CA115 Digital Innovation Management Enterprise

Lecture 4: Digitial Innovation #1 - Introduction

2022-01-17

Dr. Niall McMahon

These notes will be posted to Loop.

Invention and Innovation

- Inventors come up with new ideas.

- Invention is associated with creating *something* for the first time while innovation implies the practical implementation of new ideas that lead to new or improved goods or services.

- Innovation is mostly associated with commercialisation. New products, new manufacturing methods, new markets, new sources of supply or reorganisation of an industry.

- Innovation is also used to describe new movements in art and other areas of endeavour.

- The words *invention* and *innovation* are sometimes used interchangeably.

History of Innovation

Before the Industrial Revolution

- Stone Age - use of stone tools, from about 3.4 million years BCE to approx. 2000 years BCE with the advent of metalwork.

- Bronze Age - use of bronze (mostly copper and some tin), with some writing and urbanisation. From about 3000 years BCE to about 1000 years BCE.

- Iron Age - where iron and steel replaces bronze as a working metal. From about 1000 years BCE to about the year 1 CE/AD.

- Roman Empire (and others) with many political, social, military and technical innovations. The Romans constantly evolved advanced military structures and techniques, e.g. maniples, and innovated with aqueducts, roads and arches.

- Dark Ages and Medieval Times - after the Fall of Rome around 476 AD and before the Renaissance. Universities, water and wind mills, gothic architecture, farming techniques and cannons.

- Renaissance (1400 - 1600) - emergence from the medieval period. Revival of Greek thought. Innovators and thinkers such as Leonardo da Vinci and Copernicus. The printing press is invented by Gutenberg.

- Scientific Revolution (1543 - 1687). Copernicus, Galileo, Newton etc.

- Enlightenment (1715 - 1789). Descartes, following the Scientific Revolution. Ideas filtering into society.

History of Innovation

After the Industrial Revolution

- Industrial Revolution (1760 - 1840). Steam power, trains, factory automation.

- 20th century. Mass adoption of motor cars, aviation, computing, modern medicine.

- Space Age (1957+):

  - Computers. PC revolution (1970s+)

  - Internet and World Wide Web (1991+)

  - Technology boom (2000s+)

    - Pessimism about the impacts of technology (2010s)

    - Renewed positivity about technology (2020s)

  - Space, again (2020s+)

  - AI (2020s+)

  - Renewable Energy (2020s+)

- AI Singularity?

- Predicting the future is hard. Take most things that have happened in the past year as an example: a worldwide pandemic, democracy in real peril in the United States, unexpected losses for hedge funds invested in GameStop shares.

The Foreseeable Future

This was a book by from 1955 by [George Thomson](#), a physicist and nobel laureate. In it, he made some predictions:

- He successfully predicted video calls and the use of fiber optics, writing: "I believe there are some kinds of communication ... for which one really needs to have people actually together in the room, but they are the exception."
- He also predicted many other things, for example, travel to space.
- However, no mention at all of climate change.
- No mention of wind energy or solar energy as replacements for fossil fuels. Only nuclear.
- Predicting the future is hard. Thomson finishes his book with optimism and concludes that the future is not foreseeable.

How Innovation Changes the World

- Often slowly then quickly. See [diffusion of innovation](#).
- The speed of diffusion of innovation depends on the innovation itself, the adopters (people or organisations), how communication of the innovation happens and what's happening in society, i.e. what the other influences are.
    - In 2020/2021, the innovation in vaccine development was spurred on by an active pandemic.
    - During WW2, innovation was a race against time for the combatants.
- History is not a neat transition from one thing to another.
- Most innovations take some time to take hold. Some faster than others. Examples include:
    - Smartphones - reached almost every part of the world within a decade. Slowly at first, then rapidly.

Innovation Ecosystem

- Government often undertakes expensive, unprofitable innovation.

- In US, national laboratories and administrations, e.g. NASA, NREL, Los Alamos/Sandia build some of the fastest computers (for weapons simulation).

- University research, often in cooperation with government and industry.

- Large companies best placed to take risk on unprofitable enterprises.

- Start-ups have ideas and energy. Like shooting stars.

- This is an ecosystem.

University, Government, Industry Cycle

- In the US and Europe, there is an innovation cycle.

- In Silicon Valley, universities are close to industry and national laboratories.

  - The University of California, Berkeley is close by Lawrence Berkeley National Laboratory, in San Francisco.

  - Both are close to Silicon Valley.

- In Darmstadt, in Germany, the technical university has a close relationship with Merck.

- The universities produce students that go on to work, and move between, industry and government.

- Some leave to set up businesses.

- Ideas and talent are constantly moving between these institutions.

Innovation Doesn't Happen in Isolation

SpaceX

- Innovation since its inception has been remarkable, with many talented engineers.
- Reusable first stages of its orbital rockets, i.e. the Falcon 9 (2015).
- Much lower cost per launch.
- Starship development an example of rapid innovation.

Innovation Doesn't Happen in Isolation

On the Shoulders of Giants

- SpaceX's innovation would not be possible without the work of NACA/NASA.
- Visionaries such as Wernher von Braun.
- Decades of rocket and space technology development by NASA and large corporations, i.e. Boeing and Lockheed Martin.
- These companies themselves were originally technology start-ups over a hundred years ago.

Important Areas of Innovation

- Slowing climate change and improving our environment.
- Solving the energy crisis.
- Fixing the social experience of the internet.
- Understanding the impact of the rise of artificial intelligence.
- Space, exploration and its utilisation for a better world.

People

- Steve Jobs.

- Elon Musk.

- Greta Thunberg.

- [BioNTech](#) founders Uğur Şahin, Özlem Türeci and Christoph Hube.

Conclusion

This is an exciting time of renewed positivity about technology.

- It's a time of new discoveries.

- Significant investment in technology.

- Rapid adoption of new technology and ideas by consumers.

References

- [Ars Technica](#) is a good source of news about innovation.

- Watch [AlphaGo - The Movie](#) from [DeepMind](#).

- Read about the [Google story](#), starting in a garage in the late 90s.

- Read about [SpaceX](#) and [Tesla](#).

- Read about the American National Laboratories. See [NREL](#), the National Renewable Energy Laboratory, as an example.

- This is the vaccine maker from Germany, [BioNTech](#).

- The Foreseeable Future. Sir George Thomson. London, Cambridge University Press, 1955.

- [The Economist](#) newspaper has a good technology section.

- [Great human advances were made throughout the 'Dark Ages'](#). William Reville. The Irish Times, 2020.