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IT 103 Research Paper: Nanotechnology and Human Augmentation

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Abstract

This paper focuses on Nanotechnology with the implications of this technology towards the field of Medicine and advanced technology. It provides a glimpse into the physical changes that can occur in humans and their tools by using this technology. Another objective was to define and explain some of the benefits and disadvantages of this emerging technology, and the ethical implications, and complications as well. Furthermore, this papers holds the consensus that this advanced technology could hold the key for all technical advancements of the 21st century, especially pertaining to the ability of medical field and for our species to achieve true transhumanism.

Keywords: Nanotechnology, Human Augmentation, Transhumanism, Nanochips, Prosthetics, Neural Augmentation, Moore's Law, Nanomedicine, Cybernetic Augmentation, Bioethics, Biological Engineering, Cloning, Genetic Modification, Nanocircuitry, Nanodrugs, Dip-pen Nanolithography®, Carbon Nanotubes, Buckminsterfullerene, Quantum Dots, Nanocrystals, Nanobiology, Nanocomputers.

Nanotechnology and Human Augmentation

Nanotechnology ***"is the science and technology of small things in particular things that are less than 100nm in size. One nanometer is 10-9 meters or about 3 atoms long (Rathbun, "What is Nanotechnology?" NNIN, 2005)."*** As stated above by the ***National Nanotechnology Infrastructure Network,*** Nanotechnology is technology that is reduced from traditional sized technology into the atomic level, with more space and reduced components it enables faster use and other abilities. Many forms of our current technology, from laptops to toys employ aspects or technology resulting from it. Future "nano" applications, can focus on the Biomedical field[1]. Within this medical application Nanotechnology can incorporate the idea of Human Augmentation: increasing the exploration of knowledge of upgrading the human body to levels beyond normal human capacity[2]. An example of Human Augmentation today would be using Nanochip implants in eyes of the blind.[3]

Background

Nanotechnology was a term originally used by Norio Taniguchi in 1974 to making products and materials to atomic-scale dimensions using machines, i.e. Nano sized objects (NNI R& D)**.** An important milestone within this area is Moore's Law[4], This law accepted by experts has been followed almost uncannily to the current date. The discovery of Buckminsterfullerene (C60)[5] a carbon molecule discovered at Rice University (NNI R& D), was a significant breakthrough for

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[1] (e.g Nanotechnology created drug delivery systems, as listed in the ***Handbook of Nanomedicine*.)(Jane, 2008**

[2] *"In the context of engineering, human enhancement can be defined as the application of technology to overcome physical or mental limitations of the body, resulting in the temporary or permanent augmentation of a person's abilities and features." – (Stewart, 2013).*

[3] ARGUS II, a bionic eye implanted on Sept. 3rd 2014. The implant is able to transmit sight to allow the user to see in functional ways like recognizing shapes, and being able to read certain images **(Shah, 2014).** It is expected that by 2017 this field will develop better versions and possibly more camera-free options with retinal implants with greater capabilities. (Shah, "First Bionic Eye Implants", 2014(Miah, 2011)

[4] a rule stating that transistors inside computers would double every 12 months; later updated to say 18-24 months according to NNI R& D website and the Encyclopedia Britannica Definition. See Footnote 9, for exact quotes.

[5] This C60 molecule is significant in its extremely strong, and one of the primary molecules being used in Nanotechnology. (NNI R&D)

this technology. In the early 1990's came the discovery of Carbon Nanotubes[6] (NNI R& D**).** These discoveries lead researchers to find a way to create Quantum Dots also known as Nanocrystals[7] (NNI R& D**).** It is important to note that Quantum Dots make Nano-chips/etc., viable and possible. One of the more recent technologies created was Dip-pen Nanolithography® (DPN®)[8]. We now have the ability to create electronic circuits by writing at the Nanolevel. This opens up other avenues in Nanoencryption and biomaterials (NNI R&D). The most recent achievement was in 2013, when the first carbon Nanotube computer was created by NNI R&D **(NNI R&D).** Today, there are many manufactured products that have used Nanotechnology in their development. The highlighted history is a glimpse into the future use of Nanotechnology[9].

