Surprising Scenarios. Imagination as a Dimension of Foresight

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> *Imagination is more important than knowledge.*
>
> ***Albert Einstein***

Abstract

This paper explores two ways to integrate more imagination into foresight studies: through the use of wild cards and through the utilization of science fiction. Both follow the principle of "What if…" and both are aimed at imagining surprising events or developments. In both cases, thought experiment starts with an assumption – the invented wild card or the novum of science fiction (element of difference to our real world) and searches for possible implications. Foresight needs neither pure daydreaming, nor incoherent fantasies, but – paradoxically – stringent, methodologically controlled kinds of imagination. With this background, differences and commonalities of science fiction and foresight are discussed. Whilst the science fiction writer often indulges himself in an excess of imagination, futures studies often lack it.

Two EU projects – IKNOW and FESTOS – are taken as examples for the methodological integration of collective and individual imagination within foresight processes. Putting wild cards or science fiction ideas into context implies to fathom plausible social, political, economical, and cultural consequences, counter-intuitive findings and surprises included.

Introduction

The future is a time fundamentally different to our age. Most efforts of futurists are aimed at identifying and describing at least the main differences. Trends are of some help, but as they follow the principle of "more of the same", they are a kind of prolongation of the present and do not enable us to grasp the real great tectonic shifts that transform the present into the future. Some of these shifts can be predicted in one way or another, but history tells us that there are always surprises.

One may even say like Herman Kahn that a surprise-free future would be the biggest surprise of all.

This however poses a fundamental problem. How can we include surprises into futures studies? It is obvious by definition that we cannot analyse the real unknown unknowns, the things we do not know that we do not know. As soon as we identify them and make them available for analysis they are no longer totally unknown. The best we can do is to work with "proxies", with invented, simulated near-unknowns. They are within our reach. They can provide us with some idea of what the future could be like, the weird "flavour" of things to come.

In an age of deep transformative shifts and high volatility in all spheres of life, futurists have tried to tackle the problem of surprises and disruptive change in different ways. Two of them are outlined in the following; the use of wild cards and the utilization of science fiction. These two approaches have much in common. They build on a voluntary detachment from the present and from mainstream thinking: It could happen otherwise. They are both rooted in the "What if…" principle. And both require a lot of imagination. At best, wild cards and science fiction provide a good test bed for thought experiments.

It is commonly acknowledged that foresight needs imagination. But imagination is a broad field, including all forms of wishful or fearful daydreaming and of incoherent fantasies. It is obvious that not all forms of imagination are suited to foresight processes. But what kind of imagination can contribute to foresight? There is no easy approach to delimit the realms of "useful fantasy". One can pose only some requirements: Imagination in the service of foresight should not be too narrow, and not without any focus, any borders. Counter-intuitive ideas are highly welcome, but they should be sufficiently consistent, logically coherent. On one hand, the resulting visions should be understandable by others, but on the other hand one should not fall into the trap of watering the "freakish" visions down for ease of communication.

Paradoxically, we need stringent fantasies, methodologically controlled visions, reasoned irrationalities, counter-intuitive intuition.

Imagination in science fiction: "What if…"

Science fiction (SF) is one of the most successful and influential contemporary genres. Quite generally, it shapes our images of science, technology and – last, but not least – the future. As an integral part of post-modern culture, science fiction has penetrated all fields of the media landscape: fiction, comic books, computer games, movies, even plays and musicals. Science fiction themes and images surface sometimes quite unexpectedly in everyday life, in TV commercials, video clips, and technical shoptalk. For the public, technology is science fiction come true. And for many scientists and engineers science fiction provides the imagery of (or the inspiration for) their visions.

