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The Nano Revolution Mirrors the Industrial Revolution:
Who Will Benefit From the Nano Revolution?

Abstract

By the 18th and 19th century the robot was no longer simply a concept but a reality made possible with the Industrial Revolution. The robot was considered a breakthrough novelty that captivated millions of people. Considering how much our society has advanced over the course of 200 years, it is almost inconceivable to imagine the robot as something that could be considered rare, novel, or revolutionary. To be clear, the robot addressed here is not simply referring to a machine resembling a human, but any machine capable of carrying out a complex series of actions automatically. One could say the robot was the face of automation that was developing during the Industrial Revolution. Some of the very first “robots” were, in fact, locomotives. Over the years as more advancement took place, “robots” were programmable by computers. Now, the coming era of nanotechnology potentially has the ability to redefine the robot once again. Nanotechnology’s potential for advancement is so great that many experts are describing its effect in modern society as the NanoRevolution. The NanoRevolution will bring about another major change to the robot; Machines that one could at one point identify with the naked eye will now become a molecular-sized, thus multiplying their usage in various fields. Nanotechnology will also be a first step towards transgressing the norms rooted in our society by integrating with biotechnology to bring about extraordinary changes in the human system.

The impact that nanotechnology can have in today’s society can be related to the impact the Industrial Revolution had on American and British societies. The Industrial Revolution had both beneficial and unfavorable effects on both societies. Regardless, the event helped our capitalist system grow to what it is today. Some of the advancements made possible by the Industrial Revolution were the production of more effective manufactured goods, the reduced costs of commodities to consumers, and the increased standard of living (“Industrial Revolution”). While the Industrial Revolution brought about advancements, it still came with consequences that some people may either hail or disapprove of in varying degrees. As this new technology was taking hold in society, small groups seized the opportunity to take control over the new technology, and in the end the capitalist system gained more power and influence with

this industrial boom (Majewski). Those who are fervent supporters of capitalism, mainly those of the ruling, wealthy class would argue that the Industrial Revolution was the best thing to happen, but others who sit at the opposite end of the situation would probably disagree. While the capitalists sat back to reap that profits and benefits of the industrial boom, the lower, working class experienced a different, less luxurious side effect.

The Industrial Revolution created new machinery that allowed for the mass production of goods; there was no way the capitalists would ignore an incentive that great. They could not ignore it back in the 19th century, so why would they ignore it now with Nanotechnology? This NanoRevolution will probably have a greater impact on our society than the industrial one ever did. After all, now we are talking about things once thought impossible such as enhancing and repairing humans on a molecular level. There will also be less novel, but still significant impacts such as extending longevity and further dividing the line between rich and poor as well as possibly creating a new divide on man and machine. Nanotechnology claims to be achieving similar advancements only on a far greater and more efficient scale. Similar to the Industrial Revolution however, this new system will further affect how we define our capitalist system.

Many people have probably not considered how the NanoRevolution will affect the way America's capitalist system works or how it would affect society in more than just one way. People are being swept by the hype of this new technology without stopping to think about the issues. Shannon identifies investors as the group with serious interest in the development of nanotechnology:

While experts say it's still the early days of the research, nanotechnology has been around for years. During its lifespan, the technology has already gone through its own hype stage, say those in the industry. But the cycle has turned again, and nanotechnology has once more caught the eyes and dollars of expert investors and tech prognosticators. They can't be blamed for getting excited. After the computer industry rocket syndrome, the world is ready to pounce on another phenomenon

in technology ride, the Internet boom and bust, the telecom fireworks, and the mobile-phone mushroom. Nanotechnology looks ripe to fit the bill, and has the research to back it up (Shannon, 21).

The business community is donating huge amounts of money for the progress of nanotechnology.

The fact that the business sector is taking a lot of interest in this technology can only mean one thing in our capitalist society: and that is profit at the expense of the “weaker” groups. A very similar pattern was seen during the Industrial Revolution; those with money and power invested in machines and industries; as a result a division between the elites and the lower, working class became evident. Unlike the Industrial Revolution, however, this Nano-Revolution will concentrate power and wealth even further. Certain companies will play a larger role in the funding and economical support of nanotechnology; such companies would include those that are more dominant and wealthier, like the pharmaceutical companies. Allhoff states that the pharmaceutical companies are already investing enormous amounts of money into nanomedicine:

As expected, pharmaceutical companies are already investing in nanotechnology. Analysts have predicted that, by 2014 the market for pharmaceutical applications of nanotechnology will be close to \$18 billion annually (Hunt 2004); another report indicates that the United States demand for medical products incorporating nanotechnology will increase more than 17% per year to \$53 billion in 2011 and \$110 billion in 2016 (Allhoff, 2009, 4).

