Transhumanism –
Viable vision or just a deus ex machina concept?

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How realistic are the utopias and dystopias on the topic of "human enhancement" from a STEM perspective?

Figure 1: Transhumanism symbol. Source: Antonu. In: Wikipedia: Transhumanism. https://en.wikipedia.org/wiki/Transhumanism, accessed: Dec. 17, 2024.

> "Up till now human life has generally been, as Hobbes described it, 'nasty, brutish and short'; the great majority of human beings (if they have not already died young) have been afflicted with misery… we can justifiably hold the belief that these lands of possibility exist, and that the present limitations and miserable frustrations of our existence could be in large measure surmounted… The human species can, if it wishes, transcend itself – not just sporadically, an individual here in one way, an individual there in another way, but in its entirety, as humanity."[1]

[1] Huxley, Julian: Transhumanism. In: *New Bottles For New Wine*, London: Chatto & Windus, 1957, pp. 13-17. https://archive.org/details/NewBottlesForNewWine/page/n15/mode/2up, accessed Dec. 16, 2024.

The transhumanism vision…

According to Wikipedia,

> "***Transhumanism* is a philosophical and intellectual movement that advocates the enhancement of the human condition** by developing and making widely available new and future technologies that can greatly enhance longevity, cognition, and well-being" and

> "**Transhumanist thinkers study the potential benefits and dangers of emerging technologies that could overcome fundamental human limitations**, as well as the ethics of using such technologies. Some transhumanists speculate that human beings may eventually be able to transform themselves into beings of such vastly greater abilities as to merit the label of posthuman beings."[2]

As stated in the introduction, the concept of transhumanism is not brand new, but dates back to the year 1957, when biologist Julian Huxley popularised the term "*transhumanism*" in an essay.[3] **The idea of becoming immortal, staying young forever and increasing one's power and intellect to (demi-)god-like levels, however, is much older and goes way back in human history**.

Such visions may have been expressed as early as in the *Epic of Gilgamesh*, which had been written in approx. 2100-1200 BC.[4] Later on, such ideas surfaced in the writings of influential philosophers such as Aristotle, René Descartes and Friedrich Nietzsche as well as famous authors such as Dante Alighieri or Mary Shelley, and they became a mainstream theme in the 20th century due to the rise of the science fiction and fantasy genre.

… and the science fiction and fantasy genre

Today's film industry has largely embraced the science fiction and fantasy genre. This should come as no big surprise, if we bear in mind that ***Star Wars*, *Avatar* and Marvel's superhero movies, such as *Iron Man*, make**

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2 Wikipedia: Transhumanism. https://en.wikipedia.org/wiki/Transhumanism, accessed Dec. 17, 2024; emphasis added by the author.

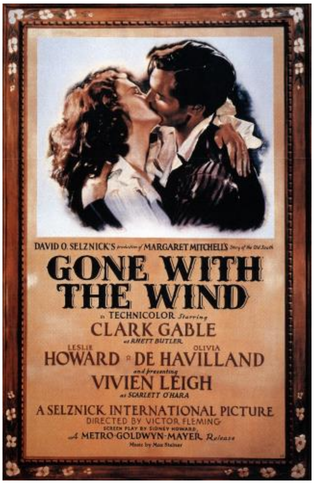
3 Huxley, Julian: Transhumanism.

4 Sin-leqi-unninni: *Epopeia de Gilgámesh*. Belo Horizonte: Autêntica Editora, 2017. https://books.google.at/books?id=OolDDwAAQBAJ&redir_esc=y, accessed Dec. 17, 2024.

up the best cash cows in the cinematic sector. Seven out of the top ten Top Lifetime Grosses[5] are science fiction movies, with the top three being:

1. ***Avatar***, released in 2009, lifetime gross: $ 2,923,706,026
2. ***Avengers: Endgame***, released in 2019, lifetime gross: $ 2,799,439,100 and
3. ***Avatar: The Way of Water***, released in 2022, lifetime gross: $ 2,320,250,281

Even on the list of the highest-grossing films of all time,[6] five of the top-ten movies are connected to the science fiction genre (in a red box), and it is likely only a matter of time until *Avatar* obtains first place on this list as well.



