Promising Technosciences in the Economy of Attention: Why Have Pessimistic Stories of Disruption and "Artificial Intelligence" Performed so Well?

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Abstract: The promises connected to emerging science and technology do not merely assist research and innovation, but are a part of it. Their diverse roles in producing hype and ensuring coordination have been extensively studied in the sociology of expectations. However, promises also circulate on a massive scale in the media sphere, as occurred with nanotechnology and artificial intelligence, recounting what the future will be like. The popularity that technoscientific visions manage to attract is less well studied and understood, although it is closely connected with how research is directed and innovation funded – and thus deserves more attention. This contribution explains why so much promising and visioneering is taking place, identifies a "regime of promising", and discusses its implications for the relationship between science and society. Drawing on cultural and media studies to expand the sociology of expectations, it attempts to better understand the role of fiction in building socio-technical imaginaries.

Keywords: promising technosciences; credibility; popularity; economy of attention; counter-fiction; scenarization.

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1. Introduction

Once, in 2017, when I was invited to a high school to talk about new technology and stimulate a debate on science and society with students of around 16, a boy who had not yet participated raised his hand and asked me:

"Have you seen the movie *WALL-E*?"

I gladly answered, "Yes I have."

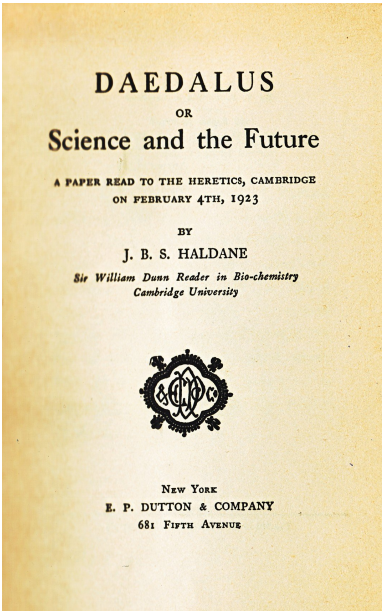
He went on, "Well, I think we're going to end up like that: machines and robots will soon be able to do everything. What I'm being taught today in school is going to be useless tomorrow. And I'll be left without a job or a place in society."

These pessimistic words echo the promises of "artificial intelligence" (AI), and especially the tone used to speak of a future of machine learning and the supposedly "disruptive" impact it will have on the job market and society. They raise numerous questions about the "economy of technoscientific promises" (Felt and Wynne 2007; Joly 2010) and its effects beyond the circles of stakeholders in research and innovation, namely on the public and media sphere, as well as on society and culture more broadly. What are the ethical implications of these promises? What should (or must) scholars try to do about them? What do they reveal about the relationship between science and society today, as compared to the recent past? What is the image of technosciences in society? Do people actually believe in such bold technoscientific claims? Here, "disentangling the future" challenges the sociology of expectations to broaden its scope of analysis and extend its work "beyond an actor-centered approach" (Sand and Schneider 2017, 22). In this contribution, I intend to explain what is meant by a "regime of promising," arguing that in order to fully investigate its implications, it must be understood in the context of the economy of attention that governs the media sphere and draw on art and literary theory to study its intensive utilization of fiction.

Before 1990, literature in science and technology studies (STS) focused exclusively on expectations and future visions was scarce, although the role played by promises has always been acknowledged. From a historical point of view, the modern sciences have generated much anticipation, as well as many utopias and expectations, that STS – while not overlooking – understood in terms of the dominant discourse of progress as a technical fix. Hence, the question arises: why did the sociology of expectations develop starting from the 1990s? Or rather: why have so many promises and technoscientific future visions recently followed one another? Appeals to the zeitgeist or the turn of the millennium are not sociological explanations of this phenomenon. This contribution thus approaches promising technoscience via the sociology of expectations, attempting to supplement it with missing analytical elements derived from cultural and media studies. I hope to show that these extensions of STS are critical for addressing what is at stake in the widely disseminated promises of technoscience and to reflect on public engagement.[1]

2. "History of the Future" in Different Literary Genres

Following Francis Bacon's *New Atlantis* (1626) and René Descartes' early ideas about organisms as machines, stories intended to stimulate the imagination and promote rational thinking became a genre in itself during the 18th century. A whole genealogy of future visions, technological utopias, and promises of progress unfolded during the 19th and 20th centuries. Technoscientific imaginaries of the past have forged the epistemic cultures of physics, chemistry, biology, and computer sciences. One example of such anticipatory vision and imaginary is "Daedalus, or Science and the Future" (1923, Fig. 1), a text read by the famous British geneticist J. B. S. Haldane at the Heretics Society, in which he coined the word "ectogenesis" (pregnancy outside the female body) – which would become possible not later than 1950 – and envisaged genetics as soon being able to modify individuals, as well as to cure or eradicate certain common diseases. It is this discourse which inspired the novel *Brave New World*, published in 1932 by Aldous Huxley (Fig. 2), mocking the promises of his friend (Atlan 2005). Interestingly, the fame of Haldane's promising discourse was made by its "counter-story", namely Huxley's satirical utopia.


DAEDALUS

OR

Science and the Future

A PAPER READ TO THE HERETICS, CAMBRIDGE
ON FEBRUARY 4TH, 1923

BY

J. B. S. HALDANE

Sir William Dunn Reader in Bio-chemistry
Cambridge University

NEW YORK
E. P. DUTTON & COMPANY
681 FIFTH AVENUE

Figure 1. J.B.S. Haldane: *Daedalus*, or Science and the Future, 1923.

