Nesta...

DON'T STOP THINKING ABOUT TOMORROW:

A MODEST DEFENCE OF FUTUROLOGY

Jessica Bland and Stian Westlake

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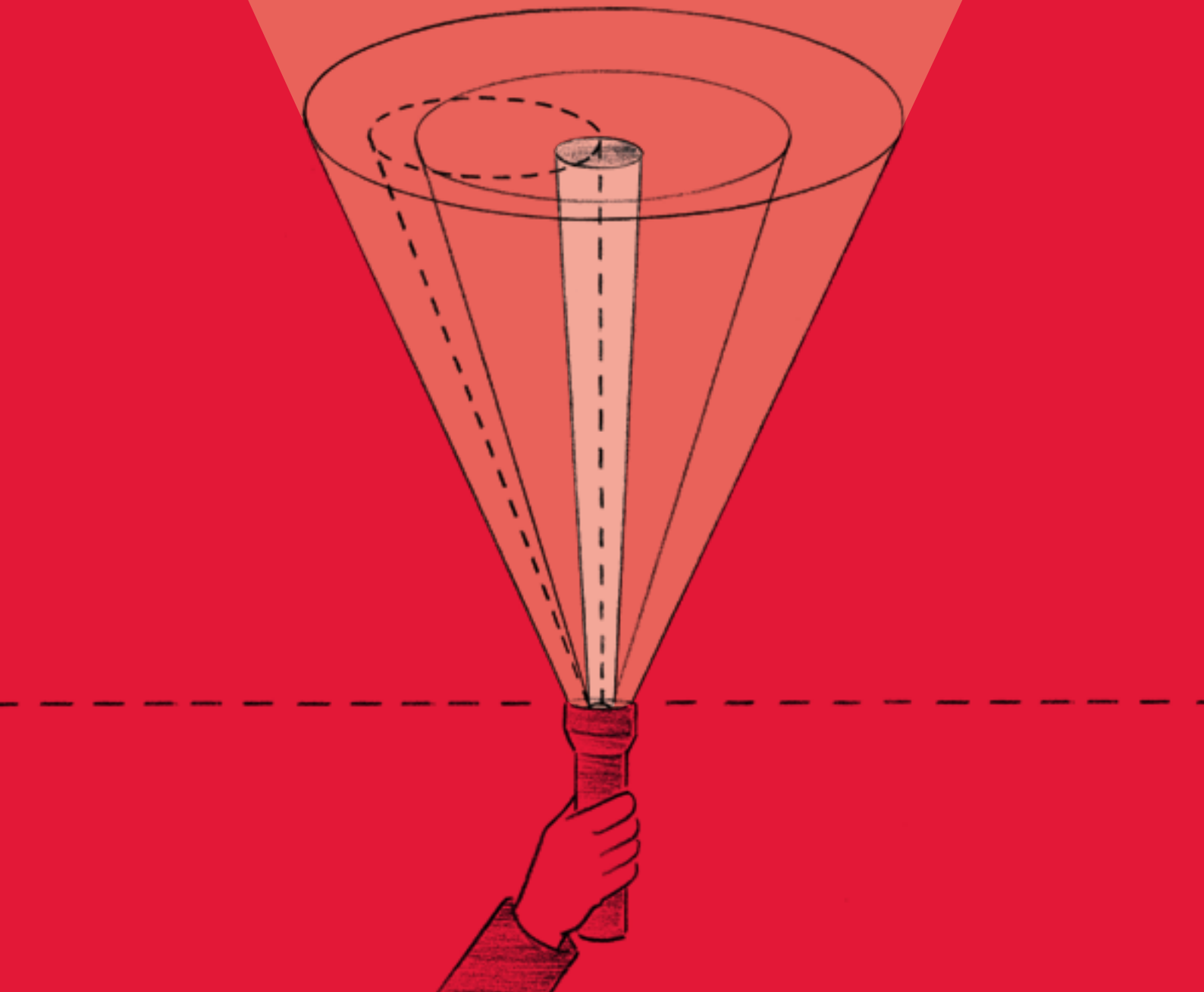

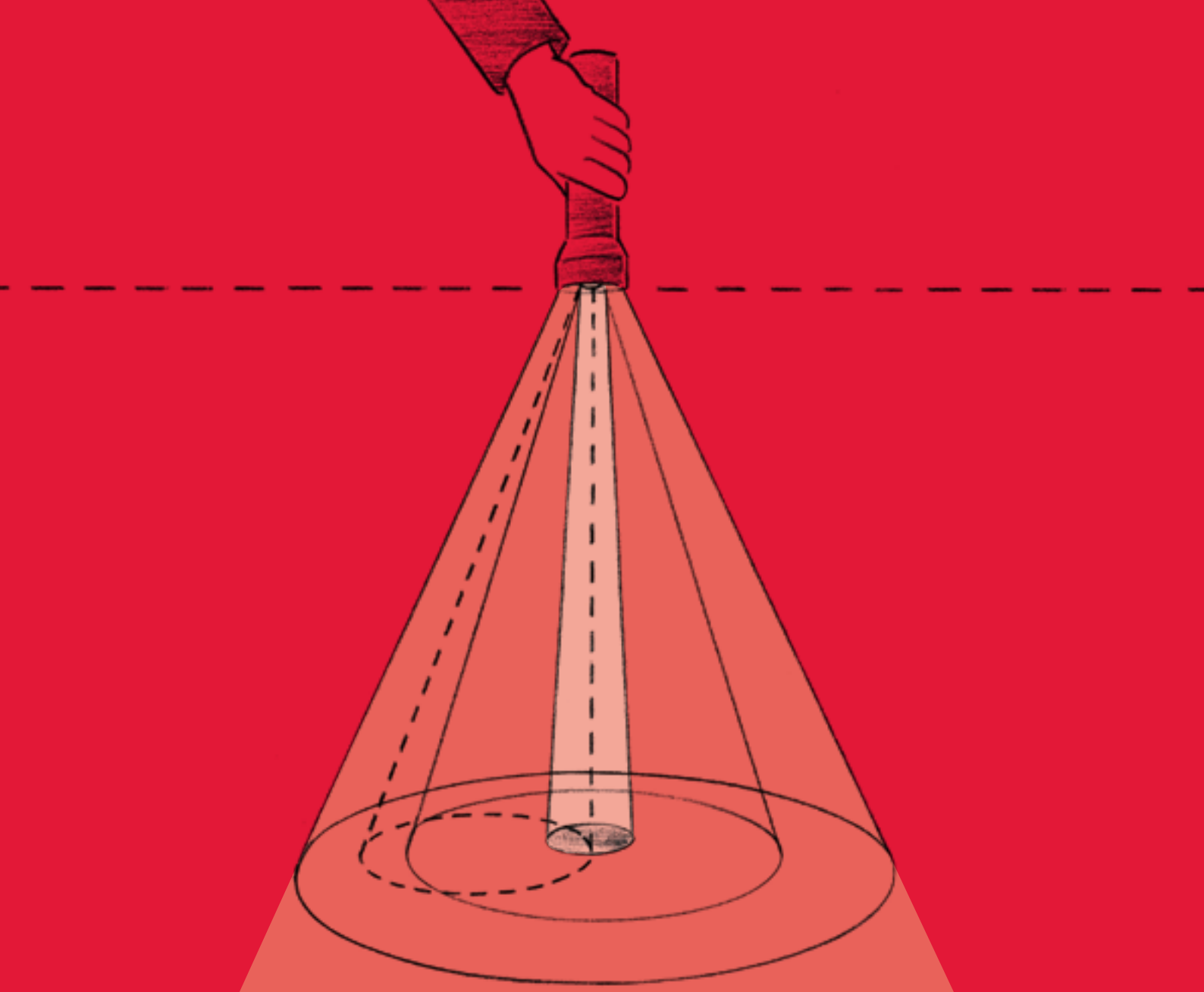

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A RECENT HISTORY OF PREDICTING THE FUTURE

Since time immemorial, people have tried to predict the future. In the second half of the 20th century, these efforts grew more ambitious and sophisticated. Improvements in computational power, data gathering, and analysis were all put to work to try to lift the veil on the future.

