

# Nanotechnology: Man vs. Machine

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PASS

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## ABSTRACT

There is currently a revolution waiting to happen within the scientific world that could potentially literally change us...forever. Its name? Nanotechnology. This paper aims to give the reader a short introduction into the world of nanotechnology, and explore what it may have in store for us in the future with its various medical applications within the human body. The ethics of the situation are also discussed, and I conclude the paper with my views on whether or not man will slowly become more mechanical.

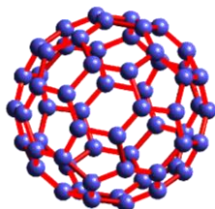
## INTRODUCTION

Nanotechnology has the potential ability to achieve anything that man can imagine. It is due to this that it is possibly one of the most feared areas of science within the scientific community, yet if utilised correctly, could become the most useful. Described well by the title of Feynman's (1959) speech "There's Plenty of Room at the Bottom" and the concept up building "From the Bottom Up", nanotechnology deals with particles between 1-100 nanometres in size. Table 1 puts things into perspective.

Example	Size
Molecules	1 nm
DNA	10 nm
A Virus	100 nm
Bacteria	1 000 nm
Amoeba	10 000 nm
Pollen Grain	100 000 nm
Nematodes	1 000 000 nm
Insects	10 000 000 nm
Small mammals	100 000 000 nm
Large mammals	1 000 000 000 nm

**Table 1: Relative sizes in nanometres**

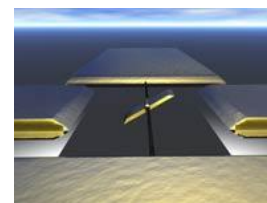
There are two types of nanotechnology: nanoscale technology and molecular manufacturing. The former encompasses all of nanotechnology and is where standard sized tools are used to manufacture simple structures and devices, whilst the latter involves the use of these nanoscale tools and non-biological processes to build structures, devices and systems at the molecular level. Though it is hard enough when we are dealing with the manipulation of what can not be normally seen, in terms of research, it is the molecular manufacturing where there has been little effort because of the popular concept of 'grey goo', highlighted in Drexler's (1986) book "Engines of Creation". Fortunately, both types have their applications within medicine and it is because of their size in comparison to our cells and specific properties that their applications can be so useful. Two famous examples are shown below:



**Figure 2**

An important discovery was the new form of carbon known as fullerenes, discovered by Smalley, Curl and Kroto (1996), leading to the possible uses of buckyballs (Figure 1) and carbon nanotubes in medicine. These have been proposed to be used in drug delivery systems within the body and indeed, a tiny elevator<sup>[1]</sup> was built in 2004, which, with further adjustments, could become pistons for remote controlled drug delivery.

The first nanomotor was created by McLellan (1960), which fitted into a cube  $\frac{1}{64}$  inches on each side. Now however, research has gone on to progress and the Figure 2 shows the world's first nanotube nanomotor made by Zettl (2003), which could potentially be used to drive fluids within the nanotubes or in nanofluidic devices, as well as for drug delivery by nanosyringes, amongst other uses.



**Figure 2**

Though many concepts have already been imagined, we are still limited as to what nanotechnology can currently do, when there is still much more that can be done. As shown above, a foundation has been laid and much work has been done to get to this point; advancements have been made and achievements are visible. However, we do not have the needed knowledge to extract their full potential safely. Thus, we can only hope that as more ideas are supplied, research advances and catches up to show us that it is possible to achieve what is currently considered as 'the impossible'. The big question is...when?

## DISCUSSION

A common science-fiction concept is that far into the future, man will have advanced to the point where they could be considered to be more machine than man. I believe that with the help of nanotechnology, this will not be too far from realistic.

Currently, research has been going into fashioning tissues<sup>[2]</sup> out of carbon nanotubes. If they should succeed in achieving this, would the creation of artificial organs not be the next step? After all, organs are merely a group of tissues working together to perform a common task. Of course, communication will be of the utmost importance lest coordination be out of synch or if something were to go wrong, but if nanomachines<sup>[3]</sup> were present, they could be programmable or controlled remotely, reducing the chances of a severe accident from happening.