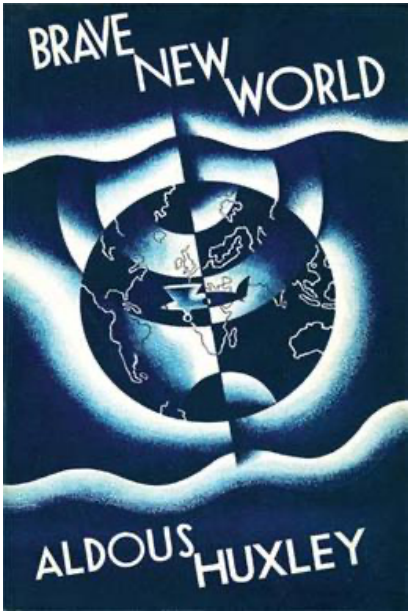


Figure 2. Aldous Huxley: *Brave New World*, 1932.

Another example can be found in the works of H.G. Wells, who, in a 1924 interview about the possibility of deriving technology from the new atomic science and the theory of relativity, answered that it would perhaps take centuries for something concrete to be developed. However, in his 1914 novel of anticipation *The World Set Free,* Wells imagines a world war in the middle of the coming century that comes to an end following the mass destruction caused by a new kind of bomb developed on the basis of atomic science (Cazes 1986, 69). This novel, dedicated to physicist F. Soddy, was read by Leo Szilard in 1933, during his flight from Germany, and it encouraged him to continue his work and to warn that an atomic bomb had to be developed before the Nazi regime managed do so itself (Cazes 1986; Guston 2012).

These two examples indicate that the future should be approached by comparing literary genres. Many anticipatory scientific visions have been based on purely technical rationality, while other genres of literature mix different types of rationality, e.g., the historical, the economic, and the technological in some philosophical essays. But literary genres underwent differentiation and were eventually separated out in the context of the "two cultures" (Snow 1959). While Wells published novels as well as anticipation essays, the specialization of fields of knowledge and common opinion about literary genres came to see science fiction as the opposite of rational scientific knowledge. The Cold War period witnessed attempts to develop fields of knowledge that anticipated the future, such as prospective science or technology assessment/technology foresight, not to mention game theory and risk assessment. For their part, the foundations of the social sciences (as they are still practiced today) were established by excluding prophesizing, prediction, and fiction. The two lessons learned from the "history of the future" are 1) that promises and fiction are constitutive of modern science and 2) that the dialogue about the future of technoscience is apparently situated in between literary genres.

3. "Fabricating Stories" for "Selling Science"

In order to foster economic competitiveness and growth following the Second World War, new layers of research funding began to be added on top of the existing positions of disciplines in academia. In the context of the Cold War, defense was also a driving force behind technoscientific research. The new research-funding schemes were organized on a competitive basis, on the model of the US National Science Foundation (1950). Following a linear model conceived as a pipeline, science policy separated "fundamental" from "applied" research, with the latter leading to R&D. In OECD countries, for about three decades everything – the economy, energy, consumption, and public health – was growing and getting better. However, to simplify somewhat, a new era started in the

1980s with the advent of emerging countries, like Japan and South Korea, which were perceived as new competitors. The integration of Europe led to the first Framework Programme for Research and Technological Development (1984-87), which supplemented national research funding with European funding. OECD nation-states implemented new forms of legitimization for additional funding, still on a competitive basis, with terms like "strategic" and "priority" research. Competition increased between nation-states, as well as within the research system.

The theoretical basis of science and technology studies was laid down in the 1970s and 1980s. It was then deployed in many different directions, leading in recent times to the development of the sociology of expectations. Two early works in this field are worth mentioning here: the editor of the 1979 book *Controversy: Politics of Technical Decisions*, Dorothy Nelkin, published *Selling Science: How the Press Covers Science and Technology* in 1987. Among the many different issues discussed in the book, Nelkin paid attention to the relationship between scientific journalism and public relations (PR). She observed that journalists and PR people have very similar skills, interests, and occupations and that there is a strong complicity with scientists and engineers. Scientific journalism and PR have an osmotic relationship, in which a person passes from one domain to the other while doing almost the same job. Her observation still remains completely valid today: the president of the Swiss scientific journalists' association wrote that journalism and PR cannot be separated (Dessibourg 2013). Moreover, looking back to the first decades of the present century, universities and research laboratories have – for many different reasons, including but not limited to the Shanghai ranking of universities which has been published since 2003 – hired more and more communication staff, including many scientific journalists. A competition heightened on the level of communication that had not previously existed.

In 1993, Ulrike Felt published the results of a study about high temperature superconductivity (HTS) conducted between 1987 and 1989. Widely cited, the article *Fabricating scientific success stories* is a comparative study of four countries in which this field of physics has been established. Press coverage in these four countries is counted up and its content analyzed. The article starts by interrogating the relationship between science and society as they looked in 1960 and in the early 1990s:

> Science meets the public under radically altered conditions: communication and trust, credibility and authority, support and cultural meaning are no longer what they used to be. (Felt 1993, 375)

What is the point of the paper? It seemed to Felt that "no scientific discovery [...] has given rise to such a wave of enthusiasm," and that "stories" were told about "fundamental breakthroughs" and "technological dreams..." (Felt 1993, 377). A physicist articulated an interpretation of

what was happening: "he puts the blame for what he sees as misjudgment on the part of US science policy makers and on the distortion by media-hype...". He explained the scientific success story as the result of a "joint venture between some scientists and breakthrough-hungry journalists", considering it "an aberration" when compared to many other advances in postwar physics (Felt 1993, 377).

