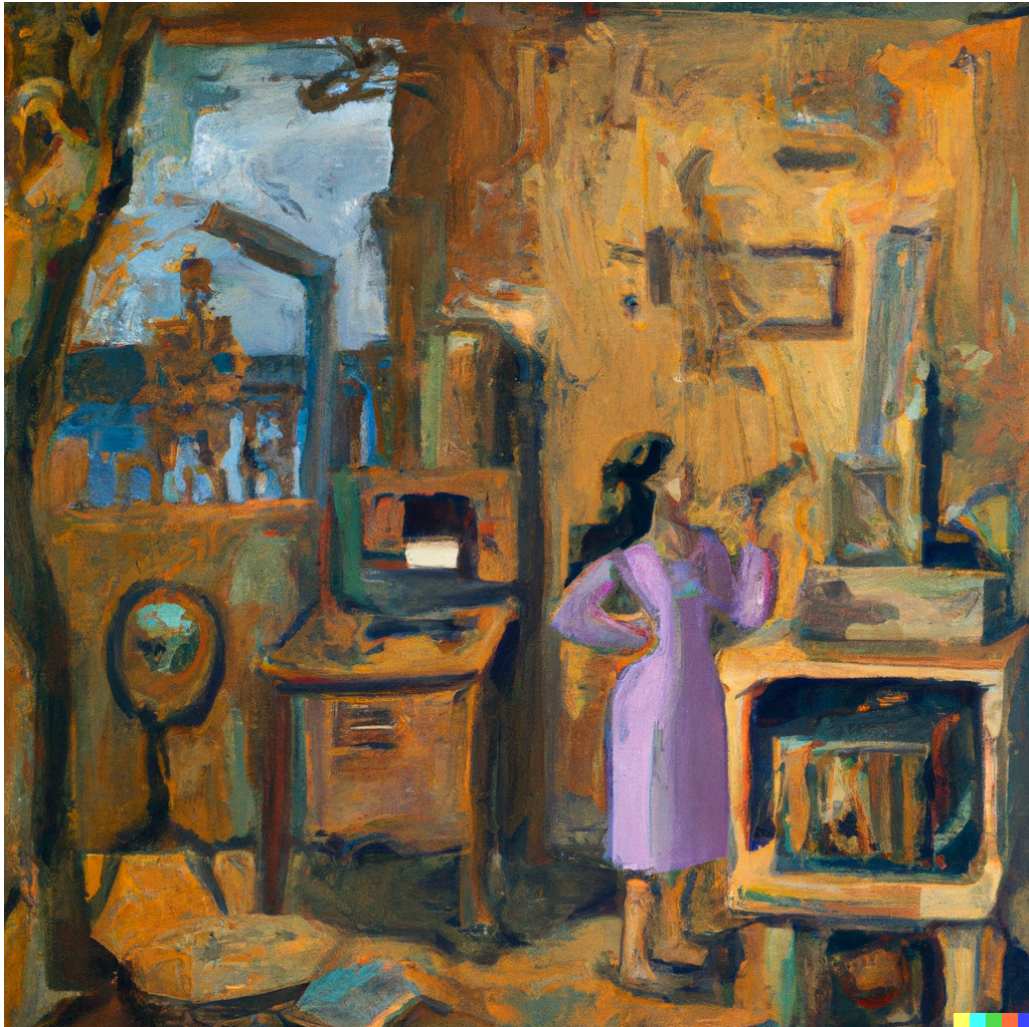


## From Metal To Megabytes : The Three Most Important Inventions In Human History (The Telegraph)



*Dall-E, an oil painting of human history depicting a furnace, microscope and computer*

For the roughly 200,000 years humanity as we know it has existed on this planet, it has been conquering new frontiers on the daily, its scientific and technological advancement progressing at lightning speed. From when our ancestors learnt to make fire and used it to colonise every part of the globe, to our own times, as physicists experiment with the fundamental molecules of creation. Human innovation is growing at an exponential rate, and the future holds tremendous potential. However, we must be mindful of the implications of these advances. Experimentation without thought of consequence is often much more dangerous than faulty experimentation, and considering the fragile nature of our planet's biosphere, and of many of our own societies, we must pause to think of the consequences of our actions. In the words of Jeff Goldblum's Ian Malcolm, "Scientists are actually preoccupied with accomplishment, so they are focused on whether they can do something. They never stop to ask if they should do something."

When we look back at our rich history of discovery, we often see similar situations, with some innovations leading to both massively beneficial yet deadly outcomes. Those who do not learn from the past are doomed to repeat it, and with that in mind, we shall explore the three most important scientific discoveries of our times, examining their rationale, impact and implications for the future (i.e. our own time).

