



Mitigating the quantum hype

Since the beginning of 2021, some negative buzz on the current “quantum hype” has been steadily growing. It was fueled by contradictory messages: a couple skyrocketing startups funding and valuations (IonQ, PsiQuantum) and a sluggish progress with quantum computing. The confusion is high between some vendors presenting so-called “quantum advantages” and others, if not the same, forecasting “useful” quantum computers in a 10-15 years timeframe. On top of that, many consulting companies and analysts are urging corporations to adopt quantum computing, otherwise their competitors will outsmart them.

You can be easily torn between, on one hand, skepticism on the potential advent of real useful quantum computers, and on the other hand, with putting trust on the many serious and patient scientists and engineers working hard to solve some of the most complex scientific problems you could imagine.

Being embedded in the quantum scientific, entrepreneurial, enterprise and government ecosystems, I found it a bit worrying as overhype and related underdeliveries could cut short long term investments in the quantum field, and not just for quantum computing but also, for examples, for quantum sensing which has much better short term applications.

I tried to lay out the situation in a paper, making comparisons between the current quantum hype and other past and present technology hypes (symbolic AI, IoT, AR/VR, cryptocurrencies/Blockchain/NFTs) and also science hypes (nuclear fusion, genomics).

I then inventoried some specifics of this quantum hype, which is characterized by a very high scientific uncertainty whereas many other technology hypes were related to technology, economical and societal uncertainties more than scientific ones. Quantum technologies and particularly quantum computing are particularly hard to fact-check and it demands very specific skills that can’t be acquired in a click or Tiktok videos. It is even harder to figure out whether creating some useful quantum computing is more a scientific or engineering challenge. I uncover how the quantum vendor scene including well-funded startups and the “IGAMI” (IBM, Google, Amazon, Microsoft, Intel) is driving a structural change on how fundamental quantum research is undertaken, organized and communicated, mostly at the expense of public research labs.

At last, I list some proposals of actions that could be undertaken by quantum ecosystems to mitigate the most negative impact of this quantum hype. It deals with education, shared benchmarking methodologies, transversal projects coordination, vendors communication and fact-checking. All-in-all, it is about putting in place a responsible innovation approach, putting serious science and society at the center of debates.

This is (documented) food for thoughts and debates! Feedbacks welcomed!

You can download this paper [here](#) or with clicking on its first pages below.

Mitigating the quantum hype

Oliver Ezaryn¹

¹consultant and author, Paris, France, oliver@ezaryn.net /oliver

We are in the midst of quantum hype with some excessive claims of quantum computing potential, many vendors' and even some scientific organizations' overstatements, and a funding frenzy for very technology readiness level startups. Governments are contributing to this hype with their large quantum initiatives and their technology sovereignty aspirations. Technology hypes are not bad per se since they create emotion, drive innovations and also contribute to attracting new talents. It works as scientists and vendors deliver progress and innovation on a continuous basis after a so-called peak of expectations. It falls with exaggerated overstatements and underdeliveries that last too long. It can cut short research and innovation funding in the mid to long term. After looking at the shape and form of technology and science hypes and deriving some lessons from past technology hypes, we investigate the current quantum hype and its specifics. We find that, although there is some significant uncertainty on the potential to create real scalable quantum computers, the scientific and vendors fields are relatively sane and solid compared to other technology hypes. The vendors' hype has some profound and potentially positive impact on the organization of fundamental research. Also, quantum technologies comprise other fields like quantum telecommunications and quantum sensing with a higher technology readiness level, which are less prone to hype. We then make some proposals to mitigate the potential negative effects of the current quantum hype including recommendations on scientific communication to strengthen the trust in quantum science, vendor behavior improvements, benchmarking methodologies, public education and putting in place a responsible research and innovation approach.

INTRODUCTION

Artificial intelligence specialists who have been through its last "winter" in the late 1980s and early 1990s keep saying that quantum computing, if not quantum technologies on a broader scale, are bound for the same fate: a drastic cut in public research spendings and innovation funding. Their assumption is based on observing quantum technology vendors and even researchers overpromise, on a series of, over and over again, unmet promises in quantum computing and on the perceived slow improvement pace of the domain.

The quantum race launched by many governments, particularly with the USA, China, and other developed countries in between is also artificially fueling this trend, fed by "technology sovereignty" concerns. The recent funding rounds of leading startups like IonQ, PsiQuantum and Rigetti contributed to overstate this overhype perception. Some go as far as to say that quantum computing is a scam created by scientists who found a way to get funding for their research ventures.

Trying to stage a balanced view, this paper describes the shape and form of this quantum hype and what are its similarities and differences with other digital era hypes like symbolic artificial intelligence, 3D television, consumer 3D printing, virtual and augmented reality, blockchain and crypto-currencies as well as with other science related hypes. It proposes some insights and code of conduct for the quantum ecosystem that would avoid the pitfalls of the current quantum hype while keeping the benefits of a vibrant scientific and technology ecosystem. It also builds on and complements earlier work by science philosophers in the field of quantum ethics and responsible innovation¹.