Despite a multitude of studies, science fiction still defies a simple, commonly accepted definition. Ever since the term SF came into use during the 1930s there have been attempts to bring all its different currents and subgenres into one formula.[1] For our present aim it may suffice to follow Moskowitz, who defined science fiction as a "... branch of fantasy identifiable by the fact that it eases the 'willing suspension of disbelief' on the part of its readers by utilizing an atmosphere of scientific credibility for its imaginative speculations in physical science, space, time, social science, and philosophy." (Moskowitz 1974, 11)

As long as the future is highly determined by the progress of science and technology, science fiction is future fiction. Of course, it is never literature about the future as it will be, but "futuristic" fiction in the sense that it gives its imagery an exciting character combined with a touch of amazement. Science fiction in its most original works (not the repetitive mainstream sci-fi trash) can prompt what Darko Suvin (1979) calls "cognitive estrangement"; fantastic imagination in the service of intellectual discovery, not as vehicle for escapism. However, one should not mix up cognitive value with prediction. "What if..." does not aim at forecasts, but at implications of a presupposed novum (element of difference to our real world). SF, from this perspective, comes close to a kind of fictional technology assessment. Or, as the SF writer Fred Pohl put it: "A good science fiction story should be able to predict not the automobile but the traffic jam." (Lambourne et al. 1990, 27)

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[1] Compare e.g. the entry on "Definitions of SF" in Clute & Nicholls (1993).
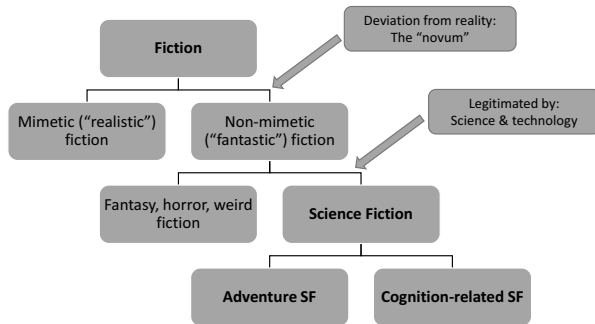
Figure 1: The Place of Science Fiction (Steinmüller 2010, 20)

The general principle of imaginative speculation in SF has often been described as the "What if..." approach (comp. Steinmüller 2003). What if interstellar travel or time travel were feasible? What if machines could be made more intelligent – or more ethical – than human beings? What if a self-replicating nano-assembler escapes from a laboratory? What if the internal combustion engine had never been invented? In some rare cases, writers do not ask for implications but for prerequisites, for reasons or causes: "How could this happen?" How could a sustainable economy based mainly on renewable resources work? How could we inform our distant descendants, perhaps living in a new medieval age, of the hazards of nuclear waste deposits? Or, seen from a distant future: How was the collapse of our civilization brought about? In any case, a lot of imagination is needed to invent starting points full of potential, rich, fascinating settings, plots with unexpected turns and, primarily, convincing characters.

Following these questions, SF can be understood as a kind of thought experiment similar to thought experiments in science (Steinmüller 2003). The experimenter – the writer – begins with a hypothesis and sets up initial conditions. Following the inherent logics of these conditions (i.e. the plot) they derive some results, perhaps surprising ones, as in pointed short stories with twisted or double twisted endings. Use of imagination is as central to the fictional thought experiment as to the scientific one, with the difference that the imagination of a writer is not controlled by scientific, methodological constraints, but by aesthetic, narrative principles. Characteristically, the writer does not look for the most plausible outcome of the experiment but for the most striking, most dramatic, most surprising. Perhaps the most profound reason why so many scientists feel attracted to science fiction, is that – without the methodological restrictions of science – SF opens up vast opportunities for a playful manipulation of scientific concepts, for

speculations on alternative laws of space and time, on more than two genders or on changed sexual roles, on machine self-reproduction and last but not least on cunningly devised political and sociological models.

Science fiction and foresight

Science fiction and futures studies anticipate the future in specific ways however – and they are in some respects even complementary. As literature, science fiction narrates stories in a pseudo-realistic setting, a detailed, complex world of the future, with people acting in it, heroes and villains. Everyday human needs and behaviour patterns along with emotional aspects play a fundamental role, and the writer uses explicit or tacit value statements. Foresight, on the other hand, stays mostly at a certain level of abstraction, details have only an illustrative function; to be too specific makes a forecast less probable (except special cases of quantitative trend extrapolations or forecasts focused on specific technical developments), or burdens it with unnecessary additional hypotheses. Value statements, if given at all, have to be transparent and explicit and not hidden in attributes or perspectives.

