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LILLIPUTIAN COMPUTER ETHICS

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ABSTRACT: This essay considers some ethical issues of nanotechnology and quantum computing, particularly the issue of privacy, and questions related to artificial intelligence, implants, and virtual reality. It then examines the claim that research in this field should be halted.

Keywords: artificial intelligence, bionic humans, computer ethics, nanotechnology, privacy, virtual reality.

Nanotechnology and quantum computing have the potential to radically change information technology. If research in these technologies is successful, and there are signs that it will be, computers will become very, very small and very, very fast, and will have an enormous amount of memory relative to computers of today. This possibility is creating excitement in some quarters, but anxiety in others. Speaking of nanotechnology, in a recent and much publicised article, Bill Joy wrote that

> . . . it is most of all the power of destructive self-replication in genetics, nanotechnology, and robotics (GNR) that should give us pause. . . . The only realistic alternative I see is relinquishment: to limit development of the technologies that are too dangerous by limiting our pursuit of certain kinds of knowledge. (Joy 2000)

Given the variety of benefits promised by nanotechnology in medicine, the environment, and information technology, to pick out just a few, Joy's claim seems a little strong. This essay will discuss a few potential developments to see what the appropriate reaction to this technology is. Are the worries enough to give his call for a limit on research any weight?

Before proceeding to examine the claim that some research in computing should not take place, we need to look at nanotechnology and quantum computing, to see what dangers they may pose.

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Nanotechnology and Quantum Computing

Nanotechnology is relatively new, although it was first mooted by Richard Feynman in a lecture entitled "There's plenty of room at the bottom," in 1959. Nanotechnology involves the manipulation of individual atoms and molecules in order to build structures. One nanometre is one billionth of a metre (three to five atoms across), and "nanoscience and nanotechnology generally refer to the world as it works on the nanometer scale, say, from one nanometer to several hundred nanometers" (NSTC 1999). This technology is important because it enables very small things to be built and gives great control over the properties of the materials constructed. This technology is claimed to have enormous benefits in a variety of fields. Nanoparticles inserted into the body could diagnose and cure diseases, building materials could adapt to the weather conditions, cheap and clean energy could be produced, sensing devices could become much more sensitive, and computers could be made much faster and could have more memory. While these benefits have not yet accrued, they are not mere speculation. The theories underlying the proposed applications are, it is argued, scientifically based. The technology for manipulating atoms individually is available: In 1989 IBM physicists produced the IBM logo by manipulating atoms.

The main interest of this paper is the relationship of nanotechnology to computing. Quantum computers would be much more powerful than any available today. According to one researcher, it is expected that a quantum computer would be able to perform some computations that could not be performed by all the current computers on the planet linked together, before the end of the universe (Simmons 2000). Computers will also become very small. For example, at one end of the spectrum there would be devices that incorporated "nanoscale computers and several binding sites that are shaped to fit specific molecules, [that] would circulate freely throughout the body . . ." (Merkle 1997). At the other end "we should be able to build mass storage devices that can store more than 100 billion billion bytes in a volume the size of a sugar cube, and massively parallel computers of the same size that can deliver a billion billion instructions per second—a billion times more than today's desktop computers" (Merkle 1997). Smalley is a little more cautious, but still estimates that the efficiency of computers would be increased by a factor of millions (Smalley 1999). In addition, there could be "detecting devices so sensitive that they could pick up the equivalent of the drop of a pin on the other side of the world" (Davies 1996).

This technology, if it develops in the predicted manner, will facilitate some interesting developments. Monitoring and surveillance will become very easy, particularly when the new computer and communication technologies are linked. People with microscopic implants will be able to be tracked using Global Positioning Systems (GPS), just as cars can be now, only more efficiently. One need never be lost again! Other implants could increase memory, reasoning ability, sight, hearing, and so on. Some argue that the distinction between humans and machines might no longer be useful (Kurzweil 1999). And virtual reality could become indistinguishable from reality itself.

Before considering some of the ethical issues raised by these possible developments, it is worth asking just how credible are the claims. Apparently many are quite credible. Many are being made by researchers with impressive records in computer science and in other sciences, and research is being supported by reputable universities and governments. More important, some progress has been made. It is already possible to manipulate individual atoms, as stated earlier; nanotubes have been developed; and some progress has been made in building simple quantum computers. Theoretically, nanotechnology can work. There is enough evidence to suggest that nanotechnology and quantum computing will become realities, probably sometime around the middle of this century, and so it is worth looking at any ethical questions that they might raise.

Ethical Questions

While nanotechnology has potential benefits and dangers in a wide variety of areas—for example, in health and in the environment, as previously mentioned—we will consider here just some potential dangers in the field of computing. That there are also benefits in this area is not being questioned.