The comparative study goes on to present Felt's insights: the domain of physics to which HTS belonged was under "severe financial pressure," and "scientists hoped to gain visibility in the public domain to show the relevance of their research," thus "put[ting] pressure on policy makers and funding agencies" (Felt 1993, 387). The number of press reports and public visibility "could be turned into valuable negotiation capital when competing with others for money." For policy makers, in turn, fabricating success stories brought advantages: it provided them with a better foundation for setting funding priorities and legitimizing their decisions in an increasingly competitive context. I intend to show that the relations described here between science, the media, and science policy are on the verge of turning into a regime whose operating speed will only increase.

What were the reasons for the large differences in press coverage in the nation-states compared in the study? In Switzerland, where in 1986 an important discovery in superconductivity physics was made at the IBM lab in Zurich, in Germany, home to one of the two Nobel prize winners, and in Austria, "there was no perceived need to inform a wider public" (Felt 1993, 388). In these countries, the press did not at all tell the same story, being much more interested in technical details, and "played far less with speculations on future applications." In the US, by contrast, "most universities are aware [...] they get public money and therefore need the support of a broader public." The press in the US thematized international competition, especially with Japan, so that stories of "technological dream and fiction were sold." The conclusion, evoking Nelkin's book, is that:

> In a climate of fierce economic competition, in a time of stagnating budgets and confronted with a public that is constantly facing the consequences of science and technology, "selling science" cannot be regarded as a luxury any more – it has become an obligation. (Felt 1993, 389)

The value of this study, especially when compared to traditional media studies, which counts occurrences without considering actor networks, is that Felt focuses equally on the research and decision-making milieus. Her conclusion goes against the dominant and naive view that only journalists exaggerate scientific prospects, telling stories, while the scientists themselves are precise and neutral.

4. The Market of Promises and the Sociology of Expectations

Arie Rip pioneered the sociology of expectations, as one of the first researchers, at least in Europe, to pay attention to science policy and funding agencies (Rip 1994). He directed the PhD thesis of Harro van Lente, who is often associated with the beginnings of this field (Van Lente 1994). Van Lente forged the concept of the *promise-requirement cycle,* and was followed by colleagues who developed other basic concepts, mainly those of the *situatedness* and *performativity* of promises (Brown et al. 2000; Brown 2003; Borup et al. 2006). At the end of 1990s, the sociology of expectations literature was about to deploy. This development had to do with the amplification of the economy (or market) of scientific promises.

The sociology of expectations explains that hype, fiction, and stories of distant futures are primarily aimed at stakeholders in research and innovation: i.e., scientific policy makers, scientists, engineers, innovators, business managers, venture capitalists, and early users. Performativity supposes that promises do actually influence stakeholders' behavior towards the envisaged technology and looks at the means used to achieve influence. One privileged way of influencing is to articulate "rhetorical devices," for example about the inevitability of competition and progress, and to circulate "compelling narratives" (quoted in Sand and Schneider 2017, 20) like a "forceful fiction" (Van Lente and Rip 1998).

As a conceptual framework, the promise-requirement cycle works well for analyzing individual promising endeavors, as well as broad emerging domains. A future vision protects a technoscientific endeavor for a certain time, granting it some credibility. A promise is like a shared belief, creating some space for a domain to progress and to secure research or R&D (Ruef and Markard 2010). Eventually, however, a requirement must be fulfilled: there must be some concrete result. It can be far from what has been promised, as long as it is convincing enough for a new round of funding. Cycles of funding may go on or, if no results are reached, end.

Xeno-transplantation, gene therapy, the human genome project, biofuels, stem cells, synthetic biology, personalized medicine, nanomedicine, brain sciences, neurotechnology, wearable sensors, blockchain technology, autonomous vehicle, cultured meat, etc., have all followed such cycles of promise-requirement. The sociology of expectations allows us to analyze emerging science and technology in an alternative way to the popular hype-disillusionment curve, a tool developed in the 1990s by the Gartner company for bench-marking innovations, which, however, organizes, and takes part in, the market of promises (Pollock and Williams 2010; 2016).

Emerging technosciences often need a period of sustained promising before acquiring their own impetus. Referring to biotechnology in general, and genetically modified organisms and nanotechnology in particular, Joly states that promises pass *tests of credibility* (2010; 2015). These can occur either following an R&D event or an incident on the market, or

due to a lack of alignment between the actors, or because the technology is contested, or simply because of the time that has passed without significant advances. Sometimes hype rebounds, while in other cases the result is a cold shower, as happened to the bold promises of gene therapy in 2000. When concrete results do not meet expectations, the promissory field in most cases retreats from the spotlight. Although it seldom disappears completely, it attracts far less enthusiasm and money, leaving stakeholders with their belief and lost investments in the venture. Usually, nothing highly problematic happens in these cases, which are probably much more numerous than those ventures that eventually reach the market. Nobody can be held accountable for those promises that are not delivered on, except in rare cases where patients have been misled, for example, or fraud is proven, as in the case of Theranos which led to the conviction of its managers.[2] This case has shed light on the methods of promising used in Silicon Valley, as summarized by the popular positive-thinking aphorism "fake it till you make it."

The sociology of expectations investigates the market of scientific promises and highlights that future visions do not merely accompany scientific and technological development, but are a part of it. They play various roles, such as creating excitement, orienting, coordinating research efforts, and drawing road maps. Hype can be fabricated, sustained if necessary, and revamped if it has vanished (Audétat et al. 2015).

Nevertheless, the framework of the promise-requirement cycle, together with the concepts of performativity and credibility, does not always work. Indeed, there are cases of promises which do bring results, but which are either not attractive enough for venture capitalists or bother vested interests, and are thus abandoned after one or two rounds of funding (Parandian et al. 2012). Meanwhile, although they fail to bring promised breakthroughs, credibility and money continue to be granted to certain emerging technologies, as if there is no requirement to deliver, or more precisely, as if that obligation could perpetually be postponed. These expectations appear to have a second, third, or even eternal life, although their plausibility is sometimes far from being established.