Finally, science fiction writers are not bound by questions of technical (or social) practicality and thus can be particularly vivid when depicting desires, goals and concerns in their scenarios. One could even argue that science fiction writers – because they take into account everyday human behaviour patterns and by way of example include at least speculatively the options for abusing any given technology – have a more correct (more complex!) perspective on people and technology than some futurists. Naturally the great majority of science fiction does not satisfy this ideal model.

Table 1: Comparing Science Fiction and Foresight

	Science Fiction	Foresight
Aim	• Entertainment • Intellectual stimulation	• Provide orientation for action
Approach	• Intuitive, creative (with artistic methods of fiction)	• According to scientific / best practice methodology (including creativity)
Guiding questions	• What is imaginable? • What are the most striking, amazing, disastrous implications?	• What is possible? • What is likely? • What is desirable? • What are plausible implications?
Challenges	• Suspension of disbelief • Inducing a "sense of wonder"	• New convincing and useful insights about the future(s)
Criteria for quality	• Originality • Powerful, compelling visions • Style, dramatic quality • Convincing characters	• Plausibility, logical coherence • Realism • Methodological transparency (e. g. with respect to value statements)
Success criteria	• Readers' pleasure / satisfaction • Sales	• Client's satisfaction • Usefulness in making better decisions

Both kinds of anticipation – SF as well as foresight – possess certain disadvantages. SF writers do not intend to describe a future that a futurist would regard as probable or plausible. They play with ideas. Frequently, SF writers combine futuristic technology with traditional social models. Sometimes SF becomes FS ("fictional science"), where imaginary inventions are inconsistent with physical laws (e.g. faster-than-light travel) and only the *atmosphere* of scientific credibility (prescribed in Moskovitz's definition mentioned above) prevents the story to be labelled as pure (non-scientific) fantasy. Sometimes the quest for the spectacular leads to exaggerations that are almost absurd. And which

writer is not inclined to sacrifice scientific plausibility or even consistency for the sake of a good story?

Foresight, on the other hand, often remains too abstract, shrinks back from the specific item, the small detail, even in cases where details would be helpful. Perhaps more importantly, most futurists feel obliged to stay within the realm of the plausible and realistic. But narrow realism amounts to "presentism", to perpetuating present conditions, and plausibility often equals to nothing more than consistency with shared images of the future, not to mention preconceptions and prejudices. While the SF writer indulges himself in an excess of imagination, futures studies often lack it. In these cases, a slight touch of the science fiction mentality could be helpful to foresight. It could help to overcome some of the limitations of "presentism", and it could even make foresight studies more tangible – and therefore more realistic (in the sense of giving it a touch of literary realism) by adding concrete details.

Livingston (1969, 1978), Gaßner (1992), Steinmüller (1995) and others have repeatedly emphasised the value of science fiction, the "epistemological genre par excellence" (Malmgren 1991, 172), for foresight. SF can be used heuristically as a "mind opener" and source of inspiration, e.g. in the framework of specific types of workshops. Short readings from a SF story or a sequence of a SF movie transport the participants into the unknown land of the future; they can help to overcome mental barriers, and to sensitise the participants to change and to boost their imagination.

Sometimes SF is used as an indicator for social or cultural trends, expression of fears of future catastrophes, possible technological or scientific breakthroughs, or the impact of these breakthroughs on man and environment. Seen in this way, SF is not only an inroad to popular expectations about the future, but also a fragmented early warning system for the big transformations to come.

Cases of a systematic scanning of SF for foresight purposes are rare. Within the EU project iKNOW (see below), lots of SF books have been screened for interesting wild cards and weak signals (see below for definitions of these terms), and SF writers have been invited to share their ideas in workshops. The quality of items found in SF was not so different to wild cards and weak signals derived from other sources.

Another example for this kind of utilisation of SF is the study "Innovative Technologies from Science Fiction for Space Applications" (ESA 2002), commissioned by the European Space Agency. This stocktaking included many

technical ideas from novel space suits and propulsion systems to space elevators, terraforming, and asteroid mining. This study induced much debate between the participating ESA experts and SF specialists. Even if one has to assume, that no idea of the study has direct influence on ESA planning, one has to acknowledge that a broad field for further research has been opened.

