9th World Engineering Education Forum, WEEF 2019

Disruptive technologies that are likely to shape future jobs

S.V.Nagaraj, [1]

Vellore Institute of Technology, Vandalur-Kelambakkam Road, Chennai 600127, India

Abstract

The motivation for this article is to understand future job requirements in the field of computer science and related fields. It is obvious that emerging technologies will necessitate new skills and roles. Technology powers the economy, allows businesses to prosper and creates jobs. In earlier years, the focus of the IT industry was primarily on programming. Strong programming skills are still needed but industries wish to select students skilled in technologies when they recruit them from institutions imparting engineering education. It is necessary to understand which disruptive technologies in fields related to computer science and engineering are going to shape future jobs.

Keywords: Disruptive technologies

1. Background

Disruptive technology is basically any completely new or enhanced technology that replaces and disrupts an existing technology. The disruptive technology could finally make the existing technology obsolete. Disruptive technologies often have a profound effect on the way businesses carry out their processes. The phrase *disruptive technology* is attributed to Clayton Christensen who introduced it in an article (see [7]). Further popularity for the phrase was through his book "The Innovator's Dilemma," published in the year 1997 [5]. According to Christensen, disruption occurs when a small firm without many resources, for example, a start-up is able to challenge large firmly established companies or is able to capture totally new markets. Disruptive businesses often target overlooked, unserviceable or underserved customer segments to secure industry presence. Over the years, many disruptive technologies have emerged and have had a profound impact on the world. The focus of this article is solely on disruptive technologies related to the field of computing science or closely related fields. Disruptive technologies occur in other branches of science or engineering but that is not looked at in this article. The phrases *disruptive*

[1]

* Corresponding author. Tel.: +91-44-3993 1553; fax: +91-44-3993 1555.
E-mail address: nagaraj.sv@vit.ac.in

technologies and *disruptive innovations* are not unrelated. The phrase *disruptive technologies* was first described in depth in the book [5] by Christensen; but emphasis was later changed by Christensen to *disruptive innovation* in a later book, "The Innovator's Solution" by him [6]. Christensen, feels that disruptive innovation is often widely misunderstood and has been applied to businesses that are not truly "genuinely disruptive". For example, Christensen in an article (see [3]) argues that the ride-hailing app of the ride-sharing company Uber is actually not a good example of real disruptive innovation. Many would perhaps disagree with Christensen because they may regard Uber, the firm enabling taxi hailing as being a great market disruptor because of its substantial effect on the taxi-cab industry.

Many modern disruptive technologies have origins in computing science. For example, the World Wide Web and the Internet have changed the ways people transact business or correspond or communicate with each other or exchange information. They have enabled live streaming of surgeries across continents and hastened and simplified purchase of train or flight tickets. Few people and perhaps none would have been able to predict the significant impact of the Internet on society. The Internet and the World Wide Web are basically computer networks. Email has rendered telegrams and postal communication almost obsolete. Instant messaging is often even faster than email messaging and it enables economical real-time communication which was unthinkable earlier. Smartphones have replaced dumb and unintelligent cell phones and other devices such as pagers and personal digital assistants. They have offered stiff competition to calculators, GPS devices, and handheld cameras and so on eliminating their need. Imagine the consequence of a current day smartphone that has the capability of a supercomputer of the year 1985.

Computing power has grown tremendously over the years. Computer memories such as RAM chips and hard disks now have much higher storage capacities than those of earlier years and are also much cheaper when capacities are compared with those of yesteryears. Cloud computing has been an extremely disruptive technology in the business world. Cloud computing offers many benefits to companies and organizations. These users can now use software online as and when they require, without the need for installing it or maintaining it, and without the need for purchasing it. Drones and unmanned aerial vehicles are now being used to deliver goods or parcels. They are also being used for surveying, in real estate business, and also for surveillance by the police or the armed forces. Self-driving autonomous vehicles including cars are becoming commonplace. Robots are becoming unglamorous and routine in manufacturing and in industries. They are even employed in restaurants. Many disruptive technologies have their origins in computing. Artificial intelligence which is a sub-discipline of computing science has been in existence for a long time; nevertheless, it is widely anticipated to many disruptions in the future. Augmented reality, virtual reality, and mixed reality are expected to have many applications in the future. 3D printing, block chains, and Internet of Things (IoT) are expected to have a significant importance in the future.