The lesson of these cases is that finance is to some extent the master of the game. But they also show that the game, i.e., engaging in new endeavors then picking the winners, does not exactly work this way. Promise-requirement cycles are also conditioned by how much popularity promises manage to attract. Popularity here is connoted neither positively nor negatively, in the sense of reflecting either enthusiasm or concern. Simply put, the more popular a promise is, the more compelling it is for stakeholders. Thus, another arena is in play, just as critical as finance, which has to do with the performativity and popularity of promises in society, i.e., which includes, and goes beyond, actor networks. This arena, which is mainly located in the media sphere, connects with cultural representations and the true power of myth.

5. Nanotechnology, or the "Regime of Promising"

Promising technosciences have proven to be highly speculative and attracted growing attention. A threshold was crossed when nanotechnology started to be advertised following the adoption of the US Nanotechnology Initiative (2001). Fantastic stories of the future, mixed with the discourse of transhumanism and fostering human enhancement, left many stakeholders uneasy, especially in science (where people have informed views about feasibility and different opinions about the ethics involved in promising) and European science policy. The sociology of expectations developed further, and STS specialists were "hired" by decision makers in the EU, who did not know how to react other than by funding nanotechnology to stay competitive. Attempts to discuss with science policy makers and stakeholders, and to engage more responsibly with the public, resulted in a report to the EU Directorate of Research (Felt and Wynne 2007), in which the "economy of technoscientific promises" was subject to discussion and counterbalanced with an alternative possibility called the "regime of collective experimentation," in an effort to create more commitment and engagement with European society. The EU finally responded with guidelines for "responsible research and innovation," sidelining the 7th Framework Programme of Research (2007-2013).

Questions were asked and the word "plausibility" was in the mouths of many when the bold discourse about convergence at the nanoscale, nano-machines, and connecting brains with machines and brains with brains (Rocco and Bainbridge 2002) was promoted as an absolutely certain future, as only a matter of time (Schummer 2010). Speculation about future technological achievement has often been found to be completely disconnected from what was actually going on in laboratories. Technical plausibility could be understood as an arena of negotiation of trust and credibility, while societal plausibility opens discussion about the desirability of certain technoscientific developments (Selin 2007; Lucivero 2016). The concept of *anticipatory governance* was elaborated in order to open space and provide methods for deliberation and assessment between stakeholders and society (Guston 2012; Konrad et al. 2016). Nonetheless, the ethics of promising came to be seen as completely unbound – with nanotech being only one particular case – and matters of principle were raised for discussion, for example, whether running ethical, legal, and social impact studies (ELSI studies) on technology whose plausibility was still in question was not granting it credibility (Nordmann 2007; Sand and Schneider 2017) and diverting technology assessment from more concrete and urgent issues.

With the umbrella term "nanotechnology," another direction in the sociology of expectations has been explored following the observation that "struggle for meanings"[3] was taking place, opposing quantum physics to chemistry, bionano, micro-mechanics, neurotechnology, and so on. Every domain of science wanted its piece of the cake, producing "nano-

narratives" (Milburn 2002), with the result that "folk theories" (Rip 2006) circulated on a massive scale in a kind of competition of speculative science.[4]

In short, the "economy of promises" became an issue in itself. The term came to be used by many people to describe what they had to deal with. Richard Jones, a British physicist involved in science policy, who engaged as much with the scientific and technical debates about nanotechnology as with its societal implications, was among the first to talk of an "economy of promises" (Jones 2008) and started a blog in 2004 in order to promote informed debate.

It is important to note that the claim here is not that present scientific expectations are more fantastic than past ones. For instance, from the 1960s to 1980s (or later), it was thought certain that science would always provide new solutions to production problems or societal challenges. Energy production, which was seen as an exemplar, was said to be ever increasing at ever-decreasing costs. New modes of energy production (e.g., nuclear fusion, anti-matter) would continue to be discovered and exploited. It was believed that this logarithmic progression would go on until the point when an infinity of energy could be produced for free. It is hard to believe today. At the time, though, the industrial world was at the tail end of several decades of economic growth. This example is meant to show that future visions of technoscience should be understood in relation to the economics, society, and environment of their time. As such, past visions of the future are not less or more fantasies, or phantasma, than contemporary visions like "convergence at the nanoscale" or the "singularity." These examples also tend to show that plausibility is perhaps less important than – albeit a part of – the promotion of a certain technoscientific imaginary.

A touchstone of the architecture of the sociology of expectations was the formulation of the definition of *socio-technical imaginaries*: beliefs "collectively held, institutionally stabilized, and publicly performed visions of desirable futures..." (Jasanoff and Kim 2015, 6). Although "desirable futures" may not necessarily be the case, as we shall see, the value of this definition is to state that the condition is to be shared across various milieus, including in the public – meaning beyond stakeholders' circles, beyond actors' networks, which pushes this sociological enquiry into new areas.

The meaning and definition of the term *regime of promising* was forged by and with Arie Rip. To begin with, the word "expectation" is perhaps not entirely convincing for the object of study. On the one hand, it is good for potentially encompassing all kinds of horizons of expectation, including those of stakeholders and those of citizens. On the other hand, it has a passive meaning. The term "pro-spect" might be better: "prospecting" meaning "looking forward" in Latin, indicating an active bet on the future. Indeed, Brown and colleagues speak of "prospective techno-science" (2000). This is perhaps a reason why the word "promise" came to be used more frequently. Moreover, the adjective "promissory" is

a quality attributed to something, while the verb "promising" indicates what proponents are doing and aiming at.