Rank	Title	Worldwide gross (2023 $)	Year
1	Gone with the Wind	[GW]$4,341,000,000	1939
2	Avatar	[A1]$3,957,000,000	2009
3	Titanic	[T]$3,677,000,000	1997
4	Star Wars	$3,563,000,000	1977
5	Avengers: Endgame	[AE]$3,275,000,000	2019
6	The Sound of Music	$2,984,000,000	1965
7	E.T. the Extra-Terrestrial	[ET]$2,917,000,000	1982
8	The Ten Commandments	$2,758,000,000	1956
9	Doctor Zhivago	$2,615,000,000	1965
10	Star Wars: The Force Awakens	[TFA]$2,577,000,000	2015

Figure 1: Poster of the movie "Gone with the Wind", the leader on the list of highest-grossing films of all time, as of 2022 adjusted for inflation. Source: Wikipedia.[7]

[5] IMDbPro: Top Lifetime Grosses. Box Office Mojo, https://www.boxofficemojo.com/chart/top_lifetime_gross/?area=XWW, accessed Dec. 17, 2024.

[6] As of 2022 and adjusted for inflation, see Wikipedia: List of highest-grossing films. https://en.wikipedia.org/wiki/List_of_highest-grossing_films#endnote_GWTW, accessed Dec. 17, 2024.

[7] Wikipedia: List of highest-grossing films. 2024. https://en.wikipedia.org/wiki/List_of_highest-grossing_films#endnote_GWTW, accessed Dec. 17, 2024.

Whether it is the movie *Star Wars*, *Limitless* or *Iron Man*, *The Witcher (Geralt of Rivia)* or the satirical superhero television series *The Boys*, one commonality in all of their plots is the concept of human enhancement. **The protagonists feature faster reaction rates (*Star Wars, The Witcher*), rely on higher power levels (*Iron Man, The Boys*), succeed due to enhanced consciousness (*Limitless*) or overcome their foes because of their improved regeneration (*Deadpool, Wolverine*).**

One element often discussed in conjunction with superhero powers are the ethical limits and/or responsibilities involved. "*With great power comes great responsibility*" has become a famous proverb that also touches upon this. Popularised by Stan Lee's Spider-Man, the underlying idea dates back to the parable of the *Sword of Damocles* or the French expression "*La noblesse oblige*" and emerged in several books and stories in previous centuries. In essence, the proverb states that "**power cannot simply be enjoyed for its privileges alone but necessarily makes its holders morally responsible both for what they choose to do with it and for what they fail to do with it**."[8]

Obviously not everyone will live up to this moral code. A protagonist for such a "fallen warrior" is Khan, Captain Kirk's adversary in *Star Trek II*. Khan is the perfect warrior who, thanks to genetic engineering, is stronger, smarter and faster but also much more unscrupulous than Captain Kirk and others. In the end, he comes into direct conflict with Kirk and Spock and although he is stronger, he loses against Spock. **Albeit very unscrupulous in his appearance, Khan represents more of a grey than a purely black figure and one might ask oneself whether he has always been like that or has been turned into this cold-blooded being because of the genetic engineering that he had to endure.** (Figure 2).

[8] Wikipedia: With great power comes great responsibility. https://en.wikipedia.org/wiki/With_great_power_comes_great_responsibility, accessed Dec. 17, 2024.