Potential Benefits

Fitting more information into smaller places provides additional space, better heating, and creates new applications. Some of the broad applications of Nanotechnology include, using Nanotube wires to improve electrical efficiency, reduce cost, and rate usage in addition to decreasing computer hard drives toward smaller phone hard drives. Nanotechnology also has potentially endless applications in the Nanomedicine field. As technology becomes smaller it opens many new avenues of medical treatment and prevention. Here is a list of Nanomedical applications many of which are listed by ***the Handbook of Nanomedicine*** and by **Binns in 2010,**

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6 These tubes have been shown to have extreme strength that provide efficient electrical distributions that handle thermal conductivity well. (NNI R& D**).**

7 These quantum dots act like artificial atoms and have significant electrical implications in the field of technology. (Sigma-Aldrich, "Quantum Dots", 2012) (Nanowerk, 2015)**.**

8 *"Dip pen nanolithography (DPN) relies on the power of the atomic force microscope to pattern directly on a range of substances with a variety of "inks".* – (Web Stanford, "Dip Pen Nanolithography", 1999)

9 *Moore's Law," described the density of transistors on an integrated chip (IC) doubling every 12 months (later amended to every 2 years). Moore also saw chip sizes and costs shrinking with their growing functionality—with a transformational effect on the ways people live and work".*- (NNI R&D)**.**

Moore's law- "In 1965 Gordon E. Moore observed that the number of transistors on a computer chip was doubling about every 18–24 months. As shown in the logarithmic graph of the number of transistors on Intel's processors at the time of their introduction, his "law" is still being obeyed"- (Encyclopedia Britannica, 2013*)"*

with added descriptions and examples see footnote[10]. The list contains items such as *"Nano-Endoscopy, Nanotech-based drugs, Regenerative Medicine, Tissue Engineering, Nanorobotic Vascular Surgery, Nanoimaging, Artificial Organs, Nanodiagnostics, and Nanocoated Stents"* **(Jain, 2008)**[10]. These applications include the most promising aspect towards Human Augmentation[2]**;** improving human biology beyond our natural human capabilities, (essentially, we upgrade/augment ourselves). Another important idea relating to this type of advancement is Transhumanism; that is best defined by the **Oxford Dictionary**[11]**.** With Nanomedicine, Transhumanism is achievable, if not desirable. Some critics cite LASIK Eye Surgery as being a Transhumanist application because it provides subhuman eyesight (i.e. better than 20/20).

Ethical / Legal

Patents protect the use of Nanotechnology. An important ethical question associated with a patent, Is it is legal to change the human body, its genes, or functions? Some opponents of Artificial Organs do not believe they should be used because of natural selection or a religious belief in "God's" Will. This concern could apply to all artificial enhancements and be objecting on many different levels besides religious concerns; the future of the human race and other valid health reasons. Ethical implications relate to technologies using Nanosized listening bugs or other similar devices. These new biological capabilities can also create issues in standard care, not only in our society but also in less developed countries where signal infrastructures is primitive. For instance, a pacemaker that cannot reach a synchronous signal could malfunction.

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10 "***Nano-Endoscopy"*** (i.e. instead of using the traditional Endoscope or Barium Swallow); "***Nanotech-based drugs"*** (e.g. Chemotherapy using Nanotechnology), ***"Regenerative Medicine"*** (e.g. Anabolic Nanobites helping with muscle growth) ;"***Tissue Engineering"*** using Nanosized bots to be able to use "*Exosomes from donor Dendritic Cells"* for drug -free organ transplants (i.e. to prevent organ rejection); ***Vascular Surgery*** by way of Nanorobots introduced intravenously; ***"Nanorobotic Treatments"*** - (e.g. treat scrap or burns); "***Nanoimaging"*** (e.g. using Nanobots to take internal pictures similar to a capsule Endoscopy); "***Nanopumps"*** and other improved delivery systems for drugs. "***Implants*** that use ***Bio-implantable sensors"*** that connect electronics and Neurological Systems (e.g. chip in brain to help memory or cognitive reasoning); "***Artificial Organs"*** that are Rejection-Resistant tissues, (e.g. made from non-biological materials or semi-permeable biologically grown and technologically infused); "***Nanodiagnostics"*** (i.e. finding out people's sickness by way of Molecular Diagnostic Testing); ***"Nano-coated stents"*** in Coronary Arteries (i.e. Stents made to prevent clotting)(Keywords from Jain, 2008), other concepts from my understanding of (Binn, 2010) and (Mody, 2012).

11 *"The belief or theory that the human race can evolve beyond its current physical and mental limitations, especially by means of science and technology."*- (Oxford Dictionary).