There are at least two sets of issues. One set concerns existing problems that will be exacerbated by the miniaturisation of computers. This miniaturisation will involve the development of smaller, much more powerful machines with much more sensitive input devices. The second set concerns potential problems, problems that as yet have not arisen, at least not in any significant way.

Exacerbated Problems

It is likely that most existing ethical problems in computing will be exacerbated. Easier and faster copying onto ever smaller devices will make protecting intellectual property more difficult. There will be more worries about Internet content as that content becomes more feasible and more difficult to control. It is likely, however, that one of the greatest impacts will be on privacy.

Privacy problems will be enormously increased. Vast databases that can be accessed at very high speeds will enable governments and businesses to collect, store, and access much more information about individuals than is possible today. In addition, the capacity for data mining, the exploration and analysis of very large amounts of data for the purpose of discovering meaningful and useful rules and patterns, will increase dramatically. And perhaps most important, the monitoring and surveillance of workers, prisoners, and even the general population will be greatly enhanced with the use of small, powerful computers and new sensing devices for input. GPS will be able to specify the location of individuals; cameras with artificial neural nets (or other learning technologies) will be able to pick out unusual behaviour in crowds or just on the streets and notify authorities.

While all of these possibilities have benefits (for example, for safety and efficiency), the possibility is also opened for large-scale control of individuals, either by governments, employers, or others with authority. There will be a need for the reassessment of privacy legislation, the use of personal information by governments and corporations, and guidelines and legislation for the use of monitoring devices.

New Problems

Some problems are new in the sense that so far it has not been necessary to face them in any realistic way. Just three will be mentioned here.

Artificial intelligence. If machines are developed that behave in much the same way as humans do, in a wide variety of contexts, the issue of whether they are things with moral rights and responsibilities will arise. Consideration would need to be given to how they should be treated. If they behaved like us, would we be justified in treating them differently?

Bionic humans. Chip implants that enhance various senses, memory, and perhaps even other capacities such as reasoning ability and creativity may blur the distinction between human and machine. We already have eyeglasses, hearing aids, cochlear implants, hair implants, skin grafts, tooth implants, pacemakers, transplants, and so on, so why should more advanced implants matter? Perhaps there is a difference between helping people to be "normal"—that is, correcting a deficiency—and making a normal person a "super human." But just why this is the case would need to be spelt out.

Virtual reality. Virtual reality systems will improve to the point where it may become difficult to tell the difference between "real" and "virtual" reality. There may be no apparent difference between really hang gliding and doing so virtually.

Should the Research Be Controlled?

If Joy is right about the dangers of this new technology, then there is some research that computer scientists ought not do, or, if they do it, they ought to be held morally responsible for the consequences of that research. Or so it would seem. There are, however, a number of issues that need to be sorted out before we can be confident in affirming this. One concerns the differences between pure research and technological development; another issue is the use to which that development is put. The first question here is whether there is any pure research that should not be undertaken—that is, whether there is any "forbidden knowledge": Is there any knowledge that we should not attempt to discover? A related question is whether there is any technology that should not be developed, and there is the further question of limits to the uses of that technology.

We should bear in mind that there are distinctions between knowledge, the technology developed from that knowledge, and the uses to which the knowledge is put. Certain uses of knowledge (or the technology based on the knowledge) ought to be avoided if those uses cause harm. The emphasis for the moment is on the knowledge itself. The knowledge must also be distinguished from the method of gaining that knowledge. Clearly certain methods for gaining knowledge are wrong, for example, those that cause harm. (In particular situations some greater good may make some degree of harm, both in the gaining of knowledge and in its use, permissible.) The question of whether the knowledge itself ought to be forbidden is, or seems to be, quite a different matter. Knowledge is neither morally good nor morally bad in the way that methods or uses might be.

It is difficult to make sense of the claim that there is some knowledge that is morally bad in itself regardless of any consequences. It is certainly difficult to find any examples. It is easy to find examples of knowledge with harmful consequences. Joy himself seems to acknowledge this when he says that knowledge of nanotechnology should be limited in order to limit the technologies that would be developed from that knowledge. If knowledge has harmful consequences, should it be forbidden? Not always, because many types of knowledge can be put to both beneficial and harmful uses, and we do not automatically want to rule out the beneficial uses.

At this point it is worth looking briefly at Somerville's argument in *The Ethical Canary*, because perhaps the discussion should not be couched just in consequentialist terms. Her two basic principles are these:

> We have a profound respect for life, in particular human life . . . and we must act to protect the human spirit—the intangible, invisible, immeasurable reality that we need to find meaning in life and to make life worth living—that deeply intuitive sense of relatedness or connectedness to the world and the universe in which we live. (Somerville 2000, xi–xii)

She suggests that if scientific research violates either one of these principles, then it ought to be avoided even if it has some beneficial consequences. Her second principle has particular relevance for nanotechnology and quantum computing, although she does not discuss these fields. We shall touch on this principle later, and now consider some more consequentialist arguments.