We came to speak, with Arie Rip, of a regime of promising for the speculative market, standing above research and innovation, which has consequences for the whole research system, for academia, and from which no discipline is protected.[5] For domains of science actually not perceived as competitive enough, the situation has often become "promise or perish" (Audétat et al. 2015). In Rip's view, a regime is not an institution: it holds as long it is fed by various flows coming together. It follows that it can break or collapse if one flow – or all flows – diminish, if trust disappears. Rip wrote an "STS fiction" about how this could happen in the near future, sketching a change in science policy that now asks for proof of concept before funding, prioritizing translational research, after a dramatic decrease of trust in the current system of scientific reputation and allocation of money (Rip 2015). Another proposition, coming from French scientists disgusted with the competition and the percentage of projects granted against the total number of applications (13-17%, according to estimates from the 2010s), would be to grant research funds by lottery. Competition in promising would decrease; fairness would improve.

The flows feeding the regime of promising are: 1) financial, the money granted to research on a competitive base; 2) scientific, the number of researchers applying for funding; and 3) communicational, the appetite in the media for technoscientific breakthroughs and future visions. The regime of promising technosciences results from an increase in competition at all these different levels. Global competition for technological leadership became more intense when China entered the game as a new player around the turn of the millennium. The term of "knowledge economy" has been used in the EU Lisbon Agenda (2000) as an answer to this perceived elevation of competition. More money has been granted to competitive technosciences, like the Flagship scheme, granting about a billion euro to promising fields. The Human Brain Project, as well as Graphene, obtained such strategic funding after, literally, campaigns of promising. Another competition, in addition to that between nation-states, is the one between different promising fields of technosciences, as well as within individual fields. The third type of competition which is added to these two takes place in the media sphere. It is perhaps this latter battlefield that is least well understood. The sociology of expectations is mainly interested in the functioning of visions, promises, and imaginaries within science policy and innovation systems, and less in the massive circulation, rewriting, and popularity of socio-technical imaginaries, including their cultural meanings. The bridge between STS and cultural studies always existed, although the linkage of popular culture with promises and innovation, as, for example, in Magaudda (2012), remains too rare and is to encourage.

6. Storytelling and the Economy of Attention

Yves Citton originally came from the field of arts and literature, later becoming a media sociologist who caused an earthquake in this field in the French-speaking world with *Mythocratie* (2010), *Pour une écologie de l'attention* (2014), and *Médiarchie* (2017).[6] Citton traces back the concept of the economy of attention, explaining how it came to dominate the media and cultural spheres. The concept is much older than the Internet, although it really became critical in relation to it from end of the 1990s. The economy of attention then rapidly came to be considered critical to work in and understand the digital transformations taking place in the media sphere (Citton 2014).

The basic idea of the economy of attention is that, for example, when it comes to the number of movies you can go watch downtown or at home in front of your television, or the number of novels published every year, it is simply impossible to pay attention to everything: the offer very much exceeds what you can watch or read. Any economy relies on resources, and in this case, the rare and limited resource is the attention an individual can pay each day, or week, which can by no means be increased or multiplied above a certain ceiling. With the globalization of access to the web, since the emergence of mp3s, YouTube, online video games, social networks, and more recently streaming platforms, the information and cultural goods available have increased manyfold, whereas the resource of attention has remained the same. As a matter of consequence, attracting attention became the main struggle for any informational or cultural product. The competition has only become fiercer and fiercer.

A whole business developed, very much centered on advertising professionals, which is concerned with how best to capture attention, maintaining it, creating addiction. According to Citton, at the turn of the millennium politicians, communicators, and managers discovered a treasure: storytelling. Storytelling came to be the privileged mode of communicating anything. Recipes and toolboxes multiplied that were aimed at helping advertisers, web managers, and business managers learn how to attract attention, notably through storytelling.[7]

As mere consumers (which we all are), it was difficult to understand why more and more things were made available for "free," and how so many costly informational services became "free," but we became accustomed to accessing things for "free." Of course, advertisement was there to explain part of this strange new economy – although it was difficult to understand all of its implications, until the following saying started to circulate widely: "If something is free, then the real product is you." So, nothing is for free: we are paying with our attention. It started to become clear that accumulating attention was equal to accumulating capital. The way in which the economy of attention has unfolded has numerous consequences, including for the print press and the public sphere as a whole.

It became a matter of survival for musicians, authors, journalists, and filmmakers. Since then, all cultural goods struggle to be noticed. Science and technology were subjected to the economy of attention as well, and promising conformed with these trends by producing catchy images, stories, and videos personifying desirable futures. SF writers and social scientists were asked, if not hired, to contribute to creating stories and writing or filming about how life would look in the future thanks to technosciences (Milburn 2002). The old scientific ethos of distancing oneself from common sense and the media was completely turned upside down. Even protected by its own rules, academia is subject to these trends determining how to stay afloat in the ocean of available (scientific) information. This generates bias. Take, for example, the two Stanford scholars who, in 2017, presented themselves as whistleblowers, warning that deep learning can now guess people's sexual orientation by analyzing their faces and thus determine if someone is gay (Baya-Laffite et al. 2018). Part of the explanation is that breaching ethical conventions has been a way to come to the fore, to get noticed and quoted.

Mythocratie, the title of Citton's book, is meant to speak to and restore the power of myth, the power of stories. The targets of stories are desires, values and identity – all dimensions that Citton collectively refers to as "affects," i.e., as what moves people. An individual's personal story, which facilitates identification by the audience, is central to these strategies. The rules of telling a story efficiently or touching people's emotions, together with all the tricks to attract attention, are about mind control. Yet, were the technosciences sheltered from the economy of attention? By no means. In fact, promising itself has been subjected to it, and pushed further and further by fabricating successful breakthroughs, promoting champions, and visioneering. Scientific expectations require the broadest possible popularity in order to influence stakeholders. Thus, the regime of promising may well have been shaped by the economy of attention, eventually explaining "why so many promises."

