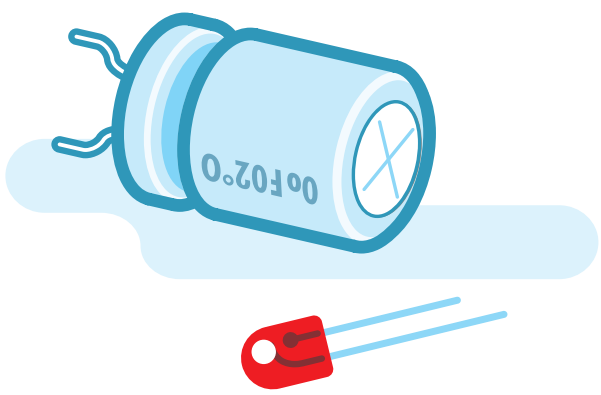
CCF13

COLOGNE CONFERENCE FUTURES

ANNUAL SYMPOSIUM ON MEDIA EVOLUTION



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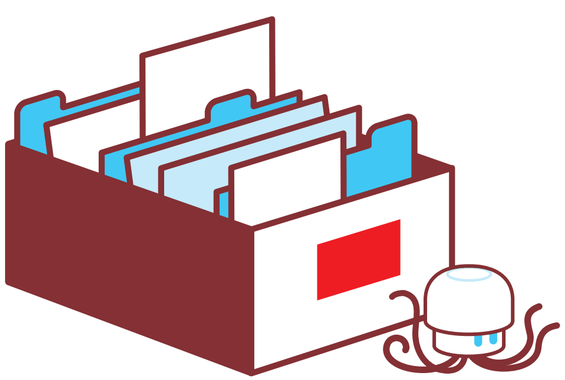
DOCUMENTATION



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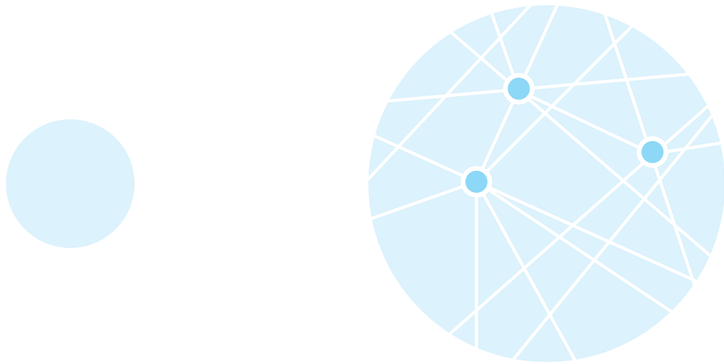
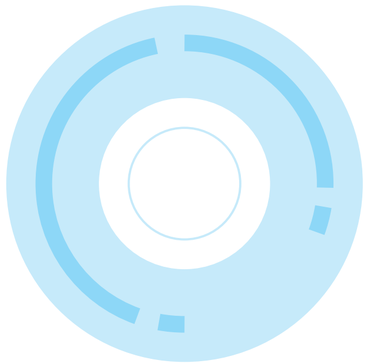
EDITORIAL





The development, interdependence and ever-increasing complexity of media and technologies has reached such a level that one comparison seems inevitable: natural evolution. New technologies emerge from old ones, computer chips auto-design the next generation of computer chips, and self-replicating robots won't be science-fiction much longer. On top of that, neuroscience, bioinformatics, and genetic engineering erase the boundaries between the animate and the inanimate world, merging nature and technology in ways never seen before.

Describing technology in evolutionary terms as an ecosystem is more than just a metaphor. *Wired*-co-founder Kevin Kelly outlined the contours of this global super-organism, its life-cycles, its growth and its boundaries in his book *What Technology Wants*.

To address the consequences for us humans living alongside and within this technological organism and the ways we think about its possible and impossible futures, *Cologne Conference Futures* (CCF) was established as an annual symposium on media evolution in 2013, taking place each year at the beginning of October in Cologne as part of the renowned TV and media festival Cologne Conference. CCF is the joint brainchild of the Institute for Media and Communications Policy (IfM), the think tank and design agency Zentrale Intelligenz Agentur (ZIA), and the Shareground unit of Deutsche Telekom.

Each year, CCF focuses on a specific topic, invites 4-5 German and international speakers and an expert audience of about eighty scholars, journalists and professionals from the media industry.

In 2012 there was a first trial run of the symposium with contributions by cyberlaw and net neutrality expert Tim Wu, critic of the „Californian Ideology" Richard Barbrook, philosopher and TV journalist Gert Scobel and journalist and media scholar Philipp Albers of Zentrale Intelligenz Agentur. Their lectures have been documented in the German trade journal of the media industry, *Funkkorrespondenz* (vol. 20/2013, May 17, 2013).

CCF13, documented in this publication, tackled "Future Biases", exploring the scope and validity of prognostics in the field of emerging technologies. Can we know in which direction this weird creature Technology will be heading and how it will interact with humans? Is the singularity inevitable? Or are all predictions doomed to fail in light of increasing complexity, uncertainties and "black swans"? What are the blind spots in the forecast of future media and tech developments?

CCF13 tackled "Future Biases", exploring the scope and validity of prognostics in the field of emerging technologies. Can we know in which direction this weird creature Technology will be heading and how it will interact with humans?

In their introductory remarks the conference organizers Lutz Hachmeister (IfM) and Holm Friebe (ZIA) layed out the main issues and guiding questions for the symposium.

Kevin Kelly in his opening keynote then painted the next transitions and long-term developments in the evolution of media and technology in broad, bold strokes, calling for the need of positive visions, predictions and science fiction in an ever-faster changing technological world. Cloud computing makes ownership less relevant and access crucial, artificial life further changes the way we work and live, and the "Quantified Self" changes the way we observe our bodies. While these changes of the next 20 years might make the changes of the last 20 years seem relatively small, the products that will *really* change us are not even invented yet.

Dan Gardner highlighted and illustrated the importance of cognitive biases in the prediction business. The disillusonary findings: by and large renowned experts are no better in their future judgement than anybody else. But there is hope: a critical and cautious mindset makes up for better results and even "superforecasters".

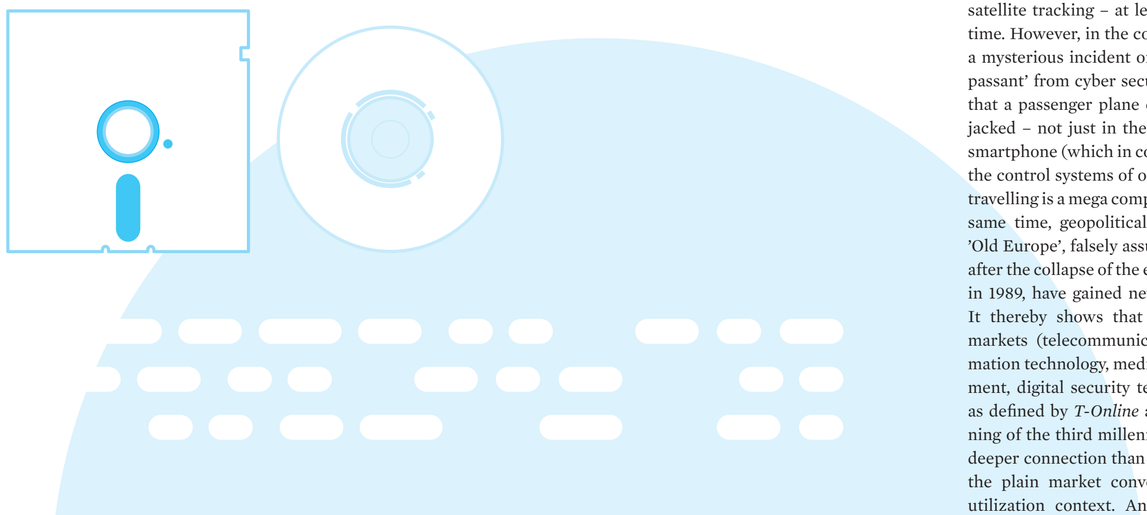
In the final lecture, Kathrin Passig analyzed the argumentative structure of utopian as well as dystopian thinking about technology and what the recurrence of this structure tells us about our ways of dealing with technological change. There are, however, techniques of avoiding to think and reason in these patterns.

We live in the age of prognostics. Predictions are necessary, even though we regularly fail at them. Knowing about the inherent limits of prognostics – our psychological, social, and technological future biases – might not make us more accurate prophets, but helps us to fail better at glimpsing the future.

Philipp Albers, Cornelius Reiber

LUTZ HACHMEISTER

INTRODUCTION



Dr. Lutz Hachmeister is the founding director of the Institute for Media and Communication Policy in Berlin. He is an associate professor for journalism at the University of Dortmund and president of the international film and television festival Cologne Conference.

Lutz Hachmeister is considered one of Germany's most renowned documentary filmmakers and authored numerous non-fiction books on contemporary historical and media political topics.

Recently, a number of reports have been published regarding the boom of new plans for architecturally elaborate libraries. One could think that these were investments in long obsolete "paper museums" (Kathrin Passig) being done for prestige reasons – but that would be missing the point: Apparently, new spaces are being created which allow the coexistence of media artefacts and new information technologies. And as it seems, these instances of social reproduction are being accepted by the citizens who precisely are not just "users". From a sociological and humanistic perspective it becomes clear that such initially contradictory processes can only be analyzed – and possibly even well and reasonably predicted – with McLuhan's collidoscope and an advanced model of media evolution.

In our days of the alleged "digital total interconnection and total communication" (Byung-Chul Han) it appears to be possible for a Boeing Triple Seven to disappear from all radar and satellite tracking – at least for some time. However, in the course of such a mysterious incident one learns 'en passant' from cyber security experts that a passenger plane can be hijacked – not just in theory – with a smartphone (which in comparison to the control systems of original space travelling is a mega computer). At the same time, geopolitical conflicts in 'Old Europe', falsely assumed settled after the collapse of the eastern block in 1989, have gained new relevance. It thereby shows that the TIMES markets (telecommunication, information technology, media, entertainment, digital security technologies), as defined by *T-Online* at the beginning of the third millennium, have a deeper connection than indicated by the plain market convergence and utilization context. An intellectual approach to this complex demands the consideration of anthropological, evolutionary biological and geostrategic vectors. Every conventional technology critique, which already has run out of words over the constant evocation of the "digital revolution", will remain blind without any concept of the co-evolutions of biological, psychophysical and technological potentials.

In this sense, Martin Heidegger's philosophical insight applies that the nature of technology itself is nothing technological.

At the Cologne Conference 2012, we began posing the question about "media evolution" more decidedly and systematically. Immanently connected to this is the work on the definition of "media" following the Canadian school of media theory and, moreover, the question of the comparability of developments in the information and communications technology, and the biological-physical evolutionary theory. At this opening colloquium, Philipp Albers, Gert Scobel, Tim Wu and Richard Barbrook measured the transdisciplinary field, considering aspects of global economics and the history of mentalities.. The following event in 2013, which is documented here, added the factor of predictability, a field formerly called "futurology" – think of names like Robert Jungk or Karl Steinbruch in Germany or Alvin Toffler and Herman Kahn in the US. This "futurology" had lost its charm over the ecological technology skepticism of the 1970s and 1980s and has withered away into "sociology of technology" or "accompanying research" (*Begleitforschung*). Today, short-winded and often ideologically and economically grounded tech-conferences seem to haven taken their place. But perhaps it is just McLuhan's already classic observation of the narcotic effect of technological disruptions that applies here.

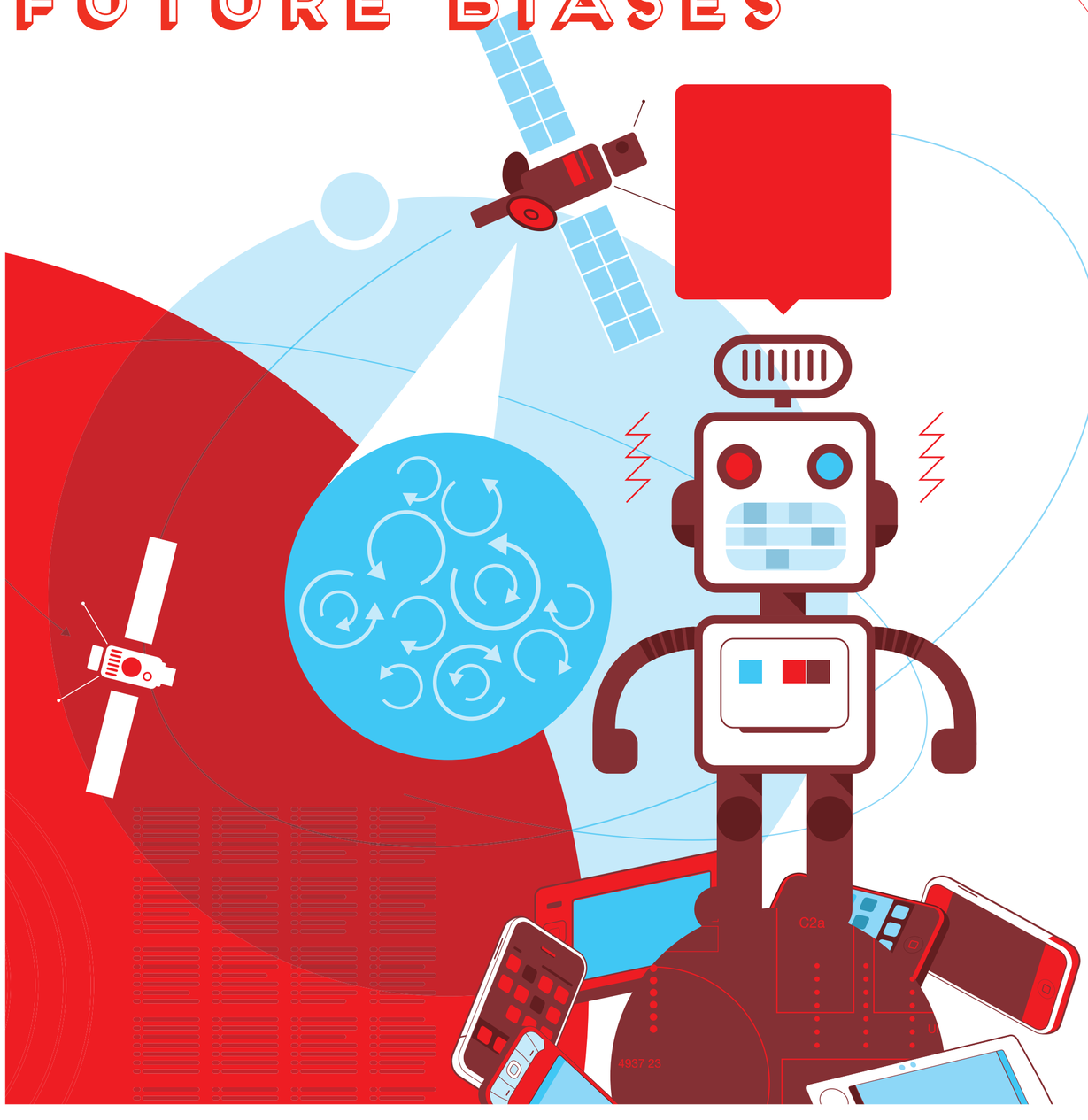
Generously supported by the Deutsche Telekom and the city of Cologne and in cooperation with the Zentrale Intelligenz-Agentur (ZIA), the *Cologne Conference Futures* (CCF) has now been established. Holding their presentations inside the impressive Stiftersaal of the Wallraf-Richartz-Museum in Cologne, Kevin Kelly, Dan Gardner and Kathrin Passig connected technological dynamics, the challenges of management in the information and communication industries, and the conventions of the psychophysical acquirement of new techniques of consciousness. When Kevin Kelly, to pick just one example, outlines the meaning of techniques of *self-optimization*, specifically the feedback between a permanent data stream and human bodies, it becomes clear that a primarily technological assessment of this phenomenon does not suffice. Moreover, the growth of all hyperconnected, electronical risk technologies is accompanied by the need for security and the wish for institutionalized defense against undesirable political or terroristic interventions. The management of the telecommunication and IT companies needs to thoroughly prepare for and expect these ambivalences. It therefore requires parameters of a *societal prognosis* exceeding mere trend research.

For a further exploration of the questions about technological and "media evolution", it would make sense to follow the model of the "Altenberg 16", the group of international evolutionary biologists, and develop a guiding catalogue of questions whose partial aspects can then be exemplified and elaborated further during additional Cologne Conferences. Does the differentiated examination of "media evolution" and general technological dynamic make sense? How do biochemical evolution, cultural-technical development and the evolution of reflexive consciousness interact? Does "information" – in the sense of the evaluations of Norbert Wiener, Claude Shannon and Warren Weaver from the 1940s – become the transboundary substantial term of genetics, mathematics, physics, linguistics and the human sciences in general (which, incidentally, already Heidegger suspected)? Where does our ability to predict future technologies come from? Which visions of the future presented by the media affect our attitude towards the conceivable *futures?* Is the "digitalization" an intermediate technological state (whereupon the poor metaphor of the "digital society" already misleads) and which transport and transmission technologies exceeding it are imaginable? Which (geo-) political, military and economical dynamics, fractionations and resistances result from this?

What is sure is that 70 years ago, excluding the few visionaries of IT and cybernetics, such questions and fields still used to belong to the domains of science fiction. By now, the technological present has largely voided the science fiction. In an unexpected way, the future is transferred into the present time. Whether that leads to a stronger willingness to adapt or new resistances or whether this matter will be settled transhumanistically, provides the material for further predictions and debates at the Cologne Conference.

HOLM FRIEBE

FUTURE BIASES



Holm Friebe, economist and journalist, is co-founder of Zentrale Intelligenz Agentur in Berlin and a teaching professor for “Design Theory” at the Hochschule der Künste in Zurich and the Kunsthochschule Kassel.

He has authored best- and long-selling non-fiction books, among others **Wir nennen es Arbeit – die Digitale Bohème oder intelligentes Leben jenseits der Festanstellung** (together with Sascha Lobo, 2006) and **Die Stein-Strategie – Von der Kunst, nicht zu handeln** (2013).

The following text is a transcript of a lecture held at the Cologne Conference Futures 2013 – the Annual Symposium on Media Evolution Cologne, October 2nd, 2013

The principal topic of Cologne Conference Futures is “Media Evolution”. A concept, at first glance, pretty simple and obvious: Media is evolving. We witness that everyday. But this idea implies at least two problems: First, in what capacity does the analogy of biological evolution apply to technological progress? And what does it imply? Is it a mere metaphor? Or is there really an evolutionary logic underlying the developement of the media system?

There is an evolution-like progress in technology in the sense that one thing leads to another, one innovation inspires the next. There is a mechanism of mutation (by scientists and designers) and selection (by the market).

Obviously, there is an evolution-like progress in technology in the sense that one thing leads to another, one innovation inspires the next. There is a mechanism of mutation (by scientists and designers) and selection (by the market). There are, as we can see from the evolution of, say, electric shavers, bifurcation lines where the genealogical tree branches out. Some branches die off, others prosper. But does technological progress follow a specific trajectory, an autonomous path? “What does technology want?” to quote Kevin Kelly. Is there really a “technium” out there, an autonomous superorganism that only needs humans to feed and nurture it? “By aligning ourselves with the imperative of the technium, we can be more prepared to steer it where we can and more aware of where we are going. By following what technology wants, we can be more ready to capture its full gifts.” writes Kelly, and it’s more than just a frivolous anthropomorphizing of technology.

Second, can we predict the path of technological evolution? Are there recurring patterns we can detect and then apply for prognosis? Let’s go back with this question to the evolution of the biosphere:

In 2002 the BBC, Discovery Channel and some other TV stations teamed up with biologists, to start an experiment. Can we predict the path of biological evolution after the extinction of mankind? What will the biosphere look like in 5, 100, 200 Million years? The result was the animated documentary series “The Future Is Wild”. In 100 million years Antarctica will have shifted to the equator, sparking an evolutionary push of new species: the poggle, the last land-living mammal, harvested by silver spiders; the toraton, a giant tortoise that grows to 120 tons, etc.

Is this scientific? Yes. It is science fiction in the literal sense, every creature presented has an underlying plausible rationale. Will these creatures come to life? Most probably not. Although we understand the underlying forces – geological plate tectonics, climate change – evolutionary processes always carry an element of contingency that makes them impossible to predict.

The same is true for technical progress and media evolution. They result from the overlay of different systems with different rates of predictability.

1. Mechanical Systems

Like the stellar system, mechanical systems strictly obey the laws of physics and therefore are pretty good to predict – exactly, mathematically.

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In technological evolution Moores Law – stating that in the course of computing hardware’s development, the number of transistors on integrated circuits per US-Dollar doubles approximately every two years – comes closest to an underlying mechanical trend. It charts a steady trajectory of exponential growth. Ray Kurzweil has traced it back well beyond microprocessors to the year 1900 and it holds true over five different specieces of computing – from punchcards to transistors to integrated circuits – a straight line. Still we must not confuse it with a law of

physics. It is more of a self-fulfilling prophecy induced by corporate decision-making processes.