According to the data provided, the US demand for nanomedical appliances will increase from \$53 billion in 2011 to \$110 billion in 2016. The important thing to note here is that money and power go hand in hand; that is to say, it will be a select group of companies that will end up controlling nanotechnology.

In this capitalist society any new product that is introduced in the market with the potential to make millions, if not billions of dollars, draws the immediate attention of ambitious, money-seeking investors. Big companies are the first to invest because that is how they secure

the power to monopolize any new commodities. In Foster's book about early British Industrialization, she examines an early form of monopolization: "...the merchants who provided the credit had to be guaranteed a monopoly of investment which they themselves enforced (15)" According to Foster, these early industrialists, though not yet part of the classical bourgeoisie, were still concerned with the monopoly of their commodities. Without control over their investments many merchants would not continue with their businesses; after all they needed something in return for their services. This idea of monopolizing commodities still persists today and will also apply to the products made by nanotechnology in the next few years. Hede makes the connection between the digital monopoly that took hold in society years before with the monopoly that will occur with the introduction of nanotechnology:

Like the digital divide that has accompanied the introduction of new information and communication technologies, it is likely that there will be "nano have" and "nano have not" countries, and that nanotechnology will accelerate the trend toward corporate concentration of power and monopoly formation (Hede, 305).

This desire to monopolize new products, such as those dealing with nanotechnology, will create a competition between the corporations and cause a concentration of power and wealth. As experienced times before, this corporate competition will most likely lead to socioeconomic issues.

Anthropologists and educators, Foladori and Invernizzi, have addressed the socioeconomic implications of nanotechnology; one of their arguments is the following: "the conflict of interests is the main reason why any new technology only tends to benefit the rich and concentrate wealth (Foladori and Invernizzi, 70)." Nanotechnology has the potential to affect various fields of interest ranging from medicine, electronics, and the environment but only select groups will be able to reap the benefits of this technology entirely. Noting the socioeconomic gap created during past technological breakthroughs, Foldari and Invernizzi believe nanotechnology

will bring about similar results: "...in the context of a free market, any new technology leads to heightened concentration of wealth (Foladori and Invernizzi, 69)." In fact nanotechnology may only serve to increase this invisible yet very real socioeconomic gap. As such, Foldari and other writers are correct in discarding any hope in nanotechnology's ability to bridge the gap between rich and poor. Such a thing would be a contradiction to our capitalist society where we have our class division. Just as the Industrial Revolution "inevitably produced winners and losers (Mokyr, 70)," the NanoRevolution will have a similar effect. If we look back to the Industrial Revolution we can easily identify the real winners of industrialization; the industrialists and investors profited immensely from the rise of machinery in society, while the working class mainly experienced a drastic change in labor and way of living. The industrialists and investors in this NanoRevolution will be the pharmaceutical, biotechnical, and electronic corporations. According to Hede, it is very easy to identify the benefiter of nanotechnology:

It is well understood that biotech & pharma corporations would invest and capitalize in nanotechnology in areas of drug delivery and biomedical engineering, while electronics corporation giants would innovate to make a fortune in miniaturized portable electronics with the help of smart nanomaterials (Hede, 306).

Hede mentions three big corporations that would benefit immensely from nanotechnology. Biotech and pharmaceutical companies would invest and profit from nanomedicine, while electronic corporations would profit in the electronics sector. Either way, according to Hede, it is not only the public that will benefit from this new technology but of course the private, business sector as well. Here we see that the benefits of nanotechnology will differ between individuals and companies. For instance, companies will benefit economically and the rest of us will mainly benefit in the social and health aspects.

Should we really worry over the monopoly that will arise with nanotechnology? After all, this new technology holds a lot of promise for improving and reinventing the world. One promise that has captivated most of those who have heard of nanotechnology is its role in the medical world, particularly in diagnosing and treating cancer. Cancer is a deadly disease that is untreatable once it has reached the advanced stages; to make matters worse there is no cure for cancer even if it is diagnosed early on. Currently, there are only treatments for cancer and those are expensive, painful, and do not guarantee that the cancer will not come back during one's lifetime. Chemotherapy is currently the most used treatment for eradicating cancer but as stated, it is painful, expensive, and not 100% guaranteed to work successfully. Nanomedicine promises a solution to this issue. As Hede describes in his work, nanotechnology can provide a more effective method of eradicating only cancer cells without damaging the normal cells:

Nanotechnology offers the possibility of making nano-sized machines ("nanobots") to carry out molecular manipulations or "nanochips" to monitor microscopic environments such as blood cells. "Nanobots" could detect diseases like cancer at early stages and provide efficient treatments with negligible toxicity and reduce the physical pain and the emotional damage suffered by the patient (Hede, 308).

