noticed an interesting pattern in my peripheral vision.

Of course the EEG waveform, contaminated with magnetometer and inertial sensors data was all 'noise', pretty but completely corrupt, ebbing and

¹¹ Akin to Crime Scene Investigation_NewYork, http://www.cbs.com/shows/csi_ny/

¹² STEM: science technology, engineering and mathematics

flowing with random swirls for a couple of seconds. But then it happened; arriving like a giant tsunami wave that washed over the brain emerged a 'slow' wave, only observable subtly in the time waveforms as a small dc shift. We could only see it begin to emerge after about 1900msec and it lasted for at least a second; spatially it moved around the brain sites, detected first by one electrode, then another; as realisation of the 'answer' to a question in the subject's brain emerged at the frontal cortex, built up and then moved clockwise to the right temporal lobe, then occipital, then the left, and then the front again. It appeared that as an event occurred, as a question was answered, 'cognition' was being achieved and the answer filed to memory, then checked as part of intra-brain communication and a form of brain democracy. And then, a second identical pattern, like Usain Bolt¹³ on a celebration lap as it became apparent to the source (i.e. the human mind) that they 'knew' that they knew it! But the shift was only there in the 'hybrid' system and best observed in a simpler system, like the Insight.

But why were we seeing it now? It was pure serendipity. The EEG by itself was too noisy. In labs there were too many channels. By subtracting the magnetic field and compensating for movement, using crude subtraction, the dc shift pattern could be sustained, after the EEG potentials had normally ebb away. I thought, "Brains, no Archie, he's a genius!"

A few weeks work with our PhD students followed. The pattern was reproducible in our lab. Well, with this potential we could now objectively test if a person really 'knew' an answer to a question. Think of its effect on teaching and learning; this could for the first time become a shared collaborative and measurable paradigm. This was a game changer; no longer would a student be able to claim that they understood a topic, a memory dump was no longer a substitute for 'active learning'.

3.5 Testing Times

Twenty first year students filed into a computer lab to take their final part of their year 1 Computer Networks assessment. At the instructor's desk I could check on an individual's progress or choose to view a 'dashboard' summary of attention as measured by each student's glasses. Each student donned the intelligent glasses. I told my students,

"Think about it, I know where you are looking". "For this final test I would like you all to wear a BCI headset", I said. "The test is only worth 5%, but I want to check your understanding of our subject, I said".

Puzzled looks from the class, but the glasses had been such a hit so no revolt. The test began. I checked my eye gaze metrics. The students were looking at the test, a few distractions but totally acceptable. Task 1 accomplished, they were engaged, but would they demonstrate cognition – acquisition of knowledge?

The test was designed to be pretty easy as first, to encourage the student, and then become a bit more tricky as time progressed. The data was streamed to the computer for analysis in the lab. Twenty questions to provide my

¹³ Usain Bolt is the Olympic & World 100m & 200m champion and officially the 'fastest' man on earth

objective test of understanding, five straightforward recall, ten which required some logical deduction and five which required significant problem solving.

The off-line process was automated and quite fast, being visualized a few minutes after acquisition. The 20 student hybrid EEG patterns were displayed on a 5 x 4 grid. As the test questions kicked in, and following the data processing delay I could begin to visualise the brain waves of the students, and then the tell-tale circuits of EEG (and subsequent victory laps) began to emerge. As the test became more difficult, the performance fell off, just as I had anticipated. The marking was anonymous and automated; 1 mark for each question which elicited the double-lap cognition pattern, with marks returned directly to an-online student system.

3.6 Lecture Theatre May 2014

The first year student was clearly perplexed. "I paid the money and this is all I got in your test. I got good marks in my other modules, I just don't UNDERSTAND". "I know", I said, "UREKA".

This was my confirmation; the potential could be collected in the classroom. Using this potential the students could work at a topic until they understood it. We had a potential switch for understanding. I had the research algorithms, real world data and now user feedback. I could write a really important paper, even if I had to give way to my genius sixth form student. I started to write the first draft:

Title: Ureka Potential: An objective EEG measure that can measure cognition for use in and Immersive Education Environment

Authors: Archie Medes, Paul McCullagh, et al.

Text: How can we be sure that the students attend to our lectures? How can we be sure that the student has understood a topic? These two questions were the holy grail of pedagogic research.....

Now for my next challenge, potentials for measuring knowledge, even artistic "genius", like Bowie. I thought of a Bowie lyric:

"....Knowledge comes with death's release" [2]

Better leave that one - for now.

4. Conclusion

The prototype investigates the difference between recall and acquisition of knowledge or cognition, in education. Future technology may be able to help

here. Intelligent glasses could have a clear role with measuring engagement between learner and teacher, but the application of hybrid EEG technology, while existing, is much more speculative at this stage. I'm sure the former will find use in immersive education very soon.

There is a spectrum between recall, cognition, knowledge and finally creative genius. In this paper the Eureka potential taps into cognition and the acquisition of knowledge.

The fictional prototype can serve to apply hybrid BCI technology into immersive education, much like a futuristic 1970s language laboratory, which used advances in magnetic tape recording to allow a student (and their instructor) to listen to their pronunciation of a foreign language. The prototype suggests similar feedback that can report on understanding, in a subject way.

The motivation for the work is the worry that in digital age education where storage of materials can comprise a link to the cloud, students utilize this learning paradigm and simply recall their work (for assessment) without sufficient understanding. Memorizing is necessary but not altogether sufficient for understanding.

Acknowledgements

Thanks to BCI colleagues who worked on the hybrid BCI eye gaze system, colleagues who attended the 'David Bowie Is' exhibition in London in June 2012 and to colleagues at Essex for providing inspiration in immersive education and a plausible scenario.

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Science Fiction Prototypes in Educational and Business Settings

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Abstract

This paper examines the intended purpose of Science Fiction Prototypes (SFP) in conjunction with the significance and use of workshops in business education. We explore why the SFP as a form of education delivery has proven to be popular. Finally we argue that the merits of alternative delivery methods, including the use of science fiction prototypes within different venues or alternative delivery methods can enhance educational engagement with broader audiences outside the traditional classroom setting.

Keywords. Science fiction Prototype (SFP), business education, non-traditional classroom setting

Introduction

To date, Science Fiction Prototyping practice has largely focused around delivery within classroom style workshops or as role playing activities. The tendency within this current practice is to merge two distinct 'parts' of a Science Fiction Prototype; the first, the creative creation of the science fiction prototype introduces a vision or projection of future conditions while the second offer up the prototype for interpretation and encourage participants' to attempt to strategise and operationalise the vision (Figure 1). In this paper we re-examine the intended purpose of Science Fiction Prototypes in conjunction with reflections upon the significance of case studies in business education and the reasons why this form of delivery has proven to be so popular. Finally we argue for the merits of alternative delivery methods such as, for example, the use of science fiction prototypes within a digital shopfront to enhance educational engagement with broader audiences outside the traditional classroom setting.

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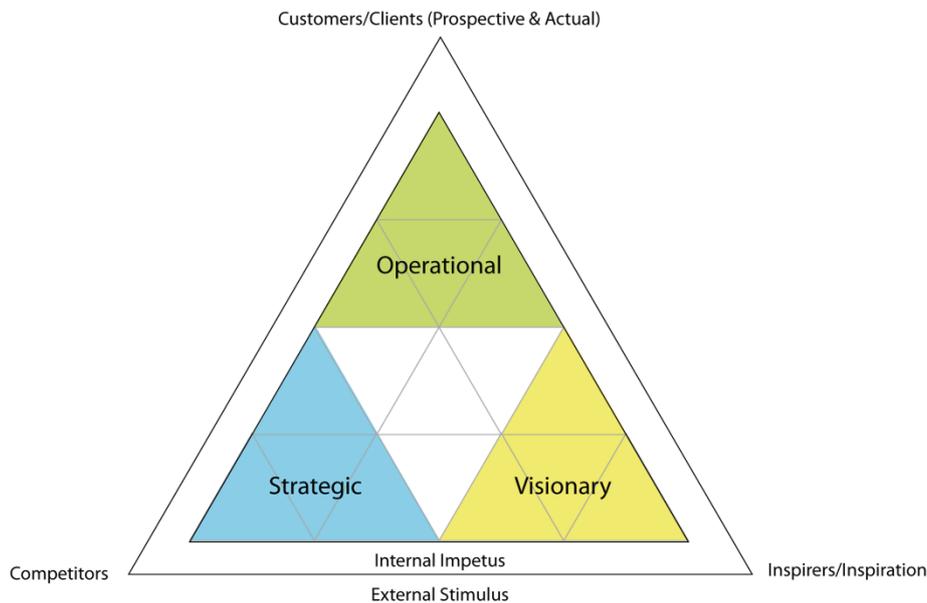


Figure 1: The relationship between visionary and operational aspects of an organisation that are captured within the two parts of the Science Fiction Prototype.