2. Chaotic Systems

Chaotic or fractal systems, such as the weather system, are characterized by many bifurcations and a high feedback rate, resulting in non-linear dynamics. They are easy to model and simulate, but truly impossible to predict – in the medium and long run.

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A good example is climate change. Although the models are very sophisticated and IPCC-scientists pretend they know all about the human impact on global warming, the results have recently been challenged by the real climate curve that lies way beneath the low estimate of 1990. A typical example of "models behaving badly" – because reality is always more complex.

3. Socio-cultural Systems

It becomes worse once you insert human beings and brains into the (feedback-)loop, e.g. in financial markets.

Social behaviour becomes quite predictable – if you have enough data points. Humans, statistically, behave quite coherently and can be tackled with smart algorithms.

„In physics you're playing against God, and He doesn't change His laws very often." writes Emanuel Derman in *Models.Behaving.Badly.* (2011). "In finance, you're playing against God's creatures." And God's creatures use „their ephemeral opinions" to value assets. Moreover, most financial models „fail to reflect the complex reality of the world around them." On the other hand, social behaviour becomes quite predictable – if you have enough data points. Humans, statistically, behave quite coherently and can be tackled with smart algorithms. "Wunderkind" Nate Silver has proven that for the US-elections by correctly forecasting every state outcome using a proprietary statistical model. German forecasting institutes did not do that badly either, forecasting the surprising results of the recent German election. Still, even the best forecast by FORSA missed the exact result of the CDU and Die Grünen by 1.5 percent – a relative deviation of 3.5 respectively 18 percent. Not nothing.

Prognostic Borderline

Some scientists like Dirk Helbing of ETH Zürich are optimistic that they cannot only model and forecast socio-economical systems by intelligent use of big data, but make them better controllable – Helbing recently failed to raise 1 billion Euro for his FutureICT-project "Living Earth Simulator". However, there seems to be an essential and fundamental "prognostic borderline" for what we can know or find out about the future. John D. Barrow states it in his book *Impossibility* (1999). Although we might be able to push this borderline a little bit further into the future with smart algorithms and sheer computing power, we should be aware of the fundamental impossibility to overcome the threshholds and epistemological limits of human knowledge about the future. The more you know, the more you know you don't know. We might be even better off practicing a more humble attitude toward the future.

That brings me to the topic of this years CCF: future biases. Our mistakes in predicting the future are not randomly distributed. They don't add up to a bell curve – as you would expect it of a rifleman shooting at a target many times. Instead, they are oftentimes biased, meaning they are systematically wrong, because we structurally make the same mistakes over and over again. By understanding the patterns of our biased thinking about the future – that is the great hope – we might get better in eliminating future biases and eventually get a better grip on how the future, how technology and the media system might evolve.

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Biases

Cognitive biases have for some decades now been been subject of extensive scientific research, mostly in the new discipline of behavioural economics. Wikipedia lists over 200 different biases, some familliar and overlapping, some mutually exclusive and contradictory. Daniel Kahneman, Amos Tversky and Dan Ariely are the pioneers in the field of experimentally researching biases. Their books have become bestsellers only recently and there are also popular adaptations currently on the bestseller lists, such as Rolf Dobelli's *The Art of Thinking Clearly* (2013). I will highlight only two biases that seem fundamental to me for our topic. Dan Gardner is the expert in that field and will surely supply much deeper insights later on.

Our problem – to get the future right – is strongly intertwined with our problem to get the past right. The name for this is hindsight bias.

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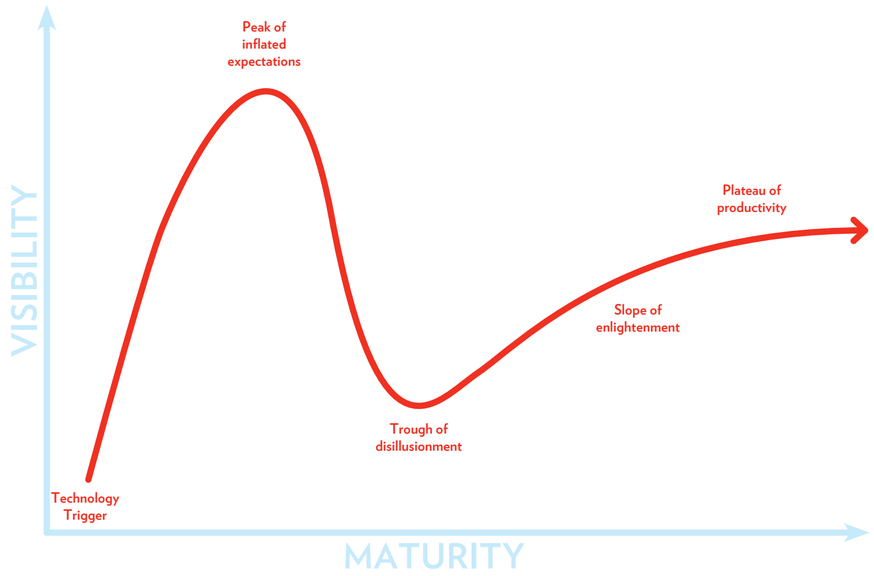
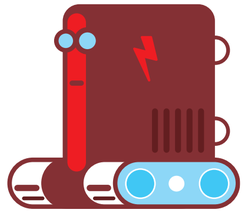
Hindsight Bias

It addresses the simple truth that we get smarter as we go along and can't imagine in retrospect how it felt to not know how things eventually would develop. After the cookie actually crumbled in a certain way, we think, it was always obvious it would do so. We rearrange the past in such a way that it neatly fits the present, highlighting predictions that nailed it and masking out the pink noise of erring forecasts. For example, if we come accross a one hundred-year-old vision of the cellphone like this by Robert Sloss on "the wireless century" from a book of 1910 edited by journalist Arthur Brehmer called *The World in 100 Years.*

Gartner's Hype Cycle:





„Die Bürger der drahtlosen Zeit werden überall mit ihrem 'Empfänger' herumgehen, der irgendwo, im Hut oder anderswo angebracht, auf eine der Myriaden von Vibrationen eingestellt sein wird. Der Empfänger wird trotz seiner Kompliziertheit ein Wunder der Kleinmechanik sein. Konzerte und Direktiven, ja alle Kunstgenüsse und das Wissen der Erde werden drahtlos übertragen sein. Monarchen, Kanzler, Diplomaten, Bankiers, Beamte und Direktoren werden ihre Geschäfte erledigen und ihre Unterschriften geben können, wo immer sie sind, sie werden eine legale Versammlung abhalten, wenn der eine auf der Spitze des Himalaya, der andere an einem Badeorte ist."

We might think: wow! This guy is an amazing prognostic genius commanding visionary superpowers. But it might as well have been a statistically unremarkable lucky punch that occurs every once in a while. Not unlike the chimpanzee with the typewriter that eventually writes *Romeo and Julia,* or the broken clock, that is right twice a day.

We rearrange the past in such a way that it neatly fits the present, highlighting predictions that nailed it and masking out the pink noise of erring forecasts.

Overconfidence

Next one is maybe the mother of all biases concerning future predictions. The "overconfidence effect" is twofold in leading to prognostic errors. First, experts tend to overestimate their prognostic qualities. "I feel lucky" is their default state of mind. Secondly, they overestimate the impact of their special topic on the overall developement of the future, because they are too deep into it and confuse it for the rest of the world. If you are, say, an expert on social media marketing, you live in your personal filter bubble together with other experts on social media marketing, reading their articles, going to the same conferences, reassuring yourself together with them that social media marketing definitely is the one and only next big thing.

Hype Cycle

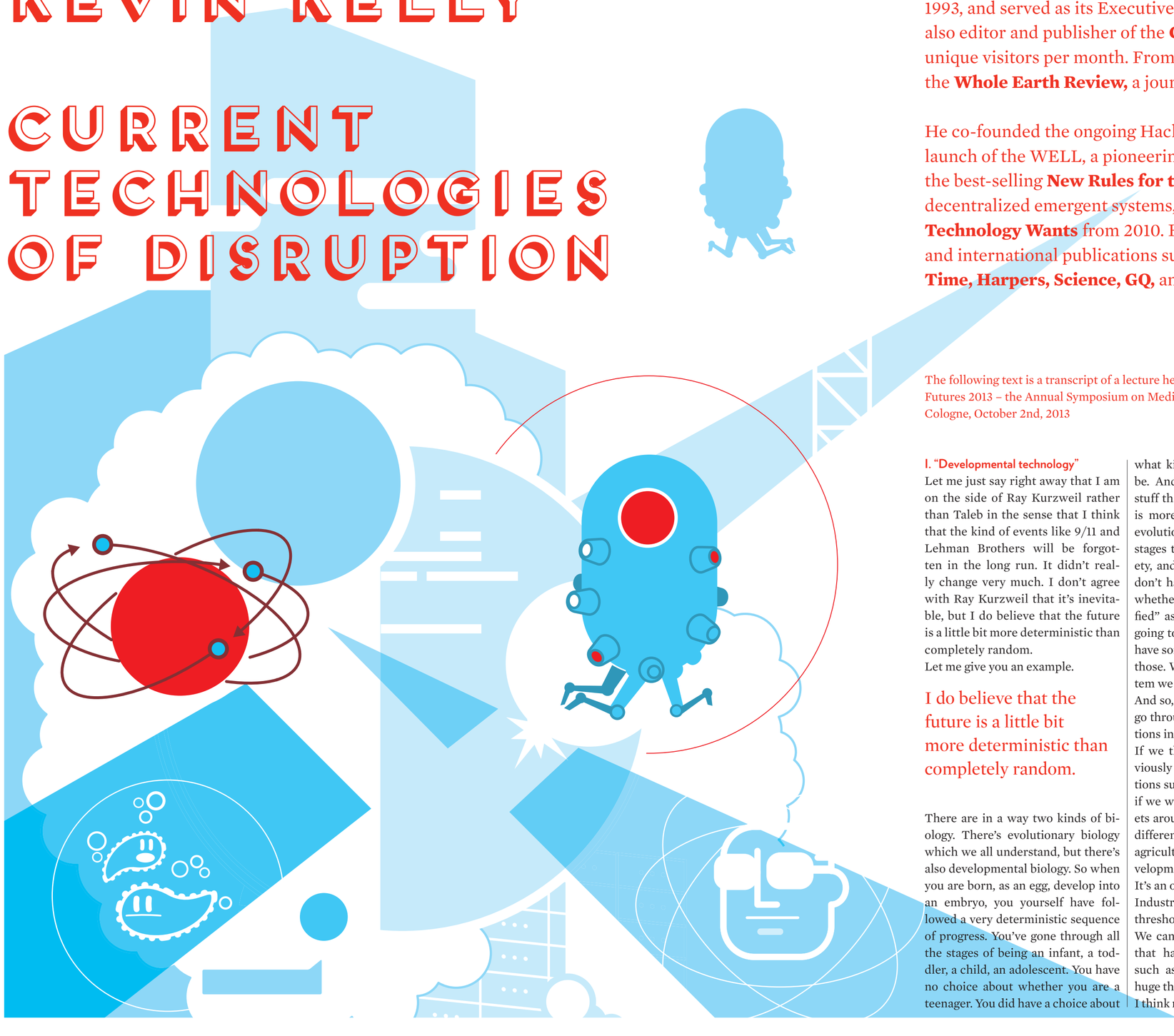
On a collective level this overconfidence bias of experts' public opinion – emphasized through the media feedback loop – leads to a recurring pattern of public over-enthusiasm and public disappointment. Jackie Fenn, who charted it first for Gartner Consulting, coined in the mid 1990s the now iconic "hype cycle". It mirrors a damped oscillation until both curves – the medial excitement and the actual distribution of new technologies – meet on the "plateau of productivity." The hype cycle encapsulates the truth that we overestimate the short-term impact of new technologies, but – second part of the equation, because we tend to be disappointed too easily – underestimate their long-term impact. "Don't invest in a technology just because it is being hyped or ignore a technology just because it is not living up to early over-expectations." Jackie Fenn summarizes the message of the hype cycle. And this is maybe a good starting point for dealing with future biases and our conference day.

Determinists vs. Skepticism

Just one more thing. Mapping the playing field of prognostics, there are two extreme positions standing out, marking the outposts. In the left corner of "determinism" we see Ray Kurzweil, plotting Moore's Law towards the future and predicting that by 2045 mankind will inevitably gain immortality, just by the sheer number of circuits in the world. In the other corner of "skepticism" we have the fundamental skeptic Nassim Nicholas Taleb who states: whatever we might plan, in the end it is all in vain, because something else will happen, a Black Swan will cross our plans, some very unlikely event with enormous impact such as 9/11 or Lehman Brothers. Hence we should better not make any plans at all, and remain within a humble and fatalistic position of "Antifragility." I am curious to see, where in this field our experts, Kevin Kelly, Dan Gardner, and Kathrin Passig position themselves.

KEVIN KELLY

CURRENT TECHNOLOGIES OF DISRUPTION



Kevin Kelly is Senior Maverick at **Wired** magazine. He co-founded **Wired** in 1993, and served as its Executive Editor from its inception until 1999. He is also editor and publisher of the **Cool Tools** website, which gets half a million unique visitors per month. From 1984-1990, Kelly was publisher and editor of the **Whole Earth Review,** a journal of unorthodox technical news.

He co-founded the ongoing Hackers Conference, and was involved with the launch of the WELL, a pioneering online service started in 1985. He authored the best-selling **New Rules for the New Economy** and the classic book on decentralized emergent systems, **Out of Control.** His latest book is **What Technology Wants** from 2010. Kelly's writing has appeared in many national and international publications such as the **New York Times, The Economist, Time, Harpers, Science, GQ,** and **Esquire.**

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I. "Developmental technology"

Let me just say right away that I am on the side of Ray Kurzweil rather than Taleb in the sense that I think that the kind of events like 9/11 and Lehman Brothers will be forgotten in the long run. It didn't really change very much. I don't agree with Ray Kurzweil that it's inevitable, but I do believe that the future is a little bit more deterministic than completely random.

Let me give you an example.

> I do believe that the future is a little bit more deterministic than completely random.

There are in a way two kinds of biology. There's evolutionary biology which we all understand, but there's also developmental biology. So when you are born, as an egg, develop into an embryo, you yourself have followed a very deterministic sequence of progress. You've gone through all the stages of being an infant, a toddler, a child, an adolescent. You have no choice about whether you are a teenager. You did have a choice about what kind of a teenager you would be. And I believe that a lot of the stuff that we're seeing in technology is more developmental rather than evolutionary. So there are certain stages that we go through in a society, and as we go through them, we don't have much choice in terms of whether we're going to be "electrified" as a society, or whether we're going to have agriculture. But we do have some choices about how we use those. What kind of agricultural system we have.

And so, what I want to try to do is to go through some of the major transitions in the past.

If we think about our cultures, obviously there are some major transitions such as agriculture, and I think if we were to visit many, many planets around the universe and come to different civilisations, the stage of agriculture would be a common development in many of those planets. It's an obvious thing to do.

Industrialisation is another kind of threshold that we've gone through. We can think of more recent stages that have reorganised our society, such as electrification. That was a huge thing. That was a transition that I think many civilisations throughout the galaxies would go through. And we have the computerisation and automation. That was a huge transition that just reformed things. Again, if you were to visit many, many planets around the universe, you would expect many of them to have gone through the developmental stage of automation and computerisation. And so the question would be: Where else are we going?

And I do think that there is something very powerful about the idea of a bias. For instance, if we were to send everybody here into a time-machine and send you back just twenty years into the past, and you tried to explain to your friends and family what we have right now, you would be saying things like, "We've got this one thing in our pocket, and by using it, I can not only talk to my friends, but I can see every street and every city. It's got the latest stock quotes. It's got news in real time from around the world. I can ask it questions and it can tell me answers. It's got an encyclopaedia..." It goes on and on. "And oh, by the way, most of the stuff is for free." Your friends twenty years ago would say, "That's impossible. There's no economic model in the world that would support that. You're making that up!" And yet here it is. We have the impossible. Wikipedia: Here is an encyclopaedia, probably the best encyclopaedia we've ever had available for free, that's made by the fact that anybody can edit any article. That is impossible. Everything about human nature that sociologists have been telling us for a long time, would say: There's no way that this would work. So what we're learning is that we have to believe the impossible a lot easier.

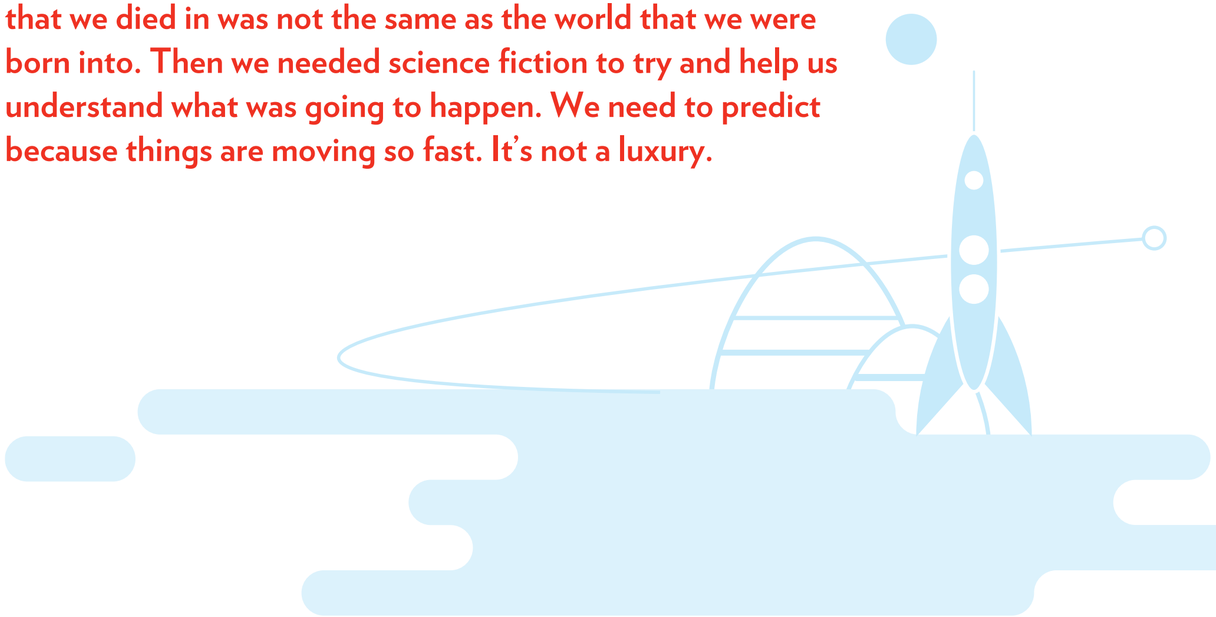
> We have to believe the impossible a lot easier.

So what I'm going to try and talk about is that some of the thresholds and some of the things I may suggest may seem impossible. But remember about Wikipedia! Remember about Google Street View! Remember about all these things that we have! Sometimes, we have to release our ideas of what is possible in order to accept them.

II. Long-term developments

So let me do a quick introduction to some of the long-term, Ray-Kurzweil-version of transitions or thresholds that we're coming up to. Kind

We had no need for science fiction until the moment when the future would change within our lifetime. So the world that we died in was not the same as the world that we were born into. Then we needed science fiction to try and help us understand what was going to happen. We need to predict because things are moving so fast. It's not a luxury.



of the far future. And I think Lutz Hachmeister is right, that it took many, many years for science fiction to be invented; we had no need for science fiction until the moment when the future would change within our lifetime. So the world that we died in was not the same as the world that we were born into. Then we needed science fiction to try and help us understand what was going to happen. We need to predict because things are moving so fast. It's not a luxury. We have to think ahead because we're moving so fast, because we know that the world that we're going to and the world that our children will live in, will be different from the world that we're in right now. It has become a necessity to look at things in the future. We may not be right, but we have no choice.
And so science fiction has failed us right now, because there is no positive view of the future. We have tons and tons of dystopian views how the world will end: the collapse of everything. But we don't really have a single positive view of a future that we all want to live in, right? I mean, we can make these utopian views that don't seem believable, but where is a science fiction story of a world that we all want to go to? We haven't had that since the 1950s. And I think this is a real problem and challenge for us right now: We're having trouble imagining a place that we want to go to in the future. And I think unless we can imagine it, we're not going to get there. Rather than being stymied or prevented by the fact that we may get it wrong, I think there is a tremendous benefit in trying to imagine a future that we want. So here are some of the thresholds that I see coming of a planetary system which I call "The Technium". These are all planetary-scale stages that I think any civilisation will go through.