Some of these made considerable headway. Over the last 30 years, meteorologists have drastically improved computer models for weather forecasts. They are as accurate at seven days as they were at four in 1980.[1] Banks developed statistical techniques to estimate the risk of complex bundles of securities, based on their past performance. Businesses, governments and institutions like Shell and the RAND Corporation gained a reputation for using qualitative futurology – foresight – to improve their ability to react to the unexpected.

But the last decade has not been kind to futurology. Bankers' and insurers' forecasts of risk turned out to be drastically wrong, torpedoing the financial system and ushering in a long stagnation. Politicians' visions of long–term stable economic growth evaporated. Perhaps relatedly, scathing critiques of our ability to foresee the future rose to the top of bestseller lists.

Nassim Taleb skewered investors' belief that they could compartmentalise and predict risk based on past performance, drawing attention to unforeseeable 'black swans' that undermine careful predictions. Philip Tetlock showed empirically that foreign affairs experts were as accurate at predicting events as random chance or guesswork, and that the more sure experts seemed, the more wrong they turned out to be. And Daniel Kahneman revealed how people are systematically misguided when they think about the future. They find specific stories about the future more likely to be true than general possibilities, even where this is logically impossible; most people estimate the chance of a major earthquake in California to be higher than the chance of any major natural disaster.

In these criticisms there is a tacit assumption that being able to predict the future accurately is the only useful kind of conversation about the future. This might be true for bankers betting on the future of markets from a trading floor, who need precise and accurate forecasting models. If they have no way to change the future of a market, then correctly predicting the market is all that matters.

However, consumer electronic brands trying to compete in a new market are attempting to play a role in the future of that market. And in this case, it is not correctly predicting the market that is important, it is shaping it so that you can lead. A clear vision of a particular future goes a long way in motivating the changes that will bring that future to life.[2] The history of the eBook (Box 2) illustrates how Douglas Adams' space–age fiction played a significant role in the corporate history that led Apple to the iPad. When there is a chance of agency in the future, then there is value in talking about it other than to predict it precisely.

BOX 1 WE WERE NEVER PREDICTION MACHINES ANYWAY

a. A group of the UK's senior economists wrote to the Queen in response to her question about why no one predicted the 2008 economic crisis. Part of their explanation was that small–scale risk analysis was misused as a way to estimate risks to the total financial system:

> *One of our major banks, now mainly in public ownership, reputedly had 4,000 risk managers. But the difficulty was seeing the risk to the system as a whole rather than to any specific financial instrument or loan. Risk calculations were most often confined to slices of financial activity, using some of the best mathematical minds in our country and abroad. But they frequently lost sight of the bigger picture."* [3]

b. Rafael Ramirez, Director of the Oxford Scenarios Programme, and Angela Wilkinson, recently appointed Counsellor for Strategic Foresight at OECD, describe the foresight work they do for governments or companies as 'canaries in the mind' rather than predictive mechanisms: a planning tool providing early warnings for our minds much like the death of a canary was used to warn miners of toxic gases underground:

> *To work with scenarios is to treat the future as a fiction – which, in any given present, it is – and thereby attend to the weak signals from those future fictions that might undermine the existing dominant logic… we suggest, scenarios can be deployed as 'canaries in the mind' to help test where our (often implicit) assumptions about the future, and its role in the present, are wrong and enable the time to develop a better course of action."*[4]

c. Science fiction author William Gibson, in a recent interview, dismissed the idea that his writing should be predictive:

> *I think the least important thing about science fiction for me is its predictive capacity. Its record for being accurately predictive is really, really poor… In a sense, if you're not getting it wrong really a lot when you're creating imaginary futures, then you're just not doing it enough. You're not creating enough imaginary futures. Because if you create enough of them, you'd better get it wrong — a lot."*[5]

Box 1 collects responses to critics of three disciplines that have sometimes claimed predictive powers. The economists (a) argue that that the predictive power of financial risk managers were overstated, and that it was the lack of overview not individual models that failed. The foresight experts and science fiction writer, (b) and (c), claim that they have never saw their work as predictive; it is done for other reasons.

In this newly self–conscious mood, Nesta funded research that tries to get under the surface of different ways of talking about the future. Three streams of work focused on technology in the future. One package reviews quantitative analysis of technology futures. Another paper compares government foresight methods in nine countries as well as the European Commission and the OECD. Science fiction, as a recognisable genre, developed quickly over the last century. What role did it play in the development of products and service? Does it also play a role in helping make sense of new scientific and technological development? The last two papers help answer these questions.[6]

This research navigates the myths and realities of good and bad futurology. As a body of work, it makes the case that thinking about the future is not pointless or dangerous. It can be summarised in three maxims that show that thinking about the future in a structured way is not just useful, but essential:

1. New forms of data–driven forecasting tell us valuable things about the near future. There is scope for experimenting with these techniques in order to find out what works.

2. Thinking about plausible future scenarios can help guard against fragility. Governments and businesses need foresight capabilities in order to address systemic challenges.

3. Innovation starts with a story about the future. Imagining and sharing desires and fears about the futures is a way for all of us to shape it.

BOX 2 THE INTERTWINED FACT AND FICTION HISTORIES OF THE eBOOK

In 1971 Douglas Adams lay drunk in an Austrian field looking up at the night sky, holding a battered copy of the *Hitch-hikers' Guide to Europe* and thought that somebody really should write a guide to the galaxy. Somewhere between this thought and the radio show *The Hitchhiker's Guide to the Galaxy* broadcast in 1978, Adams imagined a kind of slim, portable, electronic thing which stored thousands of articles, images, video and audio with location awareness and an interface so elegant a mere human could understand it. By the Mark II version described in *So Long, and Thanks For All The Fish, The Guide* was personalised using data from its user, and (in some versions of the book) the data it collected and the advice it so conveniently offered was manipulated by its programmers for commercial goals. The similarity to current devices and concerns is astonishing and not coincidental.

Before *The Guide* and the iPad, tablet computers had already appeared in popular culture. Asimov put a calculator pad in *Foundation* in 1951, and Arthur C. Clarke thought up the Newspad, which then appeared in Stanley Kubrick's 1968 film *2001: A Space Odyssey. The Guide* brought these problems together. Adams did not merely expand the idea of the book, but transformed it into a complete guide to life: an assistant that renders a whole galaxy of new worlds understandable to the baffled everyman Arthur Dent.