We live in a world dominated by a singularity, one that controls the opening of dams, the money in banks and the direction of guided missiles. Two digits practically run our societies, everything from supermarkets to toasters guided by 1s and 0s. Computers are now a necessity in the modern world, and continue to develop at an astronomical pace. Social media, a byproduct of the Internet, has allowed billions of people from across the globe to share information, connect and form communities on scale never before seen, fostering global cooperation. Initiatives such as YouTuber Mr. Beast's Team Trees and Team Seas have seen support from hundreds of thousands of people around the world, while figures such as Greta Thunberg have used the internet to promote climate activism, increasing global awareness on the severity of the crisis we continue to face. They are now capable of creating art, such as the image above. In the realm of science, almost all mainstream research is now aided by computers, with even the Large Hadron Collider, a chamber that can reveal the inner secrets of the universe being operated digitally. It isn't all rainbows and lollipops however. Social media is a tool often used by the corporations who run it to perform quasi-social engineering through the algorithms that feed its users new information to keep them active. The totalitarian hellscape of Orwell's *1984* is almost a reality today, with massive volumes of personal data being owned and sold by social media giants everyday to advertisers. You might not want someone knowing what your dog's name is, but with enough money it can be bought from Facebook. While the internet facilitates cooperation, it also allows misinformation to be dispersed effortlessly, furthering political radicalisation and bigotry worldwide. Job automation has resulted in mass layoffs and increased unemployment, and shows us the ever-present need to exercise democratic control over this powerful tool. Computers are here to stay, and we cannot imagine a non-apocalyptic future without them. Modern living is essentially defined by digitalisation, and will continue to be for quite some time.

What makes us sick ? Most of us would say that microbes do, bacteria, viruses and sometimes even protoctists. However, a few generations ago, that would not have been the most common answer. Indeed, even among eminent scientists, the idea that microscopic beings cause disease was laughed at. Where were these beings, and what was the proof that they existed ? This is where the microscope came in. Despite being invented and used extensively centuries prior, it was still a tool that had not yet been used to its full potential, and it was crucial in discovering the existence of microorganisms. The microscope allows us to see a world previously unimaginable, allowing us to fully identify creatures that we would have never thought existed. More importantly, it allowed us to finally conduct research into the cells that made up our own bodies, opening up a new avenue of treatments for the diseases that we have ailed from for millennia. Without it, the fields of cell biology, microbiology and genetics would be non-existent, and modern medicine would not exist in its current form. From the humble light microscope, came a slew of discoveries, ranging from the existence of bacteria to that of the cell. The cell is the most basic unit of an organism, and a failure to recognise its existence would be a grand folly in medicine and biology at large.

Almost all modern antibiotics work on a cellular level, killing bacteria that have been identified and cultured initially using microscopes. Cancer and its tumours are but rampaging rogue cells, while dying cells such as in a liver with cirrhosis cause disease. The code of life – DNA – would also not be discovered without the invention of the more sophisticated

electron microscope, meaning that genetic disorders wouldn't be able to be identified and beneficial genetic engineering (such as that producing bacteria that secrete insulin) would not take place. In simple terms, the field of medicine and biology would be unrecognisable if not for the invention of this simple tool. Not all of these advances have led to benefits, however. Biological weapons are synthesised using the same methods of genetic and cellular engineering, and threaten to wipe out humanity if given half a chance. Genetically modified crops continue to face scrutiny over fears of adverse effects on health and the environment, as well as the power they give to their manufacturers (Corporations like Monsanto) over ordinary farmers. Genetic engineering, particularly in the context of CRISPR and its ability to create babies with chosen traits, also threatens to increase the gap between the wealthy and the poor, making clear the need for public, democratic control of these technologies which, in the right hands, can improve all of humanity and end world hunger.

Between the processes that led to the modern age, and the lives of our stone age predecessors, lies a single step - the discovery of metal and its use using furnaces. The furnace is one of the few contraptions that has played a major role throughout human history. Save for the few hunter gatherer societies still in existence, almost every society has a tradition of metalworking, from the Bronze Age to the current Digital Age. At its core, the furnace represents the most raw instinct of man : to extract resources from his environment. Whether in the early Bronze and Iron Ages, where it was limited and restricted to the wealthy, to the Industrial Revolution and its near-exponential rate of production, the use of metal has been a constant. Indeed, our societies began to be organised by it, such as the development of steel and mining towns in the Industrial Revolution and the building of the economy around heavy industry that produced the refined minerals used in every facet of life. The furnace kickstarted human development, and continues to shape the dynamics of our society. Our material conditions are shaped by the use and development of new technology, and this in turn shapes our society. With the continued extraction of resources from an area, we had more reason to settle down and form communities, trading with the rarer minerals we dug up from the ground. We formed kingdoms and territories and traded with each other, using goods made from melted-down rocks and often paying in the same. We used the same metal to build machines for factories and industry in the Industrial Revolution, skyrocketing production and clearing the way for the new capitalist system of production. Some humans invaded and occupied others, plundering minerals from their land to send back to their factories and fashion them into goods using metal machines. They enforced this control with weapons made of metal, transporting troops in metal containers across the globe, eventually fighting each other in wars using their planes, ships, tanks and guns. The use of this metal has lifted people up out of misery and into modern comfort, while also being used to kill millions and subjugate billions by those wishing to enrich themselves. The story of metal extraction is the story of humanity, and it is a story with no protagonist. Our societies are driven by technological development, and what development exists without metal ? Try as we might, we cannot do anything but subsist off of the extraction of mineral wealth from the earth. From the Congo to Papua New Guinea, from Peru to South Africa, the world depends on metal, and how else to procure it but with the mighty furnace ?

From agriculture to assault rifles, human history is the history of innovation, and nothing else has shaped our world more than these three contraptions.

**Word Count : 1510**