→ The first one is that we invent an **artificial intelligence.** Think about "HAL": That's the bad version of it from Stanley Kubrick's "2001: A Space Odyssey". They are not going to happen over night. But eventually, we will have some kind of "smartness" that we can purchase, that we can just buy and use. And that will change lots of things, for many reasons that have been talked about. Not alone is the fact that the AI can help us make another AI. So that is coming and will be very consequential when it happens.

→ The second one is **artificial life.** That means many things. For example the kinds of artificial life that Craig Venter is working on: He's trying to make a synthetic cell from taking DNA, which they sequenced from a computer, and then start it from the bottom up, making an artificial cell that they can then direct to do many different kinds of things. There's a little bit more control over a cell that you make from the beginning. The kinds of things that Craig Venter would like to do is to make bacteria that could for instance dissolve oil from oil spills or even permeate into a rock to extract the gold. There's lots of things that these little tiny cells can do. And if you have control over them by making them artificially, that again is a very powerful threshold, a very powerful technology, that we call an "enabling technology" because it enables other technologies. So these can all be thought of as coming enabling technologies.
→ Another planetary stage that we'll go through is that we'll eventually make a **universal family tree.** Every one of us here is related. Our relation goes way back. As we start to make it common for everybody here to have their full gene sequenced, we can use what history we have and we can use DNA to figure out how everybody is actually related, including everybody who used to live in the past.
Thus, we can actually assemble a universal family tree and show that every single person on this planet, alive and dead, is related in a certain way. That's a very powerful thing that helps medicine and changes our understanding of culture. Again, that's another threshold, a coming enabling technology.

→ The **"All Species Inventory"** is something that I was involved in starting, which was a campaign to identify and catalogue every living species on this planet. To my horror, I discovered years ago that we've only identified

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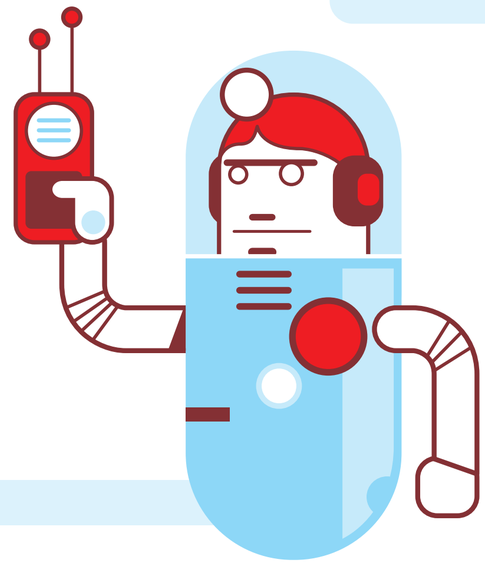
five percent of the living species on this planet so far.



I think that if we found life on Mars somewhere, the first thing we would try to do is do a systematic survey of that planet to see everything else that was there. But we've given that up on our own home planet. We're trying to do biology and ecosystem management without even knowing all the species. That is like trying to do chemistry without knowing all the elements. Knowing all the species on the planet is one of the stages that any civilisation will go through at some point.

→ There's the **"Memorex",** which is this idea that eventually every song, every book, everything that you do will be saved and catalogued together. We save everything basically. So

We've only identified five percent of the living species on this planet so far.

you have complete "Memorex" of the entire culture that's available and can be searched and unified. Think of it as a kind of unified universal library. We're on our way to that. That again is enabling technology.

→ **"Mirror World"** is the idea that we'll make a virtual world that mirrors our own world. So there is a kind

We save everything basically. So you have complete "Memorex" of the entire culture that's available and can be searched and unified.

of a virtual New York City in a computer that is reflective of the actual city – there is a mirror of it that is data-driven, that is kind of a data-reflection. And that world is where you can do simulation. So if you have a Mirror World, you can begin to simulate: What happens if...? Or if we do this that way, what happens? That is one of the advantages of having a Mirror World. The other one is that you can record and you can begin to analyse things. You can extract patterns that you wouldn't normally see. So it is the idea that there is a data mirror for large, complex systems.

→ Every planet will go through a stage in which the entire system begins to work as a whole. I call that the **"Global Super-organism".** There's not really a good name for it. But the idea is as follows: Everybody in this

We'll make a virtual world that mirrors our own world. So there is a kind of a virtual New York City in a computer that is reflective of the actual city.

room is very smart, but there's no one person that could make, for example, a laptop. In fact, even if everybody here was working together for years, we would be unable to make a laptop by ourselves, because this piece of technology is made up of hundreds of other technologies. And each of those requires hundreds of other technologies like the copper wire, the battery – this is really a network of many technologies.
If we take a step back to the network of all the technologies supporting each other, I call that the "Technium". We take it back even further, we have this large system where

Every planet will go through a stage in which the entire system begins to work as a whole. I call that the "Global Super-organism".

right now all the computers in the world, all the transistors, are connected together. It's as if it was its own machine – one single machine. And by the way: The number of transistors in that one machine, the number of transistors that are right now connected together, is approximately the same as the number of neurons you have in your head. The number of links on all the webpages in the world is approximately the same as the number of links to the synapses in your brain. So right now, worldwide, we have a machine that's about as powerful as one human brain. But your brain isn't doubling in size every eighteen months. Think of Moore's law. So this global brain is doubling every eighteen months. And by the year 2040 or somewhere around what Ray Kurzweil says, it will be equal to all the human brains on the planet. It will be equal to six billion humans: That's the scale in which we're making this machine! I called it the "Global Super-organism" which means only that this system, like all systems, has its own quirks, its own biases, its own agenda. It's going to do things because it's a system. And that's the nature of all systems, that they tend to repeat certain things that are inherent in the system itself. Independent of what other choices you make, systems have certain biases. This system, the Global Super-organism, will have a certain bias.

→ **"Class 1 Energy"** is this idea of a Russian science fiction author that if you take a galactic view of civilisations, there are some civilisations who have mastered all the energy on the planet. Second stage – "Class 2" – is where they have mastered all the energy in the star of a planet. And then "Class 3" is where they've mastered all the energy in the galaxy. We're headed eventually to try and have more and more energy density and more and more sources of energy. That is a stage way far in the future, but I just wanted to mention it as a stage.

→ **"Methuselarity"** is longevity. Research steadily increases the lifespan of humans on average. If research can increase the lifespan of humans by one year per year, that is the same thing as immortality. That's sort of the goal: Can we increase the lifespan of the average human by one year per year? Then you have something where you can live forever. That is another stage in a far distance future, but it is something that we are working towards.

→ **"Transhumanity"** is the idea that, like kind of a cyborg or Iron Man, we add technology to ourselves. And we're further along than we think. Just take anybody who's had a laser surgery on their eyes or a cochlear ear implant. We've already passed the threshold where we're doing that. The question is, how much are we going to do it?

→ And then the last thing is **"Singularity"** which is Ray Kurzweil's idea

that we reach immortality, and we have AI, and it takes over. I don't believe that will happen. But I do think that there are singularities in the softer sense, which means that we come up to thresholds where we can't really see what happens beyond. Humans have been through one singularity already. That was the invention of language. So the humanoids before the beginning of language could not imagine what life would be like after language. Once language happened, it completely changed us. And I think, as we in the future are going to have all these things like AI and immortality and so on, that all will be so different that we probably can't even imagine it from this point on. That's what they mean by Singularity: That things change so much that it becomes really hard for us to see beyond it.

Those are all things so far in the distance that we don't really need to think about it other than the fact that we tend to be headed in that direction, which says something.

III. Twelve coming disruptions

I want to switch from that kind of science fiction status to bring us back to the near future, and talk about some things that I think are going to be thresholds in the coming years. Not science fiction at all. Things that will be within your lifetime, within the lifetime of your business, and that we need to think about right now. The following are twelve disruptions that are coming. These are disruptions that are very similar to the disruption we had with the PC. Or the disruption we had with mobile phones. These are stages that I think are already happening! The question is going to be: What consequences do they have? How important are they? And while most of these are inevitable, I think we still have a choice.

It was inevitable that we would have the World Wide Web. What was not inevitable was what kind of web we would have. Who would own this web? Would it be a transnational? Would it be a non-profit? Would it be a corporation? Would it be open or transparent? Those are all questions that we have as a culture. They are political questions.

And I'm going to suggest that these things that are coming are probably not things that we have a choice about whether or not they're coming. But we do have a lot of choices about how we want to make them.

→ So, one of the things that I'm not going to talk about because it's already here, is the "cloud". People talk about the cloud all the time. The cloud basically means that you are doing things and have information that you actually aren't in control of, that sort of exists in a distributed way out there. You talk on your phone, but it's happening in a big store and then being transmitted elsewhere. That kind of cloud is out there. And it's all "big data", right? That's the buzz term of the day. I don't need to say anything about that because it's so far along.

But what I want to bring your attention to is the word **"clouds"** – the plural. Because what we have right now is not one cloud. We have many clouds. We have Amazon and Google and Microsoft and these other big players where you put information up. So the big invention in the 70s and 80s was the Internet. Previous to the Internet, there were networks: CompuServe, Arpanet... There was so many networks. When I first had my email – that was on CompuServe – you could only send email to other people on that network. The Internet was the network of networks. It brought all those networks together and it made the Internet, and that was the huge thing. And the clouds are the same thing: If we can make one cloud out of many clouds, that would be a really big deal. And that remains to be seen, whether we're going to have one cloud or many clouds. If we make one cloud, recognize that it will be an enabling technology!

So, one of the consequences of life in a cloud is that it shifts the benefit of access away from ownership. If I want some music from the most obscure African Mali band and I just grab it and I have it now, why should I buy it? If I have access to any movie any time, why should I ever buy a movie? In fact, Netflix has changed our behaviour in that sense: We no longer purchase movies. We buy access to the movies. We buy access to the music. My prediction is, Amazon will do the same thing in a few years. You will subscribe to Amazon and you will get any book, digitally, that you want, any time, with no additional charge. So books are free, as long as you're paying the subscription.

So, this shift from ownership to access is happening, and I think it begins with digital properties but will quickly go to physical things with 3D printing, as I'll mention, and other things. You'll be able to get something when you want it. Thus, ownership will become less important. In fact, ownership will be seen as a liability. Because if you own something, you have to store it, you have to back it up, you have to upgrade it – it's a hassle! If this is true and we really see a shift from ownership to access, this is very fundamental, because capitalism is based on the idea of ownership. We have all kinds of laws revolving around it. The fact is, it is fundamentally based on ownership. And if ownership becomes less important, that changes the whole fundamental core of what our system is running on. It is a fundamental cultural shift.

→ Another thing I want to talk about is something I was involved in starting, called the **"Quantified Self",** which is very briefly about tracking yourself by wearing little devices that track – in the beginning – movement. But let me tell you that anything you can possibly imagine that can be measured, somebody right now in the world is tracking it. I know this for a fact. We started this five years ago. There are now "Quantified Self" meetups around the world. There are probably 700 or so start-ups in this arena. And there are guys, extreme quantified-selfers, who are trying to make devices that help you tracking everything you can measure: Whether it's oxygen rate, activity, location, your genes, your exposure to toxins – whatever it is. And these devices, things that you may have to wear on or attached to your body, are becoming very sophisticated and very quick. Nike and others are very involved in trying to make these things easier, so that in a non-invasive way, you can begin to track your life. And particularly in your health.

There is "Scanadu", which is a start-up. They are based in the San Francisco Bay Area, and they have a little device called the "Tricorder", modelled after the Star Trek device that Spock used to wave over somebody who was sick, and it would tell him the diagnosis. Well, this Tricorder by Scanadu is a little thing that you touch to your temple. And when you touch it to your temple, it can tell you your EKG, it gives you brainwaves, it gives you blood pressure, it gives you oxygen rate, heart beat... And eventually you are going to be able to breathe on it. It's like taking a blood test without having to be pricked. Your breath exhales micro-molecules that can be detected by this device. So that's an example of technology that exists today. And the idea is that it's becoming mainstream.

> Ownership will become less important. In fact, ownership will be seen as a liability. Because if you own something, you have to store it, you have to back it up, you have to upgrade it – it's a hassle!

We can identify many different devices being sold in the Apple Store today that are quantified self-tracking. So I think that the long-rumoured "Apple Watch" is really just going to be a quantified self-tracking device. I mean, people don't really need another clock, but you do need something that you wear that will be monitoring your body. And if Apple goes into this, that will make it fairly mainstream, and again, it will launch thousands of other technological companies to occupy that eco system.

When people are using this, they are generating huge amounts of data: You become a source of big data. Exabytes of data over your lifetime. We have been monitoring the many, many early adopters who are quantifying their lives and monitoring all kinds of things constantly. And when you do that, what's really interesting is that you get a base line for what is normal for you. When doctors talk about what is normal, they don't really know what that is. I mean, normal is an average. Nobody here is average. It turns out that your own body temperature over time is unique. Your heart rate is unique. Your sleeping patterns are actually unique. And we know that because now we can self-track people all the time. Rather than going to the doctor's office once a year and have your blood pressure changed, if you have your blood pressure being tracked 24 hours a day every day, you begin to see that your pattern is different from other people's patterns. Which is very important, for if you do become sick, you now know what your base line "normal" actually is. And you can detect these things long before the doctor might.

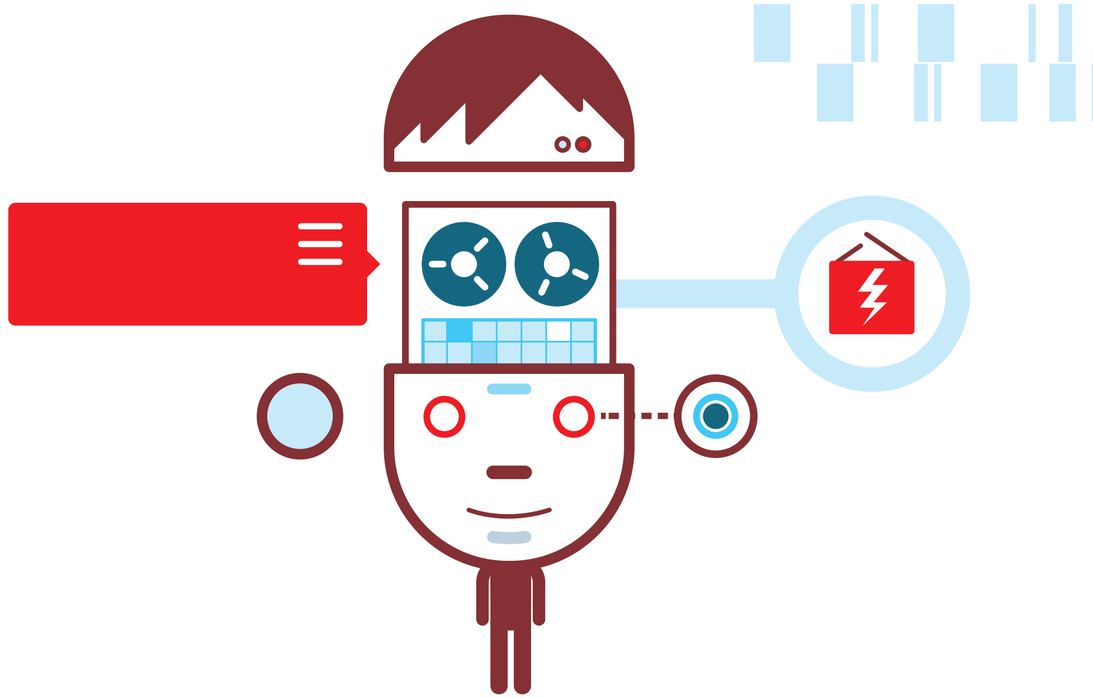
So, the goal of what we see is people generating all kinds of huge amounts of data, tracking any kind of thing that you can imagine. Weight, performance, the things that people are eating – not just calories but the nutritional aspects of it – their mood, their intelligence: If you can think of something you can measure, somebody in the world is tracking it right now. And the long term goal is to make a life log: a log of your life.

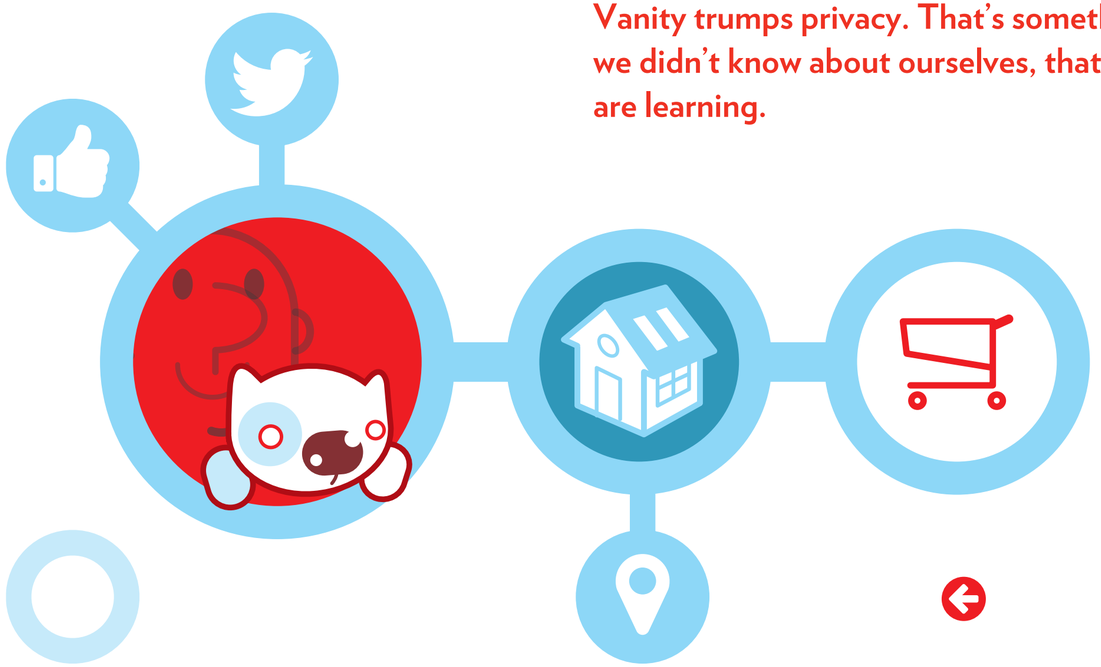
There are people and devices that will take a picture every minute, there are people who record every keystroke that they make, every email or every calendar – all that stuff can be saved and processed and analysed. The tools for analysing these are slow and coming but very, very important and a huge opportunity for start-ups. Each person here is going to generate this huge amount of data. It has to be made meaningful! That is a huge opportunity for people who want something to do.

In health, the goal is to take all this information and to make personalised medicine; to actually make a drug that's just for you. That again is a huge thing because most drugs have some ill effects on some part of the population. If we can exclude those people and say, "Well, you can only take this drug if you have this profile," this will save hundreds of billions of dollars a year and release all kinds of drugs, because lots of drugs never come to market because some subset of the people of the population are affected. But if you can exclude them through testing – gene testing or other kinds of testing – and say, "Ok, you can't take this, but you over here can," suddenly many more remedies are available. Ultimately, what we want to have is therapeutics that are targeted just to you. That can be made possible by self-tracking.

→ So we take self-tracking and we add to that this other obvious thing of **"Ubiquitous Tracking",** meaning that we're being surveilled everywhere. There are cameras everywhere, there is drones coming. It's this idea that we're living in a society where our own movements are being collected by others: So we have "Big Brother" and we have "Little Brother" and we have a kind of "Nano Brother". And it's not just them: We are doing it. Everybody here has a cell phone, so we're carrying our own cameras with us. Basically anything that we can watch can record us. And so, all that data is flowing into the governments, the big corporations and we're – sometimes voluntarily – surrendering where we are, for example by "checking in" with Foursquare. So, we often do this voluntarily, saying, "Here I am! I'm over here! Track me! Use my cookies! Follow me around the web!"

The ultimate destiny is a scene of a film that I worked on with Steven Spielberg, "Minority Report": There's the character of John Anderton, played by Tom Cruise, who becomes a refugee, and he's running away, and he's running through a mall, but all the ads in the mall recognise him and they are targeting him with this specific ad. So they





Vanity trumps privacy. That's something we didn't know about ourselves, that we are learning.

are kind of defeating his purpose of trying to be invisible, because they are saying, "John Anderton! We have a special offer for you!" And that future where we are personally targeted is what's driving a lot

So we have "Big Brother" and we have "Little Brother" and we have a kind of "Nano Brother". And it's not just them: We are doing it. Everybody here has a cell phone, so we're carrying our own cameras with us. Basically anything that we can watch can record us.

of this. But also understand that we often benefit from it. So I can talk about the privacy issues of which there are many. Generally, when people are given a choice, they will take personalisation at the price of transparency. This is a surprising thing that was impossible, that we didn't know about ourselves. All the sociologists said that we would value privacy rather than transparency. But personalisation requires transparency. If I want to personalise my interaction with you, I have to know about you. You have to reveal yourself to me. So, we are finding that if people, like in the Facebook generation, are given a choice, they will always choose more personalisation rather than privacy. The way I say it is: Vanity trumps privacy. That's something we didn't know about ourselves, that we are learning.