However, that is not all. If carbon nanotubes could be used structurally to replace whole bones, would we not have a huge increase in support? With strength 100 times stronger than steel, yet being six times lighter at the same time, breakages would soon become a very scarce occurrence if this became possible. Unfortunately, although joints in-between bones could be made with carbon nanobuds, it would become very troublesome as I imagine constant friction between them would need constant attention and maintenance, so there is a possibility that it could become very overcomplicated and/or need a non-toxic lubricant between them. Thus, it is most probably redundant in the face of standard techniques. However, the possibility must not be overlooked as we continue to find out more about nanotechnology and its possibilities.

If tissues could be made, why not trying to make cells? Through molecular manufacturing, as long as the blueprint for making the cell was mapped out accurately, it should be something that can be produced. Thus, things which are hard to replace/synthesise now, could potentially be mass produced very easily to replace ones in the body. Cell such as neurons are a good example: if done correctly, it is likely a large batch of neurons could be manufactured before the time it would take for them to regenerate normally, as it usually takes a long time, if at all. If it was not faster, carbon nanotubes could be used as replacements for the axon and dendrites to speed the entire process up (less matter to build in total through molecular manufacturing), as they would be able to act as conductors to pass on the electrical signals constantly being sent along the nervous system.

Diseases have plagued our species since the dawn of man. But what would happen in the event of near immunity to all of them? I believe this to also be another possibility that can be reached. In the event that a human becomes more mechanical than organic and functioned perfectly (the machinery not encountering any rejection at all from the organic part of the body) there will be less organic tissue to infect to start with, not even considering any advancements in the prevention of diseases. It goes without saying that there is currently already a branch of nanotechnology dedicated to fighting human diseases and it can be said without a doubt, that there will be many discoveries in this area before we reach the stage of the 'mechanical human'. An example of this would be the current research in fighting cancer<sup>[4]</sup> – already; methods are being thought out to improve the chances of beating it, such as the use of carbon nanotubes to identify and target cancerous cells and have radiation applied to kill them off.

In addition to this, there has been work in producing better 'taken' medication with nanotechnology<sup>[5]</sup>; producing results on par with standard medication with fewer side-effects or fewer possibilities of allergic reactions. However, it must be noted that although these products they have been commercialized, I envision that they will become redundant with the rise of molecular manufacturing. With carbon nanotubes acting as sensors<sup>[6]</sup> alongside nanomachines, certain actions could be signalled to take place, based on any irregularities in the body; for example, initiating the delivery of a drug to a

particular area of an organ because it is showing signs of being cancerous. What's more is that, the drugs being used could have been 'built' through molecular manufacturing by a different group of nanomachines, as they were 'informed' what was needed from the sensor.

Unfortunately, it goes without saying that there are many ethical issues that arise with all of these potentially lifesaving changes and these must be examined thoroughly before considering whether or not these applications within medicine are acceptable; there is no point in wasting resources to produce something that is deemed outright unethical and will not be used anywhere when there are more useful alternatives available for the use of these resources. However, as is always the case with ethics, there is usually never a correct answer, so whilst I cannot present any answers, I hope that what follows may at least help to make your mind up as to what is right and what is not.

It is an unstated law of science that religion will almost always oppose something that will cause great change within society. Though this merits mention within this section, I shall state now that I will forego any further discussion on this matter as the debate between them will forever rage on and there would be no end to this paper.

First and foremost would be to consider the possibility of causing harm to the patients with these applications of nanotechnology. For example, under certain conditions, carbon nanotubes are actually cytotoxic – how likely is it in these future applications that the patient suffers as a result of this? It will be important to ensure that, as a medical treatment, it does no harm, or at the very least, the patient is forewarned of the possible implications. No doubt, methods such as these would undergo rigorous testing beforehand anyway, but humans are impatient, and it is important not to lose sight of the fact that this is a medical treatment, otherwise it would be all too easy to cause harm when good was intended.

