**Module1 - Critical Thinking Assignment: Technological Innovations**

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Its325: Artificial Intelligence

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Throughout history, technological innovations have been a catalyst for social changes by profoundly reshaping how we communicate, learn, work, and interact with the world. From the printing press, which democratized knowledge, to the telephone, which revolutionized communication, and the personal computer, which brought about the digital age. This essay explores how these technological innovations have impacted society, how the recent transformer architecture is reshaping AI, and consequently, society, more specifically education and the software engineering job market.

**The Printing Press**

The printing press was a technological innovation that brought knowledge in the form of books and newspapers to the masses. Before the invention of the printing press, in mid-15th century Europe, books and manuscripts were handwritten by scribes, usually catholic monks or clerics (Quocirca, 2024). This confined knowledge to the elite, nobility, and religious institutions as books were rare and very expensive. A printing press is a machine that transfers ink from a movable type (letter stamps) to a substrate, typically paper using pressure (Britannica, n.d.). Johannes Gutenberg, a German goldsmith started designing a machine capable of producing pages of text in 1436, by 1440 he had established the foundation of the printing press by using a mobile, reusable set of type (removable letters) using a traditional screw press design (Special Collection & Archive Research Center, n.d.). In 1454 the printing press was commercialized and started printing thousands of pages for the church.

In the following decades and centuries, the printing press had a considerable impact by spreading knowledge and information. It increased the number of books in circulation and consequently lowered their price, the printing press made printed material more available, leading to an increase in literacy and education (uCertify, 2025, Lesson 1.4). Additionally, by making knowledge and information more accessible, the printing press had a substantial social effect. It played a crucial role in the Protestant Reformation, Martin Luther's "95 Theses" and the following tracts were produced using the printing press allowing them to be rapidly and widely spread. Luther’s writings challenged the authority of the Catholic Church, and ‘between 1517 and 1520, more than 300,000 copies of Martin Luther’s publications were sold. In the next 50 years, the number of religious tracts produced by Protestant reformers would outnumber those of their Catholic opponents by a factor of 10 to 1” (uCertify, 2025, Lesson 1.4.3). This ultimately led to a shift in the religious, social, and political landscape in Europe, by weakening the Catholic Church's political and social influence and contributing to the rise of Protestantism. Furthermore, the printing press in the mid-15th and 16th centuries contributed to the emergence of newspapers which made information rapidly and widely available, and it also provided an important new way for almost all private citizens to get their points of view heard. This influenced the emergence of democratic ideals in the 17th and 18th centuries.

**The Telephone**

Another technology that had a significant impact on society is telecommunications, more specifically the telephone. It is one of the most transformative inventions in history. The telephone began as a rudimentary device capable of transmitting sound over short distances, and now we carry it with us everywhere we go, we watch videos on it, and we use it to talk to family members living overseas. Alexander Graham invented the telephone in 1876. The first phones could only connect through an analog direct line between two phones (Jurado-Gutiérrez, 2024. Since then, telephones have evolved from static, immobile analog phones, accessible only to the wealthy elite, to ubiquitous mobile digital smartphones carried by nearly everyone, from young children to grandparents.

Over the years, as telecommunication technology has advanced, the phone has had an immense impact on society. Once it became readily available, rotary telephones helped family members, friends, and coworkers to stay connected and communicate more effectively. However, with the emergence of the mobile phone and soon after the smartphone, it has brought social media, global communication, and a constant flow of information, turning some of us into digital addicts. A study at San Fransico State University showed that the overuse of smartphones is just like any other type of substance abuse, leading to increased loneliness, anxiety, and depression (Owens Viani, 2018).

**The Personal Computer**

It can be argued that smartphones are a type of Personal Computer (PC). The invention of the PC was a turning point in human history. It profoundly transforms society; from the way we work to the way we live our everyday lives. In 1971 the microprocessor was invented by Intel’s Ted Hoff, Federico Faggin, and Stanley Mazor marking the beginning of a computing revolution (Echelon, n.d.). The microprocessor's small size allowed it to be integrated as a Central Processing Unit (CPU) into small and more affordable computer systems paving the way for the PC and smartphone inventions. In 1980, IBM began developing its first PC, and it released it in 1981 with the MS-DOS (Microsoft Disk Operating System) operating system specifically designed by Microsoft for the IBM PC (Advice Scout, 2025). The PC has evolved, largely following Moore's Law, which says that the processing power of computers roughly doubles every two years. Over the years from being mostly used for word processing, the PC has found new functionalities and taken many forms, becoming mobile in the form of tablets, smartphones, notebooks, and laptops and having specialized functions such as gaming PCs and workstations.