Adams was an active participant in the development of new forms of books and media. In the first Dot Com boom he founded The Digital Village and made text adventure games. He collaborated with Voyager, an early and admired multimedia company, to create an expanded book edition of *The Guide.* He promoted this with a skit on inventing the book 'properly'.

Adams was also an avowed Apple devotee. He claimed to have bought one of the first three Macs sold in the UK, he met Steve Jobs, and the last words he posted online were in praise of OS X. The link from *The Guide* to the iPad seems obvious. Stephen Fry called it *"the closest thing to his Hitchhiker's Guide that humankind has yet devised"*. But the paths of product development and imagination overlapped and stumbled many times before they merged. In 1987, while Adams became a multimedia producer, Apple created a concept video – a form of science fiction in itself. Then CEO John Sculley, described The Knowledge Navigator – a touchscreen phone and tablet computer with a voice assistant who makes sense of a busy professor's schedules, messages, and the public and private data available to him.

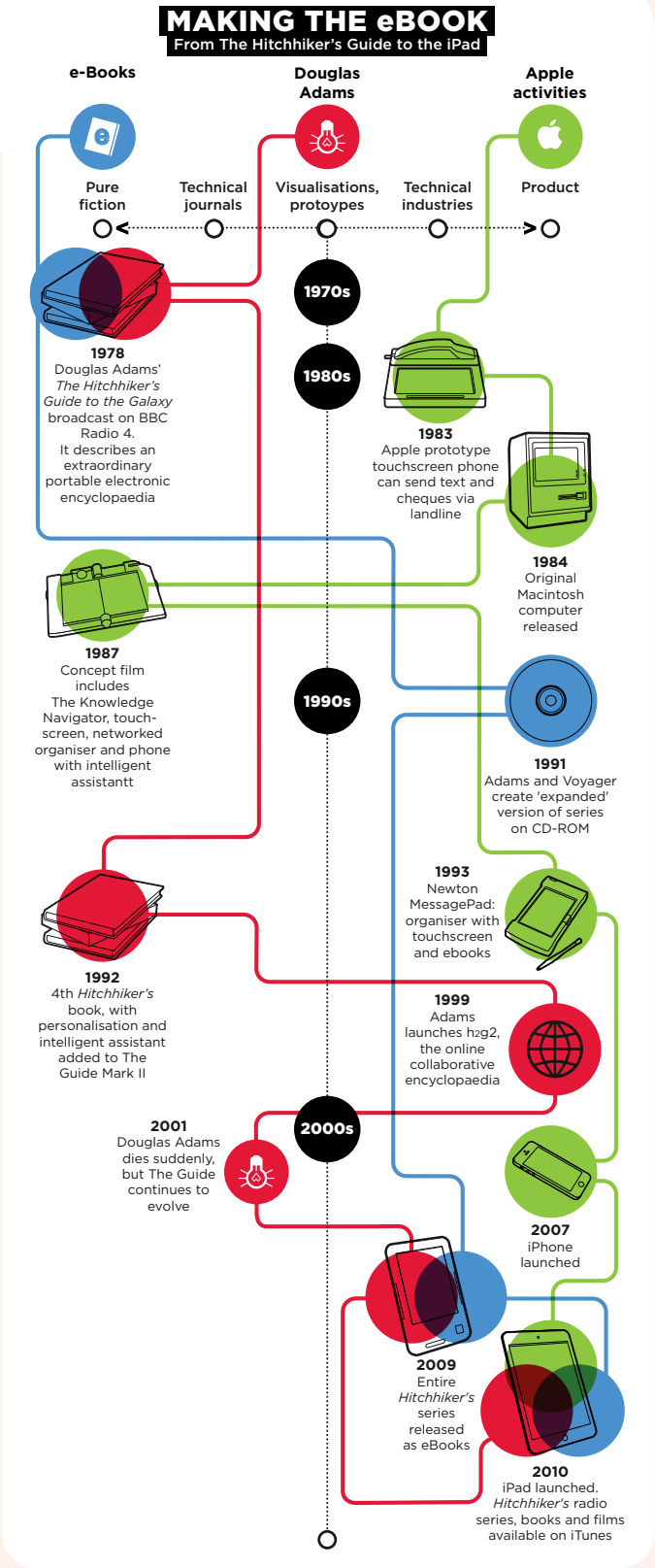
These ideas were included in the Newton Messagepad, launched in 1990. Sculley intended to include a guide service, Newton Intelligence, in the Messagepad, which would anticipate users' behaviour and act on those assumptions. But the technology was not ready. The combination of the $1,000 price tag with these broken, unfinished features made the Messagepad a failure.

Steve Jobs' return to Apple in 1996 marked a return to principles of mobility, usability

and responsiveness, connecting imagination to good design and sticking firmly within the features current technology was capable of doing well. The iPod redesigned storage and access to audio, the iPhone redesigned access to information – from personal communication to maps. In 2010 the iPad launched and owners were able to access *The Guide* in film, audio and eBook form through iTunes.

It is now easier than ever for people to tell and share their stories across a huge variety of platforms. These imaginative resources can play a role in shaping public debate, and have a real influence on our communities and culture. In 1999 Adams launched h2g2, a collaborative online encyclopaedia, and opened the creation of *The Guide* to everyone.

The realisation of augmented reality through products like Google Glass, and Microsoft's real–time computerised translation service, makes another of Adams' fictitious inventions increasingly plausible. In *The Guide,* a Babel fish inserted in an ear means the listener can instantly understand anything in any language: the fish decodes the 'brain wave matrix' of the speaker rather than the language they use. There could be another generation of Adams–led innovation just around the corner.



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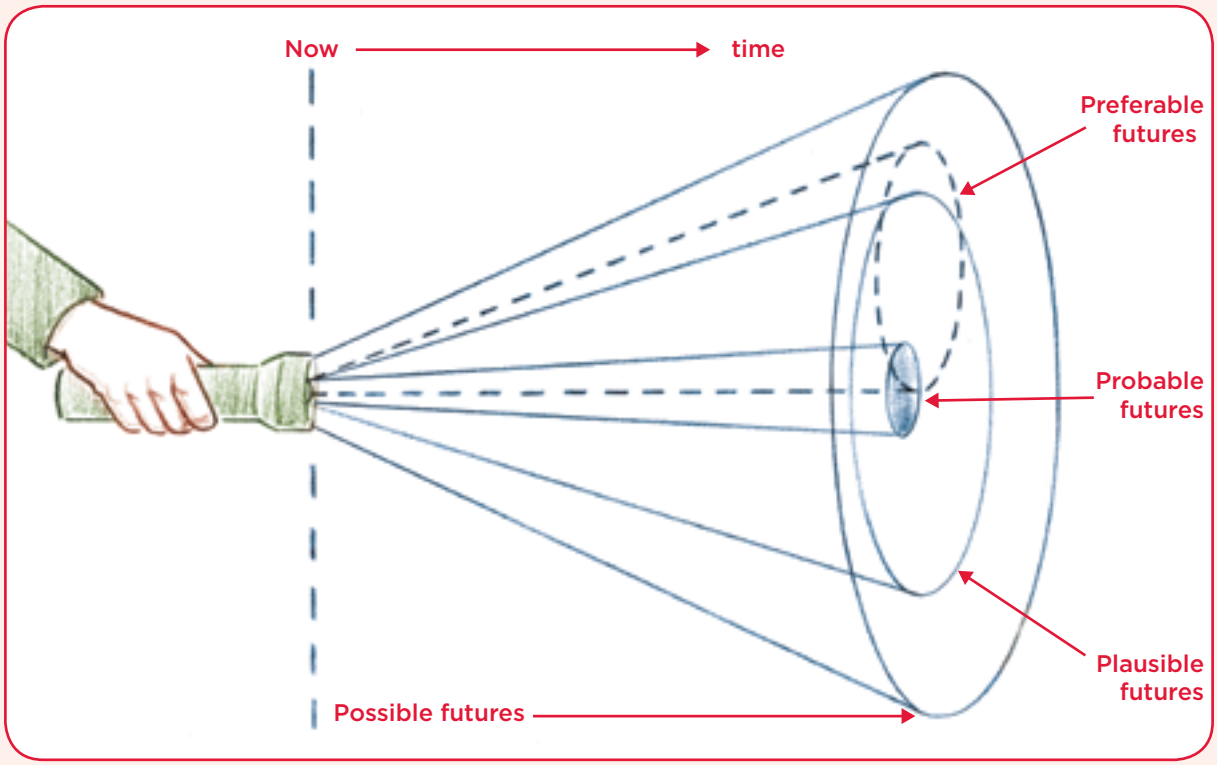
THREE MAXIMS FOR TALKING ABOUT THE FUTURE