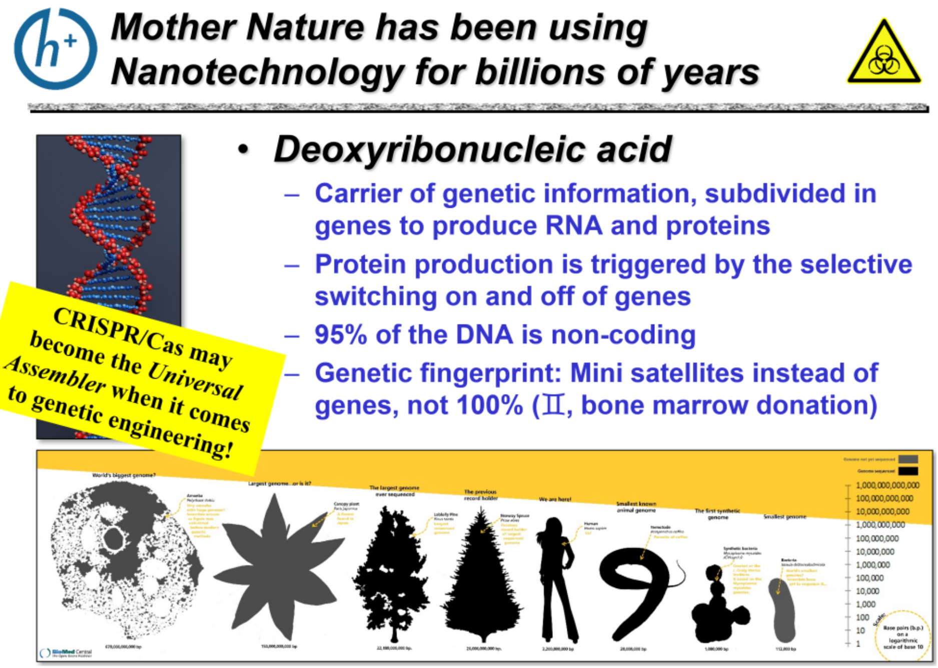


Figure 2: Genetic engineering may be the easiest gateway to human enhancement. Author's compilation.[9]

The ethical dimension is not only depicted in Khan, but a key element in *Limitless*, *The Witcher*, *The Lord of the Rings* and numerous other science fiction and fantasy movies, novels and books. This gives the whole transhumanism discussion and its interconnection with the science fiction genre an interesting spin, as on one hand science fiction movies are likely the main populariser of the underlying philosophy, as they visualise its concepts and stream the resulting representations of transhumanist thought to the public, while on the other hand the movies also critically address the ethical issues that come with human enhancement and humanity's desire to become (demi-)god-like.

[9] Sources: https://pixabay.com/de/photos/gen-dna-lernen-wissenschaft-6527964/, https://www.biologyonline.com/dictionary/exon and https://blogs.biomedcentral.com/on-biology/2014/03/20/worlds-largest-sequenced-genome-unlocking-the-loblolly-pine/.

Deus ex machina?

Khan is not only a great warrior and a controversial character due to the effects of eugenics,[10] but also a great example of a *deus ex machina* moment in the science fiction movie "*Star Trek Into Darkness*". This moment arrives when Captain Kirk sacrifices himself to save his crew, but is then brought back to life by a dose of Khan's blood, which is able to entirely negate the lethal effects of radioactive poisoning. The ability of Khan's blood to act as a miraculous cure comes out of nowhere and provides the movie with a completely unforeseeable happy ending.[11] **This is what *deus ex machina* is all about: the "*god from the machine*" moment is typically…**

> […] a plot device whereby a seemingly unsolvable problem in a story is suddenly or abruptly resolved by an unexpected and unlikely occurrence. Its function is generally to resolve an otherwise irresolvable plot situation, to surprise the audience, to bring the tale to a happy ending or act as a comedic device.[12]

Needless to say that some *deus ex machina* moments create severe headaches for the audience. **Notable examples are – besides Kirk's rescue by Khan's blood – *Superman*, who twists time to rescue his girlfriend Lois Lane, *The Lord of the Rings*, where Sam and Frodo are taken to safety from Mount Doom by giant eagles, and *Jurassic Park*, where a T-Rex appears like a ghost out of nowhere and rescues the protagonists from assured death by attacking the velociraptors.** It is not so much the fact that the T-Rex attacks the smaller critters, which have surrounded the humans and are about to kill them in the next few moments, but the issue of the movie's immense focus on the size of the T-Rex, which makes it completely impossible to overlook an approach by a T-Rex due to the tremors that accompany it. The movie depicts this nicely through the vibrating water

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10 Wikipedia: Eugenics. https://en.wikipedia.org/wiki/Eugenics, accessed Dec. 17, 2024.