1. Discussion

The case study in business education is a well-established and regularly used practice. At the core of its many claimed benefits, case studies enable the educator to achieve learning objectives that draw upon recognisable but systematised real-life situations. These are situations that are regularly presented as examples of success with the implication that these are the models to follow in other contexts. Argyris (1980) has, however, outlined the benefits of the case study approach as a means for introducing and hearing the views of others; confronting differences; making decisions; and becoming aware of the complexity of reality. Overall the claimed benefits of case methods recognise that there are rarely right or wrong answers and that cases are invariably as incomplete as real-life situations. For all these apparent benefits Argyris (1980) also outlines a critique in the use of case studies. Case-based teaching methods are regularly used by faculty "stars" as their preferred method for management development programs as it facilitates learning that does not question the underlying values of the executives described or the policies in their organizations. At the same time the case study inhibits learning that would enable learners to question their basic assumptions and to improve their application of new learning within their current or future organization. Levi-Strauss (1969, p.18) makes a similar observation regarding cultural practices more broadly, "There is rarely any doubt that the unconscious reasons for practicing a custom or sharing a belief are remote from the reasons given to justify them." Science Fiction Prototyping pushes this remoteness that Levi-Strauss observes to an extreme position where it can become more clearly evident.

In contrast to case studies, which focus upon historical evidence drawn from actual events, science fiction prototypes develop a future extrapolated from the authors' experiences and knowledge of the present. The vision that is presented through the prototype emphasises the concerns and interests of its author(s). This reversal of perspective arguably offers greater opportunity for the critique of current environments and practices and follows in the spirit of the science fiction genre's longer-term tradition for assertive social and political commentary. The prototyping approach also highlights the separation of two distinct activities that are often merged without acknowledgement in other teaching and learning methods. These two activities can be broadly described individually as the creative and operationalising parts of the whole prototype. The authorship of the prototype is a creative activity that can be an entire workshop itself, part of a series of activities or a discrete workshop with the output then becoming the input for a separate later workshop with entirely different audience and purpose. This is what Papanek (1997: 307) describes as "the omni-directional net of several design 'events'". His perspective highlights the relationship of one event to another by implying a sequential process where alternatively there are a contraction of ideas to a collective consensus or special case followed by the expansion of ideas from a single starting point to a multitude of possibilities. Different sequential design events cycle through this contraction and expansion of ideas (Papanek, 1997: 309). Alternatively, Wu (2013), in his work on SFP imagination workshops, advocates an evolutionary model in what he terms 'cyclic SPF'. This model has a series of processes containing feedback loops in the form of an iterative co-creation process that can include a range of deliverables such as product specifications or business models (Wu 2013).

To date, science fiction prototyping activities have often focussed on the creative parts of the prototype with an implicit goal to 'build something' through the activities (Egerton 2013; Johnson 2011, 2013). Although, as previously acknowledged, Wu (2013) has broadened this vision to create more 'intangible' prototypes. In Papanek's (1997) terms this is a contraction event. The focus on creation reflects the desire of earlier SFP workshops to invent and create new technological and physical artefacts. What could be described as the science of science fiction prototyping? In contrast, we focus here on the less explored aspect of science fiction prototyping that is concerned more with the business of science fiction prototyping. This can be identified (see Figure 1) as an attempt to move from the vision of the prototype to the operationalisation of the prototype and ultimately the potential implementation of the vision. In order to achieve this focus on strategic and future operational issues, the creative part of the prototype for this workshop has been pre-prepared. It draws upon discussions by the authors and, perhaps inevitably, reveals some of their own current interests and awareness. This story is consciously written for science fiction prototyping in its description of a future world in a matter-of-fact style with details that provoke questions rather than providing direct explanation. The purpose then of this prototype is not necessarily to "invent something" from the description of the prototype but to elicit discussion around how to get from a current situation - the present environment - to the vision outlined by the prototype (if, in fact, the described environment is actually considered a desirable situation). The operational workshop - an expansion event - itself then benefits from participants' varied knowledge and specialisms to bring the operational and strategic elements to the aspects of the vision that are already described by the prototype.

We also problematise here, the choice of venue for a workshop. Workshop locations are often an indicator of the approach and intentions of the organisers. The perceived privilege of universities and their distancing from everyday life is commonly represented in the 'ivory tower' description. Yet the choice of workshop location, such as a university building, is usually a matter of convenience for the organisers rather than a conscious selection. Very rarely does a workshop break out of this orthodoxy. One example, a workshop held during the Abandon Normal Devices (AND) Festival was located on an open piece of rough land in the centre of Salford (AND Festival 2010). A venue that could generously be described as, curious. Hosted by Heath Bunting the icebreaker involved throwing rocks at cans and the main event placed the attendees in a simulated air-drone attack that was enhanced with the inclusion of remote control planes and cameras. Similarly, the Rochdale Borough High Street Foundation (2011), with a concern for the number of empty shops in the borough, located their urban planning workshops in an empty shop within a central local shopping centre. Music, theatre and dance were used as inspirational stimuli for the attendees to assist in building an alternative vision of their high street. The intention in both of these examples was to encourage participation from within the locality and purposely drawn away from convenient academic locations.

We describe these combination of factors for consideration as a parallel set of sliding scales (echoing Papanek 1997: 176). This view presents a multitude of combinations (Figure 2) that both charts the approach we are advocating here through the use of Science Fiction Prototyping while also highlighting the relatively small range of combinations that are currently used in conventionally teaching and learning practice.

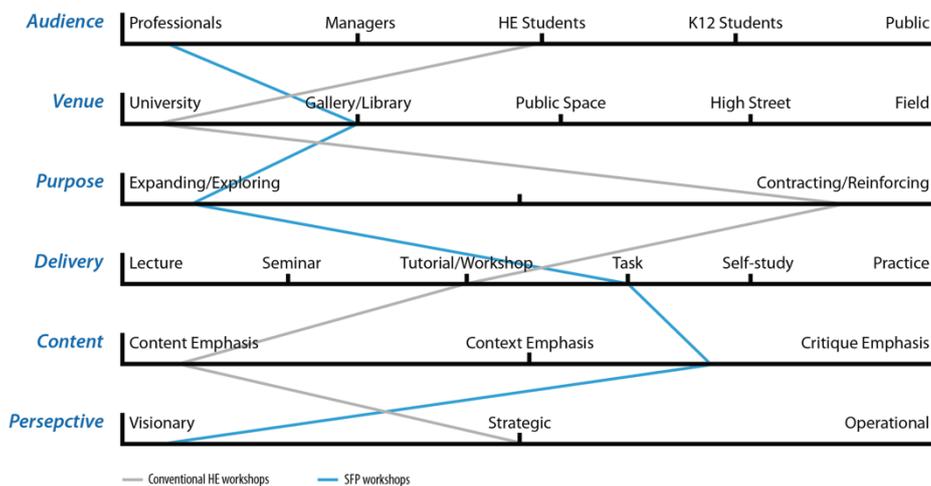


Figure 2: Sliding scales of the comparative design and pedagogical concerns of teaching and learning activities

The following Sci-Fi narrative provides a platform for audience participation to develop an operational prototype (or prototypes) that encourages an imagined future to be achieved. The story has been written to stimulate participants' thinking around a range of key issues and provides a framework world for future imaginings. By writing the narrative as a framework rather than a complete 'whole' story supports attention to

the parameters identified in Figure 2 but particularly by enabling a contextualising of Audience, Venue, and Delivery. These, we argue, are the three variables that are most likely to differ within Science Fiction Prototyping workshops. Different workshops will inevitably produce different responses but this emphasised awareness on structural differences provides the basis for comparisons of the results. Workshops that are undertaken with some form of advocacy as a stated outcome, rather than solely educative intent, also benefit from understanding the different bases from which the prototypes emerged.