→ So, we take "Quantified Self", we take the "Ubiquitous Tracking", and we add to it the fact that we have **"Wearables":** wearable computers. For example the Google Glasses which I've been talking about for five years before they came. There's not just Google, there's Looxcie, there are about ten others right now, and there will be more. And everybody is wearing them!
Whether Google Glass survives or others: These are coming very, very quickly. And it's not just glasses, it's your clothes. There are experimental clothes, jackets and other things, that you actually use in the same way as your iPhone: You can touch them, swipe them, use them, and they feed back. I just saw a demonstration yesterday of a friend who is a doctor. They are making a vest that you can wear and it vibrates. It has sensors and it vibrates depending on the input. And they are actually using it to let deaf people "hear" and blind people "see". So there's a camera and it translates the optical information, so the person can "see" by feeling on this vest. Or they can "hear" by using this vest. There are clothes that not only detect things but can actually respond as well. So these are things that may have sensors and may have actuators, so it becomes a garment that we actually interact with. I've already talked about the "Mirror World". Right now, there are all kinds of signals in this room. But with special glasses, we can actually see them. We can see the overlay. We can take the virtual world, which is being embedded into the real world, and then we can actually see both of them: an overlay of this Mirror World and the real world, allowing us to interact in both.

→ So we take those "Wearables" and "Quantified Self" and "Ubiquitous Tracking" and we add to it **gestures.** For 20 years or more we've interacted with computers in basically one way: with our fingertips – by typing. But we don't have to do that. Take again "Minority Report", which I've worked on. There was this idea that in the future we might stand and interact with our computers. Use our whole bodies. We can gesture. So the Tom Cruise character is – like in a symphony – conducting the data. And we saw the same thing in "Iron Man" where he's actually computing using his full body.
The Samsung Galaxy S4 has an eye tracking device. So while you're looking at it, it's looking at you, showing you where you're looking and responding to that. There's software being developed at the MIT that is not just tracking your eyes but can track your emotion. So it knows if you're perplexed, if you don't understand something, or if you're distracted, not paying attention, or if you're very engrossed or excited. It can respond to those things. And we take something like eye tracking software, which is tracking the eyes, and it can for example generate a heat map of where there's a lot of eye activity. So it can show for example, which parts of a web page people are paying attention to. If you know that, then you

can begin to modify the content in response. So you have this adaptive system. Basically anything that you are looking at is looking at you and responding. If you don't understand something, it will give you more. If

There's software being developed at the MIT that is not just tracking your eyes but can track your emotion. So it knows if you're perplexed, if you don't understand something, or if you're distracted, not paying attention, or if you're very engrossed or excited. It can respond to those things.

you're really enjoying it, maybe it speeds up. It can respond in a life-like way to being watched or read or used. And of course, voice is another gestural thing. The voice recognition is moving very, very fast. After 20-30 years of very much hard work and slow progress, the understanding of what you say is moving very fast. And it will be a disruption.

→ We have **flexible displays** in addition to wearables. So there's not just the fact that we will wear things that are flexible and computational. But also, screens don't have to be hard and flat – they can be flexible and cheap, made of plastic, and they can be everywhere. On my laptop, there is a big screen, but it's kind of a stupid screen. If we have a smart LED screen or plastic screen, it will be as big and there will be things that it can wrap around, like that Apple wrist band. Or you can have an eBook, but it doesn't have to be flat, it can actually just be flexible pages. And they are so cheap that there's a whole bunch of them. You have the same beautiful navigation device that we have, and a book that can tell you where you are. So that again opens up a huge array of possibilities, if we have things that we can print on thin, flexible screens.

Screens don't have to be hard and flat – they can be flexible and cheap, made of plastic, and they can be everywhere.

We used to be people of the book: That used to be the centre of western culture. We had authors, which was the stem of authority. We had laws, we had the scripture, we have the constitution: All things based on bookish text. We've now left that behind and we've become "People of the Screen". And the foundations of truth – how we make truth – is different. There are no longer authorities. It's much more liquid; we have streams and flows. Nothing is monumental and fixed. So, "People of the Screen": There's a whole new culture based around screens rather than on books.

→ **3D printing** is coming very fast. It's another disruptive enabling technology. They look like toys in the beginning, if you've seen these things. But that again is changing very fast. It's like the first personal computers that people also dismissed as toys. They would say, "What can you do with this?" Not very much, but they are going to get better. Twice as good every year. 3D printing is happening in the same way. The kinds of things that you can print with this are phenomenal. You can make things out of metal. You can make things out of tissue. And you can even make things that cannot be manufactured in any other way. And it's not just little, tiny things. There are industrial size 3D printers that are printing turbines. And there's of course micro printing which is on the electron scale. So this is a huge field, and it has the power to actually disrupt the current regime of offshoring manufacturing to places like China. If 3D printing can really get going on an economic scale, there is the possibility of having manufacturing at the local level. Not at the scale of factories, but at the local neighbourhood level, and you could be producing things in small quantities when they were needed. This would change man-

There are industrial size 3D printers that are printing turbines. And there's of course micro printing which is on the electron scale.

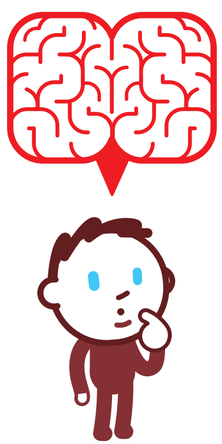
ufacturing and the economy. The real "Holy Grail" for 3D printing has been to make a printer that could print another printer. Wouldn't we want that? Well, there is one that is able to do that. But unfortunately,

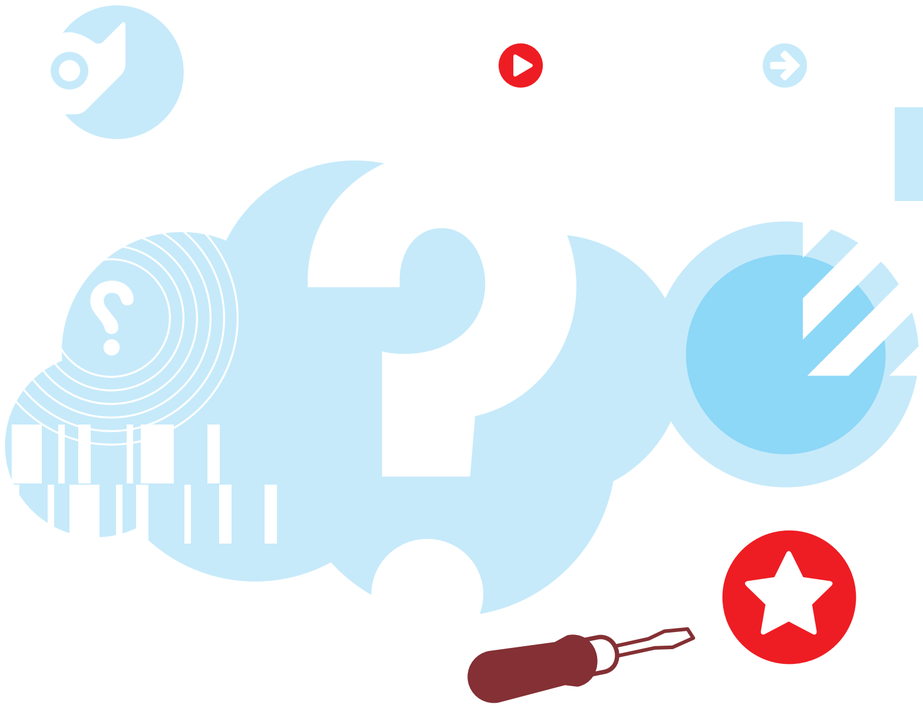
If 3D printing can really get going on an economic scale, there is the possibility of having manufacturing at the local level.

the printer couldn't print much else besides itself. But it's a good existence proof, that that is possible – so as to show you the versatility of these things.

→ So we take all this stuff, and then we add another one, which is **personal robots**. And by "personal robot" I mean not so much the Roomba that is your personnel, but the way that the personal robots are the same as personal computers. We had computers for a long time, then personal computers came up, which meant that you owned it rather than some corporation. It was your personal computer. And again, in the very beginning, they weren't very useful. But they became immensely powerful.
We have personal robots right now, which is the idea that they are cheap enough that you could own one. There is a robot that is programmed to recharge itself, to find a wall plug and to plug itself in. The real game changer has been "Baxter" which is an industrial personal robot. It's about 20,000 dollars, compared to a million or 200,000 or 250,000 dollars for a standard industrial robot. And it can be programmed by showing it what to do, so you don't need a code. It watches you, you can move its arms and say, "Do this! Do that!" And it does it, and you can work right next to it – which you cannot do with any other industrial robot – because this robot is aware of you.
That changes everything in industrial capacity, because this means that you basically can afford to purchase the world's cheapest labour by buying a robot instead of going to China or Bangladesh. You can have these things in your garage, helping you to put things together. And that is a very powerful idea. It's like the personal computer, which took it out of the big room and made it into your bedroom, and suddenly you could do things with it that no one has even thought of before. This, combined with 3D printing, has the chance to relocate manufacturing from third world countries back into the developed world. With 3D printing and a personal robot, you could begin to manufacture things in your backyard. And that shifts the whole model.

→ **Self-driving cars:** I've been a long proponent of them. They're finally here. They really do work. They will drive safer than you. The thing about self-driving cars is that they are actually inherently safer than us. And my prediction is that





our grandchildren will be completely incredulous and unbelievable that we were allowed to drive cars on the highway ourselves. They'll say, "What?! You were allowed to drive 60 miles per hour? That's crazy!" And it is crazy! Because these cars will drive much safer than we do. And the consequence of this is kind of a revamping of our transportation system, because you can just call your car when you need it, the car

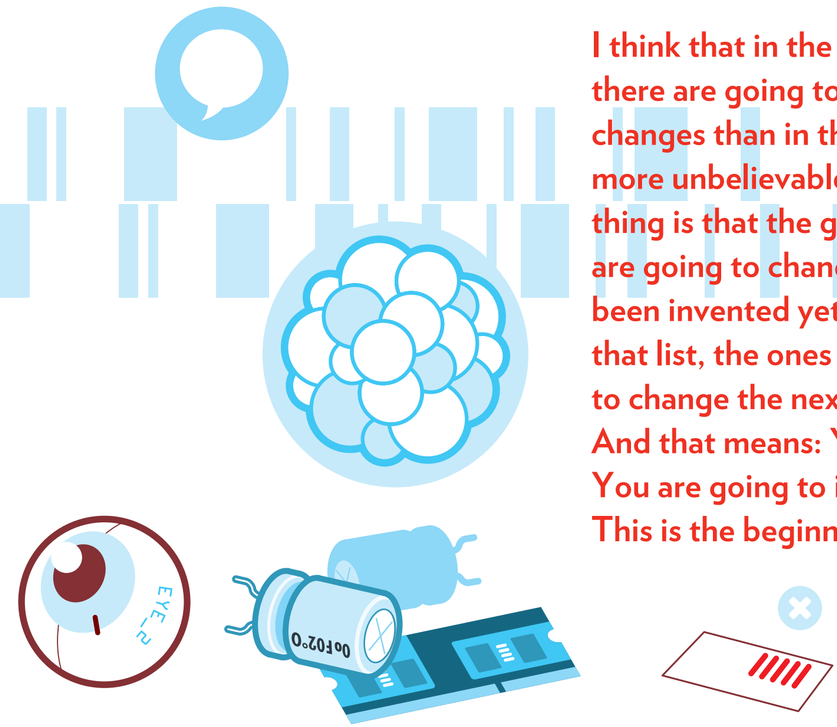
The thing about self-driving cars is that they are actually inherently safer than us.

comes to you, and you get to the city, and you let the car go find parking itself. And they can be made into long trains – they will transform the traffic issues.
And I think it's all done through a lot of smartness of all kinds. But I think that one result is that it will turn the car into an office. This is what we'll do with our time as we move around. It's kind of like living in a train, where it actually becomes a productive time. Think of a car really as a computer with wheels! Only 30 percent of the costs of a car these days is for materials, all the rest of it is for the intangibles. So we really want to think of these things as an extension of computation.

→ I mentioned AI in the beginning. AI is very controversial, because people get stuck on this idea: Is it really conscious? How intelligent is it going to be? – And I advocate using the idea of "Utilitarian Intelligence". Which means: We don't really care if it's conscious. All you want to know is that this smartness is useful. It's kind of like Siri. Who cares whether it's intelligent? All you know is that it's useful. And that usefulness increases over time. So it will get smarter and smarter and smarter. Let's set aside the issue of whether it's ever intelligent or conscious! What that means though is that as AI becomes more and more useful, it becomes a commodity. So basically, you'll be able to say, "I want to purchase X amount of smartness. I want to buy this kind of AI for this use." And so rather than having to reinvent it, AI becomes a commodity that you can purchase from whatever source you want. We now use AI to diagnose X-rays, to actually do mortgage-lending – there's lawyerly evidence it's all done by AI – the brakes in your car right now are done by a little computer, and they brake better than you brake. That's why all the cars have them. And so this idea of it becoming a commodity is where we're headed. So it's going to be like, "Yeah, I need this much intelligence, and I'm willing to pay that much for it."
The new thing in AI is called **"Deep Learning".** That's what Google has figured out. It's using an all-technology of neural nets, which has been around for 50 years. But we're trying to do neural nets with thousands and hundreds of thousands of nodes, and it turns out that it doesn't work. You need billions of them! And once you have billions of them, you can get "Deep Learning". So that's what's happening right now in the AI research: At the scale of Google and Microsoft, they have billions of these nets and they can finally do this cascade of neural nets and they finally do work. It is unsupervised learning. Here is an example: Google took ten million YouTube videos and applied it to this neural net and said, "What do you see in these ten million YouTube videos?" And the net said, "I see cats." They didn't say anything, they just said, "What's the picture you see?" and what the AI said of all these ten million YouTube Videos is, "This is the pattern I see. This is what is happening." And that is a case of deep learning, where there

Google took ten million YouTube videos and applied it to this neural net and said, "What do you see in these ten million YouTube videos?" And the net said, "I see cats."

is unsupervised learning. So that is now going to be available to use in a commercial way.
"Watson" is another example of deep learning. It can't just beat "Jeopardy!", but now they're using it for



I think that in the next 20 years, there are going to be even more changes than in the last twenty years, more unbelievable. But the important thing is that the greatest products, that are going to change us, haven't even been invented yet. They are not even on that list, the ones that are really going to change the next 20 years.
And that means: You're not late!
You are going to invent them here!
This is the beginning of the beginning!

medical diagnosis. So it can actually do doctoring. Now, will "Watson" be as good as a human doctor? No. But it's better than no doctor.
You see, that's the whole point: All the people of the world who have a phone can now get doctoring that is pretty good. Maybe not as good as the best human doctor, but good enough – better than no doctor. So that's where we are right now.
And Google has used deep learning to actually do an amazing thing: They did real-time translation from English into Chinese. So there will be something going on. And now when we will be talking, it will be translating into Chinese in real-time. That's very impressive. And again: Is it as good as human simultaneous translation? No, but it's better than no translation. So anybody could have that.
And games of course: They have AIs in games. They are not as good as human players, but they are better than having no human playing at all. So a lot of people play against AI-players. That's the idea: It's not as good as maybe a human, but it's better than having nobody there at all.

→ **Crowdfunding.** We all know about "Kickstarter". I actually did a successful Kickstarter campaign; it was quite an amazing experience of having fans fund a graphic novel. Besides Kickstarter, there are 450 other platforms that are doing crowdfunded projects. This is really transforming the start-up culture right now, because people don't have to wait for VCs to get money to do something. They go out to the fans. So far, there has been about 3 billion dollars in crowdfunded programs, and even companies like Samsung and others are actually doing crowdfunded projects as a marketing test. They don't really need the money, but they're putting these things out just to see how the fans react. To see if there is any audience or appetite for these. It's a brilliant thing.
But the real transformative thing actually happened one or two weeks ago: The US had a change of law, called the JOBS Act (Jumpstart Our Businesses Startups Act), which allowed crowdfunded equity. In the past, crowdfunding was only by project. Now you can actually become a co-owner, you can issue stock. It's a way of actually having something like an IPO done with a crowdfunded apparatus. So you can actually go out and say, "Ok, how many people are interested in funding my company, which is going to do X and Y?" And that also is going to be very transformative and enabling.

→ The last thing I want to talk about is **cyber conflict.** I don't think there's a utopia. I think there are many, many issues. All these things

I think we're entering an era where the wealth of the world is in the digital realms, which means that is where the conflicts are going to be.

will present problems in security and privacy. And I think we're entering an era where the wealth of the world is in the digital realms, which means that is where the conflicts are going to be. China vs. USA right now is kind of like: You're hacking me, I'm hacking you. But it's not just about that. It's our own identities, our own securities as well. Anonymity and security is a real issue. I think, we're seeing things like Apple's thumbprint and biometrics becoming more and more instrumental. And we are beginning to ask, "Are you really who you say you are?"
The true value that Facebook has is not the "friends to friends", it's the fact that Facebook has promoted a unique real person identifier: a persistent real name.

So all these things together – the Cloud, tracking, personal robots, 3D printing – suggest that there are lots of coming disruptions. And each one of these will be inevitable. But how we do it is going to be up to us and not really determined. I think that in the next 20 years, there are going to be even more changes than in the last twenty years, more unbelievable. But the important thing is that the greatest products, that are going to change us, haven't even been invented yet. They are not even on that list, the ones that are really going to change the next 20 years. And that means: You're not late! You are going to invent them here!
This is the beginning of the beginning!

DAN GARDNER

TURNING FUTURE BABBLE INTO REAL FORESIGHT

Dan Gardner is an award-winning columnist with the **Ottawa Citizen.** In 2008, Gardner examined the psychology of risk perception in **Risk: The Science and Politics of Fear.** A best-seller in the United Kingdom and Canada, published in 11 countries and eight languages, **Risk** was praised as "an invaluable resource for anyone who aspires to think clearly" by **The Guardian.** In 2008, **Risk** won the Canadian Science Writers' Association award.

In 2011, Gardner's next book appeared, **Future Babble: Why Expert Predictions Fail and Why We Believe Them Anyway,** a critical look at expert predictions and the psychology that explains why people believe them even though they consistently fail. Gardner is at work on a new book about forecasting, co-writing with Wharton School psychologist Philip Tetlock. Prior to becoming a journalist in 1997, Gardner was senior policy advisor to the Minister of Education of Ontario and social policy advisor to the Premier. He holds a B.A. and M.A. in history from York University and an LL.B. from Osgoode Hall Law School.

The following text is a transcript of a lecture held at the Cologne Conference Futures 2013 – the Annual Symposium on Media Evolution Cologne, October 2nd, 2013

I. Failed Predictions

We're going to be talking about the future. And if there's one thing we know about what you might describe as the medium-term future, twenty years out, one thing that pretty much everyone on the world is sure of, it's that China is going to surpass the United States to become the world's largest economy and become the dominant player in the global economy. Some people dissent, but generally, there's broadspread agreement about this. And in fact, it's not terribly controversial. But what should we do with this forecast? Is it reliable? Well, there's a good story behind it. There's good reason to think that it could be true. But we don't *know* that it will be true. We don't know that it's accurate. So, what do we do with this information? One thing that we could do, is we could wait twenty years and find out. But that's not terribly helpful to you and the planning of your investments or business strategies or whatever else. So what else can we do? Well, there's a very simple thing that we can do, that people almost never do when they're dealing with forecasts. And that's to consult history. If we're looking ahead twenty years, let's look back twenty years and look at the future from that perspective.

In 1993, there was another Asian superpower that was going to surpass the United States and become the world's number one economy. Everyone was sure of it. In fact, there was a stronger consensus then. In North America, I can tell you, we were all advised, "Have your kids learn to speak Japanese!" Everyone was absolutely sure of it. The confidence was overwhelming. I have a full shelf full of the books that were written in this time period. Of course, they were wrong about Japan. The great economic story of the last twenty years is of course the rise of China, so then it occurred to me: What did they say about China? So I got all the books down and I looked in the index, under "C" for China, and you know what I found? Nothing! In book after book after book, not only were they wrong about Japan and Japanese supremacy; they never mentioned China! And we're talking about some of the world's leading scholars, pundits, experts.

