1977	1989	2000–2020	
es and	First modern PC –	Cloud Computing	**Emerging trends**
red Computers	Apple II	and the Smart Phone	**in the 21st century**
	The World Wide Web		

Emerging Trends in the 21st Century

Learning Outcomes addressed in this section are listed below.

1.11 discuss the complex relationship between computing technologies and society including issues of ethics

1.12 compare the positive and negative impacts of computing on culture and society

1.13 identify important computing developments that have taken place in the last 100 years and consider emerging trends that could shape future computing technologies

1977
First modern PC –
Apple II

1989
The World Wide Web

2000–2020
Cloud Computing
and the Smart Phone

Emerging trends
in the 21st century

es and
ed Computers

A Time Capsule Exercise

In the first term of 5th Year, students could use a Think Pair Share mechanism to predict trends and future technology. Their predictions and analysis of future trends could be recorded using the html demonstration file for CT Challenges in section 0 of Programming Concepts on the ncca website.

Re-visit in 6th year to see if students would review their predictions or if any predictions have already been realised.

Watch a video of 10 failed technologies and predictions to see how difficult it is to predict whether a technology will succeed or fade away! Review this 2017 video of top ten emerging technologies, including Boston Dynamics amazing robots. See the background behind the famous exoskeleton video from the Brazil 2014 soccer World Cup, as an inspiring example of future trends in adaptive technology. Since 2012, robotic arms can be programmed by technology that intercepts people's thoughts to perform actions. Watch this video of a DARPA funded project by a US applied physics department to revolutionise Human Computer Interaction using mind-controlled prosthetic limbs.

9 questions for future trends in the evolution of computers in society

Emerging technological trends are covered throughout the evolution of computers in society over the last 100 years. Some of those trends are greater movement towards cloud computing and cloud services (IaaS, SaaS, etc.) to the implications of the physical limitations reached by Moore's Law and hence a trend towards alternatives such as quantum computing. There will be further emergence of AI and ML technologies in areas such as automated professional, retail and caring services, self-driving automobiles, adaptive technology for a wider variety of human needs, and so forth.

SOME ETHICAL AND CULTURAL QUESTIONS

Further emerging technological trends can be investigated online.

Perhaps just as interesting is how emerging trends are influencing some important ethical and behavioural issues. Using a suitable teaching or facilitation methodology from A Summary of Teaching & Facilitation Methodologies, such as *Stimulate a Debate*, *Think-Pair-Share-Snowball*, or just a simple *Carousel Brainstorming* exercise, examine the following questions through the lens of emerging trends, ethics or the positive and negative impacts on society. (LO 1.1–1.18)

1977
First modern PC –
Apple II

1989
The World Wide Web

2000–2020
Cloud Computing
and the Smart Phone

**Emerging trends
in the 21st century**

es and
ed Computers

Some stimulus material and prompt questions are also suggested, and in some cases the teacher and students can brainstorm around their ideas on a question.

0.   Wolfram: Is human Intelligence is nothing more than sophisticated computation?

"Normally when we think of computers we imagine constructing machines or programs for specific purposes – to perform tasks we want. And certainly this is what Turing had in mind when he set up Turing machines, or discussed how 'intelligent machines' could be built.

Originally motivated by natural science, what I did was to explore the general universe of possible programs – starting with simple programs that one might set up at random, or by enumeration. And what I found – first in the context of cellular automata – was that even extremely simple underlying rules are capable of producing behaviour of in effect arbitrary complexity.

This led me to the general principle – the Principle of Computational Equivalence (Wolfram, 2002) – that implies that beyond some very low threshold, almost any set of rules or programs that one encounters, if it does not have trivial behaviour, it will behave in a way that is computationally as sophisticated as anything else. In other words, it does not take much to be able to do sophisticated computation."

 And the Wolfram concludes:

"But what of abstract intelligence? My conclusion is that there is nothing really to distinguish it from 'pure computation.'"

Wolfram, S. *Intelligence and the Computational Universe*.