The story itself depicts a futuristic scenario where money (as we currently understand it) transcends its physicality within a limited financial domain; the notions of 'work' and 'labour' have become increasingly broad to the extent that a contemporary reading might describe these activities as games; and the current conventional arrangements and balance of transport and logistics coupled with manufacture have completely altered. The consequences of these changes have repercussions within the framework world with the hint that there are also shifts in attitudes and cultural practices. The narrative also hints at a more definitely stratified society. These devices all build a framework without being conclusive or definitive about the future. There is no single final conclusion, singular explanations or closed endings. It is a prototype of potentiality. Importantly the narrative does not prejudge the future world framework as being either utopic or dystopic. This judgement rests entirely with the reader and will be among the influences that shape their contribution to the workshop. The operational prototypes that emerge can then just as equally resist or embrace this future overall. More sophisticated prototypes can also identify individual elements of this future world as potential directions to avoid or actively work towards. This potential attends to the need to operationalise and strategise vision (Figure 1) in ways that are achievable and sustainable. Equally, and in direct contrast to the use of cases and case studies in business education, the potential bifurcation of workshop results recognises what Chesterton (1915) described as the fallacy of success. By presenting a framework that does not presuppose the desirability of the future described within the narrative there is no presupposition that the resulting future is itself a successful outcome - albeit necessarily using the judgement and perspective of contemporary experience.

2. Sci-Fi Narrative: "The New Day"

Matthew74NT@dmail stood waiting for the robo-bus. It was still relatively early and Matthew74NT, or "Ant" to his friends, was in a contemplative mood. The heady result of a combination of early morning caffeine shots and the after-effects of late night alcohol shots. It was too early for the smart streetcars to be out so Ant shared the street with just a few energetic cyclists. Almost unnoticed in the background there was the inevitable presence of the street-collecting machines carrying away the remains of everyday life from previous generations that continuously emerged onto the streets. The rush hour - unlike the detritus - was most definitely a thing of the past. Ant gripped his tablet more tightly towards his chest. Despite the evidence of the grey skies and drizzle, today was not any ordinary day and it was a day that Ant had hoped would never happen. He was waiting for the #79 robo-bus. Of course, waiting for robo-bus

wasn't the event that Ant had hoped would not happen to him. He might not be a regular traveller on public transport but nor was it the cause for his apprehension.

For the first time in his life Ant found himself unemployed. Standing at a bus stop waiting for the next robo-bus is always a time for reflection and Ant was no different. Up until five days ago he was a relatively successful member of the TwP Guild in the *World of Accountancy*. After a shaky and slow start 10 years ago as a newbie student Guild member Ant had reached chartered level 22. He had even been dreaming of making the big jump to partner level 1. The steady downturn in genecoin production in the past two years had been hitting hard. All of the large guilds in the *World of Accountancy* had shrunk their membership. The overwhelming control that they exerted over accounting practice worldwide made it difficult for individuals to progress in the world significantly and the ability to earn genecoins without the support or protection of a guild was very limited. Ant did admittedly have a ghost account that he had used to get a few extra genecoins but in his alter-ego as a part-time associate level 4 this was really just enough for a few extra luxuries.

Ant absentmindedly checked his watch and instantly recognised the futility of this action. While he normally avoided the robo-buses he knew - as well as everyone else - that one of the effects the genecoin crisis had brought was a revision of robo-bus services. Each robo-bus on each journey plotted an individual route that optimised the number of passengers it carried. Although the mechanics of the bus system was a secret, speculation was rife about how it actually worked. Some suggested it was based on weight sensors and cameras measuring the number of people waiting at each stop while others said it was simply based on calculations and extrapolations from previous journeys. Rumours also abounded on the local blogs that the bus services were constantly being tweaked to give preference to the filling of robo-buses to capacity rather than passenger convenience. This suggestion was not a surprise to anyone.

Ant sighed quietly at the frustrations of public transport. But he was also relieved to see two others walk up to his bus stop.

Sure enough only minutes later a robo-bus appeared on the road heading towards Ant and his unknown travelling companions. Behind him the man and woman chatted. Their tone was hushed but urgent. Ant tried not to listen out of a sense of privacy and politeness but snippets inevitably came clearly within his earshot. "Fantastic new blog", "actually printed?", "genecoin crisis".

The robo-bus arrived. Ant swiped his accesscard on the door and keyed in his destination. He cursed quietly under his breath. Someone was sitting in his favourite seat. Despite only travelling rarely on the robo-buses, Ant enjoyed the pleasure of sitting in the 'driver's seat' of the robotic driverless buses. It was a simple joy even though the concept of a human bus driver was something Ant only knew from the stories of his parents and grandparents. For Ant there was a nostalgic appeal in having a bus driver to speak to and although he had visited street-collector exhibitions in the past he still felt that there was a massive gulf between seeing the collected items on screen and actually speaking to a driver.

In the perverse logic of bus seating the couple from the bus stop had taken up the seats directly behind Ant. Their conversation had continued on apparently the same topic with some intensity. "Change of government." "Getting the message out there." Ant

sank back again into his own thoughts. He was visiting Andrew38EN@keycorp, or somewhat predictably Ben. Ben was a friend, perhaps more accurately an acquaintance who had been a friend at college. Ant had reinitiated contact with Ben through a mutual friend the day after he found out that he had lost his place at the TwP guild. Knowing Ben was useful as he had influence in the HDC Guild within *Logistics World*. Or at least enough influence to get Ant a foot in the door at the Guild with the opportunity to start at student level 6. Ben had offered to guide Ant through the *Logistics World* for a couple of days. Although it was unusual Ben had suggested to Ant that he should visit him at home to meet face-to-face and walk through the world together. Ben had expressed surprise at Ant's desire to change career and wanted to ease him into things. It was still unusual for members of guilds to completely change professions. Most of the victims of the genecoin crisis had stuck to their original careers as it was generally easier to progress back to their original levels fairly quickly. Knowing all of this Ant had readily agreed to Ben's offer, glad to be out of his own flat for a while and away from the reminders of his former guild - the awards, certificates and gaudily coloured paraphernalia that he had printed and collected over the years.

The robo-bus stopped and Ant realised he was already outside Ben's house. A quick Tx and Ben opened the door. Ant and Ben awkwardly shook hands. This was the first time they had stood in front of each for many years. However, both recognised the other immediately from the various images on their walls. Ant had already got himself up to date with Ben's career and family through his wall. Nonetheless they chatted casually for a while as Ben tried to shuffle his eight-year-old daughter out the door. Her school group were having a meet-up today at a neighbour's house and her combination of excitement and nervousness at the prospect of something different meant that she was running late. Ant discovered that Ben's partner, Mary27UC@outward, had already taken a robo-bus to a colleague's house to give Ben and Ant a chance to work together undisturbed on Ant's first day at his new job.

With the departure of Ben's daughter some calm returned to the house. Ben turned to Ant and in a tone that was both a question and a statement of the obvious, "To work!?"

Ben and Ant logged on and the *Logistics World* screen came up. Ben explained, "*Logistics World* is a relatively simple interface. Our task is relatively simple too. We have to shift the coloured cubes from their current locations to empty spaces that flash when you move the cube. You are starting on the student levels so the size of the cubes you can move are small but the more you move and the more you work with the guild to move larger cubes you will level up. If you are efficient and move cubes in bigger groups and the minimum possible distance the guild leaders will noticed this in their weekly reports and you will get support from the guild. Obviously you receive a payment for every cube you move."

Ant nodded appreciatively. This felt familiar but he was puzzled by the purpose of the work.

"How does the movement of the cubes relate to logistics?" Ben looked over at Ant. He had been intently staring at his own screen throughout his description. He could see from the expression on Ant's face that this was a question that came out of genuine interest. Ben realised that Ant's previous experience in the *World of Accountancy* had been a bit more - for want of a better word - conceptual. Although Ben had never seen the *World of Accountancy* interface he had always guessed that it mainly involved moving numbers around. Ben patiently continued,

“Oh, each cube relates to different printer supplies. Each colour relates to a different type of supply. I’m not 100% sure but I think the pink and brown cubes are protein and carbohydrate supplies for food printers and I’m pretty sure that the bigger silver cubes are raw graphene of some sort. As you guide the cubes around you are controlling the delivery floats and airtubes between the factory and their destination. Somewhere in the docs there is a full chart of all the item types. Honestly in all the time I’ve been working I’ve only seen about half of all the possible types.”