Perhaps the great problem, as the SF writer and futurist Arthur C. Clarke held many years ago, is finding people who combine sound scientific knowledge with "a really flexible imagination". Clarke regarded the *failure of imagination* as a major "hazard of prophecy". Based on many examples of scientists who suffered from such failure, Clarke concluded that "too great a burden of knowledge can clog the wheels of imagination". At the same time Clarke was confident that although only a very small fraction of SF readers would count as "reliable prophets", "almost a hundred percent of reliable prophets will be SF readers – or writers" (Clarke 1974, 14-15, 32). Today, one would of course replace "prophets" with "futurists" and "technological visionaries", but nevertheless Clarke hits the point.

Quite generally, it is no easy task to identify weak signals, or hints to future developments, in SF.[2] SF encompasses a cornucopia of fascinating ideas – but which ones can be seen as useful "weak signals", as early indicators of possibly approaching events? The main difficulty lies in the concept itself: Weak signals cannot be taken at face value; they have to be interpreted, since they are not factors of impact by themselves but (only) early indications, hints on an emerging trend or a possible future wild card. Therefore, an idea taken from a piece of SF becomes a weak signal only by the interpretation given to it, by making sense of it. Take e.g. the "Beggar" novels by Nancy Kress.[3] In this trilogy, a new kind (or species) of human being has developed within mankind: the "sleepless". We could interpret this idea a) as a near satirical extrapolation of the present trend of shortening of sleep, b) as the anticipation of the future evolution of man, c) as a criticism of the increasing phenomenon of cognitive overload…

These examples prove that imagination can produce many compelling and surprising items, but the value for foresight lies in their interpretation. Making sense of fantasies however, is a tricky thing. Too easily one can fall into the trap of an arbitrary attribution of meaning, driven by preconceived ideas, prejudices,

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[2] For more on the concept of weak signals see below.
[3] "Beggars in Spain" (1992), "Beggars and Choosers" (1994), "Beggars Ride" (1996).

ideology. Who seeks inspiring ideas in SF, shall find. The question is: How to filter out the really relevant portents of the future?

Wild cards: Imagining surprising events

The future is unpredictable. Even many aspects of the physical world governed by the "exact" laws of physics are not practically predictable, either due to high complexity or due to inherent fundamental uncertainty – as manifested by quantum effects. Even more so when human whims and desires are involved. Foresight must cope with the many potential outcomes of the complex interaction between human decisions and the physical world, hence with *alternative* futures rather than a "deterministic" one that cannot exist. In the past, many typical foresight studies used a single method, either quantitative (e.g. trend extrapolation) or qualitative (e.g. Delphi survey). But no single method can cope with the complex situation of alternative futures with inherent uncertainties, which become ever more severe and influential with the accelerated pace of interrelated technological, societal and other changes. Therefore, in contemporary foresight studies more effort is devoted, whenever possible, to using an appropriate mix of different and complementary approaches and methods, which synergistically may better cope with the inherent uncertainties and disruptions. In particular, experience shows that the reality is very likely to surprise us, time and again, even when good foresight studies are available on the relevant subject matter. Decision makers need foresight studies that challenge their conventional thinking and force them to think "out of the box" (Steinmüller 2007). Therefore, naturally foresight itself needs systematic "out of the box" thinking, and it is very important to challenge the "conventional wisdom" and the basic assumptions on which forecasts or scenarios are based. This is where the idea of wild cards and weak signals comes in (comp. Mendonça et al. 2004; Hiltunen 2006, 2010).

Wild cards are potential future events with low likelihood of occurrence (at least as currently perceived by most people) but with high impact if they occur (Petersen & Steinmüller, 2009).[4] *Weak signals* are slight changes in the current

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[4] Wild Cards should not be confused with Nassim Taleb's *Black Swans*, "unknown unknowns", unprecedented events that never have been on any mental map till they occur and that therefore surprise everybody (Taleb 2007).

state of affairs or in existing trends that – if observed and correctly interpreted – *may* hint at potential wild cards (more on weak signals later).