11 McCormick, Collin/ Peeke, Dan: The 20 Biggest Deus Ex Machina Moments In Film History, Ranked By How Crazy They Were. Screenrant. https://screenrant.com/biggest-deus-ex-machina-moments-in-film-history/, accessed Dec. 18, 2024.

12 Wikipedia: Deus ex machina. https://en.wikipedia.org/wiki/Deus_ex_machina, accessed Dec. 18, 2024.

in the glass scene. However, in the final, critical moment, the T-Rex approaches the scene without a sound.[13]

The 5-million-dollar question now is whether transhumanism is the big elephant in the room that approaches us silently like the T-Rex in its *deus ex machina* moment? Or is it nothing more than a "magical remedy"[14] that likely won't work in practice. Time for a STEM[15]-based reality check.

STEM reality check

Figure 3: Cover of the ITSF Study by the European Space Agency.[16]

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13 McCormick, Collin/Peeke, Dan: The 20 Biggest Deus Ex Machina Moments In Film History, Ranked By How Crazy They Were. Screenrant. https://screenrant.com/biggest-deus-ex-machina-moments-in-film-history/, accessed Dec. 18, 2024.

14 This is the way the *deus ex machina* phrase is used within the medical context.

15 STEM: Science, Technology, Engineering and Mathematics.

16 Source: Woods, Arthur: Innovative Technologies From Science Fiction for Space Applications. The Space Option. October 5, 2019. https://thespaceoption.com/innovative-technologies-from-science-fiction-for-space-applications/.

1999 saw the European Space Agency (ESA) launch the Innovative Technologies from Science Fiction (ITSF) study (**Fehler! Verweisquelle konnte nicht gefunden werden.**), "the main objectives of which were to review the past and present science fiction literature, artwork and films in order to identify and assess innovative technologies, systems, devices, designs, configurations and concepts described therein which could possibly be developed further for space applications**. The study resulted in some250 innovative technologies and concepts mentioned in the science fiction genre being found,** and a preliminary assessment was performed in order to identify whether any of these technologies might indicate potential for a more-in-depth analysis leading to subsequent feasibility studies."[17]

The technological studies within **the ITSF study centred on 35 different topics often mentioned within the science fiction genre**, such as: Warp Drives and Tunnels, Orbital Towers, Space Elevator, Space Power, Antimatter, Space Colonies, Magnetic Propulsion, Sails and Shields, Nanotechnology, Fusion Drives, Interplanetary Travel, Ramjets, Robotics and Automation, Tethers, Wearable Computers, Extraterrestrial Mining, etc.

[17] Woods, Arthur: Innovative Technologies from Science Fiction for Space Applications. The Space Option. https://thespaceoption.com/innovative-technologies-from-science-fiction-for-space-applications/, accessed Dec. 18, 2024, emphasis added by the author.