This technology could also create new challenges for privacy. What if hackers or governmental agencies review or interfere with information received from someone with Bionic Eyes? These arguments against the use of Nanotechnology are similar in scope to the Abortion debate or the backlash against Human Cloning practices, even though these practices may provide useful insight for the health community should they be used[12]? There are also opponents against genetic modification of plants that think they are poisonous or unhealthy. The FDA has found no such health hazard findings and treats the genetically altered plants with the same health standards as traditional plants **(FDA, 2014*).*** These similar issues will continue to grow and the ethical and legal complications will lead to further conflict as supported by Miah's article and others cited.

Security Concerns

The Security concerns of Nanotechnology pertain to current conventional weapons, biologically created ones, and many more by means of Nanotechnological production (Drege, 2013). Security concerns in the field of Nanomedicine can relate to artificial organs or any implanted systems. As seen in Vice President Dick Cheney, there was fear of his implanted pacemaker becoming compromised and someone inducing a Cardiac Arrhythmia **(Kloeffler, 2013).** The same concept could apply to any artificial implant received. If there are transceivers in such systems they could be hacked, interfered with, malfunction. Furthermore, with new technologies new forms of hacking may arise[13], Also if an Electronic Magnetic Pulse wave or large magnets, came into contact with said electronic organs/nanobots/other devices it could cause them to malfunction, whether by design or by accident[14].

Social Problems

[12] (e.g. Stem Cells from Aborted Babies, Cloned Organs for Transplants)

[13] (e.g. Biological weapons like a Nanovirus - using small "nanobites" could wreak havoc on people's immune systems or computers others like Nano Created nuclear weapons could also create issues (Pamlin, 2015)(Drege, 2013).

[14] (e.g. Nuclear tests, Large Industrial Magnets).

New, faster smaller digital glasses, or new Nanocoated solar panels are unlikely to cause any social problems and may receive significant support. The issues arise when upgrading, or changing the body. Black Market commodities could arise if opponents object to human testing. Social issues could also arise when more fully artificial humans change their appearance or functions. If this happens, there may be reverse discrimination on those who have not undergone similar changes not only on those who elect changes. We already have artificial limbs and prosthetic devices, but they are not as advanced as they could be. Other social issues like bombings of Artificial Enhancement Clinics could occur; similar to the bombings of Abortion clinics. The fragile ecosystems of the world could face further strain due to the advancement of medicine, and the further increased life spans.

Further Required Research

In the large field of Nanotechnology with its limitless applications the most promising and important field (in my opinion), is Nanomedicine. This area will improve quality of life, cure diseases, and expand lifespans. Once we achieve these goals we can begin to focus more research on advanced applications like artificial bodies, complex organs, and more effective surgeries. Before these giant steps, we can take smaller steps. Learning more about our biological systems and human anatomy with Nanomedicine will allow the development of adaptable prosthetics and beyond. With these new discoveries we can learn to make leeway towards creating amazing technologies that improve our daily life using Nanotechnology.

Conclusion

Nanotechnology with the idea of super, atom sized electronic systems is one of the most, if not the most important fields of study our generation has ever embarked on. The field alone was estimated at 114 billion in Nanomedicine in the State of California; no question Nanomedicine is

emerging and will continue to grow (CHI, 2011). These trends of human enhancement are no longer fiction, they are a reality. The real question is, how far will, we advance. Whether it is upgrading our own biological systems, our cell phones, one thing is for sure, our technologies will continue to become smaller and more efficient in the foreseeable future. This is in large part due to the discovery of Nanotechnology with its ingenious researchers, pursuing unthinkable fringe sciences like Nanotech.

References

Binns, C. (2010). *Introduction to Nanoscience and Nanotechnology*. Hoboken, N.J.: Wiley. Retrieved February 20th from http://proquest.safaribooksonline.com.mutex.gmu.edu/book/-/9781118017067/firstchapter

This book, accessible online through George Mason University Library, was a great book to look through for an overview of Nanoscience & Nanotechnology. It summarizes both topics, yet focuses more on Nanomedicine. It is a great source to quote from. In text citation (**Binns, 2010).**

California Biomedical Industry 2011 Report - State of California (2011) Retrieved from http://www.chi.org/uploadedFiles/2011%20CA%20Biomed%20Industry%20Report_FINAL.pdf