“What’s that small disc?” Ant was enjoying the shock of this new world.

“You haven’t changed”, Ben grinned. Working with Ant was bringing back memories of their time at college together. “The disc is a genecoin. They’re not rare but they come in lots of different colours. I think the miners customise them as a sort of branding but it also seems to be connected in some way to the source of the genecoin. You won’t be able to move them until you’ve hit the chartered levels AND gained a gold security badge. But don’t worry,” Ben looked directly at Ant, “there’s no penalty for trying.”

“I didn’t know you could see genecoins like that. In the World of Accountancy it was a bit more about making the numbers go together. We were always told that genecoins were all basically the same. Same exchange value, interchangeable, unchanging.” Ant’s fascination was coming out in the tone of his voice and he could feel himself being drawn into the mechanics of *Logistics World*. “I think I’m going to enjoy this.” Ben smiled,

“Well it’s always a better day if you actually enjoy your work.”

Ant and Ben toiled on silently. Occasionally they exchanged words around work and life in general. Then Ant in a moment of revelation suddenly exclaimed,

“This all looks oddly familiar. In college didn’t we use to play a retro-game from years and years ago that was a bit like this?” Ben smiled,

“Take a look in the license statement and scroll all the way to the bottom.” Ant did as suggested, scrolling past lines and lines of revision dates and patch information until finally he read verbatim from the screen,

“‘Original codebase Minecraft 2009 Notch Persson.’ Wow, that is old. And if I remember correctly we had to beg the college librarian to release the code to us just to let us play it. She wasn’t happy though. It was of her prized items. Odd to think that code from an old game is still somewhere in there.”

Ant and Ben worked on through the afternoon. Ben’s partner and daughter returned home together and he was distracted by their various stories of both of their meetups. Ben suggested that Ant might like to stay for dinner but the prospect of a late night robo-bus trip encouraged Ant to decline.

On his bus journey home Ant reflected on his day. He took a quick scan of the bus to see if his travel companions of the morning were on the bus too. But, of course, the chances were very unlikely and they were nowhere to be seen.

At home, Ant flicked on the printer. He couldn’t remember what meal he had scheduled for today but he didn’t mind. He left the printer to get on with his meal. He was feeling the combined effects of a day’s work at a new job and the excitement of his tangible progress towards student level 7 with only a few hours of effort. Ant quickly scanned the day’s vinecasts and blogs (failing to spot the photograph of the couple from the morning’s bus ride that was appearing in one the day’s city blogposts). His

meal finished being printed and he ate quickly. His rapid pace - such a shift from his normally relaxed evening's activities - was purposeful. Fifteen minutes later the login screen for Logistics World reappeared on Ant's tablet. Ant did occasionally work after hours as a freelancer but tonight he had a different purpose. He quickly logged in and was soon scanning the docs. His target was specifically the description of genecoins and the different meanings associated with the individual miners and item types.

In the entry for "Genecoins, Types and Meaning of" it said, "...genecoins' colours and sizes are determined by a variety of factors including the importance of maintaining security for individual genecoins as well as the anonymity of the donor. The constant factor for all genecoins of all ages is their size which is automatically created by the miners as an assessment of their initial worth. This assessment of worth is also connected to the colour of the genecoin which the miners use, in part, as an indicator of what they consider as the best potential application for the genecoin itself. Unfortunately each miner guild uses slightly different colours for this assessment and it is generally considered good practice not to consider the colour and size of genecoins for everyday use. To make matters more complex older genecoins will develop a patina over time that provides an indication of their age, their previous usage and relative rarity. Genecoins that persist after the lifespan of their donor will also develop a ridged edge as a mark of respect and as a further indicator of their rarity..."

This was what Ant had wanted to find but the description was also a surprise. His previous experience of accounting had never made any mention of any differences between individual genecoin. The perspective in accounting was that a genecoin was a genecoin unreservedly and completely interchangeable. This principle of universal exchangeability was at the heart of any currency. Wasn't it? Ant found himself considering this founding principle carefully.

Ant scrolled past details of the technical specifications and the challenges that these specifications represented to logistics. He felt slightly guilty for overlooking the very details that related to his new job but that, he reasoned, was why documentation was always available. They will always be there for the one day in the indeterminate future when you need to extract the exact details to solve a problem that you have not yet imagined. The documentation then highlighted a further complexity in the economy of genecoins.

"...it is possible that genecoins will reach the end of their usable lifespan. This is a rare event and will potentially occur only a few times during any one person's involvement in *Logistics World*. A deceased genecoin will become completely black and cease spinning within the *Logistics World* interface. When this occurs the only option available for handling the genecoin is for a minimum of three partners level 10 or higher all with gold security badges to collectively move the genecoin to a black genebin which are themselves relatively rare within *Logistics World*. As a consequence the disposal of deceased genecoins is well-rewarded and competing guilds will often attempt to hijack missions that set out to dispose of them. In periods when the availability of supply cubes is low in some regions guild leaders will instruct lower level guild members to guard known black genebins with the express purpose of preventing competing guild from using the genebin for disposal..."

Ant looked up. He knew it was a silly response but he could feel himself becoming tense. Nobody had told him that there was any adventure in logistics or that genecoins were so complex. Looking back at the tablet and a quick click closed down the documentation to return to the main interface. In one of those strange twists of fate that seem to happen so often, a genecoin had appeared in the interface on Ant's tablet. From his earlier reading it was immediately obvious to Ant that this was quite an old genecoin. Ant watched the genecoin slowly spin for many minutes almost mesmerised by the colour he saw but at the same time he knew he could not move or interact with it.

Very slowly, almost imperceptibly, the old genecoin became smaller. When he realised what had happened Ant almost dropped his tablet. If he had not been watching the genecoin so intently he probably would have not even noticed. He quickly sent a Tx to Ben,

"Do genecoins ever shrink?" The reply came back almost immediately,
"?? No. I think that would be like stealing."

2.1. *Applying the Sci-Fi narrative*

"The New Day", is intentionally incomplete in terms of the explanations it offers and instead provides contextualising and scene setting for the imagination and the workshop.

The expectation is that participants will almost unconsciously 'fill in the gaps' and in this thinking be able to make a contribution in the workshop. The focus of attention from each individual participant will vary and contribute to the richness of the experience. Understanding the overall direction, purpose and audience of the workshop through the sliding scales proposed in Figure 2 will assist a facilitator in maintaining a focus while not stifling the creativity of the contributions.

Of particular importance to the workshop and the use of narrative as a device for discussion and development is the way in which science fiction enables a breaking away from accepted practice and encourages a criticality that always evident in professional workshops or educational delivery. Levi-Strauss (1969, 19) is again instructive when he suggests that, "We act and think according to habit, and the extraordinary resistance offered to even minimal departures from custom is due more to inertia than to any conscious desire to maintain usages which have a clear function."

3. **Conclusion**

As discussed previously Science Fiction Prototyping practice has largely focused around delivery within classroom style workshops or as role-playing activities, however the workshop proposed here is an expansion event. The workshop focus presented in this paper attempts to move the vision of the prototype to its potential strategic and operational form (shown in Figure 1). As an expansion event, the workshop, therefore encourages participants to read or listen to the story prior to the workshop and bring their thoughts, opinions and critiques (hopefully of the future world rather than the literary style employed by the story). This is in conscious distinction to the tendency within current SFP practice to silently merge the two

distinct 'parts' of a prototype; the first, the creative creation and the second to offer the prototype for interpretation. The expansion element of the workshop is possible with the adoption of a critical perspective. The participants are encouraged to consider a number of question for example that may include; Is this future a desirable one? Are aspects of the future described desirable, while other aspects preferably avoided? Is a separation of the positives and negatives realistically possible? What are the social, economic and technical implications for this future? Are there new technologies that could be explored that are drawn from the story? Ultimately, there are two overarching questions. Do 'we' want this future? If 'we' do how do we get there? If 'we don't how do we avoid this conclusion? These questions are themselves precursors to a far wider set of questions including, "How could a business or a council plan to achieve the desirable aspects of the story?"