The concept of wild cards was first introduced in 1992 by BIPE Conseil (France), the Copenhagen Institute for Futures Studies (Denmark) and the Institute for the Future (USA), and at that time it focused mainly on the business arena (BIPE et al. 1992). Petersen (1997, 2000) later extended the concept to other areas. Today it is understood that the impact of a certain wild card can be on the society at large, on some segments of it (e.g. certain country, region or age group) or on a particular system (e.g. air transportation). Wild cards may result from different processes or incidents, broadly divided into "planned events" (often with unplanned consequences) such as technological breakthroughs resulting from R&D, and "unplanned events" (e.g. natural disasters). Because wild cards have by definition a low likelihood of occurrence, they are surprising events when they happen. And because they have high impact, the surprise is a major one. But this does not necessarily mean that every wild card is a surprise for all people. The level of surprise can be subjective. Certain events may be surprising for many people but not for experts who envisioned them (and certainly not for people who planned them, in the case of "planned events").

Wild cards are the ultimate challenge to "business as usual" scenarios (and even to "business as not so usual" scenarios). Many past foresight studies tended to focus on the most likely possible futures. This is hardly the best way to anticipate strategic surprises, although experience shows that unexpected events always happen and surprise decision makers (and all of us). Major surprises are often caused simply by denial (which in turn may be the cause of neglecting and missing relevant weak signals). Denial is a powerful psychological self-defense mechanism that usually protects us against things offending our self-image, but makes us at the same time more vulnerable by distorting our perception. Schwartz and Randall (2007) stress the importance of using imaginative "unlikely" scenarios to counter this effect:

"There is a tendency to deny strategic surprises altogether […] Denial is a powerful form of cognitive bias found in organizations of all sizes […]. Denial can stifle creativity and make companies and nations susceptible to strategic surprise [...] Because denial is such a strong influence, one of the most important steps in constructing an imaginative and systematic analysis of the future involves making the analysis believable. […] Well-crafted scenarios can help organizations that suffer from denial about future change to rehearse it in advance […] Scenarios encourage management to 'think the unthinkable', anticipate surprises and try out new possibilities…" (Schwartz & Randall, 2007, 103)

We may conclude that in order to enrich the outcomes of foresight studies and to strengthen their effectiveness, there is a pressing need not only to strive for consensus amongst experts (as is usually done in Delphi surveys where controversial opinions, far from the mainstream group response, are often intentionally disregarded) but on the contrary – to pay attention to non-consensual views. Such views may themselves be regarded as important weak signals that may hint at surprises unforeseen by the mainstream expert opinion. In other words, there is "epistemological need for integrating disruptive ideas – to come away from the prevalent mode of constructing consensual futures" (Schaper-Rinkel 2011).

Although the likelihood of occurrence of any particular wild card is low, it can be asserted that in the long run, our future will be largely shaped by wild cards. Why? Because as we look farther into the future, the number of potential wild cards rises, with each year new ones are added to the existing ones, and the probability that *some* will occur increases and becomes significant (Steinmüller & Steinmüller, 2004) despite the low probability of any single wild card. So the elicitation of potential wild cards as part of a foresight study is not just an interesting intellectual exercise in imaginative thinking, but may prove as an essential means for preparedness to critical future surprises. As an occurrence of a wild card has a very high or even critical impact on specific systems/stakeholders, organisations are usually especially vulnerable to wild cards. Paying special attention to wild cards in foresight/scenario studies undertaken by these organisations could alleviate this vulnerability.

At this point one may wonder if from a practical point of view the "imagining" of wild cards is really useful for decision makers (after all, this is the ultimate success criterion for any foresight method or study). A creative team (or an imaginative individual) can "invent" a large number of plausible wild cards, but given limited resources it will be impossible to be prepared for all of them – even if it is almost sure that one or more will occur. But by definition we cannot know which one(s)…

There is no easy definite answer, but there are two directions that may be followed. One is the appropriate assessment and prioritisation of wild cards, based on suitable criteria. Petersen suggested a method for assessment and prioritisation called the "Arlington Impact Index" (Petersen 1997). This index is composed of the following seven "impact factors", which can be given numerical values based on experts' judgment: Timing (near, medium or far future); Reach (local, regional, national, global); Vulnerability level; Certainty of outcome (higher uncertainty implies greater impact); Opposition (ranging from strong opposition to the

outcomes to strong support); Rate of resulting change (days, months, years, decades…) and Power (how close to an individual's essential being does the change strike).