This state government journal showed a viable statistic in the Nanomedical industry that I referenced. It also provided reasons for monetary input in the Biomedical industry, worth 114 billion in the State of California, in 2011. In text citation **(CHI, 2011).**

Cheap Nanostructured Solar Cells Made With Carbon Quantum Dots From Shrimp Shells - *Queen Mary University of London & Nanowerk.* (2015, February 19). Retrieved February 26, 2015, from http://www.nanowerk.com/nanotechnology-news/newsid=39115.php

Information from this article was useful to formulate knowledge on Quantum Dots, their application and uses. When researching Nanotechnologies history, the dots were continuously mentioned which lead me to seek additional sources. In text citation **(Nanowerk, 2015).**

Definition of Transhumanism - Oxford. (n.d.). Retrieved February 20, 2015, from http://www.oxforddictionaries.com/us/definition/american_english/transhumanism

This article gives a concise definition of Transhumanism that I referenced. It is by far the best definition that I came across in my research. I was surprised to find out that I could write an entire paper just on Transhumanism with the information that I found. In text citation **(Oxford Dictionary).**

Dip Pen Nanolithography- Web Stanford. (1999, January 1). Retrieved February 20, 2015, from http://web.stanford.edu/group/mota/education/Physics%2087N%20Final%20Projects/Group%20Alpha%20v2/dpn.html

This article is used in a footnote to define the technology DPN. It gives further insight into how the DPN process works and the possible implications of the Nano-printable technique owned by trademark. In text citation **(Web Stanford, "Dip Pen Nanolithography", 1999).**

Drege, S. (2015, February 18). Artificial Intelligence and Nanotechnology 'Threaten Civilization' Retrieved February 20, 2015, from http://www.theguardian.com/technology/2015/feb/18/artificial-intelligence-nanotechnology-risks-human-civilisation

The article is written by the Guardian and talks about the risks of Nanotechnology and the implications it has on human civilization. Although this influenced some of my opinions towards this technology I tried to balance them objectively. I also quoted the report listed by the Guardian, which was an complete report expounding on the future

threats, two of those being Nanotechnology and Artificial Intelligence. In text citation **(Drege, 2015).**

Jain, K (2008). *The Handbook of Nanomedicine* (pp.1-403). Totowa, N.J.: Humana Press. Available from Springer. Retrieved from http://link.springer.com.mutex.gmu.edu/book/10.1007%2F978-1-60327-319-0

This book available online from George Mason University Library, was the best source for information about Nanomedicine available. It really delved deep into the actual possible applications. I plan to actually read the entire book in my free time, even though it covers almost the entire field of Nanomedicine. It does need to be updated from 2008 to include current technologies; highlighting new trends and rates, including processing and specific Human Augmentation capabilities. Sadly, we have not yet reached full implementation of all the capabilities listed; when we will reach them is still unknown; which were mentioned in the paper. In text citation **(Jain, 2008).**

Kloeffler, D., & Shaw, A. (2013, October 19). Dick Cheney Feared Assassination Via Medical Device Hacking: 'I Was Aware of the Danger' Retrieved February 20, 2015, from http://abcnews.go.com/US/vice-president-dick-cheney-feared-pacemaker-hacking/story?id=20621434

This article goes on to support the idea of hacking into intelligence gathered from artificial organs or technologies that help regulate the systems of the body. This idea correlates to other Human Enhancement issues. The article illustrates a large public case. The article also displays the possible adverse security concerns with future technologies.

These ideas were useful for the paper with a relevant case study. In text citation **(Kloeffler, 2013).**

Miah, A. (2011, January 1). Ethics Issues Raised by Human Enhancement - OpenMind. Retrieved February 20, 2015, from https://www.bbvaopenmind.com/en/article/ethics-issues-raised-by-human-enhancement/?fullscreen=true

This article goes on to explain in depth, ethical dilemmas of Human Enhancement along with its potential. It's hard to describe all of the information given. I used very little information from it because there was too much information to condense for this section of the paper. If you are interested, I highly recommend reading it. **(Miah, 2011)**

Mody V. Nanomedicine. *Chronicles Of Young Scientists* [serial online]. January 2012;3(1):1-2. Available from: Academic Search Complete, Ipswich, MA. Retrieved from http://eds.b.ebscohost.com.mutex.gmu.edu/ehost/detail/detail?sid=c907f4e6-977f-493c-b05b-a370ca183cbf%40sessionmgr198&vid=0&hid=114&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#db=a9h&AN=74234152

