Computing for the Future of the Planet

Research at the University of Cambridge, led by Professor Hopper, Head of the Computer Laboratory, is focusing on how advances in computing and communications could help the environment and improve the way we live.

Is global warming happening and should we act?

The weight of evidence for global warming is increasing and whilst some people still deny its existence or the urgency, many now accept that climate change needs to be addressed. Unanswered questions still remain about the way we live and exactly how it impacts our planet. But whether you sit on the fence or either side of it, there are compelling reasons for changing what we do and how we do it, to work towards a more sustainable future.

Take transport. Improving the infrastructure and systems to reduce congestion on our roads is a good thing. And if making it easier, quicker and more pleasant to get from A to B also helps to reduce carbon emissions, it's a win/win situation.

Reducing the power consumption of computers and electronic equipment also has major economic benefits, regardless of fact it will also reduce your carbon footprint.

Evidence such as high levels of CO_2 in the atmosphere, rising species extinction and an ever-growing global population suggest that we have reached a tipping point for change. At the University, we believe the future of the planet is at risk and computing has a major role to play to help improve its prospects.

What difference can computing really make?

Computing has had a huge impact on the way we work and spend our leisure time. In the last 10 years alone, the Internet has revolutionised communications and miniaturisation has put immense computing power literally in the palm of our hands.

And while these advances have delivered exciting opportunities, there have also been 'accidental' side-effects that already contribute to greater sustainability. Take the MP3 player. It's a handy way to store and access all of our music; but it has also reduced the number of CDs manufactured and shipped around the world. There are many such examples. The paperless office is still a goal for most of us and the digital age has the potential to dramatically reduce paper consumption.

Imagine what could be achieved if the power of computing was truly focused and harnessed to deliver real environmental change.

But computing is not the solution in isolation; we need to work closely with other disciplines such as materials science, biology, economics and environmental science. Only by pulling together these areas of expertise can we hope to make a positive impact on our environment and the way we live.

It is the belief that we can help to save the planet and provide a sustainable future for the generations to come, that drives this new and exciting research at the University of Cambridge Computer Laboratory.

The research has four main goals and is focused on finding practical solutions to some of the major problems, from traffic congestion and pollution to more sustainable manufacturing and reduced power consumption.

- **2008** - One billion PCs in use by the end of 2008. (Forrester Research)
- **2007** - 2.3 billion mobile phone users world-wide. (Informa Telecoms and Media)
- **2000** - 400 million people worldwide are connected to the Internet.
- **1981** - "640K ought to be enough for anybody." (Bill Gates)
- **1977** - "There is no reason anyone would want a computer in their home." (Ken Olson, president, chairman and founder of Digital Equipment Corp.)
- **1953** - The first formal computer science course leading to a university qualification began at Cambridge University.
- **1949** - Computers in the future may weigh no more than 1.5 tons. (Popular Mechanics)
- **1949** - Maurice Wilkes and the staff of the Mathematical Laboratory at Cambridge University developed EDSAC, the first fully functional, stored-program electronic digital computer.
- **1937** - Alan M. Turing, of Cambridge University, England, publishes a paper on "computable numbers" which introduces the theoretical simplified computer known today as a Turing machine.

Optimal digital infrastructure

Our lives have become dependent on the digital world. But to sustain this appetite for technology, we need to make a major shift to more energy-efficient ways. For example, devices and systems only need to be powered when they are actually performing a function or doing something useful. They should be switched off — and not just on standby — at all other times.

At the Computer Laboratory we are investigating new computer systems architectures that precisely monitor energy consumption and can turn systems on and off rapidly. And with hardware increasingly becoming a disposable commodity, we are looking at better reuse and longer lasting components to mitigate the environmental impact of production and fabrication.

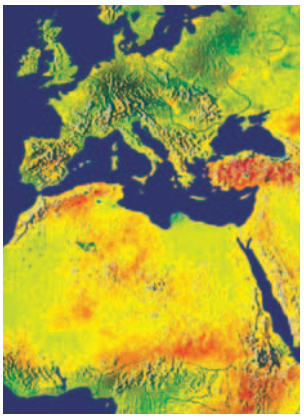
Predict & react

Using computing to make accurate predictions is an established science — from meteorology to economics. But working on such a large global scale with indeterminate multiple variables is by no means exact.

Increasingly powerful computers and algorithms are required to improve the precision and accuracy of forecasts on global warming and its effects. But more fundamental is the question of how we know if the models work. If we don't understand the problems; how can we fix them?

Even our most commonly used computing applications require frequent updates to deliver software that expresses the programmer's intent without bugs and vulnerabilities. Complex simulation applications simply multiply the risks and unknowns.

Our research is looking at ways to refine programming methodologies and processes to create models that are accurate, consistent and reliable.



Sense & optimise

Computing has a key role to play in optimising the use of resources in the physical world. One way this can be achieved is by actively sensing the environment in real time and using new algorithms to create cost functions which reflect natural resources in sectors ranging from transport to water management.

Innovative approaches to global-scale monitoring, generation of information and interpretation and analysis are needed to realise this goal, together with new technological and legislative frameworks. Our research embraces the use of sensors to provide information needed to better manage traffic flow, while maintaining the privacy of individuals.

Digital alternatives to physical activities

There has already been a major shift to the digital world in our daily lives at work and at home, reflected by the wide-scale adoption of electronic messaging, digital media and the web.

In the future there may be greater change so that the primary way we operate for the purposes of wealth creation and entertainment is in cyberspace.

This will reduce the impact of our activities on the physical world while allowing societies to grow sustainably. New tools, environments and infrastructures are being conceived that will make an accelerated shift to a digital world that is enticing, effective and rewarding for us all.

About the research team

Professor Andy Hopper

Andy Hopper is Professor of Computer Technology at the University of Cambridge and Head of the Computer Laboratory. Professor Hopper has pursued academic and industrial careers in parallel. He has worked in senior roles for multinational companies and also co-founded a dozen spin-outs and start-ups, two of which floated on stock markets. He is a Fellow of the Royal Academy of Engineering and of the Royal Society and was awarded a CBE for services to the computer industry in 2007.

Dr Andrew Rice

Andrew Rice is an Assistant Director of Research at the Computer Laboratory at the University of Cambridge. He has been developing the research agenda for Computing for the Future of the Planet since October 2006.
His interests lie in the construction of dependable computing infrastructure which acknowledges and responds to faults and in its application to efficient and reliable software systems.

Dr Alastair Beresford

Alastair Beresford is an Academic Fellow in the Computer Laboratory at the University of Cambridge. His research work explores how sensor networks and computer systems can be combined to monitor and control physical infrastructure. He is particularly interested in designs which preserve user privacy and maintain a high level of system performance.

Dr Robert Harle

Robert Harle is an Assistant Director of Research within the Computer Laboratory at the University of Cambridge. His interest in Computing for the Future of the Planet relates to novel sensor-based computing to dynamically optimise environments and to synchronise digital state with physical state to create compelling alternatives to physical travel.

About the University of Cambridge Computer Laboratory

The Computer Laboratory has been an international leader in computer science and technology for more than half a century. Its staff members have included two Turing Award winners, recipients of other international awards, Fellows of the Royal Society, the Royal Academy of Engineering, the British Academy and other academies and societies. Its students have become research leaders throughout the world and have established internationally successful businesses.