To help to clarify matters, the consequences of knowledge can be divided into two groups: physical and mental. Physical consequences are always uses to which the knowledge is put. Of most concern is knowledge that will almost certainly be used in harmful ways. There may be no way to prevent the harm without preventing the knowledge in the first place. A case could be made that such knowledge is not the fit subject of research and ought to be forbidden.

Mental consequences do not necessarily involve uses. Some knowledge is such that simply knowing it has negative consequences. Nicholas Rescher puts it this way:

> There are various things we simply ought not to know. If we did not have to live our lives amidst a fog of uncertainty about a whole range of matters that are actually of fundamental interest and importance to us, it would no longer be a human mode of existence that we would live. Instead, we would become a being of another sort, perhaps angelic, perhaps machine-like, but certainly not human. (Rescher 1987, 9)

Suppose that as a result of research in IT scientists learned how to build machines that in behaviour were indistinguishable from humans, and moreover, that it was obvious that these machines were purely deterministic and without free will. If we knew this, we would obviously have to see ourselves in a new light. Would we, in our present stage of evolution, be able to cope? If the GNR technology discussed by Joy developed in the manner that he fears, would we be able to continue to live happy and satisfying lives? If some knowledge has profound effects on the way we see ourselves, should it be forbidden? It seems that here, just as in the case of knowledge that almost inevitably leads to harm, a plausible argument can be made for forbidding it.

It has just been suggested that a case can be made in certain circumstances to restrict or prohibit research, but who should do this restricting or prohibiting? Does the state have a role? A strong argument for the freedom of science from political control is supplied by David Baltimore:

> First, the criteria determining what areas to restrain inevitably express certain sociopolitical attitudes that reflect a dominant ideology. . . . Second, attempts to restrain directions of scientific inquiry are more likely to be generally disruptive of science than to provide the desired specific restraints. (Baltimore 1979, 41)

A number of arguments are offered to support these claims. First is what Baltimore calls the “Error of Futurism,” that is, the supposition that we can predict the consequences of any research accurately enough to make any sensible decisions. The second argument is a version of one of John Stuart Mill’s. Freedom of speech and expression allows the development of new ideas, increases the choices in life, and generally renews and vitalises life and makes it richer. A third argument is that repression in scientific research is likely to lead to repression in other areas and so will increase fear rather than strengthen society. A fourth argument is based on the unpredictability of science. Even if some research is not allowed, the knowledge to which it may have led might emerge from other research quite unexpectedly.

These arguments are aimed at pure or basic research, and Baltimore admits that the further one moves toward applications of research, the weaker these arguments become. If these arguments hold for pure research, then all of the responsibility for undertaking worthwhile research rests on the scientists themselves, which is where, according to Baltimore and others, it ought to rest. It must be noted here that it does not necessarily follow that the scientists' responsibilities extend to the *uses* to which the knowledge is put. They create or generate the knowledge from their research, but others decide how the knowledge is to be used. Whether this separation of responsibilities is ultimately sustainable is another matter, but for the moment we shall accept it.

We now return to Baltimore's arguments that research should not be externally controlled. His first argument, the "Error of Futurism," is that prediction is too unreliable to provide the basis for any restrictions on research. Consider, for example, Weizenbaum's prediction that research into speech recognition could have no useful consequences (Weizenbaum 1984, 271). It now appears to be an important tool in human-computer interface design for users with certain disabilities. Prediction is certainly fraught with danger; however, we often must base our actions on predictions, on what we believe may happen, and it is not clear why the case of research should be any different.

Baltimore's second argument is that freedom of speech and expression allows the development of new ideas, thereby increasing life's choices and generally making it richer. This is true, and this form of freedom is undoubtedly an important good, but it is not the only one, and it can be in conflict with others. In general we are restricted in the performance of actions that will, or are likely to, harm others. Again, it is unclear why research should be treated differently.

The third argument is that repression in scientific research is likely to lead to repression in other areas and so will increase fear rather than strengthen society. While we can agree that repression is not good, many things are restricted or repressed in a civilised society—for example, certain research using human subjects and driving under the influence of alcohol—but these restrictions surely reduce rather than increase fear. If probable harm is as closely associated with knowledge as suggested earlier, there is no reason why pure research should be treated differently from other aspects of life. Baltimore's final argument is that, because of the unpredictability of science, the undesired knowledge might emerge unexpectedly from research that was not disallowed. This is true but not to the point. While it may not be possible to ensure that some undesirable knowledge will not be discovered, it is almost certainly possible to reduce the probability that it will be.