Talk about the future comes in different types with different motivations. Each of the three maxims here covers a different variant: forecasting or calculating about futures; creating plausible future scenarios for foresight practices; and employing fiction in order to explore preferable (and un–preferable) futures. The division between probable, plausible and preferable futures has been around since the late 1970s.[7] It is a useful taxonomy, used here as an explanatory device, rather than as a definition of fundamental categories. There is still debate over what categories should be included and how they should be defined.[8]

BOX 3 SHINING A LIGHT: THE FUTURES CONE



Possible futures including futures that involve scientific knowledge that does not exist yet: the *Star Trek* warp drive for instance that would require modifying accepted physical law.

Probable futures likely to happen, extrapolating from current trends. These are forecasts that assign probabilities to possible future worlds: forecasts of the size of the economy.

Plausible futures stem from our current understanding of physical laws, processes, causation, systems of human interaction: nomadic cities and personal air travel.

Preferable futures desirable, and largely emotional: commuting by hoverboards rather than the Underground.

1. New forms of data-driven forecasting tell us valuable things about the near future. There is scope for experimenting with these techniques in order to find out what works.

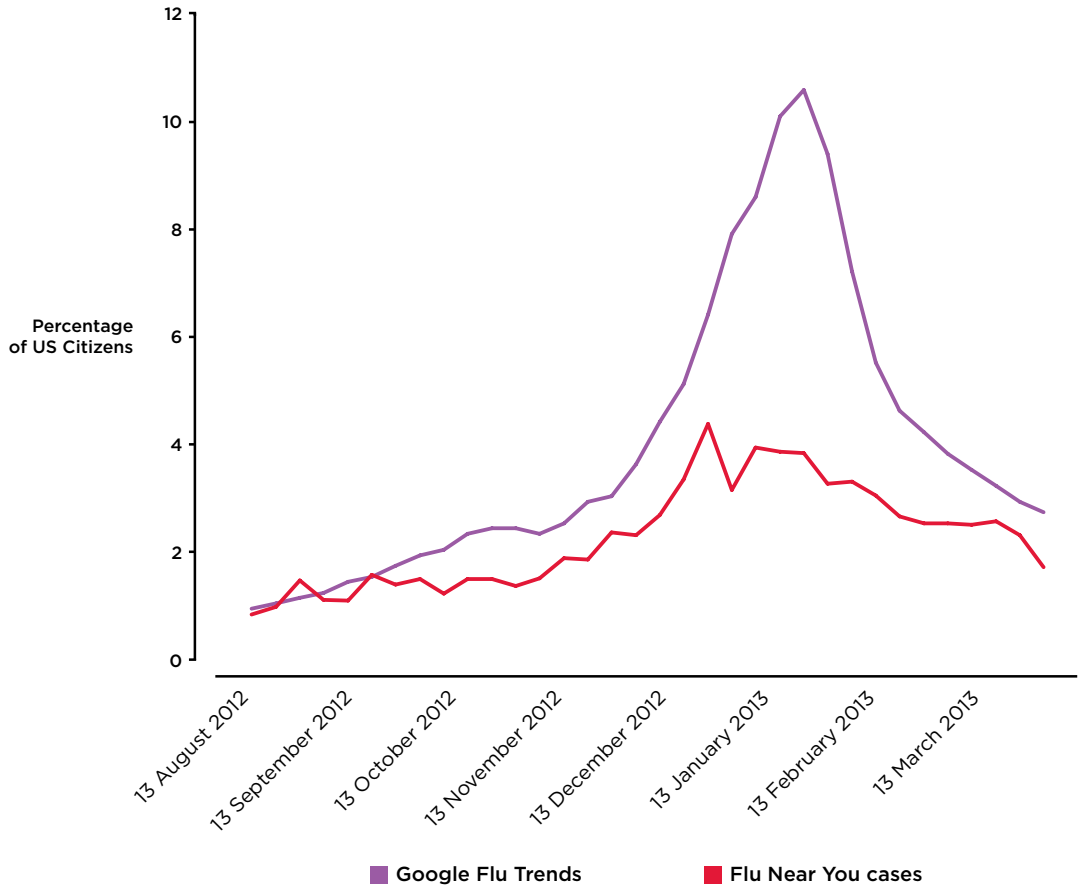
Forecasters assign numerical values to the risk of a future event, extrapolating current trends forward into the future. Different futures are given probabilities depending on the frequency of similar events in the past. They have to assume that events in the future will follow the same kinds of patterns as events in the past. This can create a narrow view of the future. If looking into the future is like shining a torch beam forward in time, then models like this close down toward a central bright beam.[9]

The lesson learnt from the economic crisis is that there is huge danger in overstating the reach of a model. Even sophisticated supercomputers assume very specific initial conditions, and will give a specific response to them. But there are new methods for forecasting that have been extremely successful. A new star was born when Nate Silver, a data scientist aggregating polling data, outdid the traditional pundits' verdicts on US election results twice in a row.[10] There are opportunities opening up in areas where there was little or no information in the past.

Online data provides an increasingly rich resource for understanding patterns of behaviour. Visualisations of twitter conversations describe how news spreads online[11] or how Government spending cuts upset the nation's tweeters.[12] There are already examples of where this kind of data is used predictively. More and more watch in real time as what we search on Google is analysed and mapped, telling us where flu might be breaking out or what new trend in footwear just hit Japan.[13] Analysts are beginning to predict the success of a musician from the way they are received online.[14] Large companies are using customer data to predict their future behaviour. Although less than 30 per cent of UK firms use online customer data in price-setting, and only 41 per cent say this data informs business strategy.[15]

Online trends are patterns in how people are searching, talking and tagging. They tell us what is exciting, and can quantify how many people are excited enough about it to mention it in their blog, tweets or essays. There are exciting prospects for forecasting using online data, but in the very short term and for events that people are likely to talk about before they happen. These are not ways to understand the future in any long-term sense. Philip Tetlock's observation that excitement spreads furthest around the clearest and most familiar ideas, not the most likely to exist in the future, is important here.[16] For instance, these techniques are likely to pick up on a 'nanobots' trend not because there is any new innovation in tiny robotics but because the TV series *Red Dwarf* is re-run in America. The mixed successes of searches to predict the spread of flu in the US illustrates the danger of extrapolating from online behaviour to offline events (Box 4).