The many questions posed by the story within the workshop contributes to the authorship of the prototype and as a creative activity can either inform an entire workshop or be expanded to include a series of workshops. Activities presented within the Science Fiction Prototype workshop will stimulate a particular desired output (for the business educator). In a series of rolling workshop events the output and creative authorship then serve as the basis of the input for subsequent workshops with entirely different audiences. A partial parallel to Papanek's (1997: 307) "omni-directional net of several design 'events'" and Wu's (2013) 'cyclic SFP'.

In contrast to Papanek (1997) and Wu (2013), however, we identify an additional purpose for generally iterative educational approaches. By constructing the SFP workshop as an expansion event we argue that alternative questions can also be asked; "How can a business plan to avoid the less desirable results described in the story?" This reverse question can be equally and validly posed as a form of critique and challenge accepts practice. This is a form of question that is very often left unconsidered in conventional business planning which results in a business succumbing to the fallacy of success (Chesterton 1915). With all of these questions there should be no expectation for consensus but rather different streams of discussion that diverge, speculate and expand on the original narrative. Potentially creating new prototypes of the future that can be, in turn, receive the same levels of scrutiny.

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The Dream Machine

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Abstract. This Science-Fiction Prototype ruminates on a post-singularity world, where transhumanism practices are in widespread use. In particular, the discussion focuses on a form of transhumanism that involves reengineering the brain, and associated reality experiences, as part of an educational process. The SFP links dreams and imagination into learning, by seeing them as a type of '*natural immersive education system*'; a "Dream Machine". The paper uses two short SFPs to explore some consequences of transhumanism for immersive education ideas (the focus of the host conference). The article concludes by postulating that we may, perhaps unwittingly, already be on a path to such a future with the advent of technologies like augmented reality glasses and wonders where we might draw a line that we shouldn't cross.

Keywords. Science fiction prototyping, futurology, singularity, transhumanism, virtual reality.

"Inside this room, all of my dreams become realities, and some of my realities become dreams" - Willy Wonka in Roald Dahl's story of 'Charlie and the Chocolate Factory').

Background

1.1. The Storyline Inspiration

This Science Fiction Prototype (SFP) was inspired by an incident in my childhood, when I was around 8 years old. I was the son of Irish immigrants and each summer, for our holidays, we returned "home" to the farm in Ireland where my mother was born. Those were amazing days, full of adventures on an old fashioned self-supporting farm that produced wheat, hay, vegetables, eggs, milk and meat. In those days horses powered the crop cultivation tools and water was fetched by hand from a nearby well. While the farm was a source of food and income to my family, to me it was akin to an exotic amusement park, a treasure trove of exciting adventures ranging from playing boats on streams, through trampolining on hay, to tending animals such as ducks, hens, pigs, cows, horses dogs and cats that roamed freely around the land. What made the experience even more exciting was the journey between England and Ireland which involved a long multi-stage steam train journey, broken by an overnight boat trip across the Irish Sea. The soundtrack of the journey was orchestrated by a choir of randomly conversing travellers accompanied by a strong percussion section made up of a puffing engine and the rhythmic noise of the train wheels crossing track joints. All in all, it was a powerful emotional and educational journey that became a life changing annual pilgrimage that I longed to experience each year, and now lives on inside me long after

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the main players made their final journey from our mortal world. So strong was my longing to return to that idyllic farm that it led to an experience that has inspired this SFP.

1.2. Days of Future Passed

One of my holidays was especially happy, the sun was shining and I was having lots of fun playing with a mountain of sand that was part of a small building project on the farm. My favourite collie dog (Chep) was sitting near me and my grandmother was going about her work in the distance; life on my farm holiday was, as always, good. However, little did I know that this idyllic world was about to be shattered in the most extraordinary way, by something equivalent to a Richter scale-9 tremor that shook my world with so much force that I *woke up!* The world I awoke in was one of total misery, as towering above me was my mother, shaking me, and saying “*wake up, wake up, you need to get dressed for school, or you will be late!*” (school was not my favourite place in those days!). To this day I vividly remember that moment and the shock of being, in an instant, transported from my idyllic holiday setting, on the west coast of Ireland, back to the reality of my non-holiday school life, in southern England!

1.3. Home Thoughts From Abroad

Finding I was not on holiday was a massive disappointment but the much bigger and more long lasting legacy was the realization that dreams and real life can be indistinguishable and, worse, it's never possible to be sure you are awake and not in your own, or even someone else's dream! That thought, and the nature of reality, has haunted me ever since. Perhaps you have had such an experience, if you have then you will probably be able to relate to the motivation driving this SFP; if you haven't, don't feel you have missed anything of value as I'm sure it's more comfortable to be able to accept your physical existence rather than to always question it! Apart from this incident, as a young boy I always looked forward to going to bed, so that I could dream interesting stories. Many were fantasies, which I would dream in a serialised fashion, picking up one night where the previous night left off. Some involved inventions of wonderful futuristic devices, wrapped up in an imaginative scenario, in which I had centre stage. Perhaps I dreamt this way because we had no TV back then, rather just books, the glowing lights of valve radios with their faltering signals and a lot of imagination. In this respect, my dreams were a type of deliberate simulation, or virtual role-play where I was able to explore potential real life scenarios. I guess that's not how it works for everyone, but that was how it worked for me, and how I link dreams and imagination into learning, by seeing them as a type of '*natural immersive education system*'. Undoubtedly computer science is the perfect vehicle to peruse such interests as, on the one hand, it provides the means to create virtual worlds, and, on the other hand, it provides an opportunity to investigate natural intelligence and consciousness as it strives to emulate the capabilities of the human brain, an issue picked up in the following section. With hindsight, maybe those experiences were the recipe for what was to become my interest in Creative Science and, of course, the general theme of the tales that follow!

2. The Singularity and Transhumanism

Almost since the beginning of time, people must have wondered about the nature of our reality. We can imagine that our ancient forefathers might have stared up at the night sky and wondered what those twinkling lights were, where they were, what greater realities existed beyond their perception and whether there was anything special about us and our place in the cosmos. Although science has gone some way to answering a few of those questions, there are still many more which challenge us. Above us is the seeming infinity of physical space and within us are the mysteries of our own consciousness and existence. One of the most basic of these challenges is whether physical matter actually exists or whether we are part of some other reality. As odd as that question may appear, it is a question that has been asked by people for almost as long as recorded history exists being traced back to great philosophers such as Plato (~423-347 BC, Greece), Descartes (1596-1650, France), Berkeley (1685-1753, Ireland) or more modern philosophers such as Russell (1872-1970, UK). Many of these philosophers have pondered if we were, in fact, just part of someone else's dream. For example, Bishop Berkeley's idealism (or "immaterialism") argued the hypothesis that we are all simply the imaginings in the mind of a greater being, God. More recently this argument has been extended to questions as to whether we might all be part of a simulation on some powerful future super computer (perhaps, our lives being authored by some newly graduated computer scientist in a future world, as depicted in the movie "*The Thirteenth Floor*" – see appendix!). Readers that are interested in a more rigorous or academic insights to these propositions are pointed to Nick Bostrom's recent paper that sets out the issues eloquently [1]. From the perspective of this SFP our interest lies in the brain's ability to assemble knowledge (memory), create sophisticated abstractions (models) and run reasoning processes (simulations) so as to function effectively in the real physical world (eg imagination, ideas, innovation, dreams and foresight etc). The SFP links dreams and imagination into learning, by seeing them as a type of '*natural immersive education system*'; a "Dream Machine".

