How Nanotechnology Will Transform Design and Manufacturing

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Undergraduate Entry

Abstract

Design and manufacturing in the year 2035 will be transformed from what we know today with the commercial use of nanotechnology into products to give innovative and energy-efficient solutions for consumers. This paper seeks to outline the manner in which a successful company in 2035 will be expected to perform with great capacitance for adapting to consumer demands primarily through Artificial Intelligence (AI) and material science to develop innovative, smart products. This paper also outlines the partnerships with various sectors as well as the predicted challenges that will be faced as a result of environmental and societal implications.

Introduction

Nanotechnology is the study and manipulation of matter at the nanoscale which is approximately 1 to 100 nanometers, where 1 nanometer is 1 billionth of a meter (10^{-9}). At the nanoscale, matter can exhibit differing properties than those exhibited on the macroscale where properties are based on a larger collection of atoms or molecules. Changes can include becoming stronger, lighter, showing a difference in electrical properties and much more. The creation of technology at such a small scale seeks to understand the reason behind these changes and harness the advantages that come with them [1].

Since its emergence in 1959 by physicist Richard Feynman [2], nanotechnology has made its capabilities known throughout various industries. In biotechnology, various research teams such as the Weitz Lab at Harvard University have been working to use nanoparticles as drug delivery agents for specific target sites, in contrast to traditional delivery through the bloodstream that often causes undesired side effects [3].

Sensory technology has been looking into the use of engineered nanomaterials/nanodevices to assist with monitoring the high-level stress areas of structures such as aircrafts and bridges to monitor the formation of cracks and even develop self-healing structures. Wearable nanoscale materials will soon enable us to have smart, electrical components to our clothing to inform us about the state of our health with blood pressure and heart rate [4]. What could be considered the important prospect is the energy sector where nanotechnology is expected to mitigate greenhouse gas emissions by 20% by 2050 [5].

With the global nanotechnology market expected to surpass US$125 Billion by the year 2024, a company can expect lucrative returns from all areas of the economy including defense, agriculture, biomedical, energy and electronics. The company will have to integrate artificial intelligence and machine learning to satisfy the inevitable global push towards ‘smart’ machines. The company will focus its sales strategies towards electronics, energy and biomedical applications since these hold over 70% of the nanotechnology market [6]. The enterprise will have to address ethical, environmental and health risks that pose as challenges to the nanotechnology market. A company that can overcome these challenges while operating strategically and forming essential partnerships will certainly succeed its goal of becoming a leading high-tech global design and manufacturing enterprise in the year 2035.

Company Characteristics

Computational Power

The technology produced will have great computational power to carry out its tasks at high speeds. In the year 2035, nanotechnology will give us devices such as nanotransistors that will allow for faster processing time with less energy used up. Soon we will be able to store your entire computer memory on a tiny computer chip. To help drive this increased speed, novel methods of memory storage will also need to be created since storage is one of the major ways in which processing speed for any device is affected.

Adaptation

The company will be able to adapt to consumer demands especially when it comes to customization. Nanotechnology will allow for this based on the nature of the changes that occur with the manipulation of a material's atoms. By changing the atoms and/or their positions, one can change the properties of the material to become stronger, lighter, less corrosive and much more. With the enhancement of sensory systems, products will be able to self-detect, report issues and perform necessary changes to self-heal or adapt to changing environmental states.

Mode of Operation

In order to be a leading major high-tech global design and manufacturing enterprise in the year 2035, the company will need to be strategic in its operations to set itself apart from its competitors as well as allowing for maximum profit.

Work Force Investment

Since nanotechnology is now and will continue to be a growing field in the year 2035, the company's human capital will be extremely important as it will need to be flexible and welcoming to continuous learning. As research will continue to improve the methodologies used in design and manufacturing, employee training will need to be conducted on a regular basis to ensure everyone is performing with the best approach at all times. Training not only increases the value of the employee as a worker, but also allows them to better learn from their job and perform with higher productivity; thus increasing the company's productivity [7]. Investing in the employees' continuing education will also become an asset to produce long-term benefits as the company will have more capable professionals to drive forward the company's objectives. The company will have to offer adequate sponsorship as an incentive and allow for flexible working schedules so employees are encouraged to further their education.