BOX 4 **GOOGLE FLU: DON'T TAKE MY SEARCH-WORD FOR IT**



Google's Flu Trends monitoring service launched in 2008. It relies on data mining records of flu-related search terms entered in the search engine, combined with computer modelling. Its estimates have almost exactly matched trends from patients reporting to healthcare centres or to online surveys such as Flu Near You — and it delivers them several days faster than those networks. The system has since been rolled out to 29 countries worldwide, and has been extended to include surveillance for a second disease, dengue.

But Google estimates for the 2012 US Christmas flu peak were double the reported number of cases. This could be due to widespread media coverage of this year's severe flu season, which may have triggered flu-related searches by people who were not ill. In 2009, Google tweaked its algorithms after underestimations at the start of the swine flu pandemic. Search behaviour in response to the pandemic was not the same as for seasonal flu.

Other services are trying to produce more trustworthy data. Flu Near You has a representative age distribution of participants that regularly answer questions about their symptoms. Academics continue to argue over whether passive data collection from millions of searches or tweets is better than survey data from thousands of participants.[17]

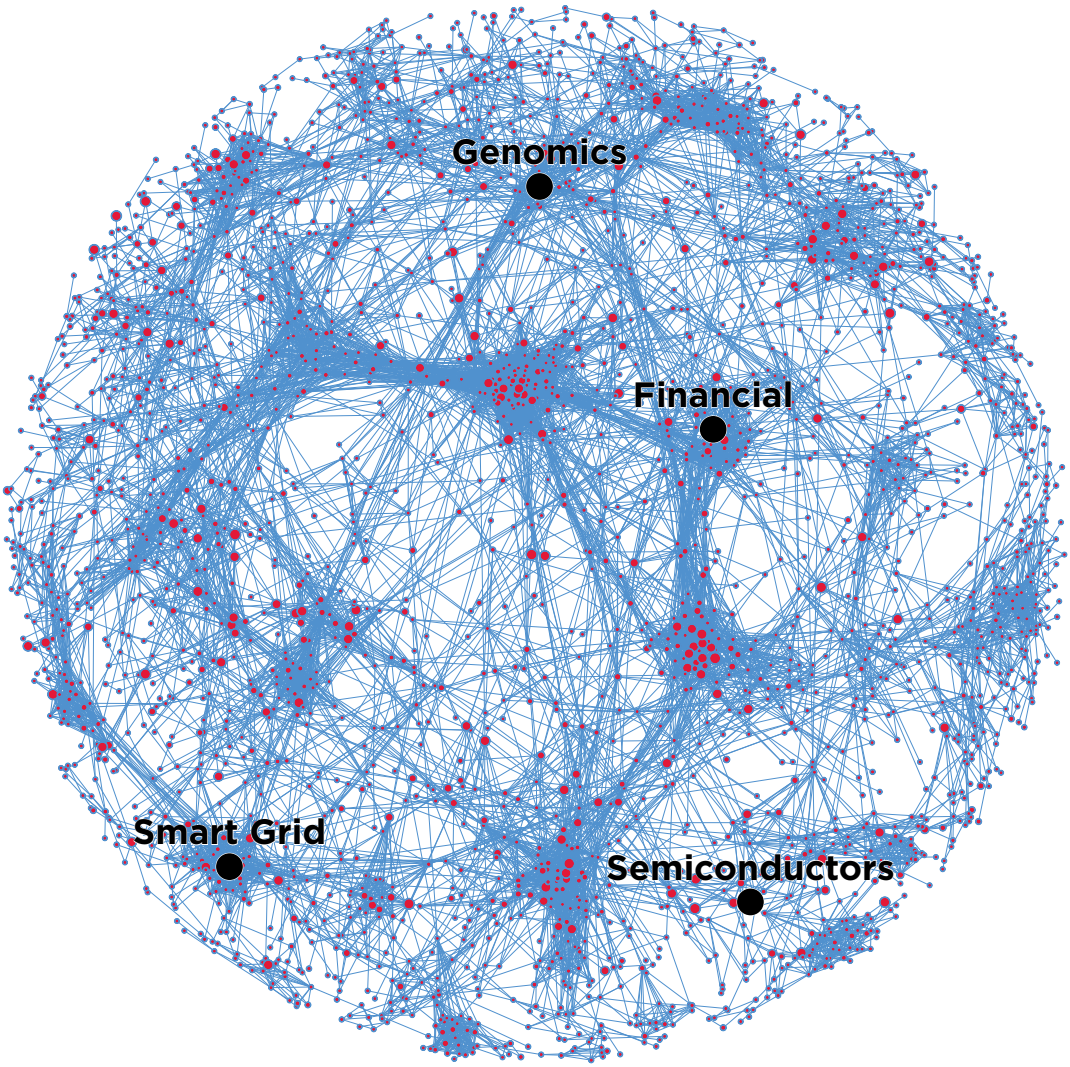
There is another concern: that the reasons behind the failure of financial risk management could rear its head elsewhere. By looking where there is rich data, it is easy to miss some other kinds of trends. To take the torch in Box 3, there is a danger that focusing the beam too tightly on one bright path means missing dangers and opportunities that lie off to one side.

For instance, in the 1990s, analysis of the carbon materials market focused on the exponential boom in fullerenes and carbon nanotubes. This focusing (closing down) blinded analysts to ongoing research on graphene, another carbon–based nanomaterial that earned its creators a Nobel Prize in 2010. Focusing on areas of research that show up in the data – in this case keywords in databases of academic papers – removed weaker signals about other future developments. This meant that analysts failed to anticipate the way that the graphene would revolutionise the market.

There are special cases where longer–term trends can be extrapolated from online data. Burgeoning scientific areas can lead to major new technologies in the future. Early signals of these developments can come from conversations among researchers; and there are new sources of data on these kinds of conversation. Users of a web platform for academics, Mendeley, create groups around specific research topics. Total–impact.org collects data on what they share: how often an article is discussed, how many people have added articles to their personal library, how many of those people are students or from developing countries. This kind of data is not yet harnessed outside the research community. It could be of great value for long–term models of industries that are likely to be disrupted. Quid.inc (see Box 5) has started to scale–up this kind of approach. The key to robust research in this area is distinguishing genuine seeds of change from hype. There is a warning from the example of graphene; this kind of analysis will only ever tell us what people are talking about, not about discoveries that will change that conversation.

BOX 5 **QUID.INC TECHNOLOGY GENOME**[18]

Quid collected data from 35,000 firms and research groups working on new technologies. By extracting words and phrases from the collected documents, Quid constructs a 'technology genome' that describes the focus of each organisation. Most companies cluster around established sectors, but a few will sit in the white spaces between the clusters and can represent the seeds of new technology sectors.