This was an online published article I used for my first IT 210 assignment. I skimmed through it for material earlier on. Although I gained a little information, it was very difficult to understand. **(Mody, 2012)**

Moore's Law |Computer Science Encyclopedia Britannica. (2013, September 22). Retrieved February 15, 2015, from http://www.britannica.com/EBchecked/topic/705881/Moores-law

I used this article to define Moores Law; even though I found other definitions I, wanted the most credible definition. As noted in my paper, the length of Moores Law vary from source to source. This source included different numbers than the NNI did, which is a Nanotechnology firm sponsored by the United States Government. In text citation **(Encyclopedia Britannica, 2013)**

Nanotechnology Timeline NNI R&D U.S. Gov. (n.d.). Retrieved February 16, 2015, from http://www.nano.gov/timeline

This website was instrumental to learn about Nanotechnology, its inception and development. Information used for the paper outlines the subjects listed or referenced on this website. Coincidentally, before writing this paper I had learned from another Information Technology class that Moore's Law intertwined with Nanotechnology. This website is run by the National Nanotechnology Initiative; a United States sponsored R&D organization. In text citation **(NNI R& D).**

Pamlin, D., & Dr. Armstrong, S. (2015, February 1). 12 Risks That Threaten Human Civilization - Global Challenges Report. Retrieved February 24, 2015, from http://globalchallenges.org/publications/globalrisks/about-the-project/

This scholarly article is referenced in the Guardian Nanotech article **(Drege, 2013).** I read this article to add to some of my examples in my paper. This article helped me understand more complex ideas regarding this technology and the impact this technology can have on today's world. In text citation **(Pamlin, 2015).**

Quantum Dots - Sigma Aldrich. (2012, January 1). Retrieved February 24, 2015, from http://www.sigmaaldrich.com/materials-science/nanomaterials/quantum-dots.html

I used information from this website to formulate knowledge on the application and the use of Quantum Dots. When researching Nanotechnology history I noticed that the Quantum Dots mentioned frequently would require me to look at additional research from other sources. This website is run by a company which creates Quantum Dots and other similar technologies. In text citation **(Sigma-Aldrich, "Quantum Dots", 2012).**

Rathbun, L., & Heally, N. (2005, January 1). What is Nanotechnology? - NNIN. Retrieved February 18, 2015, from http://www.nnin.org/news-events/spotlights/what-nanotechnology

This website is a research site, dedicated to Nanotechnology. It does a great job of defining what Nanotechnology is. In my quest to learn about Nanotechnology, I used this website as a research tool and used it to summarize some facts. I would say this is my second biggest source of information for the paper, besides the NNI R&D. In text citation **(Rathbun, 2005).**

Shah, M. (2014, September 3). Hope for the Blind – First Bionic Eye Implants in the United States | Triple Helix Online. Retrieved February 22, 2015, from http://triplehelixblog.com/2014/09/hope-for-the-blind-first-bionic-eye-implants-in-the-united-states/

This article goes on to show the current uses of Human Enhancement Technology similar to Lasik Surgery. It illustrates technology that is beyond our current applications. It provides future applications of Human Enhancement. Currently, modern day Prosthetics

are starting to reach usable conditions. In the foreseeable future, these technologies could surpass our own biological systems. These ideas were all highlighted in paper. In text citation **(Shah, 2014).**

Stewart, J. (2013, November 19). Human Enhancement - DUJS Journal Online. Retrieved February 27, 2015, from http://dujs.dartmouth.edu/fall-2013/human-enhancement#.VPD9gF3PzLc

I chose this online journal as a scientific source that defines what the science of Human Enhancement. Because it gave a clear and concise definition of Human Enhancement, I referenced it and added my definition along with it. Readers benefit from its understandability and that it is a valid, authentic source on Human Enhancement. In text citation **(Stewart, 2013).**

U.S. Food and Drug Administration Questions & Answers on Food from Genetically Engineered Plants. (2014, July 22). Retrieved February 22, 2015, from http://www.fda.gov/food/foodscienceresearch/biotechnology/ucm346030.htm

I used this website because it clearly states the opinions of the FDA when it comes to Genetically Engineered Plants and their safety. Although there is backlash against these practices, the United States Federal Government has approved such uses. In text citation **(FDA, 2014).**