

# Something stronger than magic – engineering

## Science and technology as generators for instruments of influence

Breakthroughs in the field of technology bring about disruptive changes in economic and military activities. The processes are a poorly understood and underappreciated corner of our understanding of reality. One of the books on the list of those that formed my perception of the world is Julius Verne's *The Mysterious Island*. On the ten-year-old kid that I was when I read it for the first time, it had an electrifying effect.

It was a story of castaways thrown by the force of a hurricane and the author's intentions on a faraway island. It showed to me what a powerful tool human knowledge and its practical application are. They provide the ability to apply the understanding of the laws of nature to shape the living environment, to create conditions for survival. Engineering knowledge can make helpless castaways, thrown by fate toward their doom, turn into masters of their own fate.

Engineering, harnessed to transform natural environment, was the force that generated the founding act of great agricultural civilizations. It was the irrigation systems that allowed the civilization of Sumer to rise. The regulation of the Yellow River “unlocked” phenomenally fertile soils for full use by China's fledgling agricultural civilization, previously plagued by floods. In ancient China, the digging of the Zheng Guo Canal through the infertile semi-deserts allowed the Qin state to develop this territory. Thus created farmlands in turn allowed for the expansion of economic, then military power of Qin state.<sup>1</sup> With the new economic and military might, Qin was able to conquer the entire Chinese world of the time.

The invention and subsequent improvements to the steam engine was one of the main sparks that kick-started the industrial revolution. The exponential progress produced by the events was made possible by the phenomenally rich coal deposits, previously “blocked” by the problem of groundwater flooding the mine shafts.

Along with the inventive power generated by capitalism and entrepreneurship, another key factor generating wealth for nations and synergies of progress, it is this impulse in the form of the need for innovation (lowering the cost of energy and labor) was what China lacked to initiate its own industrial revolution in 17<sup>th</sup> century, long before the English one. So argues Ian Morris in his phenomenally inspiring book *Why the West rules – for now*.

The steam engine brought to the stage yet another invention, the railroad. Rail transport radically reconfigured the geopolitical map of the world, and the map of strategic flows of power

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<sup>1</sup> The undertaking of this project is captured in a hilarious historical anecdote. A Qin ruler was instigated to build a canal by an agent of influence of a hostile neighbor. The initiators calculated that the victim of the manipulation would squander resources on a pointless ditching.

and wealth in particular. Railroads enabled the British Empire to bring the modern war to the Sudan. For two years, a railroad line was assiduously built to the heart of the Mahdist resistance. The unruly natives were defeated at the Battle of Omdurman on September 2, 1898. A war correspondent named Winston Churchill, who was reporting on the event, called it a "clockwork campaign."

The railroad enabled Germany and Russia, among others, to build a network of strategic economic exchanges without access to maritime trade routes, dominated by European states adjacent to the Atlantic. Railroads were an essential component of building Germany's economic power in the 19th and 20th centuries. Another part of that power was the technology to produce synthetic nitrates to replace those imported from Chile.<sup>2</sup> Securing the supply of this critical raw material, also needed for fertilizer production and therefore food production, was the fundamental factor in Germany's imperial aspirations, locked in the land mass of Europe. The engineering synergy allowed Germany to continue its war effort despite the British naval blockade.

The power of engineering also included two synthetic gasoline production technologies developed in Germany just before World War I.<sup>3</sup> They defined the course of the conflict, in fascinating ways, a generation later. The Germans, lacking their own oil resources, designed less safe tanks powered by gasoline that they were able to produce from coal. And even with this accomplishment, their expansion strategy, especially the decision to attack on the USSR in 1941, was determined by the need for oil.

The overwhelming power of engineering is the end product of complex scientific, social, political, and ideological machinery. At times it is able to create a pool of people and equip them with the mentality, motivation and capital to unleash the phenomenon of *civilizational synergy*. Such people can invent, build and then maintain in a state of proper functioning machinery and objects a thousand times more complicated than the cigarette lighter picked from a table at a return party by the castaway played by Tom Hanks in *Cast Away: Beyond World* (2000, directed by Robert Zemeckis). This humorous cinematic scene, though inconspicuous, in a way unintended by the filmmakers, has power to supersede this entire essay.

During editorial consultation, Col. Roman Lewandowski formulated his vision of what engineering is like this way:

An engineer, looking at a particular need or job to do, thinks with the tool of "construction-focused patterns" developed in his mind. He makes a projection by means of the "engineering intellect" – a process of transformation from the level of the identified need to the generation, through known technologies, of a device capable of satisfying the initial need in a less labor-intensive, more efficient manner.