2. Thinking about plausible future scenarios can help guard against fragility. Governments and businesses need foresight capabilities in order to address systemic challenges.

There is value in purposefully widening the beam when looking into the future – opening up to alternative futures.[19] Moving outside the world of forecasting, talk about the future becomes talk about plausible futures, where future events are not well–defined by today's world. These futures can be understood as having semantic uncertainty. Semantic uncertainty comes about when the future world is different enough from today for words to lose their meaning. 'Tanks' stopped meaning water storage and became army vehicles; 'torpedoes' were a type of fish and became a deadly naval weapon.

Government and corporate foresight exercises were developed to deal with this kind of uncertainty. All the countries covered in the Nesta–funded paper on government foresight[20] deployed a core set of exploratory techniques: analysis of trends and drivers, scenarios and expert panels.

These approaches evolved from techniques which probably began in the US in the 1950s. The RAND Corporation helped the Department of Defense to imagine future battlefield scenarios using game theory principles, pointing to the technologies that would need to be developed in response. These techniques were spun out into other areas of policy.[21] A similar French school of thinking started applying this work to industrial settings. In the 1970s, worries about environmentalism and the OPEC cartel, led Shell to implement scenario planning as part of their core business strategy. The success of this long–running programme is because it has never claimed to do more than use the future to solve a specific question today – it is not performing a predictive function.

A recent UK Flooding Foresight project faced a particular challenge: it was asked to look up to 100 years into the future.[22] This project convened an expert panel in environmental change, from agricultural land use to sea level change. They also recognised that political and social changes will be influential on how flooding is managed. So the foresight team developed a set of political options, ranging from local autonomy to international interdependence and social values, ranging from consumerist to community–oriented. From these, they formed four scenarios: National Enterprise, World Markets, Global Sustainability and Local Stewardship. These scenarios helped the experts in environmental factors to expand the kinds of futures they imagined and helped shape their models for a century's time.

The process does not give priority to any particular scenario; it does not say that one is more likely than another. The value in this case came in convincing UK policymakers to double national funding for protection against coastal erosion.

Different political values determine the way foresight is used. Box 6 looks closely at the differences between foresight in Finland and China. In the UK, the Coalition Government has led a return to industrial policy, and direct intervention in emerging technology markets.[23] In November 2012, the Chancellor announced investment in eight priority technologies based on a long list of emerging scientific ideas.[24] Less explicitly, large–scale foresight studies have moved towards understanding economic growth and key UK industries. A project on the future of computer trading in financial markets finished in 2012 and there is ongoing work on the future of manufacturing. UK foresight practices are aligning themselves with the priorities of the current administration.

BOX 6 FINNISH AND CHINESE FORESIGHT PROCESSES

Both Finland and China use foresight as a long-term planning device. A large-scale Finnish foresight project produces a report from the Government to Parliament, commissioned once in an election cycle.[25] The Government must then show how it will respond to challenges beyond that election. Chinese foresight exercises, particularly those by the Chinese Ministry for Science and Technology, play a prominent role in the Government's ongoing cycle of five-year plans. But there are significant differences in the way these countries conduct their exercises, directly stemming from different political systems and climates.

Finland held its first national foresight exercise in 2005, focused on the redesign of the science and technology funding system. This was followed by a project run by the Prime Minister's office, with the objective of informing a sustainable growth agenda. Changing political agendas shifted the focus of the national exercise considerably.

The most recent Finnish exercise included significant attempts to involve the wider public in the foresight exercise. The team ran a website that aggregates blogs discussing the futures, with a different guest editor every two weeks, as well as an online questionnaire open to all citizens. Senior ministers led regional workshops. Analysis of these exercises was used in selecting six themes for the later stages of the foresight process, which relied on small expert panels. This process reflects the desire for Finnish Government policies to respond to the long-term needs of citizens, and to include citizens in the deliberations around the decision.

In China, project selection begins with a large research group of around 60 that engages up to 320 technical experts in a Delphi in-depth survey process. Scientists, technology experts and social scientists are the main selectors. Two papers emerging from the Delphi exercise (on energy technology and materials) were published in the 2006 *Annual Hi-tech Development* report, which is a reference for decision makers and the public, especially the National People's Congress and the National Political Consultative Congress. There was a much more depth to the expert consultation favoured in this Chinese process. But it is also a more inflexible process, fitting into the rigid five-year planning cycle of the Government as a whole.

Methods that help create plausible futures are changing. Historical analysis of technology has provided a few well-known quantitative tools for describing how new technologies are adopted and diffused.[26] S-shaped growth in academic publications or patents in a particular area have been seen as signals of its potential.[27] Other recent work describes similarities in the dynamics of whole technological ages, from the industrial to the information revolution.[28] By describing common ways that technologies redefine infrastructure, these types of analysis give shape to the drivers of change and longer-term trends in technological eras.

The complex or 'wicked' problems created by the current mix of global challenges – from climate change to water security – has renewed appetite for foresight practices that can describe systemic change.[29] Nesta has recently published a suite of relevant work on systems innovation.[30] One approach has been to borrow modelling techniques from the physical sciences to create more detailed simulations of humans systems. But there is still much uncertainty about where and how to apply these techniques. In government foresight, quantitative methods for scenario planning are only used in the UK, European Commission and Singapore.

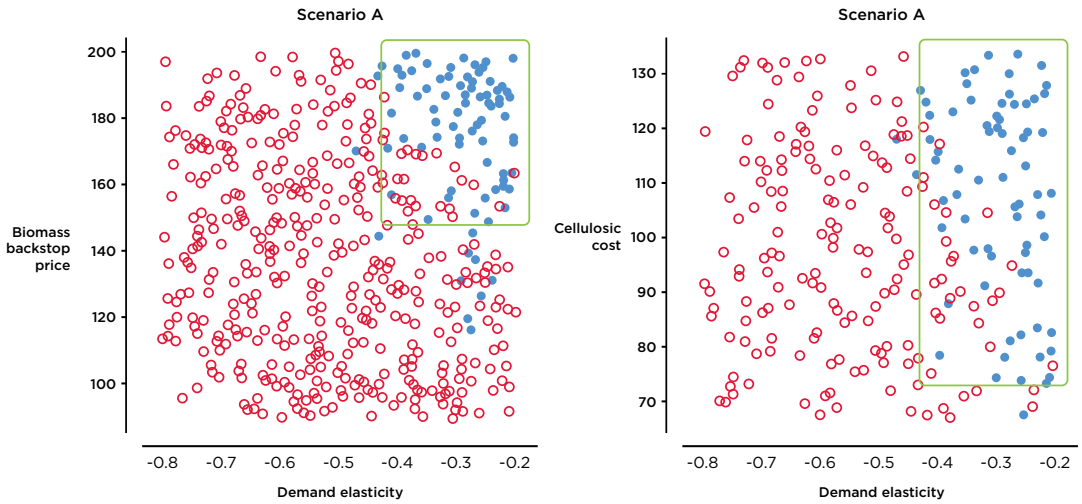
The Nesta paper on quantitative techniques points to some emerging options.[31] Agent modelling has been used since the 1970s to show, for example, how the distribution of

communities in a city regularly ends up with segregation of different social groups. This technique models the interaction of individuals or objects that separately follow simple dynamics. Added together, the objects perform autonomous decisions. These models can begin to characterise the chaotic effects that small changes can have on a complex system; they are like those used by atmospheric physicists to explain how a storm is created from a blue sky. Agent modelling has recently challenged senior economists' views that low interest rates were to blame for the US housing bubble. A model built out of the behaviour of individual home owners suggests that higher rates would have only marginally reduced the boom and bust. Agent modelling is already challenging the status quo in economics.