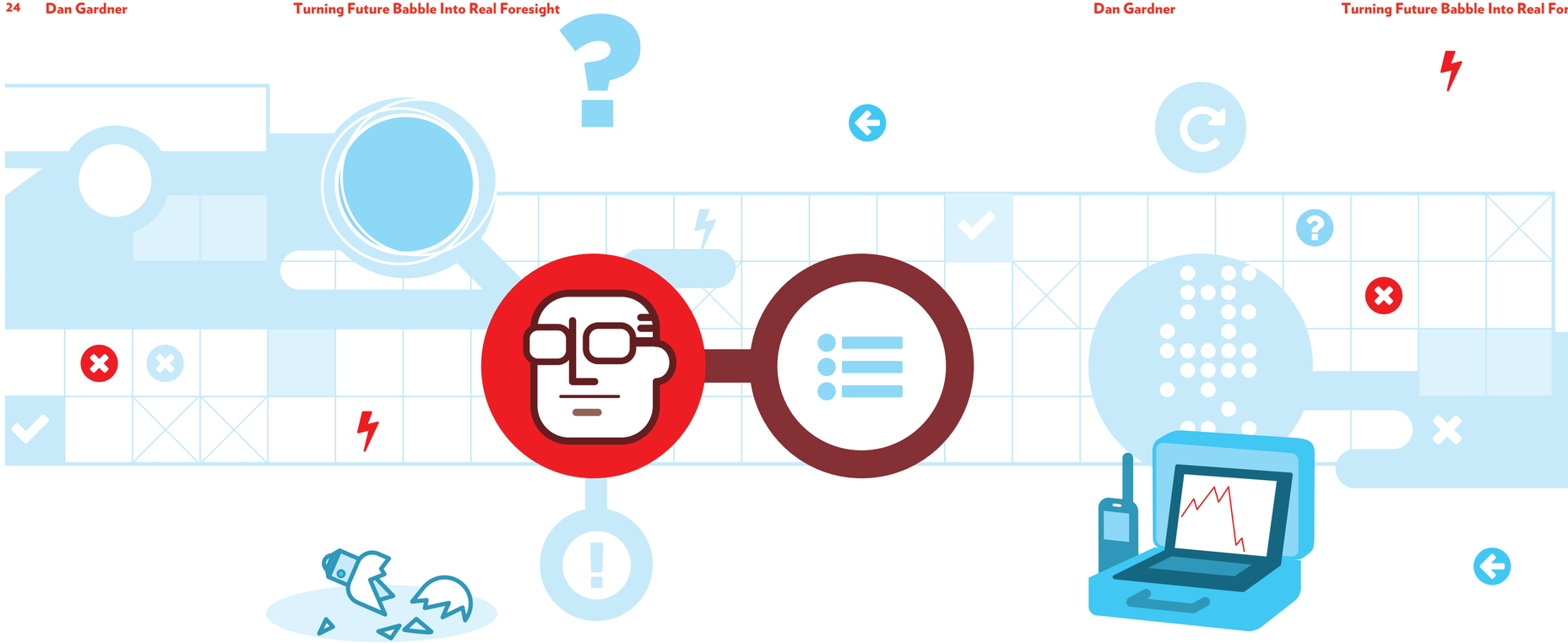
So, you might say, "Hang on, that might just be an anomaly."
Let's go twenty years before that! Let's go back to 1973. Imagine you're in 1973, and you're thinking about the far distant future of 1993. What's the global economy going to look like in 1993? Well, the United States are going to be overtaken as the world's leading economy by...?
The Soviet Union!

If you have taken Economics 101 in university at any time within the last 50 years, chances are your textbook was called "Economics", written by Paul Samuelson: One of the best-selling textbooks of all time. And in that book, Paul Samuelson, a Nobel Prize winning economist, in the 1950s, 60s, 70s, even in the 1980s, had a chart. And that chart clearly showed the United States' economy being overtaken by that of the Soviet Union sometime around 1991. And of course, 1991 was an important year in the history of the Soviet Union, but for entirely different reasons.

That's global economics. That's the big picture stuff. But let's try this with technology.

Many of you will be familiar with the book *Physics of the Future* by Michio Kaku. It's a really interesting book. Kaku is a physicist; he's got a lot to say that is very interesting, and as he likes to say, he interviewed 300 leading scientists from around the world. So boy, you can take these predictions to the bank! This is the future of science and technology all the way to the year 2100. And he's very confident and very compelling. He tells a good story when he talks about how technology really will evolve. But what do we do with this information? Well, we can wait until 2100 – useless – or we can find something equivalent in the past. And there was in fact the future of technology in 1967.

There is a book called *The Year 2000* by Herman Kahn and Anthony Wiener. Herman Kahn, of course, is the man who legendarily worked for the RAND Corporation and founded the Hudson Institute. A brilliant man. And by the way, I would note that this book is much less ambitious than Kaku's. It's "only" 1967 to the year 2000, so he's being very modest. There's a list in that book: 100



technological changes that are "very likely" by the year 2000. Note the words "very likely"! Now go down the list. It's a great, long list, very detailed. I won't take you through everything. But there are a few items like this:

- **No 4.** "New or improved materials for equipment and appliances."

Well, that's rather like saying, "In the future, people will continue to breath air." It's true – but it's not terribly helpful.

- **No 15.** "New techniques for preserving or improving the environment."

That language is so vague, it's perfectly elastic, and it can be stretched to fit almost anything.

- **No 70.** "Simple inexpensive video recording and playing."

That's better! That's real! But really, what he's describing there is: An existing technology will get cheaper and more common. Which is useful, but it's not that earth-shattering. But I have to be fair, there are a few items like this:

- **No 81.** "Personal pagers, perhaps even two-way pocket phones, and other personal electronic equipment."

Ok, "two-way pocket phones" – that's pretty good. Give the man a gold star here! But there's a whole lot more on that list, things like this:

- **No 27.** "Use of nuclear explosives for excavation and mining [...]"
- **No 31.** "Some control of weather or climate."
- **No 35.** "Human hibernation for relatively extensive periods (months to years)."
- **No 53.** "Permanent inhabited undersea installations and perhaps even colonies."
- **No 99.** "Artificial moons and other methods for lighting large areas at night."

So, that's not very good. And that wasn't the only list. There was also a list of "less likely but important possibilities". There were 25 items on the list – none happened. And then there was ten "far-out possibilities" – none happened. That's not good. And if you know that that's not good, that helps inform how you should be reading similar forecasts today. Because of course this is not an anomaly. There are many, many other examples like it. I could lecture for the rest of the afternoon on that, but that wouldn't be terribly helpful.

> There's an endless list of these failed predictions in business. My personal favorite is Steve Ballmer saying, "There's no chance that the iPhone is going to get any significant market share."

And of course, it's not just global economics, and it's not just technology, it's business! There's an endless list of these failed predictions in business. My personal favorite is Steve Ballmer saying, "There's no chance that the iPhone is going to get any significant market share."
The same thing in politics. This is my favorite: *The Wall Street Journal* editorialized about the presidential election of 1996 that "Bill Clinton will lose to any Republican who doesn't drool on stage". And in 1929, Irving Fisher, who was at that time the leading economist of the era, said immediately before the Wall Street Crash of 1929, "Stock prices have reached what looks like a permanently high plateau." This is all very entertaining. There are long, long lists. In fact, there are literally entire books of failed predictions because we all have schadenfreude when we read this sort of thing.

II. Why predictions Fail

But the more meaningful question is: Why are we so bad? We have so many smart people who are so motivated to foresee what's going to happen, and they're trying so hard. Why do we do so badly? Well, very briefly, let's go back to the beginning of the history of science.

Isaac Newton gave us the ability to predict the motions of the planets. That's an amazing thing, right? It's all very mathematical and we can do it with amazing reliability. And from the earliest days of science, that was how we understood reality. Reality was a clock. It was a big, complicated clock, but it was a clock. And the more that we understood the mechanisms of the clock, the better we would be able to predict the behavior of the clock. And that's how science advanced for centuries.

> We have so many smart people who are so motivated to foresee what's going to happen, and they're trying so hard. Why do we do so badly?

And the belief was that as knowledge grew, our ability to predict would grow with it in perfect linear fashion. Until you get to the mid-20th century and we come crashing into non-linearity. And surprise! Scientists revised their understanding of reality radically, and they start to say things like, "Well, actually the clock metaphor is not terribly helpful. A lot of reality is more like a cloud."
A cloud emerges from the complex interactions of molecules within it. You can't predict what form the cloud will ultimately take; you can only wait and see what comes out. So natural scientists have become much, much humbler about their ability to predict, and they believe that in the future, there will always be these permanent barriers to their ability to predict. Their knowledge may grow, but the ability to predict will not grow along with it. So that's one of the big ones. I mean: Reality is more cloud than clock; there are fundamental limits interwoven into reality to our ability to predict.

> Reality is more cloud than clock; there are fundamental limits interwoven into reality to our ability to predict.

Here's the other big one: Your brain. It's one of the wonders of the universe, but it has limitations. If you go to a cognitive psychologist and you say, "Give me the basics! Tell me how we decide!" he'll start with this: He'll say, "Let me ask you. You made a forecast – how did you make that forecast?" And you'll scratch your head and say, "Well, I thought about it, I looked at the facts, and I drew a conclusion that seemed reasonable. My one system of thought came to a conclusion." And the psychologist will say, "Aha! That's it! That's an illusion! You're wrong! You do not have one system of thought; you have two systems of thought." And because psychologists are very clever and imaginative people, they call these two systems "System 1" and "System 2". System 1 is the more primitive: It's the intuitive, it's the spontaneous, it's the fast. You look at a problem, and sometimes you just have an answer, instantaneously: It's there. And sometimes, when somebody asks you, "How did you come to this conclusion?" and you can't quite explain why – that's System 1 at work. System 2 is just the opposite: It's conscious thought.

Now, what's the distinguishing feature between those two systems? Speed. System 1 works just like that. Conscious thought is slow. And what that means is, the standard decision pattern that we follow is this: You look, System 1 delivers, and then System 2 can come along slowly and say, "Ok, let's have a look at what System 1 gave me." And it can say, "Oh, that doesn't quite make sense. I'll adjust it a little," or even overrule it entirely, "I'm going to throw that out!"
The only question is: Are you going to do that? Are you going to make the effort to consciously think about your conclusion, and whether it makes sense, and whether it's supported by evidence?

And what is one of the most fundamental insights of psychology? – And if you remember nothing else from this talk, remember this – It's that we typically do not. We typically draw an intuitive conclusion and say, "That's it. That's my final answer. I'm sure of it. It feels true, so it must be true." That means that your System 1, that system of thought that you're completely unaware of, is far more influential on your decision-making than you realize. And that's a problem, because what System 1 does in order to create snap judgments, in order to give you that instantaneous response, is that it doesn't think slowly and logically about all the available evidence. If it did that, it wouldn't be able to deliver the way it does. What it does is, it uses heuristics – rules of thumb. Simple rules that allow it to come to a quick conclusion. For example one of them is the availability heuristic: Can I easily think of an example of X happening? If the answer is yes, then it is very likely that X is going to happen. If you have to struggle to think of an example, then it's very unlikely that X is going to happen.
In many circumstances, that works well. But sometimes it doesn't. I'll give you a dramatic example: the 9/11 terrorist attacks. In Canada, perception of the risk of terrorist attacks prior to 9/11 – and of course, this is Canada, I emphasize, not the United States – didn't exist. It was off the charts. People weren't even thinking about it. After 9/11, it shot up to the top of the charts. People were personally afraid. The numbers are really quite staggering. Does that make any sense whatsoever? Was that based upon a reasoned analysis of the available evidence, of the threat of Al-Qaeda to the average Canadian? Of course not, it had nothing to do with that. It had nothing to do with evidence. It had to do with how people felt. "Can I think of an example of terrorism?" Of course you can, you can't stop thinking about it, because you just saw it live and in color on television. And so the intuitive mind says, "Aha! Be afraid!" And we went with that. – Are you afraid of

> The human brain is magnificent at creating patterns. In fact, it's too good. It errors on the side of inclusion. We see false patterns all the time: You look at the Moon, you see a face. You look at burned toast, you see the Virgin Mary – if you're Catholic.

terrorism? Oh yes. And that has real consequences, obviously. So that's a big problem. We have errors from intuitive heuristics.

Once we believe something, anything, for any reason, good or bad, we will readily embrace any information that supports our conclusion.

We also have false patterns. The human brain is magnificent at creating patterns. In fact, it's too good. It errors on the side of inclusion. We see false patterns all the time: You look at the Moon, you see a face. You look at burned toast, you see the Virgin Mary – if you're Catholic.
And then we have confirmation bias, and this is very, very pernicious. This is an important one to remember: Once we believe something, anything, for any reason, good or bad, we will readily embrace any information that supports our conclusion. We won't ask if it's good information or not. No, of course it's good information, it confirms what I believe! And so you'll assemble information that way. But simultaneously, you will not think to yourself, "Is there any information out there that actually suggests that I'm wrong?" You will not go looking for that; that is not what human beings naturally do. Scientists do that, because they're trained to do it. But that is not what we do naturally. And if somebody comes along and shoves that information under your nose, and says, "Here! Read this!" – you will rationalize like crazy to try and figure out some reason why this is actually very bad evidence and you shouldn't concern yourself with it. And in that way, the error that we started with becomes more and more entrenched. And we start to believe in it more and more strongly, thus leading to delusion and overconfidence. We believe things that just aren't true with way too much confidence. One of the most basic findings in cognitive science is that people are overconfident in their judgments. We're just way too sure of ourselves.
Now, you may be thinking, "But I am an intelligent, educated person. I am immune."

But think about this: What I just described to you is an extremely brief summary of Daniel Kahneman's book *Thinking Fast and Slow.* Kahneman is a Nobel Prize winning psychologist, one of the greatest scientists alive today, really. And if you've read *Thinking Fast and Slow* – and if you haven't, you really should – you'll know that one of the themes that he keeps going back to is how he himself gets getting tripped up by this stuff. The man who discovered so much of what I'm talking about says, "Even today, if I'm not careful, it trips me up." You have to realize that we're not immune. And yet a fundamental insight is: Not only does knowledge and information and more knowledge and more information not protect you against psychological biases – it can actually make you more vulnerable. You really have to be on alert for this stuff.

III. Should We Abandon All Hope?

So if you think about it, we have a world in which unforecastability is interwoven into the very nature of our existence. And we have a brain which makes systematic errors. And

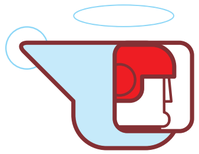
Not only does knowledge and information and more knowledge and more information not protect you against psychological biases – it can actually make you more vulnerable.

we're trying to forecast with it. If you think about these two facts in combination, what's really amazing is not that we sometimes get things wrong, it's that we get anything right. So, obviously the theme that I'm working here and what I'm trying to encourage you to do is to be skeptical. Be skeptical of forecasters! And when I say that, the audience is always saying, "Ok. I get that, but I don't need to be told that, because of course I am skeptical. We're all far too clever! We're not the customer here. We're not the guy credulously looking at the crystal ball. It's somebody else." It's always somebody else.

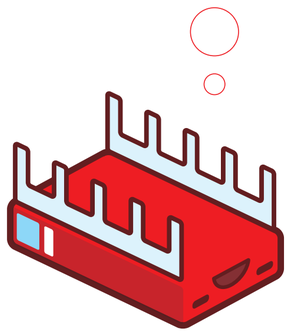
And yet, why is it then that corporations and governments spend enormous amounts of money on the equivalent of crystal-ball-gazing? Why is that? Why is it that the media spends an enormous amount of time and space and energy reporting on the equivalent of crystal-ball-gazing? Why is it that when I go to the airport-bookstore, I always see the equivalent of crystal-ball-gazing on the bestseller list? There are a lot of customers somewhere; I don't know where they are.
So what I want to suggest to you is: We're not actually as skeptical as we think we are. In the abstract, we're skeptical, but when it comes to something practical, it's very hard to maintain skepticism. And here's a neat illustration: There was a survey conducted of business executives. And they were asked a question which matters to a lot of business executives: What's the future price of oil? What will the price be in five years? Five percent of business executives said, "I don't know." Ten percent said, "I don't know what the price of oil will be in ten years." And what will be the price of oil be in twenty years? 33 percent said, "I don't know." Or to turn that around, two thirds of business executives believed that they know what the price of oil will be in twenty years.

That's ridiculous! That's self-evidently absurd! And how do I know that? Because we've been trying to forecast the price of oil ever since it became an industrial commodity in the late 19th century. And we've been wrong and wrong again. Oil is incredibly difficult to forecast, maybe impossible, I don't know. And people who really know oil understand that. I had a chance to interview the former legendary head of BP, John Browne. And so I said to him about forecasting the price of oil, "Tell me, John Browne, you spent a lifetime in oil: What will the future price of oil be?" And he said, "I can forecast confidently that it will vary." That's a wise man.

So here I am. I'm urging you to be skeptical. If you are being skeptical, if you are taking my advice, you have spotted a flaw in my argument. I haven't actually proven the premise of my argument. I've given you a bunch of anecdotes, I've given you a bunch of stories, I've given you a bunch of



The final result of Philip Tetlock's experiment was that the average expert was about as accurate as random guessing, or if you prefer a more colorful metaphor: a dart-throwing chimpanzee.



examples of times that experts made forecasts, and the forecasts failed. Does that prove that expert forecasts routinely fail? No. It's just a bunch of stories. Anecdotes aren't data, as scientists like to say. If you're going to actually have a better grip on that question, "How good are expert forecasts?" you have to experiment, and you have to do things properly. You can't go and cherry-pick anecdotes. So what would a proper experiment look like in this field?

Well, Phil Tetlock, my co-author on the new book I'm writing, started one in the late 1980s. And what he did was, he gathered about 284 experts – they were political scientists, economists, intelligence analysts, the sorts of people who make forecasts as part of their work – and he had them forecast all the sorts of things that pundits forecast: Elections, wars, the economy, that sort of thing. It was a huge number of forecasts that were made in this experiment, something like 28,000. And he waited. Time passed, he analyzed the accuracy, he crunched all the data, and then in 2005 he released the complete results. And the final result was that the average expert was about as accurate as random guessing, or if you prefer a more colorful metaphor: a dart-throwing chimpanzee.
Now, that is stronger evidence. That is a stronger basis for skepticism about expert forecasts. But is it a strong case for abandoning all hope, as some have done? Nassim Taleb for example, author of *The Black Swan*, argues that basically you can't forecast anything meaningful or important. Forget it! Just give up! And Taleb and others who make that sort of argument, they cite Tetlock's work. "Dart-throwing chimpanzee – give up now!"
But the funny thing is, Phil Tetlock himself has never believed that. In fact, his position goes by this term: "Skeptical meliorism". The "skeptical" portion is obvious, it simply means: Until you give me proper evidence, I will not believe what you say. "Meliorism" simply means the possibility of improvement. So he's skeptical about forecasts, he wants to see evidence, but he also believes that there is reason to believe that we can improve.

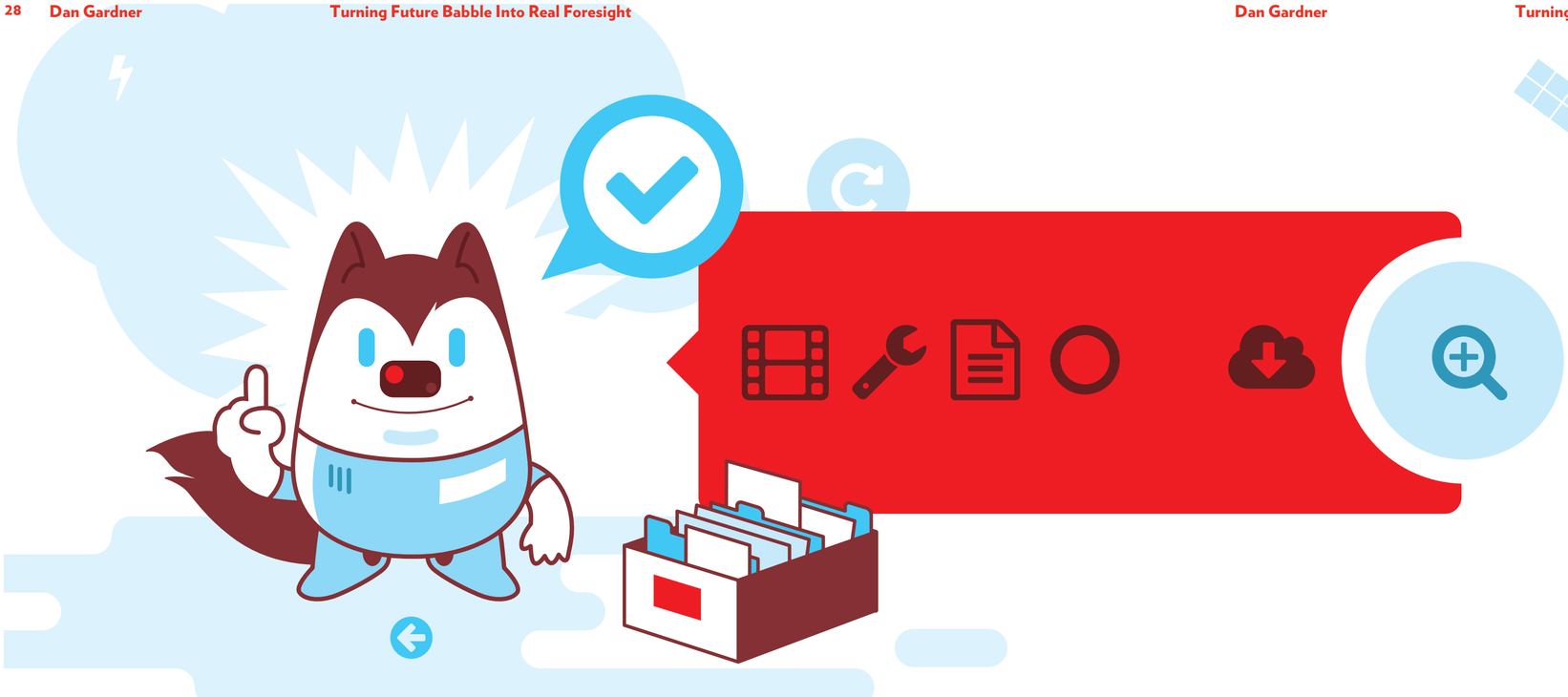
Why is that? Why doesn't Phil Tetlock take the more radical position, which is: Abandon all hope! Well, do you know the old statistician joke? That statisticians like to sleep with their heads in the freezer and their feet in the oven, because the average temperature is really comfortable? Averages can obscure. They can be extremely deceptive. And that average about the dart-throwing chimpanzee, that's an example of it.
What Tetlock actually found was two distinguishable groups of experts. One was a catastrophe; they would have been beaten by the dart-throwing chimpanzees. The other group was a long way from being the Oracle of Delphi, but they had real insight. They would have beaten the dart-throwing chimpanzee; they would have beaten random guessing. So they had real predictive insight, but as I said, they were a long way from perfection. They would have been beaten by simple algorithms. But, and that is the key finding, there was real predictive insight.