Beyond philosophy, the functioning of the brain is, of course an important area of study for artificial intelligence, which seeks to emulate or exceed its capabilities. Whether that will ever be possible is a somewhat contentious issue, but one group that believes fervently that this is possible, is the singularity movement. One of the principal advocates for the singularity is Ray Kurzweil who rather provocatively identified a date of around 2050 as when artificial intelligence will exceed that of human intelligence (the so-called technological singularity) [2]. In pragmatic terms, the consequence of such a singularity occurring would be profound, but are debated elsewhere [3] [4]. As mentioned above, one of the possible applications for such a super intelligence might be to generate soft or hard replicas of people, to enable them to live on beyond the natural biological end of their lives, thereby bringing humanity closer to finding the fabled elixir of life (elixir of immortality) that could stave off aging and death. Another possibility, and one that will be picked up in the SFPs in this article, is the potential for advanced technologies to augment our organs so as to radically enhance people's intellectual, physical, and psychological capacities; a movement labelled 'transhumanism' which manifests itself in various forms, such as the Cyborgs and Androids described in popular science fiction. The following SFPs will explore aspects of 'transhumanism' related to education, motivated by the fact that the human brain is the seat of knowledge, skill and learning. Of course brains are complex entities and

remain somewhat of a black box to current science with many mysteries, not the least being the nature and reason for dreaming. While many theories exist, no single consensus has emerged [5]. Perhaps that is hardly surprising since science remains unclear about exact purpose and function of sleep itself! Despite that, the SFPs presented here operate in that mysterious time zone, while people sleep, experiencing dream-like visual and memory effects.

3. Two Short SFPs – The Dream Machines

These two short SFPs are set in the post-singularity period and address facets of transhumanism. In many respects, they are extensions of ideas for wearable technology, such as augmented reality glasses. Mostly they were inspired by various statistics of the working of the human brain and its critical role in making us what we are. First there is the sheer scale of the human brain with almost 10^{11} neurons, each connected to up to 10^4 other neurons. Second the finding that human brain finishes building most neurons before birth (apart from some small neurogenesis continuing, mainly in the hippocampus, a region involved in learning and memory) growing in size thereafter only by continuing to weave its complex web of connections, being regarded as fully developed by around 25 years (but mostly complete by age 7). Estimates for the memory capacity of a human brain range from 1 to 1,000 terabytes (10 terabytes of data can store almost 20 million books). Apart from structure, many of the mechanisms at work in the brain remain defiantly mysterious, such as the purpose of dreaming which, given its prominence in our lives, seems baffling that we know so little about it. Of course these descriptions are gross simplifications (and a little contentious), as the wealth of published models and theories on the brain are testament to, so this SFP doesn't set out to provide a scientific treatise, but rather to use this topic as a fascinating backdrop to our SFPs. In connection with these ideas the first SFP explores the idea for injecting artificial nanobots into the body, to alter a person's knowledge and skills (creating in-body immersive experiences) by making direct adjustments (a processes somewhat akin to sculpturing) to the brain, bypassing the usual learning routes. The following SFP builds on these concepts.

3.1. *The Education Pill (aka Sculpturing Memory)*

Prologue: This story occurs during the post technological singularity period (after 2050). At this time the development of intelligent machines had taken two different directions; those that believed the future lay with developing intelligent robots to service the needs of people, and those that feared the development of such robots and preferred to use technology to enhance the capabilities of natural people. The world was almost equally split between supporters of each, with sizable sections of the community enjoying the services of their new age slaves, while others treasured and trusted only natural biological people. Of particular importance to this story was a small group of scientists in Mexico (part of a company called '*Addictive Technology*') who were working on ways to harness the services of technology to help people compete against their artificial counterparts. Their priority had become to provide people with the required mental ability and skills to match the increasingly intelligent androids and cyborgs. To these ends they had devised an innovative technology, called the "*education pill*" (*ePill*) that could, overnight, give people new knowledge and skills.

In other words, training and re-training had become a simple overnight process during sleep. The pill contained a swarm of nanobots that entered the blood stream, reaching the brain where they rewired and reprogrammed it to emulate the skills and knowledge required. All the pills were identical, they simply needed to be reprogrammed before swallowing to adjust the brain appropriately; the tool that did this programming was called *The Dream Machine* made by *Addictive Technology*. *Additive Technology* had sold one of their '*Dream Machines*' to '*Jobs+*', one of the growing number of 'learning free' training and education organisations! However, they were an education company with a twist, they were actually a jobs agency, and were using the *ePills* and '*Dream Machine*' to provide a "*skills on demand job service*".

A day in the life of Tom

Another day started with the faint hiss of a 'conveyancer' as it glided up to Tom's apartment door. The sound was caused by the atomic imbalance drives that provided levitation and lateral motion. Wheels and even thrust drives had been consigned to the garbage bin of history since the discovery of mechanisms to unbalance the motion of sub-atomic particles (eg the orbit of electrons) so as to cause net motion (someone likened it to an 'out of balance' washing machine vibrating across a floor, others muttered things about gyroscopes!). Anyway Tom always enjoyed his ride on the 'conveyancer' to and from work, as he felt he was riding on a magic carpet from 'Tales of the Arabian Nights', a cherished book from his childhood. The gleaming body of the 'conveyancer' contrasted starkly with the gloomy surroundings of the run-down neighbourhood where *Jobs+* had its offices and where he worked on the front desk finding jobs for needy people. This side of town was made up from a mix of people, some who had taken a principled stand against the rising tide of super-intelligent robots, and others who were just disenfranchised from society by poverty or ignorance.

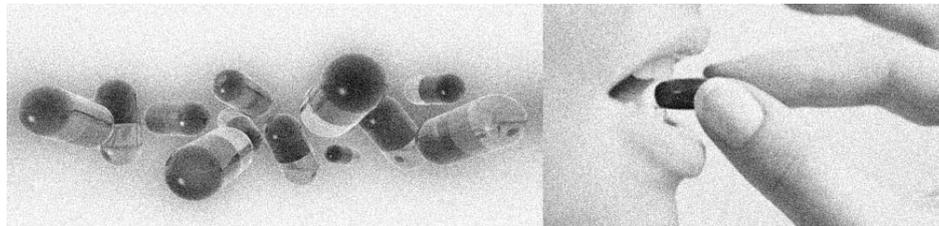


Figure 1 - Addictive Technologies ePills

More than a college ...

Jobs+ was a new breed of agency; part education establishment, part job shop. It was one of the innovative business that was built on the range of super-intelligent robots in the post singularity world; but with a difference, they were nano-sized (of the order, one thousandth of a millionth of a metre – very, very small!) and highly dexterous opening up numerous new possibilities. To-date these nanobots had been used mainly for non-invasive surgery and correcting some minor mental problems. In this case, the visionary founder of *Addictive Technology*, Aura, a neural scientist from Guanajuato, had been experimenting with a new type of super-nanobot to correct a wide range of brain disorders. However, her early clinical trials with new bots indicated they could do some amazing things; potentially altering aspects of the brain that determined people's aptitudes, skills and even knowledge. Of course, in the pre-singularity world none of

this would have been possible but thanks to the super-intelligence available in the post singularity, which supported both design and operational activities (including intelligent swarm management), she was able to create a revolutionary product. All that was pretty clever but her eureka moment, was equating physically altering the brain (crudely put, rewiring and reweighting connections) to learning, allowed her to offer a new type of '*learning free education*'. In natural learning, connections and weights are changed over long periods by repetitive and often tedious training cycles, but, in this new nanobot driven learning, the lengthy and tedious cycles of acquiring new knowledge and skills was simplified to swallowing a capsule (*ePill*) containing millions of nanobots which, while the student was sleeping, compressed a year's learning into a single night! Of course, these were smart capsules whose nanobots were programmed to activate and die at precise times, and do very precise jobs. This was important as people had to be asleep when this brain transformations were underway (the capsule also released a sleeping drug to subdue the 'learner'). The next step was just simple business acumen, linking education with jobs; so if a job came along, you just found any person who wanted a job, and reprogrammed their brain. After that, it was over to companies such as *Jobs+* to revolutionise the job and education market!

A day in the life of Lizzi

Lizzi was a gorgeous woman who never went unnoticed and the day she arrived in the *Jobs+* office with her large Alsatian dog (Remy) was no exception. Tom fell instantly in love with her, although he couldn't say the same about her large Alsatian! Unfortunately, for Tom, Lizzi was oblivious to his loving gaze as she simply enquired about the vacancy for a 'head chief' for the upmarket chain of "*Cooked by People*" restaurants. Of course using the new breed of intelligent kitchens and robots was cheaper than using people to cook food, but there was still a demand and even some snobbishness about people-based services, even though it was not cheap in this highly automated age. Lizzi had no cooking knowledge or skills but for *Jobs+* that was not a problem. Cooking skills was a standard library pack that could be quickly loaded into an *ePill* using their *Addictive Technology Dream Machine*.