7. "Half of All Jobs Will be Automated by 2034"

Recalling the classroom dialogue reported at the beginning, let us consider how the story of job replacement by machines started, unfolded, and then calmed down. Around 2012, excitement was triggered by various mathematical paradigms and methods that were competing in the algorithm industry. Neural networks – a paradigm dating back to the 1960s that had been developed during the 1990s, before being left aside by industry in favor of statistical methods – were resurrected by computer scientists prior to 2010. Neural networks allowed automatic translation to achieve better percentages of correct matches against other more cumbersome methods relying on databases and heavy statistical work. Research-

ers also found that graphic cards (GPU) made for computer games can run neural networks.[8] Whether the return and take off of neural networks represented a breakthrough or was the result of continuous improvements remains controversial in computer science (Pasquinelli 2019). It has, however, been presented as a breakthrough and the term "deep learning" has been popularized as a metaphor for truly abstract mathematical work.

Just as the enormous hype about the "third spring of artificial intelligence" was gaining steam, two economists at Oxford University published a study conducted with the help of an algorithm about the impact of AI on the job market. Their aim was to investigate the probability of jobs being automated. They based their study on expectations concerning the combination of AI and mobile robotics. They took into account the prospects of algorithms being capable of equalling or exceeding humans in performing tasks, based their estimates on the skills machine learning was expected to attain, and took for granted applications envisaged as likely to be industrialized, like self-driving cars or holding a conversation. Then, they considered the many tasks included in jobs (whether routine or non-routine) that AI could theoretically do. They took for granted that algorithms can perform without human error and that they are by definition unbiased. They also excluded tasks entailing what they called emotional, creative, or social intelligence. They then turned to a US list of 900 occupations whose description is detailed, standardized, and kept up to date, finding that 702 were suitable for submission to the algorithmic method of probabilistic analysis. By the way, they made the classic mistake of confusing work and employment, concluding that many jobs in agriculture, industry, and especially in the service sector, like transportation, sales, call centers, accountancy, cleaning, household chores, food, mail, healthcare, etc., were threatened by AI and robots. Their computational method resulted in an estimate that 47% of US jobs were at risk of being automated in the near future. The resulting article was M. Osborne and C.B. Frey, "The Future of Employment: How Susceptible Are Jobs to Computerisation?" published in September 2013.

It took some time for the study to hit the headlines, beginning (perhaps) with the *Huffington Post* publishing a series of articles: "About a 50/50 chance a computer threatens to steal your job: paper," and "47% of all jobs will be automated by 2034, and no government is prepared says economist."[9] A few weeks later, the quote appeared absolutely everywhere: in the press, in online media, on television, and on social networks. It created one of the biggest buzzes of all time. If we could model its diffusion day by day over a few months and count the number of quotes, we would see a chain reaction. The story of job replacement soon reached everybody.

The Osborne and Frey study gave rise to escalating announcements, predictions, and simplifications, with a particular appetite for the disruptive impact AI was supposed to have on employment and society. To name just a few examples, in 2015, Merrill Lynch Bank:

> predicted that by 2025 the "annual creative disruption impact" from AI could amount to 14-33 trillion $, including [...] 8 trillion $ reduction in employment costs in manufacturing and healthcare.[10]

McKinsey Global suggested that by 2030, intelligent agents and robots could replace as much as 30% of the world's current human labor, from 400 to 800 million jobs, and that the transformation of society is "happening ten times faster and at 300 times the scale, or roughly 3,000 times the impact" of the (classic) Industrial Revolution. Some voiced their belief that 99% of all jobs would disappear. A modest study came to conclude that there is "a 50% chance of AI outperforming humans in all tasks in 45 years." (Grace et al. 2017).

With these announcements, anybody can construct his or her own story about the future of employment and society. Indeed, many people entered the game of prediction. For example, Yuval Harari (the author of *Sapiens*) wrote in *The Guardian* that "by 2050 a new class of people might emerge – the useless class, people who are not just unemployed, but unemployable."[11] In the French media sphere, for a couple of years, a physician assumed the role of a techno-prophet announcing the darkest-possible future. There was not a single day that he did not appear in the media. L. Alexandre especially targeted the education system, declaring on Swiss television that "schools are teaching pupils who will be wrecked by AI."[12] That was a few days before I came to the high school and heard the echo of this dark prediction in the mouth of the pupil.

More cautious studies about the prospected impact of AI on jobs have been conducted and published, but their voices could hardly be heard. For example, in 2014, the Pew Research Center published an expert's predictions that job loss was being balanced by the job creation resulting from AI and robotics, but its media impact was close to zero compared to Osborne and Frey, most probably because there were no striking results or figures. The excitement about the disruption of employment prompted many countries, think tanks, and research institutions to conduct studies on the same topic. Schlogl et al. examined about 200 reports about "the future of work" published between 2013 and 2018, two-thirds issued in 2017 and 2018 (Schlogl et al. 2021), i.e., directly as a consequence of the buzz created around AI that the study of Osborne and Frey contributed to. Unsurprisingly, the main generators of that kind of promising are big tech corporations. For four years, the hype around AI, which eventually attracted investment, pressured all countries to come up with a strategy in order to compete. It performed dominantly in the dystopian genre.