It is, then, permissible or even obligatory on occasions to restrict or forbid research on the ground that mental or physical harm is likely to result from it. However, this should not be done lightly, because freedom in this area is important, not only for the good of science but also for the good of society. There should be a presumption in favour of freedom of research. If research is to be restricted, the burden of proof should be on those who want to restrict it. However, there seems to be a conflicting intuition here. If a *prima facie* case can be made that some particular research will most likely cause harm, either mentally or physically, then the burden of proof should be on those who want the research carried out to demonstrate that it is safe. The situation then appears to be this. There is a presumption in favour of freedom until such time as a *prima facie* case is made that the research is dangerous. The burden of proof then shifts from those opposing the research to those supporting it. At that stage the research should not begin or be continued until a good case has been made that it is safe.

The conclusion to this point, then, is that the case against the state's having a role in the control of scientific research has not been made, but that such control has dangers and it should not be embraced lightly. The argument so far has focussed primarily on pure research, because that is where it is most difficult to make a case for control. However, the case of technological development, one of the fruits of pure research, is not obviously much different. Just as a scientist can say that he or she is just adding to knowledge and therefore has no responsibility for the use to which that knowledge is put, so technologists can say that they are just developing tools, and it is not up to them how those tools are used.

Nanotechnology and Quantum Computing Research

It has been argued in this essay that nanotechnology and quantum computing do raise some worrying ethical questions. While these technologies offer the potential for great benefit, it is not benefit unalloyed, and some of the potential problems were outlined. It has also been argued that there are cases in which halting certain types of research could be justified. The question here is whether research into nanotechnology and quantum computing is in this category.

Given the quite fundamental changes that these technologies could facilitate, it is not enough merely to consider the potential benefits and harms as they might apply to life as we know it now. The issue is more one of the kind of life that we want. Can we, and do we want to, live with artificial *intelligences*? We can happily live with fish that swim better than we do, with dogs that hear better, hawks that see and fly better, and so on, but things that can reason better seem to be in a different and altogether more worrying category. Do we want to be "super human" relative to our current abilities, with implants that enhance our senses, our memories, and our reasoning ability? What would such implants do to our view of what it is to be human? Does it matter if our experiences are "real" or not, that is, if we have them in a virtual world or in the real one? Would there be any sense in that distinction? These are all big questions that cannot be answered here, but the suggestion is that they are the important ones to address when considering the future of research into nanotechnology and quantum computing. These questions seem related to Somerville's second principle, that of protecting the human spirit. Perhaps research into nanotechnology and quantum computing does not violate that principle, but much more examination of the issues is warranted.

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References

Baltimore, David. 1979. "Limiting Science: A Biologist's Perspective." In *Limits of Scientific Inquiry*, edited by G. Holton and R. S. Morrison, 37–45. New York: W. W. Norton.
Davies, Paul. 1996. "Foreword." In *Quantum Technology*, edited by Gerard Milburn. London: Allen and Unwin.
Feynman, Richard. 1959. "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics." A talk given on December 29 at the annual meeting of the American Physical Society at the California Institute of Technology. Available online at http://www.zyvex.com/nanotech/feynman.html. Accessed March 27, 2001.
Joy, Bill. 2000. "Why the Future Doesn't Need Us." *Wired*, 8.04.
Kurzweil, Ray. 1999. *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*. London: Allen and Unwin.
Merkle, Ralph. 1997. "It's a Small, Small, Small World." *MIT Technology Review* (Feb./Mar.): 25. Available online at http://www.techreview.com/articles/fm97/merkle.html. Accessed November 2, 2000.
NSTC. 1999. "Nanotechnology: Shaping the World Atom by Atom." A report of the National Science and Technology Council (NSTC), Committee on Technology, The Interagency Working Group on Nanoscience, Engineering and Technology. Available online at http://itri.loyola.edu/ nano/IWGN.Public.Brochure/. Accessed March 27, 2001.

Rescher, Nicholas. 1987. *Forbidden Knowledge and Other Essays on the Philosophy of Cognition*. Dordrecht: D. Reidel.
Simmons, Michelle. 2000. "Faster, Smaller, Smarter." A talk given at the forum Small Things, Big Science: Nanotechnology, Horizons of Science. University of Technology, Sydney, November 23, 2000.
Smalley, R. E. 1999. "Nanotechnology." Prepared written statement and supplemental material of R. E. Smalley, Rice University, June 22. Available online at http://www.house.gov/science smalley_062299. htm. Accessed March 27, 2001.
Somerville, Margaret. 2000. *The Ethical Canary: Science, Society and the Human Spirit*. New York: Viking.
Weizenbaum, Joseph. 1984. *Computer Power and Human Reason: From Judgment to Calculation*. New York: Penguin Books. Originally published in San Francisco by W. H. Freeman, 1976.