A new generation of these techniques creates exciting prospects for foresight. A recently developed scenario discovery technique uses agent modelling to produce large numbers of possible futures. These are then grouped and evaluated according to how decisions made today will affect the future. This technique has been used to model future energy scenarios in order to evaluate US renewable energy policy (Box 7).

BOX 7 NEW QUANTITATIVE MODELLING APPLIED TO RENEWABLE ENERGY FUTURES[32]

In analysis of US renewable energy futures, researchers created hundreds of micro-scenarios based on four parameters: changes in transport demand, prices of biomass that is used in biofuels, biofuel production costs, supply of low-cost biomass. They showed there is a scenario A (inside the green boxes) where the first two parameters are in the upper half of their ranges, biofuel production cost is anywhere above the lowest end of its range, and the supply of low-cost biomass is in the lower half of its range. Seventy-three per cent of the futures in scenario A have high costs. And of all the high-cost cases in the dataset, 79 per cent are in A. Renewable energy solutions based on biofuels are likely to be very expensive in the US if the conditions of A are met, and unlikely to cost so much if those conditions are not met.



Futures (dots) are plotted against changes in two parameters: on the left biomass price vs. transport demand elasticity; and on the right the supply of low-cost biomass against transport demand elasticity. The blue dots denote high costs in biofuel development. In both the right and left diagrams, high-cost cases are mainly inside scenario A's green box.

This maxim sees potential in quantitative systems modelling for describing complex plausible futures. The previous maxim warns of over–estimating the predictive value of trend analysis. The final maxim talks about the promise of network analysis to understand the preferred futures of large groups of people. Box 8 distinguishes these quantitative techniques explicitly by comparing the different kinds of uncertainty they respond to, adapting a framework developed in the Nesta paper on quantitative analysis of technology futures.[33]

BOX 8 QUANTITATIVE TECHNIQUES: HOW THEY RESPOND TO DIFFERENT TYPE OF UNCERTAINTY[34]

Type of Uncertainty	Aim	Appropriate quantitative technique	Properties of that technique
Truth Uncertainty Probabilities assigned to well–defined futures; uncertain as to which will come true	**Forecasting**	**Trend analysis eg. Quid.inc or Google Flu (Boxes 4 and 5)**	**Prescriptive, extrapolation of current trends**
Semantic Uncertainty Distinguishable visions of the future, with a sense of the drivers that will shape them; no sense of which vision is more or less likely	**Foresight**	**Agent Modelling eg. Scenario Discovery (Box 7)**	**Descriptive, inference from current trends**
Ontological Uncertainty No assumed sense of how the world will be constituted in the future.	**Fictional futures**	**Network analysis of sentiment or active responses eg. Big Picture Survey (page 18)**	**Descriptive, mapping current trends**

3. Innovation starts with a story about the future. Imagining and sharing desires and fears about the futures is a way for all of us to shape it.

There is a subset of futures that do not anticipate the future for institutional planning, but articulate desires and fears about the future in order to make them happen. Creating these preferable futures is less about understanding what might happen within the torch beam in Box 3 and more about taking hold of the torch and focusing it towards a particular future. Often this is an exercise that is motivated by deep ontological uncertainty. This indeterminacy makes space for us to create and share stories about the way the future will play out, seeding innovations that make sense in that narrative. When there is no sense of ongoing trends and drivers that constrain us to particular, plausible futures, then there is – at least a perception – that we can grab the torch and explore futures outside even the plausible.

By articulating the changes needed to bring a preferred future to life, we can fix the shape of the future in a previously uncertain landscape. Revolutionary inventors, from Nikola Tesla to Elon Musk, have had strong visions of the future. Faith in their particular view creates the irrational persistence needed to push through transformative technological change: the development of alternating current or an online payment system. Stories help entrepreneurs through adversity and convince others to collaborate with them, despite no rational reason for why a product or service will succeed.

Similar effects are at play in other areas. Buying aspirational and luxury goods is partly about buying into a certain view of the future. Large–scale scientific projects, from the Apollo Moon Landing to Obama's recently announced mission to map the human brain, begin as implausible dreams for the future. The technology needed to fulfil the mission is not available when the project is begun. They are driven by a dream of a particular preferred future.

So in a sense, a story about the future can be predictive. It mobilises people towards realising that future. Sometimes this mobilisation is an unconscious side effect, as it must be for the inventor. But as a marketing tool, storytelling is employed much more consciously. There are new opportunities to employ narrative to develop more open public debate about the future of technology.

It is not just companies and governments that build our future. The more people have the tools and confidence to share their desires about the future, the more those futures will be a shaped by those visions. There are active attempts to widen the input into government foresight processes that come from the same motivation. The Finnish Government opened up the first stages of its most recent foresight project to public engagement online and in regional meetings: asking what citizens want in their future. The Japanese foresight process was modified after the 2010 nuclear accident to include public deliberation about future technology alongside expert consultation.

Social network analysis tools have been adapted to help understand preferences about the future. The Big Picture Survey of European futures and foresight professionals asks for their professional views on the trends and drivers that will shape the future. It is simple to take these results and list the top drivers of change. But there is much more information in the survey on how respondents understood those drivers – on the structure of their view of the future. Researchers used network theory to map how the respondents connected drivers together.[35] Participants concentrated in the short term (2008 –2015) on a strongly linked trio: technological innovation, local–global cooperation and global competition in mobile technologies. Opinions diverged more when discussing futures after 2025, with many more drivers listed and many more ways of grouping them; the most consistent were scarcity

of resources, new forms of governance and climate change. Analysis like this is still at a very early stage in its development. It could be used in the future to look at much larger groups, asked about their worries about the future from a personal as well as a professional perspective.

But there remains a serious challenge: to help more people to play out their desires and fears for the future in enough detail that they could motivate change today. When dealing with deeply uncertain and emotional futures, stories say more than surveys.

In the 20th century, science fiction did some of this work. Authors created objects that are socially if not physically plausible. These objects can be hugely influential, as illustrated by the history of the eBook, where real life developments at Apple tangle with Douglas Adams' fictional *Guide to The Galaxy* (Box 2). But this example also illustrates how science fiction's success in influencing technology development is a complicated process not an event.[36]

As science fiction develops well–defined sub–genres,[37] visions of the future are no longer just built in books by single authors. They are designed and modified collaboratively. They can be websites where we build virtual lives or immersive theatrical experiences that transport you to a home in the future. They are the Second Life environments gamers create, or architects' speculation about the shape of future cities. There is also a conscious move among some contemporary authors to describe nearer term and plausible futures – purposefully taking on subjects of public debate, and describing their work as speculative rather than science fiction.[38] Science fiction has become part of broader, and often political, conversations.