And so the question is: What distinguishes the two groups? And Phil analyzed his data; he went looking for all the things he thought might make the difference – education, access to classified information, whether you have a university post or not, whether you're right-wing or left-wing, optimistic or pessimistic... None of those things mattered. One thing and one thing only defined the two groups of experts: It was the style of thinking. It was how they thought.

"The fox knows many things, but the hedgehog knows one big thing."

IV. Foxes and Hedgehogs

When Phil looked at this distinguishing feature, he came up with a metaphor and a set of labels for these two groups of experts. He called them "foxes" and "hedgehogs". And the reason why he did that is the following. Some of you may remember the Isaiah Berlin essay from the 1950s. Isaiah Berlin was quoting an Ancient Greek poet, and it was this scrap of poetry in which he says, "The fox knows many things, but the hedgehog knows one big thing." Now, the poetry is ambiguous: Who is in a bet-



ter position there? What does that mean exactly? It's not clear from the poetry. But what Phil meant was this: As in the poetry, the hedgehog knows one big thing. In this case, it means that the expert had one big analytical idea – one framework idea that really drives everything. It could be rational expectations, it could be peak oil, it could be resource scarcity, it could be any number of different things.

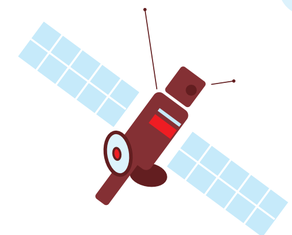
The hedgehog expert has one big analytical idea – one framework that really drives everything.

But it was one big, defining idea, and they used this analytical tool over and over again when making forecasts.
And hedgehogs prefer simplicity. They don't want to clutter up their analysis with information. They want to use the minimum amount of information necessary to produce an answer. They also demand clarity. They don't want things vague and fuzzy; they want to push the analysis until they get clarity. And of course, if you do that, you're going to be increasingly confident that you have the correct answer. And they are. They are very confident. You can see it in the language that they use. Hedgehogs are much more likely to say something like, "It is certain", "Impossible, this will never happen," or "It will / won't happen." Notice that there's no probability there. It's just, "It will," or "It won't."
The fox knows many things. In this case, it means that the fox doesn't have one big analytical idea. The fox will use many different analytical ideas and will jump from analytical

The fox expert will use many different analytical ideas and will jump from analytical idea to analytical idea, depending on the problem that the fox is forecasting.

to analytical idea, depending on the problem that the fox is forecasting.
Of course, that makes life complicated. But that's ok, the fox is comfortable with complexity. The fox wants to get as much information as possible from as many different sources and as many different perspectives as possible and draw it all together. That is going to do what? It's going to make for a messy analysis. And messy analyses usually end in not having a definitive answer. There is going to be a big pile of uncertainty underneath. But they're ok with that. "It's an uncertain world," the fox says, "You have to accept some uncertainty." And of course, accepting uncertainty requires a certain intellectual humility. Again, you can see it in the language that foxes use. The foxes are much more likely to use the language of probability: "Likely / Unlikely", "It may happen," and "I don't know." Hedgehogs really hate that.
Who is the better forecaster? The fox. The foxes were the experts who had real predictive insights. As with hedgehogs: Run screaming from the room if you encounter one.
But here is the real punch line from Phil's research: Who was more famous? The hedgehog. Phil found that there is an inverse correlation between fame and accuracy. Stop and think about that for a moment. Isn't that just amazing?

Now, why is that? I'm guessing that German television has exposed you to both such creatures. – Who makes better television, the fox or the hedgehog? If you're a TV producer, who do you want as your guest? You want the hedgehog. The hedgehog tells a simple, clear story. The fox is like, "I'm not sure..." If you're a producer, you don't want this. Which is why, when you turn on CNBC, it's a parade of hedgehogs. That's great television.
But that's just begging the question. The question is: Why is it great television? And I think part of the answer can be illustrated this way: President Harry Truman said that he wanted to hear from a "one-armed economist", because he was sick of hearing, "On the one hand... on the other hand..." That is human nature. When you have a really important question, you want an answer. And when someone comes along and says, "Well, I think there are six factors involved, maybe seven. On the one hand, some of them point in this direction. On the



The fox is comfortable with complexity. The fox wants to get as much information as possible from as many different sources and as many different perspectives as possible and draw it all together.

other hand, some of them point in that direction. Balance of probability says it's probably more likely than not that it's going to go this way, but there's upside risk, and there's downside risk, and..." There's steam coming out of your ears at this point. You want an answer. And a probability judgment doesn't feel like an answer because it says, "I'm not sure." I mean, that's fundamentally what a probability judgment is. It's an expression, "I think, but I'm not sure." That's not good enough. You want to hear an answer! You want the one-armed economist!

Why is that? Why are we so dissatisfied with hearing, "On the one hand... On the other hand... It may happen..." I argue this: We have a fundamental, deep-rooted psychological aversion to uncertainty. There's lots of research in support of this, which you can find in my book Future Babble. But I think probably the best illustration is this, because unfortunately a lot of people have experience with this:
You go to your doctor, and the doctor says, "I think you may have cancer. But we have to do tests to find out and be sure." So you do the tests, they send them off, and you wait. And anybody who's ever been through that will tell you that the waiting is hell. It's the worst of the entire experience. And unfortunately, sometimes the tests come back, you sit down with your doctor, and the doctor says, "Unfortunately, the tests have confirmed that you have cancer." Do you know what people almost universally report feeling at that moment? Relief. They always say the same thing, "At least I know." That is how fundamental our aversion to uncertainty is, that believing that something bad may happen can be more psychologically oppressive than being certain that it will.

And so it's very, very deep-rooted. And when we want an answer, and we go to the expert, and the expert says, "On the one hand... On the other hand... Maybe." – It's not an answer. So you go to the guy who says, "Well, there's only one hand. And here's the answer." And you say, "Thank you! That's what I needed." And that's exactly the wrong sort of analysis, that's exactly the wrong sort of person you should be listening to.

V. How to Improve Forecasting

Engineers often say this, "Boy, people are messed up. If we could just get rid of the humans. We have so much data, and we have PhDs, and mathematics that produce algorithms – which we don't understand, but they're almost magical! And they produce amazing results. Can't we just get rid of the people and leave it all up to the data analysts? Wouldn't that be miraculous? Then we can avoid all these other problems." To which I respond this: Long-Term Capital Management.

It was a hedge fund in the 1990s. It traded using mathematical formulae developed by two Nobel Prize winning economists. Not one, two. Long-Term Capital Management used its mathematical formulae very successfully. It made a killing. Until something happened, and then it just blew up. And if it hadn't been bailed out, there's a good chance that it would have taken down Wall Street with it. So the model worked really well – until it didn't.
And what happened? Why did it not work so well at that moment? Because there was human, subjective judgment built into the model. And there's always human, subjective judgment built into the model. You can't eliminate the people. Surely, we should know this by now. Remember what 2008 was? 2008, that horrible event – did Wall Street lack for PhDs and mathematics using clever algorithms? No, they're all over the street, the place is full of them. All the sophisticated algorithms blew up. There are many other pieces to the story, but they blew up in part because human, subjective judgments were built into the algorithms, as they always are, and sometimes they are wrong.
So we can't eliminate the people; we have to improve human judgment. How do you improve the humans? Here's a human who has done pretty well:

"You can achieve incredible progress if you set a clear goal and find a measure that will drive progress toward that goal." – Bill Gates

To which you would respond, "That seems about right, Bill. But isn't that kind of obvious? Don't we all do that?" Bill Gates has anticipat-

ed your response, and he responds, "This may seem basic, but it is amazing how often it is not done and how hard it is to get right." That is so true. And nowhere is that truer than in many – not all, but many – fields of forecasting. So, we have to set a goal, and we have to measure, and we have to progress toward the goal.

How do you do that in forecasting? For various complicated methodological reasons, Phil Tetlock argues you need to do this: You need to do forecasting tournaments. As soon as people see "tournament", they think "competition", they think "win – lose". But it's not about that. It's about getting good, hard data and real insights into forecasting, and then using them – good measurement – to progress toward the goal. And if you have forecasting tournaments, bring people together, have them forecast. You can develop that, right? That's your measuring stick; you can measure your way towards your goal. What do forecasting tournaments require?

First thing is: unambiguous questions. One of the banes of forecasting is elastic, vague, ambiguous language. A lot of the forecasts that I mentioned earlier on – Herman Kahn's for example – have vague language. When you look at the outcome and you say, „Ok, we now know the outcome. Was the forecast right or not?" you say, "I don't know. Maybe, maybe not." And the forecasters, they always say, "Yes, it's right." And so you get into these pointless arguments whether the forecast was right or not. You have to eliminate that, and the only way to eliminate that is to have unambiguous, clear, precise questions.

Five university-based teams, more than 5,000 volunteer forecasters in total, 250 forecast-questions so far, more than one million forecasts made.

Similarly, it's not good enough to use the language of "likely", "very likely" or so on, because we all understand those terms differently. We think that we are in agreement. I say, "It's very likely," and you say, "Ok, by that you mean..." And then you have a certain interpretation. Guess what? Our interpretations very often don't match. In fact, the research on this is very clear. This language is again incredibly elastic. The only way to eliminate that ambiguity is numerical probability judgments. – "How likely is it that this thing is going to happen? I say 80 percent." There's no ambiguity there. And the other neat thing about numbers is that they allow calculations.

You also need large numbers of predictions. One prediction: It hits, it's exactly right – does that mean this is a good forecaster or was the forecaster just lucky? I don't know. You need large numbers to figure that out, to have reliable and meaningful results.

So, you're asking these questions in a forecasting tournament:

"Precisely how good are the forecasters?"

"Why are some forecasters better than others?"

If you nail that down, you can then move on to: "How can we make them better?"

If we know what the "magic ingredients" are, can we use those ingredients to try and improve forecast in general?

Now, who has done this sort of thing? Very, very few. As I said, corporations and governments, they spend massive amounts of money on forecasting and they spend almost nothing on analyzing, let alone seeking to improve it. But that started to change. And there's one significant change here: There is a US government agency, an agency of the intelligence community you almost certainly have never heard of – and they like it that way. It's the Intelligence Advanced Research Projects Activity (IARPA) – this is the intelligence equivalent of DARPA. And what they have done is, they went to leading university-based researchers, including Phil Tetlock, and said, "We want to set up a forecasting tournament. We will ask questions that are the sorts of questions that intelligence analysts ask themselves all the time. You can use any methods you want, and we'll have the methods compete, and we'll look at the data, and we'll compare, and we'll learn!"

So it's a very big, expensive thing. Five university-based teams, more than 5,000 volunteer forecasters in total, 250 forecast-questions so far – by the way, we're only in year two of this – more than one million forecasts made. What are the sorts of questions that they're asking? – By the way, this isn't the actual language that they use. It's more elaborate to have that precision, I'm just condensing it:

"Will Greece default within six months?"

"Will North Korea test a nuclear bomb within the next year?"

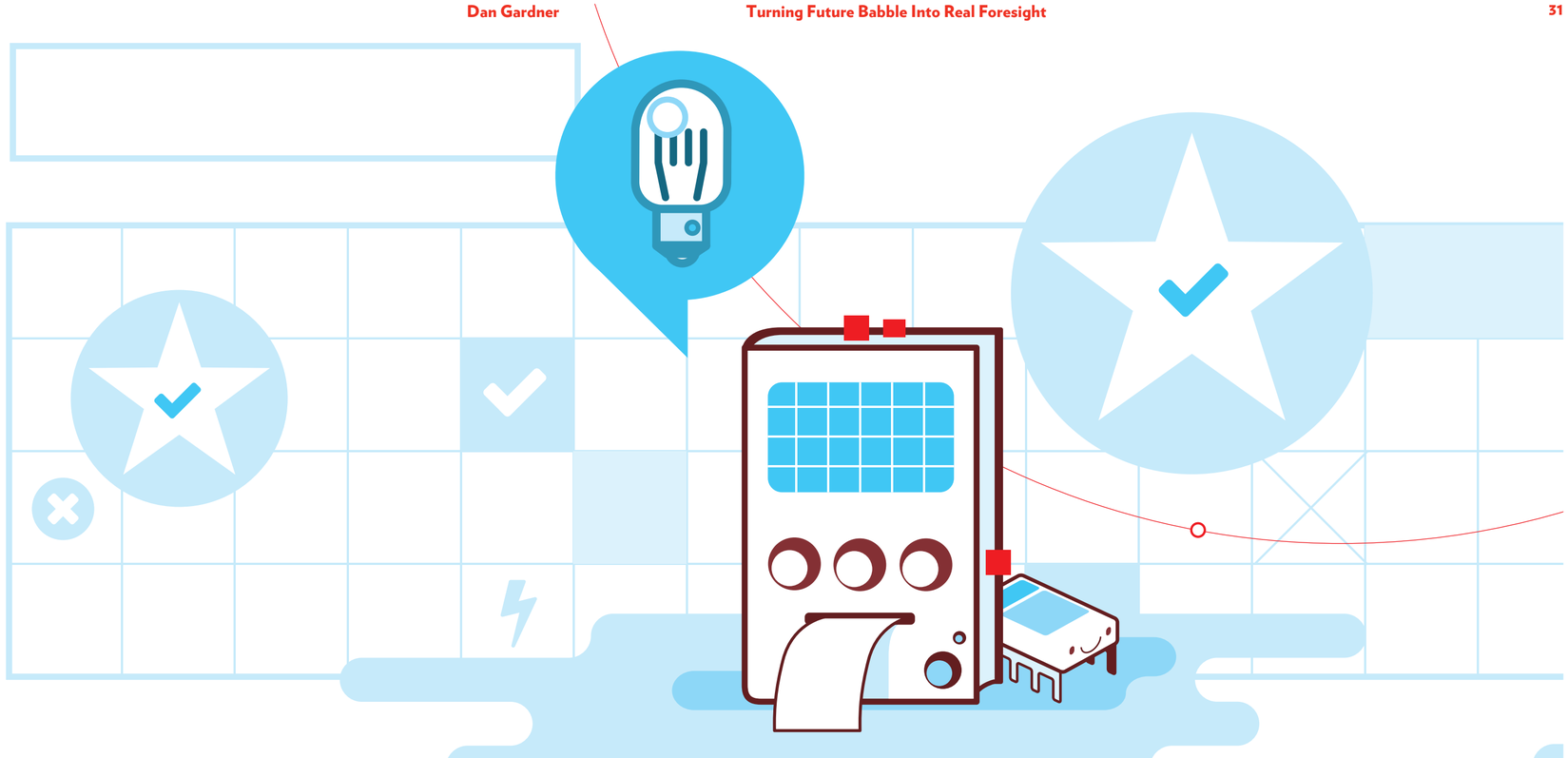
"Who will win the July election in Ghana?"

Not easy questions, I think you would agree.

The winner: Team Tetlock.

The experiments are ongoing, but I think we can now say publicly that Team Tetlock won because Team Tetlock trounced all the other university-based teams to such an extent that IARPA said, "Ok, let's just wrap up this competitive aspect," and then they folded their funding into Phil Tetlock's research program, which is now ongoing. And when I say Team Tetlock won, I should emphasize that Phil's research program is enormous and complicated, and there's so many different facets to it. I'm simplifying greatly here, but basically, what I mean is this: He has a huge base of volunteers who are making forecasts, then he aggregates those forecasts in various ways to get the wisdom of the crowds, then he applies algorithms to those forecasts to try and improve them again. And when I say "algorithms", I don't mean crazy, obscure math that no one understands; I mean very simple stuff. For example, if you have identified that some of the forecasters in your crowd are actually very weak, then you drop them, and if you've identified that some are very good, then you bump up the weighting of their forecasts. Very simple stuff like that. And Phil's best performing algorithm beat everybody by a country mile. IARPA set certain benchmark standards that they wanted everybody to clear; that was the goal. Phil blew right past them.

And one of the most intriguing results I think is this: Some gains are really easy. One of the things that Phil did was to provide simple training to certain individuals. And when I say "simple training", I mean really simple. He literally had people read some short essays about probability judgments. It took about half an hour to read, so this is really simple stuff. And it was things like for instance, "Pay attention to the base rate!" To illustrate: If you have a project, and you say that the project is going to be finished in April, and you judge how likely it is that it's actually going to be finished in April – you would ask yourself, "Who do I have working for me? What are my resources?" – That's one way to answer that question.



The other way is: Consult the base rate. Look at all the other projects like this and ask yourself, "How often are they done on time?" And if the answer is, "They're never done on time," you should treat that information very seriously. So it's a very simple point. And that is part of this base training. And the incredible thing was, just by reading this stuff for half an hour, there was a ten percent improvement in forecasting accuracy.

And that's over a year! And they weren't asked to repeat this, it wasn't that once a month they were told, "Go back and read your lessons!" They read it once at the beginning of the season. And that's it. And in that year, it produced a ten percent improvement in accuracy. So that's pretty exciting, because it's so simple and easy to do. Here's another aspect of the outcome so far that's really intriguing: "super forecasters". What Phil did was, at the end of the first year, he identified the top two percent of forecasters and called them, rather grandiosely, "super forecasters". Here's how the super forecasters did overall as an average: They beat the wisdom of the crow by 65 percent. By the wisdom of the crowd I mean: There was 5,000 volunteers all together across all the teams; if you took the simple average of all their forecasts, the super forecasters beat that by 65 percent.

Just by reading short essays about probability judgments for half an hour, there was a ten percent improvement in forecasting accuracy.

They beat the best competing algorithms by 35 to 60 percent.

And they beat two prediction markets by 20 to 35 percent.

Again, that's really impressive stuff.

Now, if you're being skeptical – and I do hope you are – you might say, "Hang on! In any tournament, there's going to be a top two percent. There are going to be people who score well, no matter what. It could just be luck." Which of course is absolutely true after one year. And so you say to yourself, "We've identified these top two percent. What will happen next year?" How much of their results was the product of luck? If it was 100 percent luck, you would see very fast regression to the mean. The people at the top would be in the middle or below very quickly. And if it was a substantial amount of luck, you would see less regression to the mean, but still a lot of it. Guess what you saw: No regression to the mean. And very excitingly, as good as they are as a group, Phil was actually able to improve the super forecasters' performance by putting them in teams with other super forecasters and by giving them that simple training.

Now here is, to use an Americanism, the 64,000 dollar question: What makes super forecasters super? In large parts it's this – not entirely: They are intelligent; they are a smart bunch, an educated bunch. There was a conference of super forecasters in Philadelphia this summer, I met them. They come from a very wide array of backgrounds, but all very clever, impressive people. But there was something else they had in common: They were all exemplars of the fox style of thinking.

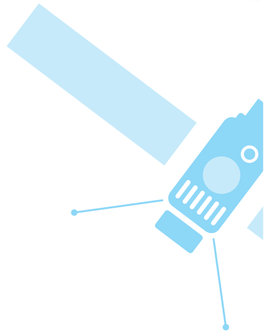
It was really interesting to be in a room full of these people, because it was just a classic fox and a classic fox and a classic fox... Very exciting stuff for me.

So if you want to get involved by the way – as I said, it's an ongoing project – you can volunteer. You can find out how good you are at forecasting.