All is fair in love and

For a moment Tom looked at Lizzi and wondered, "*what if what if I added an extra program into the ePill that made Lizzi ... like, ... maybe even love me*"? The thought turned quickly to an action, perhaps a moment of inspiration, or possibly a moment of madness! "*Ok Lizzi, its simple, just swallow this pill tonight before you go to sleep and call back to this office tomorrow morning at 9am so we can do a final check that all is well you might experience some dreams, mostly about cooking, but they will all be pleasant*". As Lizzi left, he couldn't help thinking "*and of course, you will be dreaming of me, which will be extremely pleasant!*".

Eye contact

Tom could barely sleep, waiting for the moment his dream girl would melt into his arms. Shortly before 9am a rather large dog, followed by its beautiful owner, appeared through the door of his office and he knew instantly that his dreams were set to come true. Eye contact was made and, in the blink of an eye, he was pressed to the ground with big wet warm lips pressing against his face followed by a wet cold nose accompanied by a voice yelling "*Remy Remy, what is wrong with you, leave that*

man alone” “I’m really sorry I have no idea what’s wrong with Remy today but I wanted to tell you that we had a bit of an accident last night, before I had a chance to take the capsule you gave me, Remy gobbled it up”

Postscript: In terms of immersive education, this sleep-based reengineering process had supposedly generated a type of in-body immersion via pseudo dreams and memories. The SFP was intended to be a light-hearted tale, if somewhat unlikely scenario for transhumanism. However, in telling this tale, it highlights some generic risks with new technologies, and especially those related to the singularity; they have the power for good and bad. In this story the intentions were simply motivated by love but, of course, human weaknesses such as lust, greed and control could have prompted much darker scenarios, but those are left for another SFP! This contrasts to the following SFP which will look at augmenting the brain with artificial external co-processors, co-memory and co-communications, enabling uploading of knowledge and skills.

3.2. Plug & Learn (aka Painting Memory)

Prologue: This SFP takes the form of a fictional dialogue between the Vice-Chancellor (VC) of a brand new (and somewhat controversial) type of University and a pack of reporters, shortly after its opening. As with the earlier tale, this SFP is situated in a post-singularity period where technology can replace or augment human organs in order to supplement a person’s ability or prolong their life; transhumanism. The SFP concerns the possibilities for augmenting the brain with extra processing, memory and communication power (brain augmentation). It supposes that if such fictional technologies came to pass they could have a direct impact on the nature of education as they would open up the possibility of providing people with new skills and knowledge without the usual learning procedures; rather by uploading knowledge or programs directly to the brain-augmented co-memory and co-processors. The supposition is this provides a type of deep immersion, where an altered reality is generated from within the mind (akin to painting memory). This story debates some of these issues by imagining that a transhumanist university was created where students attended to have new information and skills added and tested. Uploading information and programs to the students augmented memories was seen as a potentially dangerous process that needed to be undertaken in a controlled environment with the students sedated (or asleep). The favourite method (and employed by this University) was to do the uploading overnight as the ‘students’ slept, which frequently resulted in spurious images fleeting through the recipients minds, so-called ‘*electric dreams*’. Because the process was a little dangerous and uncertain in its effectiveness, it needed to be carefully managed, checked and certified (the new degrees!). The scenario has similarities to the previous SFP, in that is a post singularity application of transhumanism, but it’s critically different in that the learning is stored on artificial brain add-ons, rather than using the original biological structure, as in the first SFP (and of course, the programming processes are entirely different more akin to painting than sculpturing). This SFP takes the form of written notes from a press conference that followed the graduation of the first batch of students.

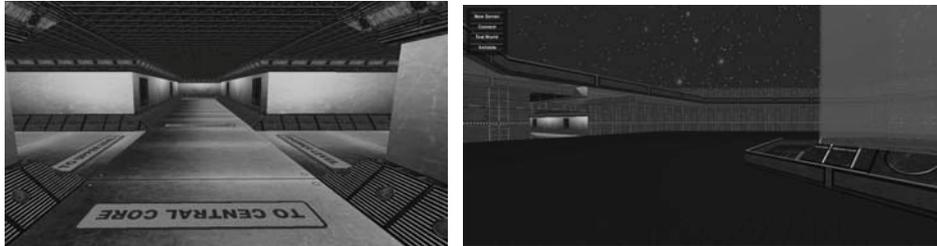


Figure 2 – HEX University (converted “New Lebanon Spacestation”)

- REPORTER: *How many students did you graduate today?*
- VC: *38,304, with various skills.*
- REPORTER: *How long did they study with you?*
- VC: *On average, they were with us for 5 nights.*
- REPORTER: *It’s interesting you say “on average”; we heard from some of your graduates there were problems and some students took much longer, is that true and, if so, why?*
- VC: *No, there were no problems but it is true that some students need more programming than others. That is because a graduate’s ability comes from a combination of their natural biological brain (its abilities and experiences) and the augmented brain, so we have to personalise our augmentation programme to ensure the holistic brain meets the education targets which may require additional uploads.*
- REPORTER: *How can the public (and indeed the students being ‘treated’, if you will forgive that euphemism) be assured that this programming process delivers graduates that are fit for purpose; after all, you are claiming that with just 5 nights programming they are fit, for example, to fly an advanced star-fighter or design atomic imbalance drives! Literally, our lives may be in the hands of some of your graduates, so how can you assure us they are competent and safe?*
- VC: *Actually, it’s just 2 nights programming, max! The remaining 3 days (and nights) are for validation and certification. During that time we perform the Zamudio stability check which has two aspects; one a mathematical proof (the processes we program into our students are deterministic) and an immersive reality consistency check; you may have heard of that, as it’s called an ‘induced lucid dreams’ test – one reason it’s been dubbed the ‘dream machine’.*
- REPORTER: *There have been reports that these so-called dreams are more like the chemical (drug) induced hallucinations of the 1960’s and that this dream machine is rather more about legalising drug-like experiences for the idle rich, than its about education; what are these psychedelic dreams students report?*
- VC: *Those so-called psychedelic dreams (by the way, we prefer the term ‘electric dreams’) are spurious images caused by the side effects of chaotic interactions between the data and programs being uploaded and installed. As you know the students are sedated during this process but the mind is complex and these dream-like experiences are not uncommon, nor unpleasant (as our*

students will no doubt tell you!) but are definitely not the reason people attend our University; this organisation is strictly focused on education!

- REPORTER: *Finally, VC, why was did you chose to build the University on a spacestation, a defunct spacestation, and why is it called "The HEX"?*
- VC: *Aaaagh, at last a question that is dear to my heart; the defunct space station (originally called the New Lebanon) was cheap, very cheap! Also, you might recall from the best-selling book by Brian David Johnson, "21st Century Robot", that the New Lebanon was built as one of the most advanced Intelligent Environments of our time, perhaps a little too advanced, as the AI went out of control (but that is another story, Brian Johnson's story!) but it gave us a high-tech infrastructure (minus the mischievous embedded agents!), and the solace of a silent space based University were perfect for sleeping Perfect for creating the ultimate "Dream Machine" !*
- REPORTER: *you didn't say why it was called 'The HEX'*
- VC: *That's right, I didn't, that one is for you boys and girls to figure out!*

Postscript: The idea for brain augmentation is a popular concept in transhumanism which, when coupled with ideas of modularisation and co-processors taken from computing and electronics, raise intriguing possibilities. In many respects, the current wearable computing market, such as augmented reality glasses, are the forerunners of such technologies which, of course, have also been touched on by other SFPs [6]. This short dialogue can't hope to expose or answer some of the deeper issues such as how the technology might be implemented or what important qualities would be lost when brains contain more silicon than biology; these questions are easier to ask than to answer as they raise deep issues about the nature of our own existence. However, hopefully this dialogue might at least provoke some thought about the sort of future we might build (or not!).