At odds with Wolfram is leading neuroscientist Miguel Nicolelis. You can see one of his TED talks or look again at his exoskeleton work that has helped people walk again. He is of the view that "The brain is simply not computable. It cannot be simulated."[18]

1.   Jeremy Howard – AI will soon replace doctors. Can caring/people centred professions be replaced by AI?

Jeremy Howard was once head of the data science project company Kaggle. His current AI company is outperforming radiologists in the US. 🎥 Watch a snippet (10:30–19:49) of a TED talk featuring Howard from 2014. Teachers, Nurses, Doctors, Home Help, etc if they are replaced, what are the implications for health, education, working life, leisure.

---

18   O'Connell (2017) *To Be a Machine*. Granta Publications (p 56).

1977
First modern PC –
Apple II

1989
The World Wide Web

2000–2020
Cloud Computing
and the Smart Phone

es and
ed Computers

**Emerging trends
in the 21st century**

2. Obama – Could the information revolution be the first revolution where the number of jobs destroyed is greater than number of jobs created?

Is there validity in this statement. What are the reasons behind the validity of this statement? Or not! Reference examples. In 2017, all line judges were replaced with hawkeye in some professional tennis tournaments, with the umpire being the only human judge. Also SMART electricity meters are being installed in Ireland over the coming years. Will a human meter reader be thing of the past? Interestingly, before the invention of the electronic computer, the word computer originally referred to the human who did the number crunching and mathematics.

3. Can we handover responsibility for driving and flying to an algorithm, for killing to war drones, for medical analysis to AI, for care for the elderly to a robot?

The role of AI crossing over to traditionally human responsibilities. Are drones harmful or helpful, plus Asimov's 3 laws for robots. There are real limitations to computers and AI in figuring out the world we inhabit. "Humans are very good at insight and hunches. Computing is very good at doing the same thing over and over again." [19]

4. Are computers and Computing Technology designed for humans and for human interaction?

Explanations of HCI (Human Computer Interaction) When computing technology is designed for profit or for government use, where is the human on the priority list? Equally, to ensure HCI is about improvements for humans, there must be investment in it or money to be mad in some from?

5. What are the implications for humans if the human mind can be uploaded?

Mark O'Connell's 2017 book *To Be a Machine* raises some thoughts on this question… is the mind then a machine … is it you uploaded?… what will be the substrate for carrying the uploaded mind around? … can a human brain and its feeling and emotion be reduced to code? The operation of transistors within a computer system share many characteristics with the operation of neurons in the neural networks of our brains. Watch a TED talk on the ▪ art of neural networks.

6. If a robot can carry out the same function as a human, is the robot showing signs of intelligence?

If yes, then what is intelligence and what is consciousness…. If no then can robots/ machines/ AI ever get to stage where they show intelligence or demonstrate consciousness? … *"at least in principle, I see no reason why it would not lead to an artificial consciousness"* Consciousness and the Brain (Dehaene, 2014). ▪ Descartes believed in dualism, that the body and mind were two separate things. How would this apply to AI: is its "mind" separate to the processing power, the silicon or the algorithm?

---

19 White (2015) *How Computers Work* QUE (10th edition).

1977
First modern PC –
Apple II

1989
The World Wide Web

2000–2020
Cloud Computing
and the Smart Phone

es and
ed Computers

**Emerging trends
in the 21st century**

7. What are the positive and negative impacts of military innovations on both society and on technology?

A fully worked example of *Stimulate a Debate* on this question (in the Colossus and ENIAC section of the main resource) allows for this question to be explored in depth. The invention of electronic computers occurred during WWII in response to human computers' inability to decrypt messages with sufficient speed; drones for example can now drop bombs while being remotely piloted and they can also drop emergency goods and supplies in exactly the same way. Which technological innovations did not arise out of military innovations?

8. How much data, and the kinds of data, governments and giant multi-nationals should be allowed to keep on citizens and consumers?

A fully worked example of *Stimulate a Debate* on this question (in the World Wide Web section of the main resource) allows for this question to be explored in depth. Certain kinds of data are vital for governments to function in the interest of its citizens (PPSN, Tax payments, criminal records, etc.). But how much data is too much? Should health records be analysed by government AI to signal who is in danger of diabetes or obesity or dementia in an effort to reduce health care costs and spend taxpayer money more efficiently? Similar arguments apply to both giant hi-tech companies and smaller online companies that need some of your data to operate profitably, and in the consumer's interest. What are the responsibilities and rights of the citizen and consumer in this regard? Should there be a right to take back all of your data with no limitations?