With the possibility of major modifications to the body, as well as the consideration of molecular manufacturing, there will be a very large issue about 'losing one's humanity'. As humanity is loosely defined in this context, it is important to consider what is actually being lost in the first place and decide whether or not that constitutes to your humanity. Besides, there will never be a time where treatments are forced upon a patient against their will, barring medical malpractice, meaning those uncomfortable with this notion will be able to just seek other forms of treatment; especially in the future when other medical treatments besides nanotechnology are sure to have improved.

For the patients who do opt for this course of treatment, they may also like to consider that these kinds of human enhancements may put them at odds with those who do not and think it is wrong. This kind of segregation may become especially bad when dealing with the disabled, who might object more to enhancements, or indeed, being stigmatised for not having enhancements themselves.

Money is always a problem in the world, and nanotechnology is no exception. Especially in the early stages of its introduction into becoming a standard medical treatment, nanotechnology will be viewed as yet another divide for the rich and the poor and the situation could easily develop to a point where priority of treatment is not as it should be; rather than going to the patients who need it, it may actually go to the rich, who are able to buy this treatment easily when they may not necessarily even need it. Fortunately however, this problem could be resolved if nanotechnology came to a point where it was possible for everyone to access it with ease.

Finally, there may be a concern about the privacy of the patient with the remote controlled sensors that are constantly monitoring their body. Again, though the patient has the right to refuse, those who undergo the treatment may potentially have to worry about strangers observing them as the

nanomachines are monitored; it is unlikely that the patient's doctor would be able to perform this task by themselves 24/7. Even considering this, it will also be unlikely for the patient to pick out who they would prefer to observe them as this could lead to a major imbalance of workloads between doctors and merely result in being unreasonable and selfish on the patient's part.

## CONCLUSION

These advancements made in the field of nanotechnology will not occur, I fear, in my lifetime. However, whether it is in 10, 50 or 100 years, I am convinced that some form of a medical application utilising nanotechnology I have speculated above will come become a reality. Granted, there are many problems that must be overcome first before this may happen, such as winning over the general public, the perfection of the actual mechanisms of the system to ensure complete safety, and the dilemma presented by 'grey goo', but I believe that science, and therefore medicine, will reach that point.

In regards to my speculations above, I believe that some of it just cannot be ignored. Carbon tubes, it seems, have a plethora of potentially useful medical applications within the body, with only the slight instability of sometimes being cytotoxic as its only current drawback. I look forward to seeing it crop up more and more often in the latest news from now on as it becomes integrated into society, being used everywhere, not only in medicine, yet remaining unseen.

The use of buckyballs to carry out drug delivery is an amazing concept - pure and simple, yet it carries out the job beautifully. When this becomes a standardised treatment, as I have absolutely no doubts of this reality, it will be a mini-revolution of its own and I will just sit back with the rest of the world and watch it in awe.

I personally find molecular manufacturing to be the most interesting concept out of all of nanotechnology, with unlimited applications to medicine, yet I am slightly disheartened at the fact that the potential consequences of it are all too imaginable. If it ever comes into usable existence, I am completely sure that the world as we know it will end (in a good way); however, I am also all too aware that it is the least possible out of all of nanotechnology to be considered a reality. I have unfortunately resigned myself to never seeing this in action.

Change will always meet with opposition. However, people also change – this is an undeniable fact of life, and it is through this that I can envision the application of nanotechnology in medicine being accepted by the general public in the future. Whether it be for personal reasons such as being ill and the treatment could save your life, to no reason at all other than the concept of being slightly mechanical as being 'cool', it has been an unavoidable step in the history of man to get to the point of no return ever since its discovery and I must personally admit that I slightly regret that I will most likely not be there to witness it.

To conclude, will man become more machine? My answer is yes...but in a time far away into the future, when all of these problems have been solved, all of these worries forgotten, medicine is no longer needed and we all lay dead (and probably forgotten as well) beneath the earth. Yet, we will still be more human than those alive, roaming above us, as the era of mechanical man dawns.

What is your answer...?

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