Such a device incorporates elements of a work process which ensure that the need is met, coupled to a system of mechanical, electrical, pneumatic, hydraulic, etc. assemblies.

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2 Richard J. Sundberg, *The Chemical Century: Molecular Manipulation and Its Impact on the 20th Century*, Palm Bay 2018.

3 Fisher-Tropsch synthesis involving the gasification of coal or natural gas and the coal hydrogenation technology for which Friedrich Bergius won the Nobel Prize in 1931.

The idea that instead of mowing grain with a scythe or sickle you can do it more efficiently by placing a “cutting tool” on a platform pulled by a horse-drawn platform, is information about a new engineering achievement and constitutes a contribution to that area of engineering which is responsible for the rate, quantity and effectiveness of impact on the situation.

Engineering is an instrument of collective achievement of goals. And the education process of an engineer is a very complicated one. It requires not only a teaching staff, but also the appropriate mental traditions of the state or nation from which candidates for engineers are recruited. The reservoir, from which the recruitment is made must manifest an appropriate level of, among other parameters, technical culture and work culture.

The process of shaping the "phenomenon" called engineering should enable the formation of a proper work ethos and conditions so that human nature, economic factors and regulations do not lead to pathological effects. The complex process of building a human resource capable of creating and keeping alive some technology is an eminently difficult art. It is very easy to bring such an enterprise to ruin or intentionally disrupt or destroy someone’s final work. Nor is it an optimal state achieved once and for all. Centers of innovation such as the Silicon Valley is to civilization as consciousness for a single human being.

We could see an instance of the degradation of the engineering world in its full glory in 2019 in the case of design flaws in the Boeing 737 MAX aircraft. Among other things, we learned from leaks that “the plane was designed by clowns managed by monkeys.”<sup>4</sup> The design flaws that led to the grounding of this aircraft type are downright obvious, even to a layman. Among the most important defects is a MCAS system, which the pilots were not informed of, that activated according to the measurement from only one angle of attack sensor, even though the standard expectation is that the readings of two sensors should match to initiate a corrective action.<sup>5</sup>

However, the knowledge about key design flaws did not penetrate public consciousness. Experienced pilot Paul Spencer points out that the pilots of the second flight, which ended in disaster in 2019, guessed the cause of the anomaly and turned off the machine's electrical trim system. Unfortunately, another flaw, requiring a redesign of the entire aircraft structure, made it impossible to manually restore the correct flight parameters. And re-activating the electric assist system defeated the purpose because the button activated the MCAS trim correction system, and the subsystem, stupefied by the erroneous reading of the only sensor, immediately put the aircraft back into dive.<sup>6</sup>

This volume is about war and competition for resources, so I will state one thing as a conclusion to the argument. The engineer and the socio-educational mechanism producing him is the key

4 Full statement from one Boeing employee: "This plane is designed by clowns, supervised in turn by monkeys." Another employee: "I'll be shocked if the FAA (Federal Aviation Administration) lets this piece of excrement pass." A third, when asked if he would entrust his family to the machine, answered succinctly: "no." Another Boeing employee bragged that he had managed to fool FAA employees, referred to as "morons," into thinking the goal was to make a decision favorable to Boeing. <https://www.bloomberg.com/opinion/articles/2020-01-10/-designed-by-clowns-and-supervised-by-monkeys-the-737-max-story> [accessed 2022.01.15].

The essence of the problem stems from the fact that decisions are made by accountants and analysts. The former stick to the decisions of people who calculate risks without even picking up a screwdriver.

5 In secure systems, three sensors are designed because if you only have two readings, you don't know which one is giving the wrong indication, so you don't know which one to switch to. The design solution is triple modular redundancy, in which a so-called vote selector decides whether a reading is correct.

6 Death Plane! The Secrets of the Boeing 737 MAX with Paul Spencer, <https://youtu.be/9OzFlqHikUc> [accessed 2022.01.15].

resource of any state. It must therefore be, and is, in one way or another, the focus, the main resource over which there is competition-- between companies and between states. Paraphrasing a clever adage, we can say “it takes a civilization [to rise an Einstein].”<sup>7</sup>

The above brief impression might not have appeared in this volume at all, were it not for the ubiquitous influence of the mother lode of inspiration – science fiction genre. At the beginning of the film *Alita: Battle Angel* (2019, directed by Robert Rodríguez), the protagonist, upon seeing a massive aerial city levitating majestically among the clouds, asks: “What keeps it up? Magic?” “No,” comes the reply. “Something more powerful. Engineering.”

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7 The original is “it takes a viillage [to raise a child]”, implying that it is a collective effort of an entire tribe to raise its new productive member.