Thanks so much!

KATHRIN PASSIG

I CAN'T BELIEVE IT'S NOT THE FUTURE – TECHNODREAMS AND TECHNOPANICS



Kathrin Passig works as a writer, journalist, and bad programmer. In 2006 she won the prestigious Ingeborg Bachmann Prize with her first prose piece.

Her non-fiction books (on the topics of procrastination, sadomasochism, open questions in science, getting lost, and the internet) have been translated into eleven languages. Her latest book on how to suck less at programming was released by O'Reilly in late 2013. At zufallsshirt.de she runs a shop for randomly generated unique T-shirts, "an experiment in artificial stupidity".

The following text is a transcript of a lecture held at the Cologne Conference Futures 2013 – the Annual Symposium on Media Evolution Cologne, October 2nd, 2013

I. Understanding the Present

Dan Gardner today already did a lot of the heavy lifting for me. Usually I have to explain all the Tetlock research and all the cognitive biases. It's nice not having to do that once in a while. Most of the examples I'm going to use are expert predictions as well, but I will not talk about how to judge these predictions; I'm going to talk about our own mistakes in judging or evaluating everyday change and dealing with change. I will try to explain how we can avoid saying things about the future that we will regret later – or in most cases not that much later. Actually, it's not so much about predictions but about understanding the present.

With some effort I found this tweet from last year by Michael Bukowski (@mbukowski), "Rough guess: 75% of all people mentally live in the 19th century, 20% in the 20th and the rest now," – this rest being five percent. We don't need to talk about the future that much, it's difficult enough to deal with the present. I usually get paid to explain not even the present to audiences but changes that have been around for five to ten years. Dan Gardner in his book and also in today's talk describes hard-wired aversion to uncertainty, but I think most change-related problems we face are not even about uncertainty. It's quite certain, in fact, it's

> I'm going to talk about our own mistakes in judging or evaluating everyday change and dealing with change. I will try to explain how we can avoid saying things about the future that we will regret later – or in most cases not that much later. Actually, it's not so much about predictions but about understanding the present.

hard to overlook that we're already surrounded by quite a lot of the developments that researchers and consultants keep talking about: The mobile Internet and its consequences, coworking spaces and a changing nature of the workplace, increasing mobility...

In many situations, there is not even a need to predict the future. You, or in some cases your company, will do fine if you just manage not to lose touch with the present, or at least acknowledge that the present is

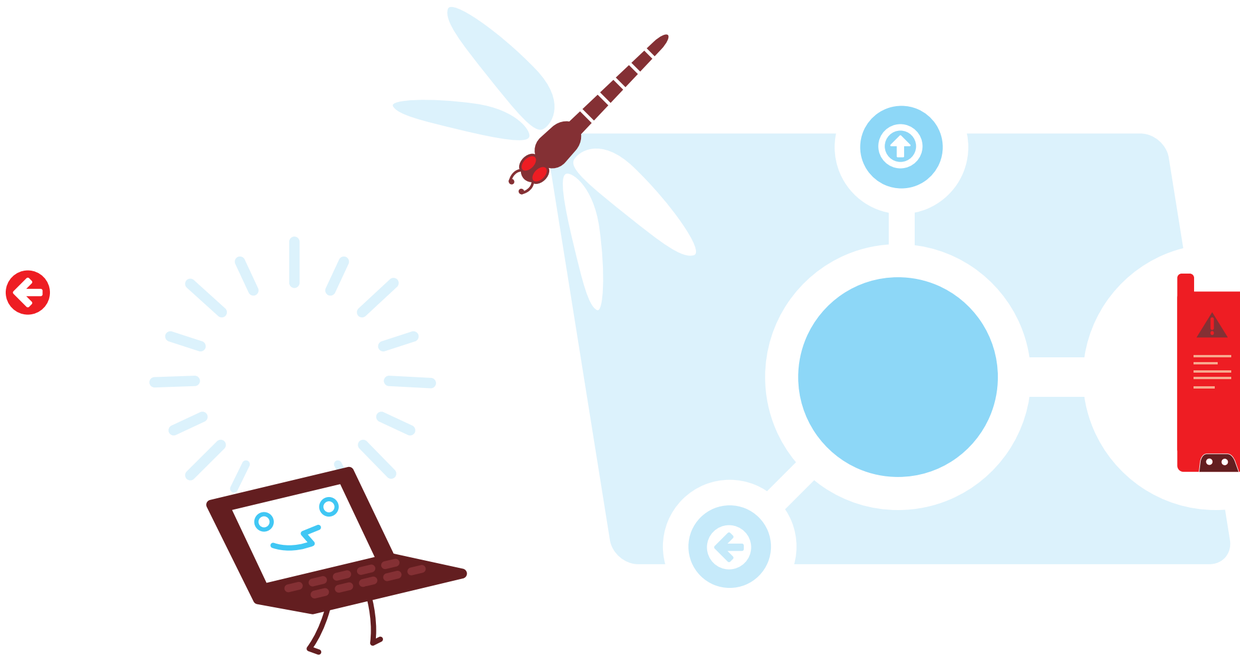
> We don't need to talk about the future that much, it's difficult enough to deal with the present.

there, and not be in a state of denial, as large parts – as far as I can see – of the book business are in right now.

I'm not preaching to the older demographic here. This is a problem everyone faces all of the time. I still remember the day when I first encountered the Internet – or more precisely: the World Wide Web – when a friend showed it to me. And what I thought was mostly nothing at all. I looked at it and I thought it would be like its predecessor, the videotext. I thought this Internet thing would be another boring invention that would appeal only to the most hardcore nerds. And I was 23 at the time, so it's not a problem of old age.

There is a quite comforting blog post, written by Kevin Kelly in 2008 with the title "Digital Things I've Been Wrong About" and in that blog post he writes, "When I saw the first version of Photoshop in 1990 I thought it was a joke." He was wrong about "The Sims", wrong about ink jets, and about eBay he writes, "I was so wrong about this it is not even funny." So, it happens to everyone. We can't avoid it altogether, but we can avoid some of the more common pitfalls.

Sometimes, some of us are getting paid to be the experts Dan Gardner was talking about. More often we are not the experts, but still we need to react to the changes in our surroundings in some way or the other. And before we can react, we need to realize that there actually is something that's changing, and that's not a trivial thing to do. A lot of the time,



our minds work against us. But since the mind fortunately tends to do that in a rather stereotypical way, I think it should be possible to at least find some simple heuristics to recognize faulty argumentation.

We need to react to the changes in our surroundings in some way or the other. And before we can react, we need to realize that there actually is something that's changing, and that's not a trivial thing to do.

In 2009, I wrote an article about failed predictions. The German title of this article is the same as the title of the book it was now printed in: "Standardsituationen der Technologiekritik", which roughly translates to "Commonplaces of Technology Critique". It was a reasonably funny article and to this day it's quoted a lot. I've seen people mention it on Facebook only yesterday. But unfortunately, it is quite wrong. This is even more unfortunate since the book only came out now, it is a collection of essays, and now people assume that this is my current opinion on this subject – which it isn't. Technology optimists liked that text because it makes skeptics look stupid. It's always nice when things make other people look stupid. It's very easy to make fun of predictions in general, and I just fell into that trap. You can easily find quite a lot of wrong predictions; it's become even easier since you can simply look them up on the Internet. And whatever people said on TV in an unguarded moment ten years ago, it will be there. But the fact that there are all these wrong predictions in itself doesn't mean anything. Dan Gardner described the difficulties inherent in determining what percentage of these predictions is wrong; the short version of his argument being: For historical predictions, it is impossible to do, because you don't know how many predictions there were to begin with and so on.

To make things worse, in this article I only wrote about failed skeptical predictions by pessimists, because back then I simply wasn't aware that there is a large body of failed predictions by optimists. Later I wrote a book trying to remedy that error; I think it is a much better book than the original article was – and it's also much less popular. I wrote the article when I was a "hedgehog" and I wrote the book as a "fox". And as it turned out, it's a lot easier to be quoted a lot when you say "hedgehogish" things.

So for the next part, please keep in mind that all of this is wrong. It's still kind of funny, so I hope you will bear with me. And after that I will try to salvage the good parts and make what I hope is a slightly more intelligent point.

II. Commonplaces of Technology Criticism

I think there is some sort of criticism cycle for every new technology, similar to the hype cycle. And reactions to technical innovations, whether in the media or in our private conversations, follow preconceived paths, mostly:

1. What is it good for?

The example that is usually given is quoted a lot as well: Robert Lloyd, an engineer with IBM, greeted the microprocessor in 1968 with the words, "What the hell is it good for?"

2. Who wants it anyway?

U.S. president Rutherford Hayes used it in 1876 when he was shown one of the first telephones. "That's an amazing invention," he's quoted, "but who would ever want to use one of them?"

There is a slight problem with this quote, which is that it probably never happened. Luckily, I'm not the president of the United States, so no one complained to me about it when I used it, but in the four years since I wrote the original article, I realized that quite a lot of those predictions never happened. Probably the most famous one in Germany is one about Bavarian doctors who supposedly in the mid-19th century claimed that using the railway was too dangerous because the high speed of the railway – I think back then around 30 kilometers per hour – must necessarily cause insanity. It's quoted endlessly, and I would almost have done it myself. Fortunately I didn't, but not because I doubted its authenticity, but because I thought it was a little worn out. There's no evidence that this document ever existed. There has been some research, and it never turned up. I think it's mostly a propaganda argument used to discredit skeptics.

3. Only dubious or privileged minorities want this.

In the 90s, the Internet was claimed to be the exclusive preserve of white men between 18 and 45, and there wasn't any chance of it reaching broader sections of the population because women were known to be less interested in computers and – I quote from a magazine article by Hanno Kühnert – "tend to avoid the impersonal barrenness of the web". And since women did most of the shopping, there was no chance that anyone would ever use the Internet to buy anything.

In 1994, Horst Opaschowski, who back then was one of Germany's most renowned futurists, predicted, "The multimedia-ride into the 21st century will look more like a ghost train for a few lost Nintendo kids while the mass of consumers will continue to be TV-crazy." Also, it was regularly pointed out that terrorists and Nazis along with pornographers and consumers of pornography were the principle users of this new thing called Internet.

4. Perhaps, if we just keep our eyes shut tight enough, it will just go away.

There are a lot of historical quotes on that topic: "The horse is here to stay, but the automobile is only a novelty – a fad." That was the advice given to Henry Ford's lawyer by the president of his bank when he asked whether he should invest in the Ford Motor Company. Charlie Chaplin took the view in 1916 that the cinema was little more than a fad; Thomas Edison announced in 1922 that "the radio craze will die out in time"; and in 1996, Ines Uusman, a Swedish minister for transport and communication, was still hoping that "the Internet is a fashion" that might pass.

The fact that a technology reached this point on the hype cycle at all means that it's very unlikely that this is going to happen. The fact that we're talking about it, that we're having this discussion, means it's far enough advanced on the hype cycle that it will not simply disappear. And even if it does die, there is this common misunderstanding – or maybe wishful thinking – that the innovation will go away to make place for whatever it was that came before it. I deal a lot with people who ask hopefully, "But won't Facebook go away five years from now?" Yes, in all likelihood it will. But it will not go away to make place for the pre-Facebook world, it will make room for something that to the critics must seem even more distasteful than the thing Facebook is right now.

5. It will make no difference.

After a while, if you see that you have to stop denying the innovation's existence, you can still continue for a while to dispute its repercussions. In 2000, the *tageszeitung* wrote that "the Internet won't change politics". Well, looking back to the last election, maybe they were not that wrong after all, but still...

5a. It's just a toy.

There is this sub-argument that the innovation is probably only a fancy gadget with no practical consequences. Lord Kitchener said that about the first tanks in 1917, "A pretty mechanical toy." And if you remember Kevin Kelly's statement about 3D printing, right now 3D printing is mostly about printing toys – and I've been guilty of using this argument myself: I've been complaining about the boring results of 3D printing for several years now, because all the examples are printed toys. But that's still not a good argument.

5b. There's no money in it.

In 1904, flying pioneer Octave Chanute predicted that airplanes "will be used in sport, but they are not to be thought of as commercial carriers".

5c. Its users have nothing to discuss.

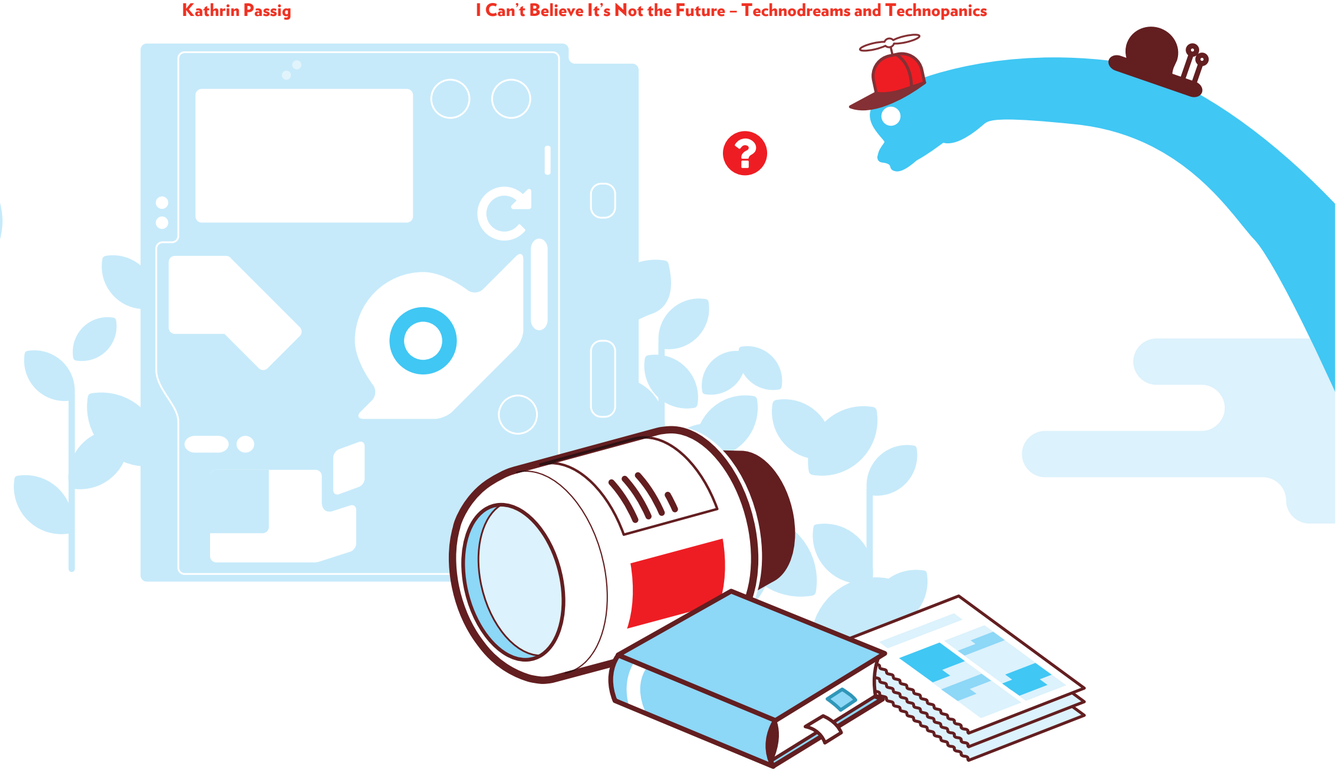
Another variation of this uselessness-argument for communication technologies is usually that their users don't have anything to say using that new medium. Henry David Thoreau wrote in 1854, "We are in great haste to construct a magnetic telegraph from Maine to Texas; but Maine and Texas, it may be, have nothing important to communicate." The telephone and the Internet have been subjected to the same accusations. I'm old enough to have heard them myself about the telephone, mostly by my parents, "You don't have anything to talk about any way." And of course the argument was used a lot when it came to the Internet. As late as 2007, there was the book by Andrew Keen, *The Cult of the Amateur*. Andrew Keen wrote of "millions and millions of exuberant monkeys [...] creating an endless digital forest of mediocrity". And in the same year, Henryk M. Broder claimed in the *Tagesspiegel* that the Internet was the "leading cause of the infantilization and stultification of our society". A little later, you can't plausibly deny that the novelty does continue to enjoy widespread acceptance. It's not about to disappear and it is even commercially successful up to a point, so it is in principal quite good, but:

6. It's not good enough.

For example it's expensive and, that is always part of the argument, it will become more and more expensive. This is a quote from an essay from the 1990s by Hanno Kühnert: "Anyone who uses the Internet regularly has a noticeably higher phone bill despite the good value of the connections. Costs for individual users will continue to rise." My phone bill in the 1990s was so high that it was actually cheaper to share an office with friends and have an Internet landline for less money than what my private phone bill used to be, and it has gone down ever since.

Same with the predictions, also from the 1990s, that the Internet was already too slow and would slow down even more. And also that soon no one would be able to find anything using search engines. A journalist writing about search engines complained in 1996 that "one of these engines answered the request for the word 'Internet' with 1881 responses." Those were happy days in '96! "After the 120th entry, I had no desire to keep clicking." He assumed of course that this exact situation would continue until there would be "over 2,000 hits". That was pre-Google, and of course, as soon as Google had solved that problem, people started to complain about other problems. I think people might have been complaining a little less between 1998 and 2000.

Also, the innovation is overcomplicated and temperamental. In an article in *The London Times* in 1895, someone considered it "extremely



doubtful" that the stethoscope would ever find widespread circulation, since it was time-consuming to use and caused "a good bit of trouble". This is also a good example of how there are usually – I'll come to that later – good reasons behind these less than rational arguments. People are not being stupid. People are just trying to find some sort of rationalization for something they're gut feeling or "System 1" told them. And in that case we happen to know what it was that their gut feeling was telling them: In the 19th century doctors were not supposed to use any diagnostic instruments – it made them look like engineers, like dentists. It was not the thing to do, so they had to look for some sort of argument that would enable them not to use this new thing that would detract from their status as doctors.

And finally, the innovation of course is not 100 percent reliable. There is a quite interesting book, *Wegzeiger* (engl.: "Signposts") by the folklorist Martin Scharfe. He collected quite a lot of reports and cartoons about illegible signposts and poor travelers that are being sent in the wrong direction and are getting lost because of those signposts. Signposts themselves are pretty new, they were introduced in the late 18th century, and this gave rise to this large number of cartoons. And since the late 90s we've seen quite a lot of stories about people being let astray by their satellite navigation devices. I think it is quite the same distrust of new-fangled gadgets and the same schadenfreude about those who think they are particularly clever and well-equipped and still manage to get it wrong.

After that, it's high time to think about what the innovation is doing to the heads of children, adolescents, women, the lower classes, and all the other easily impressionable citizens:

7. Weaker persons can't handle it.

"Weaker persons" of course in that case means: Weaker than I am. Lots of medical or psychological studies are hauled in to prove a fallen standard of some kind or posit a correlation with the technology that is currently causing a stir.

8. Bad manners

As soon as the technology is well-established, we come to the questions of etiquette. In the early days of the printing press, it was considered bad manners to give a printed book as a gift. Until the 1980s, there was a stigma of rudeness attached to typed private letters. And there used to be a lot of criticism of mobile phone use in public, as if it was any more annoying to have to listen to other people's phone conversations as opposed to having to listen to other people's regular conversations. I think I'm hearing a little less of these mobile phone complaints, but not all owners of cafés are okay with people using their laptops in public. Sitting around in public with a newspaper or reading newspapers in cafés has not caused any offense for quite some time, but using laptops in public still does in many places.

9. It will change our thinking, writing or reading for the worse.

For critics around 1870, the postcard was the end of letter-writing. The American Newspaper Publishers Association in 1897 discussed whether typewriters lower the literary grade of work done by reporters. And in 2002, a journalist in the *Neue Zürcher Zeitung* compared the sound of typewriters to music and complained how the grade of literary work done by reporters would suffer from the end of typewriters and the use of computers, "Every kind of dirt or violent motion, the angle of the paper, the compression of the lines, a raised C – all that has vanished. Which, as we know, tempts us into carelessness: which of us has not thought at some point that they have composed a splendid piece of text purely because everything was so clean and pretty to read?" The German author Peter Härtling explained in 1994 that "experts can spot prose written by a poet on a PC by the way it is imperceptibly shaped by the fear that the computer will crash". And there was a study in the scientific journal *Academic Computing* in 1990, claiming that the graphic user interface of the Apple Macintosh caused students working on these computers to make more spelling mistakes, to write more carelessly, to use simpler sentence structures and a more childlike vocabulary than other students who were using PCs, which back then had no graphical user interface. And the most recent variant of this argument is that PowerPoint leads to "shallowness of thought" – this is a quote from *Der Spiegel* in 2004 – and to a diminishing capacity to follow longer texts at all.