Waste Management

As seen by the current global push towards sustainable living such as the Copenhagen Climate Change Conference in 2009, the company will need to reflect an attitude that it is respectful of the Earth's limited resources by operating with efficient waste management. Incentives such as discounts or gift cards could be provided for customers to return undesired products to one of the company's location so the materials can be reused and/or recycled.

This attitude will also need to be adopted by the company's working environment with the use of alternative energy sources such as solar panels and wind mills which will result in a positive social image in the wider society, cut costs from reusing valuable raw materials and create valuable business opportunities in the energy sector [8].

Outreach Programs

Nanotechnology has the advantage of being used for widespread applications which translate to more opportunities for the company to connect with consumers through community outreach and being good stewards of the environment. Community outreach programs will include workshops, volunteering events and after-school programs which will improve the public's view of the company; thus yielding long-term benefits of increased sales and increased attraction from up-and-coming professionals who will desire to work for the company.

Practising Corporate Social Responsibility (CSR), a business model in which the company is socially accountable, will prove to be valuable to the company's competitive advantage by showing that it is mindful of its social, economic and environmental impact [9]. The company can adapt the "Looking Inside Out" approach of using a value chain that will lay out all the activities that occur within the company. This will provide foundation for identifying both the positive and negative effects of each process. The company must then be strategic in choosing in attempting to attenuate the negative impacts [10].

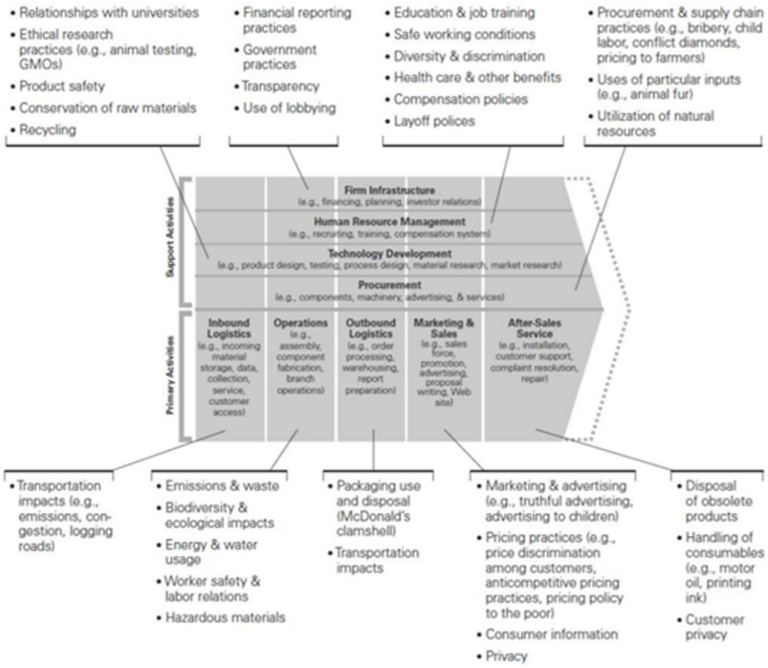

Figure 1 showing the "Looking Inside Out" Approach [10]

Supporting Technology

Artificial Intelligence

Artificial Intelligence (AI) will have great influence on any enterprise in 2035 since as our society moves towards making smarter choices, the technology also has to be capable of making decisions to save time, money and energy. The ability to process data and find patterns will be essential to isolating a design challenge and allow an engineer to generate different ways to solve the problem based the tools they have. With the wide range of data sources, AI could be used to understand consumer wants and needs by analysing the vast amounts of data made available by the World Wide Web and media broadcasts. AI would also be crucial to manufacturing by assisting with the arduous task of physically assembling the products. Machine learning will prove to be helpful both in the manufacturing processes and the logistics of human capital.

Material Science

Given that nanotechnology is driven by the arrangements of atoms, material science as the study of this activity will greatly influence the guidelines by which the company can create its products. Capable material scientists will have to be present to continuously analyse design creations and work along engineers to create innovative devices and methodologies to accomplish the tasks at hand. These scientists will also be crucial with evaluating customer feedback to determine what parameters of the product can be adjusted to achieve satisfaction.