These "nanobots" would truly be a remarkable thing in themselves because these are machines, not just drugs, that are invading our bodies and treating us. It would be misleading to refer to this new invention as a miracle pill because it is not; it is a miracle-bot! Though these nanobots' capabilities are enough to win people's support of nanotechnology, we should question how this nanomedicine would affect society in the long run. Considering that cancer is one of the deadliest diseases in our society, it would be correct to assume that by diagnosing and treating cancer with nanobots, the rate of mortality in our society will increase. As discussed in Majewski's "The Industrial Revolution: Working Class Poverty or Prosperity," a similar effect occurred during the Industrial Revolution; as vaccinations were invented and machinery

improved working conditions to a certain extent, the rate of mortality increased dramatically. This increase in mortality led to a significant increase in population. With an increase in population came various issues that should be mentioned since they may also arise with the implementation of nanomedicine in our society. In one of his works, Dr. Todd Nelson discusses the issue of ageism in respect to population increase during the Industrial Revolution:

Around this time, great advances in medicine were taking place, extending life expectancy significantly. Society was not prepared to deal with this new large population of older adults. Society began to associate old age with negative qualities, and older adults were regarded as non-contributing burdens on society. These negative attitudes have persisted in our society, and have in fact, only increased. Older persons today are treated as second-class citizens with nothing to offer society and the negative attitudes about aging that give rise to ageism tend to manifest themselves in subtle ways in the daily life of the average older person (Nelson, 209).

While Nelson's commentary seems a bit harsh, his words do hold a truth that most people either like to deny or never address openly. Living longer does not mean that the human body will not lose its vitality or perhaps in this case it does? Nelson's argument holds that these negative attitudes towards the older population have not dissipated since the Industrial Revolution; in fact, they have persisted and will continue to persist as nanomedicine yet again extends life expectancy.

However, there are other individuals, like Gordijn, who do not share Nelson's views on extended life expectancy. Gordijn argues that, with nanotechnology, we will be able to reach a state of perfection that will make us content for two major reasons: one, we will be perfect and two, the apparent homogeneity that will arise from this perfection will allow us to live side by side in harmony:

Nanotechnology is finally also expected to lead to social advances. The achievements of nanotechnology, especially nanomedicine, will make people more content and peaceful. It will be a great deal easier to live together in ideal harmony with perfect bodies and flawlessly functioning brains (526).

Even though we still cannot say for sure what nanotechnology's, particularly nanomedicine's, true potential is, let us assume that it will allow for human enhancement on multiple levels. As a society, a bigger population tends to bring a lot of economical and political issues, but on a personal level, most people would love the idea of living longer and improving themselves on a biological level. Everyone has their own reasons for wanting to live a longer, healthier, and perfect life; it can be due to greed, genuine love for living, ambitions, and among other various nonsensical or meaningful things. Hede also shares Gordijn's view on nanomedicine's possible effect on society by stating: "...these innovations [nanotechnology] can be used for human enhancement such as increased memory and intellectual capacity (Hede, 2006)." Essentially, nanotechnology has the ability to perfect the human body in ways that will not only rid us of disease and aging, but also in ways that will make us indestructible and superior to our current self. Why are these writers so concentrated in the biological contributions that can be made by nanomedicine other than just new ways of battling diseases? While we should worry about issues concerning population increase and rejoice in having healthier and happier individuals (all thanks to nanotechnology), we should also focus on the impact human enhancement can have in society.

First of all, let us consider how our lifestyles will change if we depend on nanotechnology for human enhancement. While many authors have addressed issues like population increase and emotional satisfaction, they have not addressed a more serious yet subtle effect and that is dependency on nanotechnology. McGinity hints at the possibility of a machine race due to nanotechnology:

Nanotechnology shrinks the barrier between man and machine, says the Institute of Nanotechnology. 'As computer equipment, surgical tools, and communications pipelines shrink ever smaller, the next step in engineering is to merge biological and mechanical molecules and compounds into really, really small machines,' the

institute states. 'This will happen in many different ways, and it raises many new issues' (23).

