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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 form 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 Berkley'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 'transhumaism' 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 reprogramed 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 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.

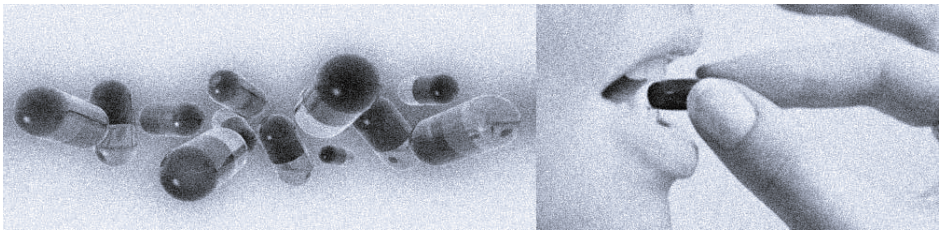

Figure 1 - Addictive Technologies ePills

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 nanaobots 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 transhuminism. 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 dream*s'. 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.

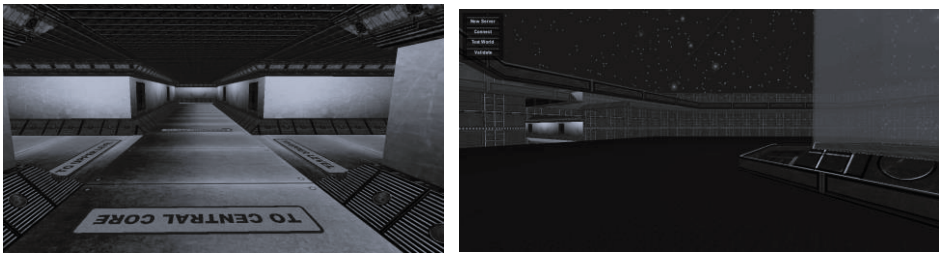

Figure 2 – HEX University (converted "New Lebanon Spacestation)

- 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 transhumanim 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].

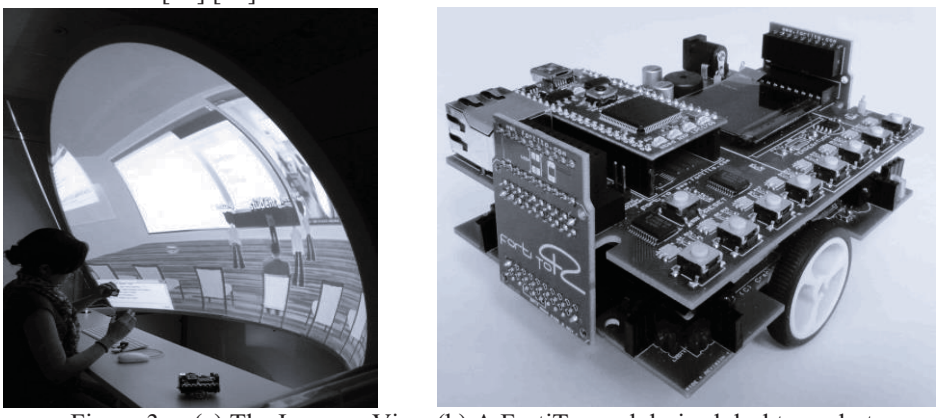

Figure 3 – (a) The ImmersuView (b) A FortiTo modularised desktop robot

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 SPP 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 *immersiv*e 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 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?

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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)