4. Background Research

The research that inspired this SFP comes from ideas cultivated in research published in over 300 papers by the author on intelligent environments (see <http://victor.callaghan.info>) that span a range from future educational environments [7] [8] to simulating real people [9]. Of course the transhumanism theme of these SFPs goes much further than the basic science and engineering from those papers, stretching it into an imaginative world to provoke discussion about directions of new AI technologies and the effects they might have on education. It drills down into interests that the author has developed concerning the potential for a technological singularity [4]. In particular the two short SFPs presented above were inspired by real research. First, the tale of the "*Educational Pill (ePill)*", which was based around nano robots swimming around in the blood came from an EU funded project "*Self organised societies of connectionist intelligent agents capable of learning (Social)*", project number EC-998299 which the author was a principal investigator (see <http://www.agingportfolio.org/projects/project/EC-998299>). In brief, this project set out to design communities of cooperating autonomous agents for maintenance missions in complex micro-fluidic environments, such as those found in current and emergent platforms of artificial organs (e.g. artificial kidney dialysers). To accomplish this task

the project adopted an integrated approach that made use of principles of self-organization found in societies of social insects. Based on these principles the idea was to accomplish a mission using the emergent behaviour of colonies of simple micro-scale robotic agents. To achieve this, the project investigated novel, micro-scale gate evolvable spiking neural network architectures built specifically for the project, so as to permit real time intelligent behaviour at the individual and social level. Of course, in reality, the physical technology remained beyond the bounds of current engineering practice and so the ideas were tested on macro emulations (using actual microfluidic environments) and software simulations. The second tale, “*Plug & Learn*”, was inspired by an EU project called “*Extrovert Gadgets (eGadgets)*”, project number IST-2000-25240 for which the author was a principal investigator (see http://cordis.europa.eu/projects/rcn/54860_de.html). In brief, this project investigated the possibilities arising from embedding sensing, computing, communication and intelligence into everyday objects, turning them into what the project termed *eGadgets*. The project addressed the design of a generic framework that allowed *eGadgets* to seamlessly collaborate, enabling people to intuitively associate heterogeneous *eGadgets* so as to compose distributed ambient systems called *GadgetWorlds*. The project motivated later work on the creation of so-called *Virtual Appliances* [10] before, eventually, inspiring the formation of an educational technology company, *FortiTo Ltd* (see www.FortiTo.com), that specialises in rapid product prototyping, which is a core enabler for a student’s science and engineering laboratory experience. All of these ideas eventually contributed to a current project which concerns the development of a modularised immersive reality laboratory (see Figure 3) which facilitate students to create intelligent system (eg robots) by plugging together co-modules in a similar vein to the “*Plug & Learn*” SFP above. The FortiTo kit, shown in Figure 3b, is a modularised set of computing modules that allows students to rapidly build modularised appliances, such as smart desktop robots, somewhat akin to the plugin co-gadgets described in *Plug & Learn*” SFP and the ideas of Makers Activities, covered in an earlier SFP [11] [12].

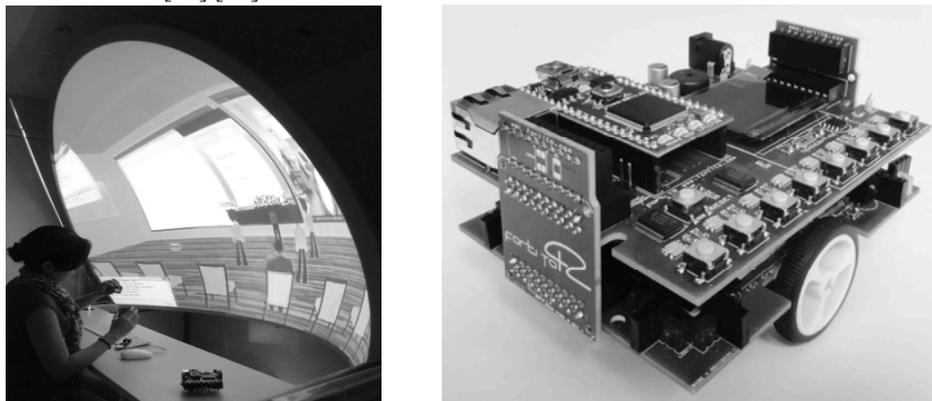


Figure 3 – (a) The ImmersuView (b) A FortiTo modularised desktop robot

Of course these technologies have huge social ramifications, as have been discussed elsewhere [13]. While it may seem like a large step is needed to take this forward to augmenting brains, work such as that started by Kevin Warwick at Reading University [14] bears testament that these ideas may not be as distant as we think. Incidentally, the

concept for an ImmersaVU arose from an earlier SFP [15], demonstrating that SFPs can have real world impact!

5. Reflections and Summary

Both SFPs presented in this paper imagine a post singularity world where robots, AI co-processors and other machines can be built which, from our current perspective, display extraordinary capabilities. In particular the SFPs look at one aspect of post-singularity worlds, the widespread adoption of transhumanism practices where human organs, can be routinely replaced or augmented. From the perspective of the SFPs presented in this article, we focus on a form of transhumanism, involving reengineering parts of the brain with nanobots, or adding additional processing, memory and communication capabilities to it. Of course nanobots are just convenient vehicles for the SFPs and other means, such as biological, chemical or directed fields, might have been adopted with similar effect. Another major focus of this article was a discussion on the various facets of reality. From the perspective of the arguments presented in this article, transhumanism was regarded as being just another type of tool that could be used to manipulate reality. Furthermore, the SFP regarded manipulation of realities as one of the fundamental instruments of learning and mused on the potential importance of dream-like mechanisms (eg imagination) in both natural and artificial learning schemes (vis-à-vis abstractions, modelling, simplification, simulation and role-play etc), linking dreams and imagination into learning, by seeing them as a type of '*natural immersive education system*'; a "*Dream Machine*". This philosophy was used to connect to the underlying technologies which are seen as ranging from *augmented*, through *immersive* to *embedded* realities. In the case of the two SFPs presented here, the technologies are situated at the embedded end of the technological spectrum, being integrated within people; a type of *embedded immersion*. Beyond the technologies, the SFPs raise some interesting possibilities such as '*learning free, education*'! Also, although implanting electronics in people may sound like a distant aspiration, in many respects this vision can be regarded as an extension of current mixed reality and wearable technologies, such as the augmented reality glasses being developed by companies such as Google, or the mixed reality environments produced by companies such as Immersive Displays. Of course these technologies are all only at the beginning of their development trajectory so it's impossible to say with any certainty where this work will go. Some variations of augmented reality glasses are already difficult to distinguish from regular glasses thereby, even now, blending somewhat seamlessly into everyday life, as would the implants or brain reengineering described in this paper.

Finally, this article started by recounting the shock arising from experiencing an especially realistic dream; the ideas in both of the SFPs presented here rely on the ability of advanced technology to sculpture or paint sufficiently realistic images into a person's brain concerning the skill, knowledge and wider context of the task being taught. What would happen if, at one extreme, these images were so realistic they could not be separated from the person's reality or, at the other extreme, they were so poor as to appear like frightening invading nightmares? Perhaps, transhumanism plays with the brain at its peril, and all of us need to be a little cautious about letting our enthusiasm for technology go too far. Maybe, somewhere in our research there is a line we shouldn't cross, that we all need to consider?

Acknowledgments

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Appendix - Related Movies

For your entertainment, these are examples of movies that have resonances with some of the themes in this SFP:

- *Fantastic Voyage* (1966)
- *2001: A Space Odyssey* (1968)
- *The Lathe of Heaven* (1971)
- *Innerspace* (1987)
- *Total Recall*(1990)
- *The Terminator* (1991-)
- *Groundhog Day* (1993)
- *Ashes of Time* (1994)
- *Gattaca* (1997)
- *Abre los ojos (Open Your Eyes)* (1997)
- *The Truman Show* (1998)
- *Dark City* (1998)
- *The Matrix* (1999)
- *The Thirteenth Floor* (1999)
- *Vanilla Sky* (2001)
- *Eternal Sunshine of the Spotless Mind* (2004)
- *2046* (2004)
- *Life on Mars* (2006 UK TV series)
- *The Dream* (2008)
- *Cyborg She* (2008)
- *Inception* (2010)
- *Caprica* (2010 TV series),
- *Amy's Choice* (2010 Dr Who TV episode)
- *The Bourne Legacy* (2012)