8. Why Have Pessimistic Promising of Disruption and AI Performed So Well?

A phenomenon already observed in relation to promising concerning nanotechnology (and other emerging sciences and technologies) is that many computer scientists felt uncomfortable with storytelling that was supposed to support their field. In the media, many experts have been saying that all this excitement is merely speculative. But it took time before it was possible to hear the more cautious voices. Again, to name some examples, experts stated that the idea of a "general artificial intelligence," which would make machines capable of competing with any kind of human agency, is groundless (Pasquinelli 2019). But the idea stimulates people (including computer scientists) to tell imaginative stories about the future. Reacting to the Osborne and Frey study about job losses and other prophecies, Rodney Brooks, a pioneer of AI, wrote an article entitled "The Seven Deadly Sins of AI Predictions: Mistaken extrapolations, limited imagination, and other common mistakes that distract us from thinking more productively about the future."[13] François Blayo, a professor in computer sciences and AI at the technical university HEIG-Vaud, in his address to a diverse audience, began by saying "Please, calm down."[14] Zachary Lipton, professor at the machine learning department at Carnegie Mellon University, has stated:

> […] people are afraid of the wrong things. [...] There are policy makers earnestly having meetings to discuss the rights of robots when they should be talking about discrimination in algorithmic decision making.

and concluded that:

> […] the interest in "machine learning" and "deep learning" has led to a deluge [...] of misreprentation of research for the purpose of generating retweets and clicks.[15]

Although disconnected from computer science, the story of robots taking all the jobs, that of general artificial intelligence, like that of colonizing Mars, indicate that plausibility is less important than the building of an imaginary in the population.

In March 2018, a series of events put an end, almost overnight, to this period of unbound hype and techno-prophecy. On March 18, an autonomous vehicle in trial by Uber killed a woman crossing the road at night in Tempe, Arizona. Other lethal accidents involving the use of the autopilot device in Tesla cars were then reported. The Cambridge Analytica scandal, although already known by a few people, aired that same month in 2018, revealing the malpractice that played a role in the Brexit referendum of June 2016, as well as in the election of Donald Trump in November of

the same year. Subsequently, the promising of AI, and especially the tone of disruption and dystopia calmed down. The number of references in the media sphere to self-driving cars, AI, and the job market dropped. More reasonable voices started to be heard. An OECD report that same year came to conclude that only 9% of jobs in the US were at risk, while 32% were at risk of important changes in relation to automation. A new study by McKinsey conducted in December 2017 concluded that, at around 2030, rather than a loss, there would be more likely a 14% increase in jobs.

Explaining "why pessimistic promising of disruption performed so well" requires us to go back to the previous decades. From the 1960s to the mid-1990s, economic growth and competitiveness was almost the sole justification given for funding technoscientific research, until one day this discourse centered on economic benefits went flat, no longer performing in a competitive environment. A need was felt to re-enchant the scientific endeavor, which could help emerging science and technology to create excitement. At the end of the 1990s, when struggles to attract attention became more severe, grand stories of technoscientific future made a comeback. Through the promises of eliminating non-infectious diseases, curing cancer, anti-aging, convergence at the nanoscale, etc., promising was turned toward a bright future. But after some time, it perhaps became too bright to be credible anymore. Therefore, bright futures have been overshadowed by more dramatic ones, futures of disruption, according to the new vocabulary of Silicon Valley. Disruption, which goes together with a dark future, became more attractive and more credible in the economy of attention. Performing with pessimism became the better approach, speaking of dramatic impacts on jobs, rather than repeating that technoscience will find solutions to everything. After nanotechnology and human enhancement started to lose popularity around 2010, venture capitalists and other stakeholders were glad to turn to societal disruption and AI.

At the same time, a TV series understood better than anybody what was happening. *Black Mirror* premiered in 2013 on the UK's Channel 4. Perhaps in opposition to nanotechnology, which hardly materialized in daily life, the smart phone, together with the algorithms directing advertisement that everybody experienced, was already making AI concrete. The success of *Black Mirror* shows that creating scenarios can serve different ends. In the case of the TV series, writing scenarios of anticipation that put technosciences at the center can result in very attractive and thoughtful entertainment. The promises of technosciences and future visions are performed by and for stakeholders, but at the same time, they acquire a life of their own in the media and cultural spheres, which then takes part in stabilizing or contesting socio-technical imaginaries.

The question then arises: do stakeholders and other individuals believe in the technoscientific promises they are exposed to? The verb "believing" is problematic, since it is still associated with religious truth and revelation. To understand what is at stake here, one should turn to theory

of representation in the arts. It is important to see, first of all, that people are not passive receptors of promises. On the contrary, there is always an act of reading implied. In light of differences, individuals may ignore, reject, doubt, or buy a promising discourse. Stories do not merely circulate, since many people elaborate on stories and rewrite them, scenarising further. Yet, what happens when we read a novel (e.g., an SF novel) or watch a movie? Citton refers to the philosopher Kendall L. Walton, the author of *Mimesis as Make-Believe: On the Foundation of the Representational Arts,* published in 1990 (Citton 2010, 81). The theory of arts speaks of "suspension of disbelief," i.e., we suspend for a while our doubts and skepticism about reality and credibility, in order to get into the story. Crafting and reading stories are thus part of a game of "make-believe." Usually understood in relation to cultural works alone, the game of "make-believe" may well be at work in promising science and technology. Do people believe in some particular promising vision? In fact, people decide whether to take it or leave it.

9. Fiction as Method

From the lab to the market, the success of innovations is highly uncertain, which is one reason why, in order to secure funding, promising is often assertive and technoscientific futures presented in deterministic terms. This is why scientific promises are fictions, although presented as future facts. In Arie Rip's words, scientific promises are to be approached as a literary genre (personal communication). Fictions and stories are essential to introducing or attempting to stabilize a socio-technical imaginary, which in turn is paramount in order to drain investment. It explains that technosciences need so much to play in the economy of attention, i.e., "why so many promises". Meanwhile, the bubbling of technoscientific promises makes the future more opaque, exaggerated hype is misleading (Joly 2010). Therefore, fiction has to be taken seriously, from an analytical point of view, as well as a method of engagement – the latter in order to enlarge space where promises and visions can be discussed, their desirability evaluated or contested. The use of fiction is a method for countering this opacity and fostering a debate about what is desirable, possible, and a priority.