Other creative disciplines have taken on a similarly speculative role, aiming at helping people experience rather than read or watch the future – what Stuart Candy calls 'travelling without moving'.[39] Critical or speculative design develops imaginary future objects – and increasingly whole future worlds – in order to spark public debate.[40] Designers Antony Dunne and Fiona Raby have created a fictional future for the United Kingdom exhibited at the Design Museum in London. The future nation is devolved into four self–contained counties, each free to experiment with governance, economy and lifestyle.[41] There have been some experiments to combine this kind of speculative design with formal foresight. Dunne and Raby's students at the Royal College of Art have been seconded to government foresight projects, and set up design consultancies like Superflux[42] that are employed for corporate foresight work.

But this kind of speculation could be much more disruptive. The founders of Superflux originally described their work as *"embracing the organic, the messy, the partial and the partisan, these fragments of the future are fuel for visions of a hybrid, humane alternative to the deterministic, policy–driven, 'business–as–usual' consensus future".* This better embodies the active role preferred futures can play. One way to do this is to give people the tools to reimagine black boxed technology as open and amenable to adaptation.[43] Cheap and accessible computing kit, design software and 3D printing has enabled a grassroots global Makers Movement, creating spaces for anyone to experiment with building their own products or software. These local labs have sprung up everywhere from Korea to Manchester.

The next step could be to extend the ideas of speculative design out into these spaces, encouraging participants to play with ideas for completely imaginary products as well as real ones. It could allow a chorus of voices in futurism, and a more widely–negotiated view of the future. An Extrapolation Factory event held in New York attempted this: prototyping future objects and selling them at a Time Warp Shop.[44] The Duke University Tip Futures Institute is a summer programme for high school students who create scenarios for 2025. Final projects include asteroid mining designed to delivery renewable power sources to Earth and bioengineered microorganisms that eat radioactive material.[45] But these events only open up the future as far as an urban design community or a class of 30 teenagers. There is a long way to go.

FORWARD THINKING ABOUT THE FUTURE

Increasingly rich data resources have led to new powerful tools for analysis. New quantitative techniques are revolutionising some areas – like political punditry. In others, such as the science of disease spread, they need more time to find their place. **Maxim 1: New forms of data–driven forecasting tell us valuable things about the near future. There is scope for experimenting with these techniques in order to find out what works.**

Global changes in the 21st century can be characterised by their seeming intractability. Social, technological and environmental challenges are interwoven into a complex and persistent web of issues . Addressing them will require concerted, coordinated effort and much better long–term planning.[46] Foresight methods such as scenario planning will be vital. **Maxim 2: Thinking about plausible future scenarios can help guard against fragility. Governments and businesses need foresight capabilities in order to address systemic challenges.**

In September 2013 Nesta is holding FutureFest, a weekend of public talks and events in London. This is in part an attempt to open up – in the widest sense – discussions about the future. As we enter an era of accessible technologies, that more and more of us can manipulate, everyone has the chance to shape their own future. **Maxim 3: Innovation starts with a story about the future. Imagining and sharing desires and fears about the futures is a way for all of us to shape it.**

More broadly, Nesta is keen to encourage experimentation with new tools for futures and foresight. This might include using online software to collect stories, data and sentiments about the futures from around the world,[47] or supporting local clubs for speculative design. Current self–consciousness about our failure to predict the future brings with it the chance to adapt and try out techniques in ways that were never thought of before.

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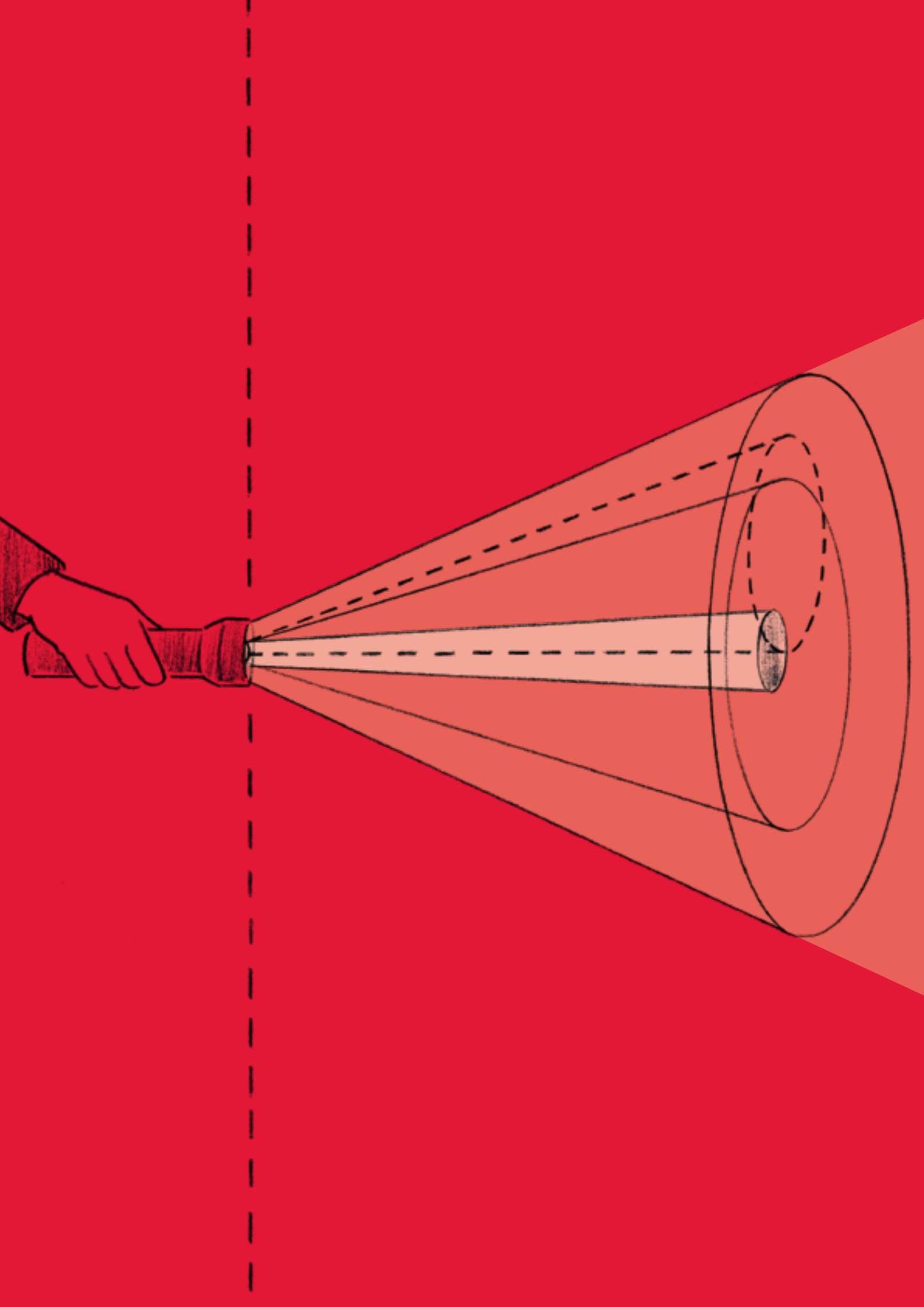

Nesta...

Nesta

1 Plough Place
London EC4A 1DE

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