It can also happen when some technology innovation is not creating real perceived societal progress and value.

At last, when technology finally matures, its visibility shines back with a growing "slope of enlightenment" and a "plateau of productivity". The technology has then the potential to become mainstream and commoditized in the marketplace, whether in the enterprise or the consumer space depending on the technology.

This Gartner hype curve is an over-simplified and empirical model that does not capture well what can happen with disruptive science and technologies². It is constructed with adding an initial "buzz" bell curve and a technology maturity S curve, given these do not rely on the same metrics. It is missing scientific, technology and even business rationales. It deals mainly with the emotional response to new science and technology and is void of any rationality. It also presupposes that a topic's visibility, expectations and needs are correlated. Its premise is that at some point in time, the given technology domain will succeed. But what if science and technology fail to deliver? What if the new needs the innovation is supposed to address do not really exist? The curve is also built out of a strong technical bias, forgetting the various technologies that totally failed for one reason or the other³.

The market is now flooded with a growing number of technology trends and fads. How is this affecting visibility? Sometimes, the technology trend is not well defined, like "nanotechnologies", which drives the market crazy⁴. The length of the trough of disillusionment can be very long, spanning several decades. We are still in it for symbolic AI and it may be what will happen with scalable quantum computing⁵. One strong shortcoming of the hype curve is that Gartner is using it to advise corporations on when to adopt new technologies. In a rational way, it should not be done because it is popular or not does because it is not in the radar radar⁶. Innovation winners are frequently contrarians!

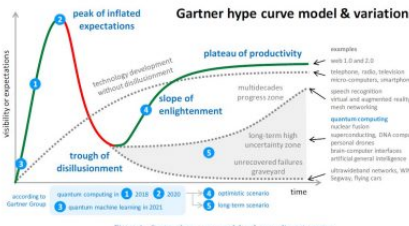


Figure 1 : Gartner hype curve model and some alternate variants.

HYPE ONTOLOGY

Hype is a term referring to over mediafication and inflated, excessive or misleading claims that are applicable to particular products, products categories, technology trends, scientific domains, personalities like artists or politicians, and even speculative financial bubbles and scams⁷. Hype characterizations range from broad societal phenomena to explicit, well thought-out and planned marketing strategies. It can be confused with marketing exaggerations which are among its implementation artefacts. On the other hand, buzz is a quiet way to disseminate promotional content, before it gets amplified by hype.

Hype existed way before the Internet but nowadays can be orchestrated by leveraging social media to amplify their effects⁸. As a marketing strategy, hype can be applied in various fields like in fashion to promote new styles and brands. It can even be based on creating artificial scarcity or fake strong demand. Also, many old Post financial schemes were created with hype development mechanisms.

Science and technology hypes

Scientific and technology hypes do not involve the same stakeholders as fashion, financial and politics hypes. They deal a lot with how the scientific community, the industry and society interact with each other in an marginalized fashion. As we get closer to the commercial world, business and financial values and systems are becoming powerful hype-echo chambers.

Technology hypes are not bad per se⁹. It depends on their scale and how self-fulfilling promises are delivered. Hype drive research, invention and innovation on a global basis¹⁰. Their main use case is to attract government and private sector funding. They can indirectly help make progress with science and make the field attractive to new talent. And unlike Gene Kranz' funding quest, failure is an option. No failure would mean that not enough scientific and technology avenues were investigated. The field of quantum technologies is probably exemplifying this phenomenon with a sheer diversity of pursued technology options, and not just with the many quantum computing split types that are investigated.

Scientific hype can also happen way before it enters the entrepreneurial and commercial scene, when various positive or beneficial aspects of science are inappropriately exaggerated and sensationalized with the great that evaluation appropriateness relies on value judgements¹¹. Hype can show up first in scientific papers' titles created by research labs communicators¹². This frequently happens in life science with the past examples of pluripotent stem cells and cancer curing monoclonal antibodies¹³. This can be driven by the way researchers are funded and rewarded in most countries. Technology vendors are indeed not the only ones competing with each other for funding. Science is also a very competitive field where visibility, recognition, careers as well as public and private funding are at stake.

The hype can then be amplified when science communication and academic publishing is translated in layman's terms in news media¹⁴. It can also be a side effect of papers being published on pre-print servers like Arxiv, without being peer reviewed although most scientific papers benefit from some media visibility after they are published in peer-reviewed publications.

Hype emotions and Irrationality

Science and technology hype is a field of collision between, on one hand, information streams stoking emotions and irrationality, and on the other hand scientific, technological and even business rationality. It builds on strong beliefs in science driven progress and on the confusion between laboratory experiments and production-grade solutions. Hype goes way beyond a mere classical build-up of rational expectations and a societal contract on the required investments needed to deliver value¹⁵.