Citton forged two concepts that may be of interest for our purposes, that of *scenarisation* and that of "contre-fiction," i.e., *counter-fiction* (Citton 2012). He elaborates on scenarisation beyond its meaning of staging: whereas narration is the art of telling a story, scenarisation concerns how to meet desires, affects, values, beliefs, and ultimately how to influence behaviors. The news are not given "reality," but always a mix of fact and fiction (Citton 2010; 2012), and telling stories, controlling the stories in circulation, is critical for governing, making war, or preparing society for some change. In the domain of promising technoscience, scenarisation would be

the art of influencing behavior, above all of stakeholders, and preparing acceptance of technosciences throughout society. Scenarisation is to be seen as the continuation of the analysis of the performativity of promises.

Yet, to call into question fictions presented as future facts, one can produce fictions of another genre, counter-fictions. *Brave New World* was a counter-fiction to Haldane's vision of ectogenesis. Arie Rip's short story about how the regime of promising can collapse is a counter-fiction. *Black Mirror* is undoubtedly a masterpiece of counter-fiction. As Isabelle Stengers explains, following author Donna Haraway (1996), "we need new types of narratives."[16] Counter-fiction can take the form of a picture, a story, or an essay, of a movie or a documentary. Collective participatory scenario-building is another method. Since the social sciences have excluded thought experiments, SF literature has been the place for alternative and reflexive stories reacting to the dominant stories about technoscience, power, economics, environment, women, and colonialism. The SF genre is diverse, although a series of authors have openly endorsed this commitment theorized by Citton and Haraway, such as John Brunner, Ursula Le Guin, Norman Spinrad, Margaret Atwood, and today Alain Damasio or Octavia Butler (to name a few). Counter-fiction does not mean contesting the plausibility of promising technoscience, but rather opening the deterministic boxes it is usually contained in. STS should be able to model the diffusion of stories in the media sphere at the time of their occurrence, to conceive counter-fictional materials and scenarios, and to engage with the public, in order to allow a debate about what technoscience could be, or should be, and to help disentangle the future.

Notes

[1] For an in-depth historical, sociological, and philosophical account of the term "technoscience," see Bernadette Bensaude-Vincent (2009).

[2] *Le Temps*, September 3, 2021; *New York Times*, January 4, 2022; *The Guardian*, October 17, 2022.

[3] *The Struggle for Meanings: Representation and Debates in the Nanotechnology Field*, session convened by Arianna Ferrari, Andrea Lorenzet, Marina Maestrutti and Federico Neresini, EASST Conference, Trento, September 2-4, 2010.

[4] Nanotechnology promises were not all highly speculative. Some were in play closely connected to laboratory work. As an example, see Crabu (2014), who analyses a promissory object existing besides the bold promising of nanomedicine.

[5] A secondary meaning is conveyed by the plural "regimes of promising," referring to particular conditions found when a broad promise is translated into the particular conditions of a country, for example, or for differing conditions when speaking of green electricity or personal medicine for which specific system of innovation and accountability are found (Robinson et al. 2021).

[6] Citton also publishes in the associative multi-journals *Multitudes, revue politique, artistique, philosophique* (www.multitudes.net), which is meant as a continuation of *Futur antérieur* (1990-1997) created by Toni Negri and is inspired by the Italian collective of authors known as Wu Ming. It contains several journal's titles, where many different issues are approached without unnecessary disciplinary borders in the human and social sciences.

[7] Citton mentions as an example T. Davenport and J. Beck (2001) *The Attention Economy: Understanding the New Currency of Business*.

[8] Sussan R. (2014, December 31) *Le "deep learning" pour tous?*. Internetactu.net. http://www.internetactu.net/2014/10/02/le-deep-learning-pour-tous/.

[9] Strachan, M. (2013, September 14) Huffpost. https://www.huffpost.com/ entry/computer-jobs_n_3926922.
Rundle, M. (2014, January 17) Huffpost. https://www.huffingtonpost.co.uk/ 2014/01/17/rise-of-the-machines-economist_n_4616931.html.

[10] The Economist (2016, June 25) *The return of the machinery question*, p. 3.

[11] Harari, Y.N. (2017, May 8) *The meaning of life in a world without work*. The Guardian. https://www.theguardian.com/technology/2017/may/08/virtual-reality-religion-robots-sapiens-book.

[12] RTS Info (2017, October 3) *L'école forme des enfants qui vont être laminés par l'IA*.

[13] Brooks, R. (2017, October 6) *The Seven Deadly Sins of AI Predictions: Mistaken extrapolations, limited imagination, and other common mistakes that distract us from thinking more productively about the future*. MIT Technology Review. https://www.technologyreview.com/2017/10/06/241837/the-seven-deadly-sins-of-ai-predictions/.

[14] Blayo F. (2018, August 23) *Voyage au centre de l'IA*, Numerik Games Festival, Yverdon-les-Bains.

[15] Quoted by O. Schwarz (2018, July 25) *"The discourse is unhinged": How the media gets AI alarmingly wrong*. The Guardian.

[16] Isabelle Stengers, professor at the Université Libre de Bruxelles, and Fabrizio Terranova, director of the movie *Donna Haraway: Story Telling for Earthly Survival*, 2016, 77', invited at the Haute école de travail social (HETSL) and the University of Lausanne, February 6-7, 2018.

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