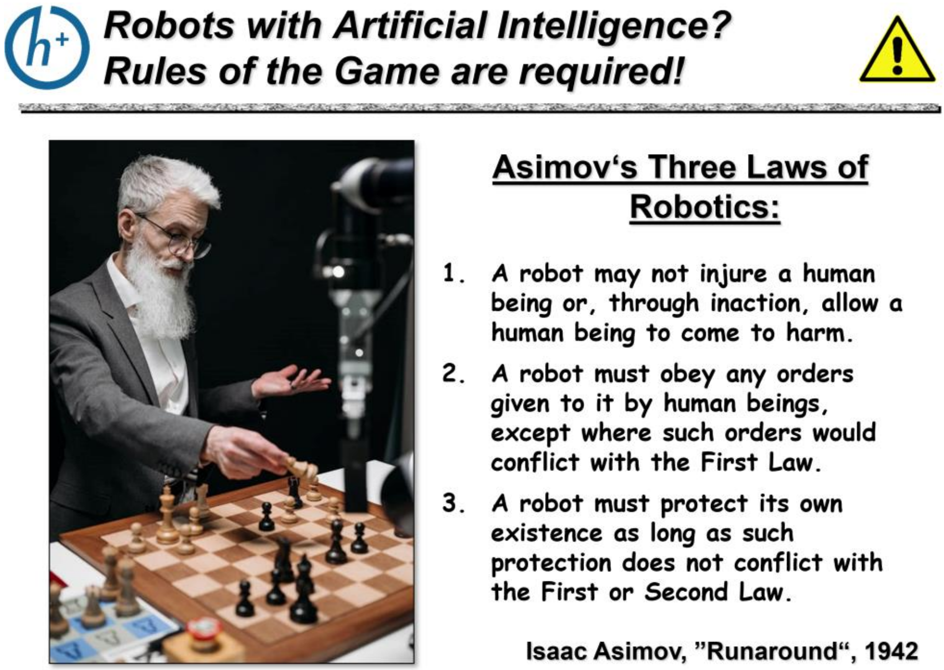

Figure 4: The three laws of robotics. Sources: Asimov, I. and Frischauf, N.[18]

Naturally, items such as **artificial intelligence (AI), as depicted by the computer *HAL 9000* in the movie *"2001"*, played a key role in the dossiers**, both from a technological as well as from an ethical standpoint. While the latter viewpoint focusses on the potential risks that may emerge with a robot that utilises a strong AI brain governed by the *Three Laws of Robotics* (Figure 4), and which are nicely depicted in the novel *"Runaround"*[19] published in 1942 by Isaac Asimov, the technological viewpoint outlines the limits that exist, the most profound being connected to the technology dimensions of information and energy (Figure 5, next page).

[18] Picture: https://www.pexels.com/de-de/foto/mann-technologie-schach-strategie-8438933/.

[19] Wikipedia: Runaround (story). https://en.wikipedia.org/wiki/Runaround_(story), accessed: Dec. 18, 2024.

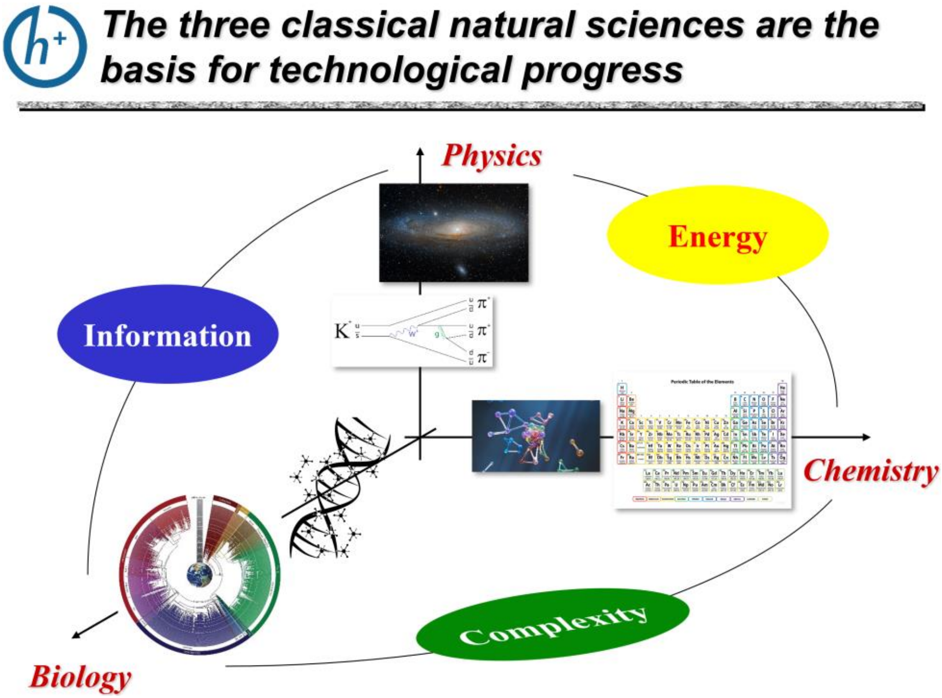

Figure 5: Biology, chemistry and physics create the three planes of technological progress.[20]