Emotionally, hype drives hope, envy and fear. Hope of solving key problems like with healthcare or climate change. Envy and fear of missing out on becoming wealthy (FOMO) for entrepreneurs and investors, or, for governments, of being overpowered by another country. Lastly, fear of losing competitiveness or missing business opportunities for corporations.

Hype related emotions are also easier to manipulate given the ignorance by its various target audiences of the various scientific or technology obstacles in creating actual solutions. It can build on magical thinking and occasionally use science-fiction references¹⁶.

Gartner hype curve model

Technology hypes were practically defined by the Gartner Group with its famous hype curve model, created in 1983¹⁷. It tries to capture new technologies' visibility and success cycles in some predictive way. The model uses a non-linear curve with uncalibrated time in X and visibility or expectations in Y. After a new technology appearance trigger, the first peak of visibility corresponds to a hyper-driven "peak of inflated expectations" when some highly positive buzz is amplified by news media, frequently at the border line of magical thinking. This buzz can be created and fed by a variable mix of scientists, analysts, consultants, influencers, entrepreneurs, corporations and sometimes governments themselves. This is where we are right now with quantum computing as shown in Figure 1.

Then, if and when over-expectations are not matched by actual technology capacities and benefits, trust vanishes in a "trough of disillusionment" with negative news coverage and an overall lack of confidence in the technology and its creators. The gap between expectations and the actual delivery capabilities of science and technology can drive disappointments in the related sciences or technology, similarly to what happened with artificial intelligence during its two winters in the early 1970s and 1990s. It can also

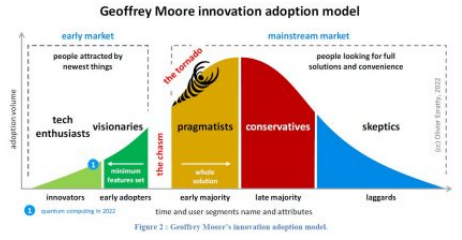


Figure 2 : Geoffrey Moore's innovation adoption model.

If we were to use Moore's model with quantum computing, it'd rather say that we are still at the innovators stage with existing pre-NISQ quantum processing systems that are still experimental devices¹⁸. The minimum feature set corresponds to the ability to reach some quantum advantage to solve practical business problems. Early adopters will jump on the bandwagon with useful NISQ or large scale and fault-tolerant computing systems in an undetermined timeframe and then, when the software and cloud ecosystem grows, we'll cross the chasm and see the early majority adopt quantum computing massively.

Clayton Christensen's innovation disruption model covers innovations that are appealing to low-end or underserved consumers and then become mainstream and eventually are based on innovative business models¹⁹. The model works when a new technology and its implementations significantly expand a given market. The classical examples are the personal computer and the smartphone. It is less applicable to quantum computing given it will, at least at the beginning, be a sub-market of the narrow high-performance computing market.

In both cases, Christensen and Moore's model are describing the implementation details of the slope of enlightenment in the Gartner hype model, when technology starts to actually work. In the case of quantum computing, these considerations will become useful when quantum computers really scale and provide some quantum advantage compared to classical computers. But some aspects of Moore's innovation adoption model are put in place early on, such as software tools ecosystems and platform like IBM Qiskit. It prepares the ground early on for a dissemination of software solutions and skills when scalable quantum hardware actually starts to work and can become a leading platform.

HISTORY LESSONS AND ANALOGIES

The last decades saw an explosion of digital and other technology waves, most of them successfully deployed at large scale. Micro-computers invaded the geek world, then the workplace and at last, our homes. Besides the Millennium Bug overhyped fears, Y2K, marked the beginning of the consumer digital era, starting with web-based digital music, digital photography, digital video and television, e-commerce, the mobile Internet, the sharing economy, all sorts of disintermediation services and at last cloud computing.

There were however some failures, with hype waves and adversarial outcomes. In many cases, while these hopes peaked, some skeptics could be built out of common sense. In Figure 3, I provide a rough comparison of successful and failed technology hypes with some simple explanation of their relative outcomes.

I will look here at some product categories and not about particular products that succeeded and crashed or crashed right away (Betamax, Alkavista, MySpace, BlackBerry, Segway, Theranos). There are also many case studies I won't investigate like hydrogen fuel, electric vehicles and precision medicine.

Symbolic artificial intelligence

In the 1980s, symbolic AI and expert systems were trendy but had practical implementation issues. Capturing expert knowledge was difficult and could not be automated when contents were not manually digitized as they are today. There were even dedicated machines tailored for running the artificial intelligence LISP programming language.

This is v3, dated February 10th, 2022. v2 incorrectly stated (with an incorrect source) that Scott Aaronson was behind the Quantum Bullshit Detector 2019-2021 Twitter account.

I published the paper on arxiv to make it broadly accessible by the quantum scientific community. I also created abridged versions of the essay in English and in French.

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