According to the Institute of Nanotechnology this new science will allow biological and mechanical molecules to somehow merge for an interdependent function. This is bound to bring consequences; such "potentially troubling issues include whether it is ethical to enhance only a subset of humanity and whether it is ethical (or wise) to enhance people to such an extent that they lose sympathy with unenhanced humans (Allhoff, 2007, 321)." By enhancing humans we are distorting the lines of what is considered human and machine and paving the way to the creation of cyborgs. Perhaps the use of this technology into humans will not only serve to cure or treat illnesses, but also in creating a new race. With a new race consisting of robotic elements certain characteristics such as emotion may be lost. If that were to happen, the social forms that exist today will change since it will become harder to communicate and coexist with a new race (at least until people adapt to these changes). A more troubling issue to consider is whether or not this new race can still be considered human. If they were considered to be nonhuman, then would that mean that we become inferior to this new group? In this case, the enhancement of humans has the potential to create an additional upper level to the hierarchy that is our already existent in our capitalist society. It is still unclear as to how this new technology will be used, so it does not rule out the possibility that it will be used to create some form of human hybrid. Even if there is no robotic race, it does not rule out nanotechnology's ability to enhance human beings and create a dependency on this technology.

While the Industrial Revolution created a dependency on machine for use in labor and everyday life, this NanoRevolution, while different in several respects, will also be creating a dependency on machinery as well. In this case "nanobots" will share a relationship with the body on a biological level. Grunwald is one of the many individuals to expect such a relationship:

“Nanotechnology, in combination with biotechnology and medicine, opens perspectives for fundamentally altering and rebuilding the human body (Grunwald, 196).” Enhancement is taken to a whole new level with nanotechnology mainly because of the integrated relationship that will develop between humans and technology. The dependency on nanotechnology will not only be for human enhancement, but also in the workforce: “The change from existing manufacturing process to be replaced by nano-manufacturing methods, would result in the requirement of workforce with specialized training, while certain workforce would have to be replaced by the newly incorporated nano-based technologies (Hede, 309).” Similar to the Industrial Revolution we will experience changes in our lifestyles and workforce. The lifestyle changes deal with human enhancement and in the workforce it deals with improving or replacing current technology. During the Industrial Revolution the transition from human labor to a combination of human and machine labor was a major change that occurred in society at the time because it was the first time people were mass-producing by using machines. Society’s dependency on machine labor has only taken a stronger hold since then and will continue to do so with this new technology.

With that in mind, let’s reconsider how a monopoly of nanotechnology will influence the manner and magnitude in which this technology is used in society. If we identify the relationship capitalism shares with the way our society functions, then we can understand how nanotechnology will impact our society. Although nanotechnology promises advancements in many areas, we should realize that not everyone would have access to the new technology in its entirety. The human enhancement mentioned previously will most definitely be something that is bought and controlled by those that are wealthy. As such only a select group will benefit from the human enhancements offered by nanotechnology. This, of course, is necessary if we are to

keep the class division in our society. However, it is possible for a slightly different, but drastic outcome to occur out of this enhancement: a robotic race. Though the idea may seem exaggerated and improbable, it is still possible. So, if a new race were to arise from this nanotechnology, then we'd be facing another addition to our class system. If nanotechnology is as incredible as everyone believes, then this new race will be superior to the rest, and thus we will be facing a new life. As of now we consider ourselves to be superior to the rest of the creatures, but will it last? No one can say for sure, at least not yet. It all depends on how far we are able and willing to exploit this new technology.

The NanoRevolution is creating a lot of hype because of its promising potential for technological advancement and profit. Still, before we allow ourselves to be lost in the frenzy of this new change, we should stop and think about the ethical and political issues that come with this grand revolution. Let us not commit the same mistakes made during the Industrial Revolution with the way we approach the issue of nanotechnology and the way we integrate nanotechnology into society. Considering the fact that we do not yet know if or when we will be able to exploit the fruits of nanotechnology, we cannot yet address the public on how we plan to use this new technology. However, we can start educating people about the benefits and potential threats of nanotechnology before there is a "nano-boom" and it becomes too late. This "nano-boom" is referring to the rapid development and introduction of nanotechnology into society. The Industrial Revolution happened rapidly and as a result many people simply celebrated all the hype instead of assessing the whole picture. The NanoRevolution is still in its infancy stages, so now is the best time to educate the public about the basic of nanotechnology and its potential. The way we approach this issue could make the difference from a smooth and easy transition, to a transition full of controversy and debate. One key issue to address to the public is that the

innovations that will occur in this NanoRevolution will not only be geared towards enhancing existing products but also used in enhancing human beings on multiple levels. Many people may also worry about any health hazards nanotechnology and nanomedicine may pose. While this issue should be addressed, it is perhaps best to avoid scaring people unnecessarily. The more pressing issue to deal with is the ethical and social implications of nanotechnology and not necessarily on the health issues because even the technology and medicine used today possess health risks.

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