Disruptive technologies have a profound impact on the economy. It is apparent that technological development brings economic growth. Many of the developed economies of the world have benefitted significantly from technology in general and also from disruptive technologies in particular. For example, Japan is one of the top economies of the world, primarily, due to its use of robots in manufacturing. Imagine a telecom firm viz. Reliance Jio that has caused a digital tsunami in the Indian telecommunication sector. Imagine a firm (Jio) that caused a disruption by offering free voice calls and roaming, a suite of multimedia apps as well as very affordable data connectivity along with low-priced new 4G technology-based handsets. Imagine what would happen when incumbent operators are pushed to change their entire view, and cut atrociously excessively priced data and voice tariff in order to stay pertinent and compete with Jio.

There is little doubt that disruptive technologies are going to have a profound impact in the future. Many of these disruptive technologies are related to the field of computing science. It is not easy to predict future job requirements. However, it is amply clear that emerging disruptive technologies will necessitate the need for acquiring new skills. Engineers graduating from institutions imparting engineering education should possess skills related to technologies of the not so distant future. As mentioned in the abstract, previously, the focus of the IT industry was primarily on programming. Even today, strong programming skills are still needed; however, industries prefer students who have skills in technologies they use, for example, block chains. Hence, we see that the academic world has to keep track of disruptive technologies of the near future. They have to understand which disruptive technologies are going to

shape future jobs. This applies not just to computing science and engineering but also to other engineering disciplines. However, the focus in this article will be just on computing science and closely related disciplines. It can be safely inferred that educational institutions which do not update their curricula in line with emerging disruptive technologies are likely to become obsolete or irrelevant. The students who graduate from such academic institutions will unfortunately become unemployable.

2. Disruptive technologies related to computing science with potential to create future jobs

Here we look at various disruptive technologies related to computing science which have the potential to create jobs of the future. These include artificial intelligence, data science, cloud computing, nano computing, quantum computing, distributed ledger technology, edge computing, cognitive science, AR+VR+MR (augmented reality, virtual reality, mixed reality), 3D printing, drones, robotic process automation, cyber security, 5G technology, serverless computing, biometrics, financial technology (often abbreviated as fintech), exascale computing, memory technologies, computer/machine vision, optical computing, hybrid forensics, molecular robotics, unmanned vehicles, sensing city, privacy technologies, computer-assisted education, bioinformatics, wearables and blended reality, computing for development, data management and visualization, machine learning, molecular information systems, ubiquitous computing, self-driving car / autonomous vehicles technology, programming languages, embedded systems, medical informatics, computer hardware and so on. This list of emerging disruptive technologies related to computing science is by no means exhaustive or complete. It has been prepared by looking at the web pages of leading technology firms such as IBM, Microsoft, Facebook, Intel, Samsung, Apple, Google, Hitachi, and Oracle and others conducting research in many of the aforesaid disruptive technologies. These firms have a huge impact in the field of computing as judged by factors such as number of patents, revenue, and so on. Educational institutions have to introduce new programmes related to these emerging disruptive technologies in order to survive in the future. This will be applicable globally. There is not much doubt that the abovementioned disruptive technologies and others missed out in this article will drive businesses and industries in the near future. Businesses and industries will need manpower with skills in these technologies. Companies have to disrupt or perish in the highly competitive technology market.

3. Conclusion

It is not easy to predict which technologies are going to disrupt the future. However, an attempt has been made to find out which disruptive technologies will likely shape future jobs. The focus of this article has been limited to disruptive technologies related to computing science or closely related fields.

References

[1] https://www.weforum.org/agenda/2016/06/what-is-disruptive-innovation/

[2] https://www.forbes.com/sites/freddiedawson/2014/09/30/how-disruptive-is-3d-printing-really/#558daeab4e44

[3] https://hbr.org/2015/12/what-is-disruptive-innovation

[4] http://claytonchristensen.com/

[5] Clayton Christensen, (1997) The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard Business Review Press; 1st edition

[6] Christensen, Clayton (2003) The Innovator's Solution: Creating and Sustaining Successful Growth. Harvard Business School Press. (2003).

[7] Bower, Joseph L. & Christensen, Clayton M., (1995) Disruptive Technologies: Catching the Wave" Harvard Business Review, January–February, pp 43-53.