The key technology dimensions: Information and energy

When we look into the various concepts of *human enhancement* and *transhumanism* and negate the biotechnological approach to it (Figure 2), as depicted in movies such as *Limitless*, *Star Trek Into Darkness*, *The Boys*, *Deadpool*, *Wolverine*, etc., and focus on **physical concepts such as the exoskeletons being used by *Iron Man* or *Darth Vader*, specific technical issues start to**

[20] Author's compilation. Sources: https://apod.nasa.gov/apod/image/1407/m31_bers_1824.jpg, https://en.wikipedia.org/wiki/Feynman_diagram#/media/File:Kaon-Decay.svg, https://sciencenotes.org/printable-periodic-table/, https://www.pexels.com/de-de/foto/proteinfaltung-25626509/, https://en.wikipedia.org/wiki/Tree_of_life_(biology)#/media/File:Circular_timetree-of-life_2009.jpg and https://pixabay.com/de/photos/genetisch-wissenschaft-dna-biologie-2716263/

arise almost immediately. These issues are interconnected to the bits/bytes – the information - and the gigawatts – the energy (Figure 5) - necessary to turn these wonders into reality.

Figure 6: Darth Vader – a dark knight in a hi-tech suit (Source: Pexels[21])

Both suits make extensive use of sensors to enhance the senses of the human inside, both employing a powerful life-support system and requiring power to enable them to be used by their bearers**. Iron Man's suit even goes one step further as it also provides a powerful AI-based companion – Jarvis – which acts as an assistant, a consultant and as a co-pilot, depending on the situation**.

Our brains are 100 W computers developed by evolutionary design. They are built upon 10^{11} neurons and are capable of performing 10^{16} floating point operations per second (FLOPS). If we assume that it will one day be possible to create an SI-based AI and that such an AI will function similarly to our human brain, then this AI will have to have:

21 Pexels, https://www.pexels.com/de-de/foto/kostum-verkleidung-draussen-helm-9482193/, accessed Dec. 19, 2024.

- a comparable capability to perform logical/mathematical operations (represented by FLOPS); as well as
- the capability to learn, to adapt and to perform operations, which are granted by a neuronal network.

As depicted in Figure 7, electronic computers do not yet match the brain's capability. **While logical/mathematical operations do now exceed those of the brain (10^{18} vs 10^{16} FLOPS), the neuronal network of the electronic brains is still mediocre (10^4 vs 10^{11} neurons). In addition, these systems are very power-hungry and demand 10 MW ("K") - 24.6 MW ("Frontier").** Needless to say that such power levels are beyond any level that can be accommodated by a mobile system, such as the aforementioned suit.