Research Challenges

Research Progress

Nanotechnology is steadily progressing as numerous groups continue to draw in to investigate its applications that could revolutionize the way we view technology. However, despite the success it has had the field is still in its developing stages with a long way to go before we see any of its applications on a mass production level. By the year 2035, there will certainly be a number of ways a company can create nanoscale devices to solve problems but what be the timeline to accessing new methods through research? Any science takes great time to accomplish. The image of the computer from its first invention in the 1800's to what it is now took over a hundred years and included the emergence of a number of new methods and other technology to create what it is today. The possibilities of nanotechnology are virtually unlimited but what is the timeline of achieving them reasonable enough to make profit and survive in the jungle of consumerism?

Moral and Ethical Implications

One of the major possibilities of nanotechnology is the ability to produce any desired product by correctly assembling its atoms. One of the classic examples of how this can be disastrous is raised by recalling the infamous "Replicator" from the Star Trek television series, a machine that can create anything one desires by directly arranging the atoms according to the instructions of the user. Something that was simply science fiction is now becoming a possibility with nanotechnology. An exciting thought, however, one can imagine that if such a device was to ever exist, there would be the point of working to achieve anything when

there is a machine to create it at the push of a button. It is generally agreed upon that one of the principles of man's existence is working to achieve necessary components of survival such as food and shelter. If this becomes obsolete, what would become of the human race? [11] How much restrictions and standards should therefore be placed on the applications of nanotechnology? These are some of the difficult questions that will be faced.

Environmental, Health and Safety (EHS) Risks

The short-term and long-term benefits of nanoscale products will be called into question regarding the potential negative impact of the product on the environment, the workers that create the product and its human users during its life cycle. The company will have to work closely with organizations such as the National Nanotechnology Initiative (NNI) to operate responsibly by consistently analysing its products to assess its risk factors and being transparent of these risk factors by publishing these results in its annual reports [12].

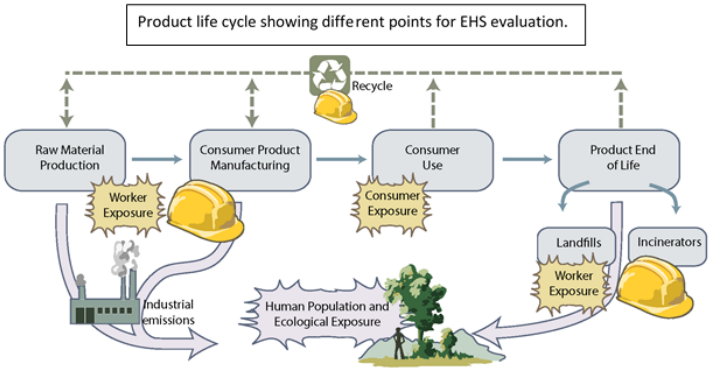

Figure 2 showing the EHS evaluation for the product

Partnerships

Academic Institutions

Relationships with academic institutions such as universities provides dynamic in which both benefit immensely. The company will need the academic institution to help drive forward research information on nanoscience and how it can better integrate AI to create smart products in a more efficient manner. Academic Institutions will be able expand their research capabilities as well as provide more employment opportunities for their students and graduates.

Research Facilities

Partnerships with research facilities will of course increase the research knowledge available for nanotechnology as well as consumer behavior to understand the underlying trends in the market that are constantly changing.

Other Technology Companies

Other technology enterprises, including the company's competitors will prove to be assets since nanotechnology has such broad applications. Communication companies could be provided with nanoscale components that make a phone's capabilities perform like never before. Computer system manufacturing companies such as Dell and Apple can collaborate with the company to produce a partnership that can benefit both companies more than they would have on an individual basis.

Consumers

With the advent of nanoscale transistors, computer speed can increase tremendously leading to faster and more powerful computers. With regards to energy efficiency, nanotechnology will allow us to access more of the advantages at the atomic scale to harness more power with less materials, producing more affordable energy sources such as solar cells. What is now outside the affordable range for a number of consumers such as solar panels, will be made more affordable by accessing and creating inexpensive materials.

Conclusion

Nanotechnology will dominate the global technology markets by 2035 as our global society searches to accomplish more with fewer resources. With an industry predicted to be worth at least US$125 Billion by the year 2024, a technology company can surely be successful by successfully taking advantage of AI both to efficiently manage its manufacturing process and the company's community of employees. By openly addressing the challenges it will face, especially ethical implications, through community outreach the can achieve sufficient understanding from consumers. Through ongoing cooperation with other institutions that can assist the enterprise by staying up to date with the most recent research information, the company can surely succeed its goal of becoming a leading major high-tech global design and manufacturing enterprise in the year 2035.

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