The PC can be defined as a multi-purpose computing device designed for individual use that is capable of performing many tasks such as word processing, internet browsing, gaming, and multimedia (Fiveable, n.d.). These capabilities had a significant impact on society. In education, they introduced interactive learning, online education, and computer literacy, increasing the overall quality of education by providing students with greater access to information and knowledge. In business, the PC revolutionized how most businesses function by increasing employee efficiency, improving communication and data management, and boosting productivity, transforming how businesses are structured and managed (Zaretsky, 1998). At home, the PC provided individuals with more freedom and entertainment, allowing them to pursue personal hobbies and interests, access personalized information, educational resources, and creative tools, as well as access to affordable entertainment through streaming services, video gaming, and digital books. However, the PC has also introduced cybersecurity risks, addiction to video games, addiction to social media, and readily available misinformation, leading to societal problems such as privacy loss, mental health issues, and political polarization.

**The Transformer Model**

In the Artificial Intelligence (AI) field, the transformer model also referred to as the transformer architecture is a type of Machine Learning (ML) model, practically used in Natural Language Processing (NLP) (Swimm Team, n.d.). It is a recent technology that was introduced in 1917 by the now-famous research paper “Attention Is All You Need” (Vaswani et al., 2017) from Google Brain. The model is categorized by its attention mechanisms and parallel processing abilities. The attention mechanism is an ML technique where Deep Learning (DL) models ‘attend’ to prioritize the most relevant parts of input data (Bergmann & Stryker, 2025). The transformer architecture was at the core of the breakthrough of the Large Language Language (LLM) ChatGPT by OpenAI, released in November 2022. This release introduced AI to the masses and fundamentally transformed the AI field by laying the groundwork for subsequent breakthroughs in the Large Language Models, generative AI, and more recently Large Reasoning models such as o3 by OpenAI and Deepseek-R1.

The transformer architecture sparked what is referred to by some as the AI Revolution or the AI era. As of early 2025, Large Reasoning models such as o1, DeepSeek R1, and o3, have expert or PhD level capability in mathematics, physics, coding, and other STEM fields (Ricciardi, 2025). Other AI models evolved into generative models capable of generating realistic images, videos, voices, and music. The impacts of these innovations are predicted to be fundamentally transformative, affecting every layer of society. One of these fields is education, where AI can bring individual learning to students, personalizing education and making it more accessible and fairer. An AI tutor-based education has the potential to resolve the biases and inequities that are associated with standardized education by catering to the individual needs of each student, allowing them to learn and progress at their own pace. AI can analyze student data, such as test scores and learning patterns, helping it to identify areas where a particular student needs improvement and support, and then provide targeted resources and feedback (Coggin, n.d.). AI tutoring tools are all already available Table 1 lists some of these tools.

**Table 1**

Examples of AI-Tutoring Tools

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| --- | --- |
| AI Tool | Description |
| Adaptive Learning Platforms | Used to analyze student data and provide personalized learning feedback on pathways. |
| Intelligent Tutoring Systems | Provides guidance and support to students, by giving personalized feedback and assistance. |
| Choice Texts | Students can create custom reading passages and questions based on their own choices and interests. |
| DreamBox and Smart Sparrow | Analyze student responses in real-time to adapt lessons to the student in real-time. |
| Carnegie Learning's MATHia | Provides feedback and support, adapting to individual learning styles and needs. |
| Duolingo | Uses a form of adaptive algorithms to provide a personalize foreign language learning education that caters to each student's learning paced and level. |

*Note*: The table provides a list of several available AI-Tutoring tools and their descriptions. From several sources (Stefanic, n.d.; University of San Diego Online, n.d., Hoang et al., 2024).

The emergence of AI, powered by or influenced by transformer architecture, may have a beneficial impact on education. However, it is also predicted to have a transformative impact on the job market, with the potential of reducing the availability of certain types of jobs and displacing workers, partly knowledge workers as AI systems are predicted to be more efficient and cost-effective than their human counterparts. One field that is predicted to be significantly affected by AI is software engineering. Open AI CEO Sam Altman in a Q/A session at the University of Tokyo (UTokyo) revealed that one of their Large Reasoning models ranks as the 50th best coder in the world, and by the end of 2025, the model will potentially rank 1st (UTokyo Center for Global Education, 2025). This has an immense impact on the software engineering field, as AI can now produce functional code in seconds, often of better quality than expert coders (Ricciardi, 2025). As these new AI models are released and since most junior software engineering positions focus on coding rather than software design, the future for these roles seems uncertain, even if software companies remain very successful. For example, the CEO of Salesforce, a major SaaS company, announced that this year, 2025, Salesforce will not be hiring any more new software engineers amid significant productivity boosts from AI (Martin, 2024).

**Conclusion**

From the printing press, the telephone, the personal computer, and now, transformer-based AI technological advancements have been the catalysts for societal transformation, with each innovation bringing profound changes to how we access information, communicate, learn, and work. While offering immense potential benefits, particularly in education, these latest AI technologies also present challenges, having the potential to influence negatively the knowledge workers' job market in fields like software engineering. Ultimately, it is up to humanity to ensure that the latest innovations in AI have a positive impact on society, as most previous technological innovations generally have.

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