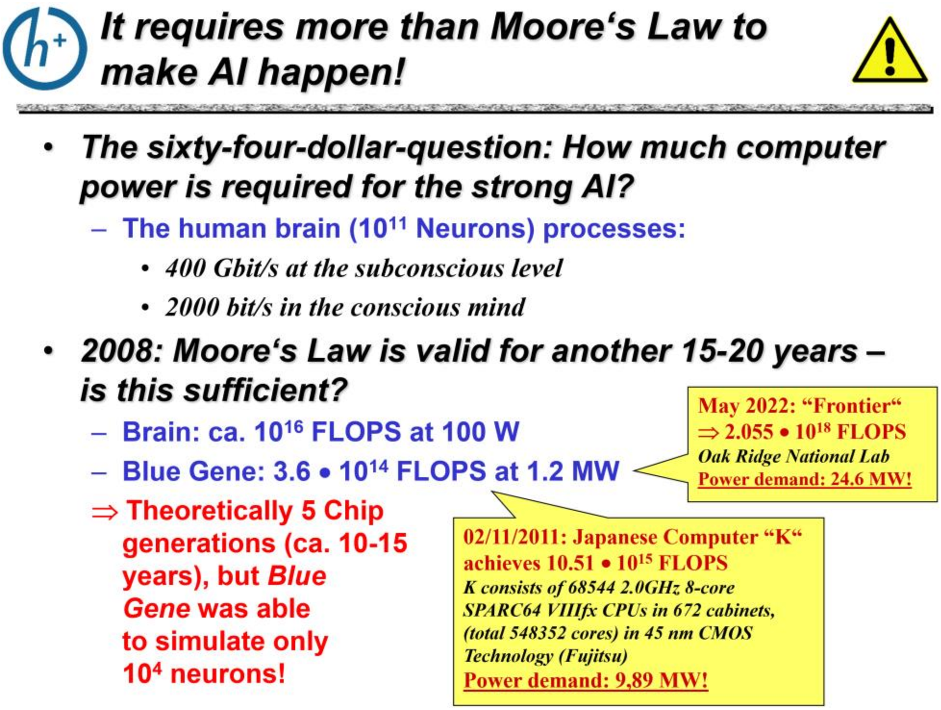

Figure 7: A comparison of the human brain with the best AI systems showcases the power demands of the electronic system. Author's compilation.[22]

[22] Source: https://en.wikipedia.org/wiki/Frontier_(supercomputer).

But even if we neglect the AI-based companion feature and just aim for the suit of Darth Vader, we face energy issues. **A typical human long-distance runner will generate 450 W of power while running (at a pace of 8.5 km/h).** If we assume that the runner continues this way for 5 hours – e.g. to finish a marathon – then the power level will turn into an energy demand of 2,250 Wh.

If this energy is to be catered for by LiPo batteries with an energy density of 150 Wh/kg, then we need at least 15 kg of batteries if we drain these batteries at 100% depth of discharge (DoD), which we would rather not do as it will have a negative effect on the battery's lifetime.

- If the **mass of the runner is twice as high** – e.g. if we visualise a supporting exoskeleton – then we need **twice the battery mass, hence 30 kg** (at 100% DoD).
- If the **runner aims to runs twice as fast**, hence 17 km/h, then the **battery mass will increase to 60 kg** (at 100% DoD).
- And if the **runner runs twice as fast (17 km/h) with twice the mass, then the battery mass will climb to 120 kg.**

These calculations are based on kinetic energy principles ($E = \frac{mv^2}{2}$) and apply to both suits. In the case of Tony Stark, who fights, flies and talks with Jarvis within his *Iron Man* suit, an additional power add-on of several MWs needs to be catered for as well.

Tony Stark, who is not only a multi-billion entrepreneur but also a genius, has solved the power issue by utilising an *ARC reactor* that powers his suit. *ARC* stands for *affordable, robust and compact* reactor and, based on the way it is depicted in the movies, this system needs to be some sort of magnetic confinement fusion (MCF) reactor. **While such an MCF reactor has been successfully tested, any technical concepts associated with the MCF principle are far from being such miniscule like Tony's ARC reactor.** In fact, an MCF system features a form factor like a classic coal/gas/oil-fired power plant, making it entirely unpractical for utilisation within any mobile system.

Is this the end to the story and is *transhumanism* therefore only a mere *deus ex machina*? As far as the power limits are concerned, concepts such as the *Iron Man* suit, exoskeletons and AI-based implants that improve a human brain beyond any limits are currently absolutely off the scale. However, if history has taught us anything then it is the fact that humans are very creative and will eventually overcome most of the limits and barriers they encounter, provided that the vision is strong enough to pursue. And the vision of becoming immortal, staying forever young and increasing one's power and intellect to (demi-)god-like levels is certainly a strong one – if not the strongest that exists within the human soul. **Therefore, it will only be a matter of time until the *deus ex machina* will be turned into a *deus cum machina*…**

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