The fact that every new technology must go through these stages explains the unexpected amount of Internet criticism during the last couple of years. At least it came unexpected to me, because in 1995 I thought that the discussion we had about the Internet since 2008 would be over and done with by 1998 – and of course it wasn't. Just at the moment that criticism of the World Wide Web, created in 1994, was coming to an end, various Internet-based innovations, such as Twitter and Facebook, were entering the first stages. And of course, as soon as people have become used to social media, there will be other horrible innovations and those will go through the first stages of this criticism.

Currently it seems to take about ten to fifteen years for an innovation to go through those most predictable stages of criticism.

When I wrote the article in 2009, the iPhone had gone through the same stages mobile phones in general went through in the 1990s: People would complain that it was only a status thing and there was no real use to mobile phones. Generally, only people who wanted to show off would own them. It was the same with iPhones when they first came out, and by the time I wrote the article, the iPhone was at stage 6. I got myself one of those iPhones, but the contract was so expensive. The phone was fine by then but the price was not.

And right now I think it's mostly the self-quantification movement going through the first stages, as well as Google Glass. In yesterday's *Frankfurter Allgemeine Zeitung*, there was an article about Google Glass that uses most of the early stage arguments. It says that only idiots would voluntarily wear such a stupid thing, and that maybe people will get used to it, "but still: I just don't see the point." Which is of course the "What the hell is it good for?"-argument.

Currently it seems to take about ten to fifteen years for an innovation to go through those most predictable stages of criticism.

III. Commonplaces of Technology Optimism

It took me a while to even realize that there was such a thing as the failed prediction by optimists. When I tried to research them, they turned out to be much harder to find.

I can imagine some reasons why that may be: Of course there might be more pessimistic predictions in general – not entirely implausible, especially in Germany. But I think the basic assumption has to be that probably there is the same amount of pessimistic and optimistic predictions. There might be more failed pessimistic predictions in theory because the optimists might have a better track record, but I don't think that's true either.

I think most likely this is an artifact caused by the fact that I did all my research on the Internet, and technology optimists tend to publish on the Internet, while the skeptics tend not to do so. So maybe I was just looking in the wrong place. Anyway, I was unable to find enough material to construct the same kind of cycle, so I'll just list some common arguments in no specific order.

1. Liberty and equality, guaranteed freedom of speech

In the 19th century, quite a few people predicted that the railway would necessarily bring democracy and free speech to all countries, just because it had become easier to travel, to take your political ideas and of course your political handbills and books to your neighbors.

This has been going on for quite some time. One of the last persons to use it was Ronald Reagan in 1989 when he said, "The Goliath of totalitarianism will be brought down by the David of the microchip." And in 1997, Nicholas Negroponte of MIT's Media Lab said that after using the Internet, children would not know what nationalism is.

2. Universal peace

This is a very enduring and very popular argument. There was this question after Kevin Kelly's talk, that there seemed to be an understanding in military circles that due to the Internet and digitalization, there wouldn't be any more wars. This is quite old.

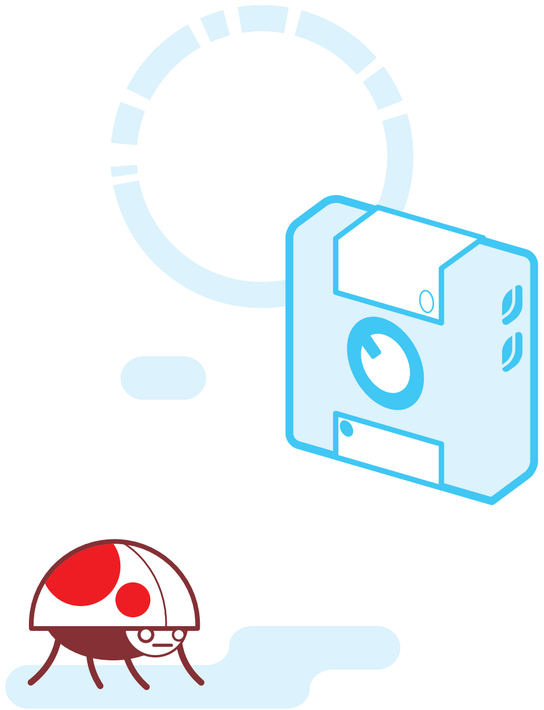
In 1858, a British ambassador predicted that the telegraph would bring about world peace. The inventor of the Maxim machine gun Hiram Maxim predicted that the machine gun would make war impossible, which quite obviously it didn't. Alfred Nobel said, "My dynamite will sooner lead to peace than a thousand world conventions. As soon as men will find that in one instant, whole armies can be utterly destroyed, they surely will abide by golden peace." Lots of people used it after that; Jules Verne said the same about the submarine; Guglielmo Marconi said the same abut the radio; Henry Ford said it about the car, because the car makes it easier to travel, so people will mix more and see that their neighbors are basically nice people; Thomas Hutchinson said it for the same reasons about TV in 1946; Lyndon B. Johnson said it about the space program; Britain's prime minister Gordon Brown said in 2009 that we couldn't have genocide like the one in Rwanda again because "information would come out far more quickly about what is actually going on and the public opinion would grow to the point where action would need to be taken."

3. Learning will be easy
Thomas Edison predicted in 1922 that the motion picture will "revolutionize our educational system," and that "in a few years it will supplant largely, if not entirely, the use of textbooks." There is another quote, this one from 1915 by D.W. Griffith in *The New York Times*: "The time will come, and in less than ten years, when the children in the public schools will be taught practically everything by moving pictures [...] You will merely seat yourself at a properly adjusted window, in a scientifically prepared room, press the button, and actually see what happened."

4. End of scarcity
Most quotes about this are from the 1950s about the fact that energy in the future was going to be free. "All power (electric, atomic, solar) is likely to be virtually costless" - this is from the 50s by Henry Luce, founder of TIME magazine. The mathematician John von Neumann said it as well at about the same time, "A few decades hence energy may be free – just like the unmetered air."

5. End of crime
In the book *Die Welt in 100 Jahren* there is an article by Robert Sloss about the "wireless century", and the author claims that the wireless century will be the end of most if not all crime. The idea back then was that wirelessly transferring pictures of criminals to other cities would deter people from committing any crimes at all. This is a very familiar argument, and right now we keep hearing it in the context of video surveillance.

6. Overcoming death
Quite surprisingly, this keeps cropping up: Overcoming death. I have this quote from 1895 by a Paris journalist after seeing one of the first films ever, who wrote, "When these gadgets [meaning film cameras] are in the hands of the public, when anyone can photograph the ones who are dear to them, not just in their immobile form, but with movement, action, familiar gestures and their words out of their mouths, then death will be no longer absolute, final."
The modern version of this idea right now is the idea that people will be able to upload their brain to the internet and thus become immortal.



There is something to be learned from these predictions. Of course that's what I thought in 2009, but back then I thought that what can be learned from these predictions is that you should not make any skeptical predictions because they would always turn out wrong. But people back then were no stupider than they are now. The same things that made them say funny things about their present make us say funny things about ours. I have personally used just about every argument on these two lists and I suppose so have most of you. I might not have used the one about death, I'm not quite sure about that.

IV. What to Learn from False Predictions

Now, a couple of years after the original publication, I think our best option to make sense of these statements is to regard them as some sort of indicator, some little blinking light saying, "There is something interesting going on here."
Whenever someone uses one of these arguments, they are trying to deal with very old problems, and while the statements in themselves may not offer any answers, they can at least lead us to interesting questions – questions that are about how to deal with change, how to deal with new technologies. Every time we use one of those statements, every time we catch ourselves doing it, we are saying, "I'm helpless. I don't know what's going on. I don't know what to make of this change. I have a gut feeling that it is wrong, and I'm fishing for arguments that help me make a more rational point." And that in itself is a useful thing to know: That as soon as you find yourself using one of those arguments, you know that you are on to something interesting there – though the argument in itself is wrong.
Dan Gardner has already named a few of the more interesting reasons why the mind doesn't work too well when it comes to interpreting and dealing with these changes. I would like to add some more: Of course there is wishful thinking for the positive changes, and there is the unwillingness to face change or to change our own habits for the negative statements. And in both cases, this is not entirely irrational. I think in a lot of cases it is a quite valid career-building or career-maintaining maneuver that is going on.
It's tempting to blame everything on age. I read an article about penguins using an iPad to play a game for cats – I think you have to catch a little fish or mouse. And penguins like to play that, although, as the article says, it's only the young penguins that like playing it. The old penguins just ignore the iPad.
I think humans are not quite like penguins in that regard. I think that age is secondary, or at least I hope it is, because this is a career-maintaining maneuver for me to claim that age can't be the limiting factor here. But Kevin Kelly is a good example, because he's not quite the youngest penguin in the room, and that shows pretty well that what counts is your motivation to stay ahead of things or at least in touch with the present. While we are young, we are very motivated to understand the present because we lack money, we lack social status and we need every foothold that we can get. As soon as we obtain some moderate degree of success, we get lazy and it's less important to us to actually understand in detail what is going on, so we simply don't invest

We tend to get stuck in our routines, and we try to make up for our lack of understanding of our surroundings by using lazy, commonplace arguments. If you make it a habit to try things, even if they feel useless or annoying, and if you do not actively keep your relatives and your coworkers from trying these things, it helps.

You might even experiment for the sake of experiment: Move small things around. People usually hate larger changes, especially in companies where change is usually forced on them. But low-level change might just work. And that will make it far more likely for you to stumble across your equivalent to the Scrabble app.

as much time as we used to do. I don't know if you remember the movie *Ratatouille*; there is this food critic that says, "The new needs friends," and it's okay if these friends are critical, but they do need to have an open mind.

You should make it your habit to try new technologies or new strategies, even if they look stupid and useless to you.

V. Rules of Mental Hygiene

In hospitals, there is a whole system of rules, strategies and habits that by themselves don't cure any diseases. You need to use sterile equipment, you need to wash your hands, you need to follow procedures, or you will be making things worse. And I think there should be similar rules for companies or even for dealing with the contents of your own mind. So I'm going to propose three of those rules:

1. Wash hands
This is of course metaphorical, even though washing hands will help you as well. If you work in any profession where understanding current events and coping with change is important – and personally I think that includes all professions, but it certainly includes all the professions of the people who are here today – I think you should make it your habit to try new technologies or new strategies, even if they look stupid and useless to you. Which they will. It's like washing your hands in a hospital: It's annoying, you don't want to do it, and the worst thing about it is that you have to do it over and over again; doing it once isn't enough. But you have to do it because neglecting that simple step will compromise all the other work you're doing.
This sounds easier than it is, because right now you're probably thinking of the one or two new things you've tried in the last year. Don't do that. Try to think about the things that you were disinclined to try, the things that you told other people you would never try because they were useless, stupid or annoying, or they looked unnecessarily complicated to you.
We aren't rational animals. We must experience things in order to find out anything useful about them. It's not enough to read about current events, and it's not enough to watch other people using whatever it is that you don't like. Just accumulating information is usually not enough for us.
There is a chapter in Kevin Kelly's book *What Technology Wants* on the Amish, and even the Amish evaluate new things by experience instead of by theory. And it doesn't mean that you should or even can force yourself to use something you hate. Every tool can be used in a lot of ways. There is always some aspect, some way of using a new tool, a new gadget, a new strategy, that will appeal even to you, that will turn out to be useful and interesting, and the rest will follow from that hook. If you're patient and keep searching for that hook, you will find that it is there.

My mother has had an iPad for about six months now. She was never very interested in technology or the Internet, and for about the first three months that she owned an iPad, she was complaining that she didn't know what to use it for. "It's nice," she said, "but I'm not quite sure what I'm actually going to do with it." And also at the same time, and for a long time before that, she kept complaining that her children and grandchildren spend their days glued to the computer. Well, she's no longer complaining now.
Strangely, the hook for her was playing Scrabble. We always used to do that a lot twenty years ago, and for her to discover that she could use the iPad to play against her children online revived this tradition for her. And everything else followed from that. It sounds trivial – Scrabble, that's not much – but that made her use instant messaging from the Scrabble app, too. She will instantly fire up Skype to complain if she doesn't like the Scrabble-word I played. She refused to use Skype for years, but it was very easy once she found out what it was for. And she realized, I think, that the internet is actually about being social. I must have told her that a million times, but of course she didn't listen to me. She had to find it out for herself. I didn't get the message through, but the Scrabble app did.
Of course now it's my father who's complaining, because she instantly acquired all the obnoxious habits my

friends and I went through five years ago. She will use it at lunch even though there are people around, and what's worse: She keeps telling people using PCs that an Apple is much better and asking why they even bothered wasting their time with these ugly and clunky machines. Of course everyone hates that. I knew that, but she's just finding it out right now. My father hates it.

By the way, have you noticed how the mobile phone ringtone – which was very annoying when used by younger people ten, fifteen years ago – now is only used in an annoying way by senior citizens on trains? Everyone has their mobile phone set on vibration or they're looking at it all the time anyway, so they see when it's ringing. But every time there's a really loud and annoying ringtone, it invariably belongs to someone who is about 80 years old. I think that might be the topic for a different article: "The seven stages of impoliteness in technology adoption." It's like evolution: we have to go through all these stages in order to leave them behind us.

2. Don't voice an opinion on any new technology you haven't even tried.

And by "tried" I mean: You have given it the chance to integrate itself into your life, not just glanced at it in passing or seen someone else using it or used it for two day. Unless you are a journalist or an expert, shutting up on the subject of a gadget or a technology is usually a very valid option. You can simply not say anything about it. And this, too, is a matter of simple mental hygiene. If you routinely dismiss things you've never tried, you encourage sloppy thinking. You encourage it in yourself and also in you friends and coworkers.

You don't have to be a curious early adopter, you don't have to be novelty-seeking, you don't even have to talk like someone who is. It's enough to avoid talking like a person who is utterly disinterested in the present. All change is complex and, as Dan Gardner said, we need to be comfortable with that complexity.

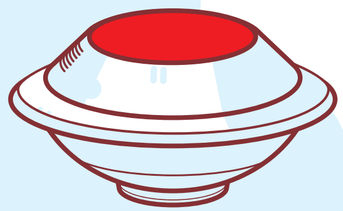
The arguments I quoted are very simple arguments. If you find yourself using one of those simplistic arguments in favor of or against some innovation, this is in itself a pretty good indicator that the argument will not help you understand what's going on. And you should be especially wary if you find yourself using one of those arguments from my list.

Of course, every single one of those arguments might be true, and in fact most of them probably are. When the printing press was new, people said it would cause wars and it would cause people to turn their backs on religion, both of which it did. So the skeptics had it right. And the optimists get it right as well. Every once in a while, scarcity really does end. For example at least in First World Countries, there hasn't been a problem with the availability of food in a long time. For our ancestors, even one or two centuries ago, this must have seemed like an impossible dream, not to have any famines anymore. But still, you're not helping the discussion by using these arguments, though every once in a while you might luckily find the case where it's actually true.

Last week, I met a university professor who was just working on a book about why printed books are better than eBooks and why they will always be superior to eBooks, for a lot of reasons. All of his arguments were more or less taken from my list of pessimistic predictions, and they sounded a lot like after-the-fact rationalizations of his own habits and preferences. I don't think he had even tried reading an eBook more than once or twice.

A useful addendum to this rule number 2 might be: If you must have an opinion about things you have never really tried, at least do not put it down in writing. You want to assure deniability. And as Philip Tetlock's research shows, if we do not put our bad predictions down in writing, we very easily forget them. But even if we put them down in writing: If you show people later what they wrote and ask them how they could have been so horribly wrong, they will still deny everything. So maybe it is okay to write it down...

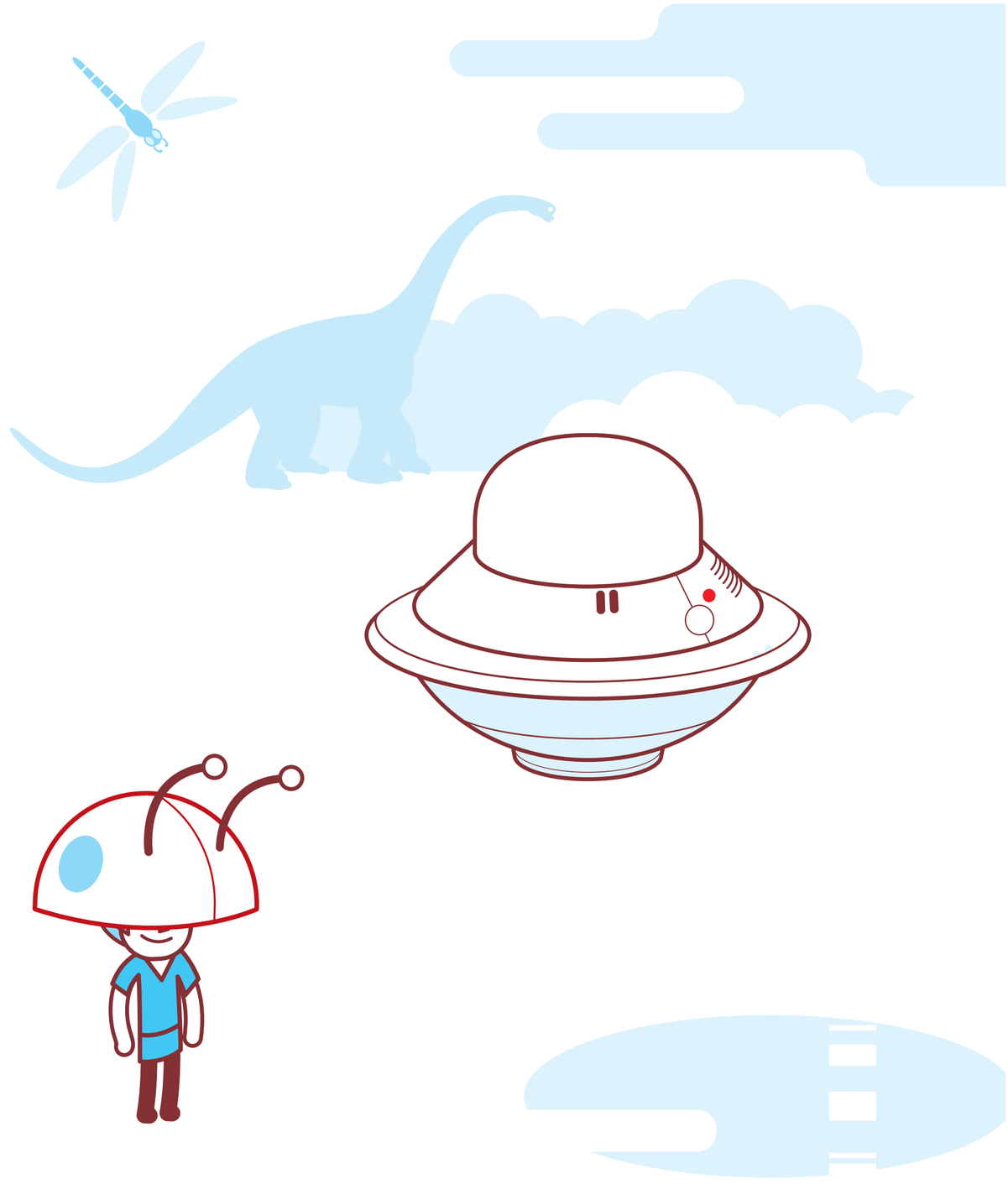
If you must have an opinion about things you have never really tried, at least do not put it down in writing. You want to assure deniability.



3. Provide a pile of leaves

By "pile of leaves" of course I mean an environment that makes it easy for you or your company to try out more things. It's like having a hedgehog in your garden. Most people appreciate having them. You don't have to catch them and carry them to your house if you want to have them living in your garden. It's difficult finding one, it's unpleasant to carry it, and it will probably decide that it doesn't want to stay anyway. But if you provide a hedgehog-friendly environment, they will come. And for hedgehogs, that means a pile of leaves. For your own ability to adapt to the present, to deal with the present, this means that you need to make it easy to experiment. We tend to get stuck in our routines, and we try to make up for our lack of understanding of our surroundings by using lazy, commonplace arguments. If you make it a habit to try things, even if they feel useless or annoying, and if you do not actively keep your relatives and your coworkers from trying these things, it helps. You might even experiment for the sake of experiment: Move small things around. People usually hate larger changes, especially in companies where change is usually forced on them. But low-level change might just work. And that will make it far more likely for you to stumble across your equivalent to the Scrabble app.

Create an environment that makes it easy for you or your company to try out more things.



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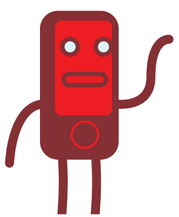

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Transcription: Christopher Albrodt

Editing: Philipp Albers

Art Direction: Thomas Weyres (ZIA)

Illustrations: Martin Baaske (ZIA)

Cologne Conference Futures is hosted by the Cologne Conference and jointly organized by the Institute for Media and Communications Policy, Zentrale Intelligenz Agentur, and Deutsche Telekom's Shareground, with support from the city of Cologne.

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