The composition of the impact index and the characteristics of its components, namely the particular impact factors, are not written in stone; variations of them or other methods of assessment can be adopted or developed for specific foresight studies. For example, within the EU project RACE2050 several transportation-related wild cards were assessed in an online expert survey, in terms of likelihood, impact on different industry segments, breadth of the effect, importance for decision makers, and more. Additional insights were obtained by linking the wild cards assessment to a classical SWOT analysis (Hauptman, Hoppe & Raban, 2015).

A second important direction is making use of weak signals. Weak signals are "precursor events" or "early warnings" that may hint at a growing likelihood of occurrence of a certain wild card. The weak signals may be unclear or ambiguous, but they may become clearer in time (if monitored) or stronger, perhaps in combination with other signals. Searching for weak signals, finding the relevant ones and interpreting them are challenging tasks and an important subject of research in the Foresight field in recent years (Hiltunen, 2006, 2010; Ilmola & Kuusi, 2006; Holopainen & Toivonen, 2012). Advances in this area are still needed, in order to increase the usefulness of the wild cards concept for decision makers.

Example: The Project "iKNOW"

The growing international interest in wild cards and weak signals has been reflected for example by the project "iKNOW" funded by the European Commission's Seventh Framework Programme for Research and Technology Development (FP7)[5] during 2008 to 2011. iKNOW was probably the first publicly-funded international project that entirely focused on wild cards and weak signals. The rationale behind iKNOW was that many important issues may have remained "below the radar" of policy makers and so far have received no (or too little) attention in forward-looking activities, because of perceived low likelihood (or denial?). Therefore, the research team of iKNOW (with the help of a large

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[5] Full name: "Interconnecting knowledge for the early identification of issues, events and developments (e.g. wild cards and associated weak signals) shaping and shaking the future of science, technology and innovation in the European Research Area". For details see http://wiwe.iknowfutures.eu/iknow-description.

number of experts) has elicited and collected a large quantity of wild cards and weak signals (termed "WI-WE") potentially shaping the future of science, technology and innovation (STI) policy in Europe and worldwide. Main thematic areas under consideration were health, agro-food and biotechnology, information and communication technologies, nanotechnology and materials, energy, environment, transport, social sciences and humanities, and space and security. The iKNOW team developed a conceptual framework on how to identify and classify WI-WEs and how to assess their potential impacts on STI policy. In order to implement this framework, iKNOW developed several elements that can be found on the iKNOW website, such as iScan (for monitoring and searching WI-WEs) and iDelphi (to assess and prioritize WI-WEs). From a large collection of more than a thousand WI-WEs (available on the project's website and still growing at the time of writing of this chapter), a sample of 60 wild cards and 60 weak signals were selected in the context of EU "Grand Challenges" like Energy security and vulnerability, Work-life balance and mental health, or Globalisation and localisation. The selected WI-WEs were described in detail and were assessed by means of the iDelphi online expert survey incorporated into the iKNOW website.

It is instructive to elaborate on the assessment approach adopted in iKNOW. In the assessment phase experts were asked to indicate what priority (on a scale 1 to 5, from "none" to "critical") should be given by policy makers to each wild card in the short term (less than 10 years) and the long term, and what importance the wild card would have for STI policy. Then, the experts assessed the potential impact level of each wild card (on a scale 1 to 5) on the following eight domains, in specific countries and in the European Union as a whole: Physical infrastructure, virtual infrastructure, social welfare, economy, security, policy & governance, environment & ecosystems, and STI systems. Furthermore, the experts also evaluated the current level of preparedness of decision makers to cope with each wild card. Finally, they selected the most relevant RTD strategies for improving preparedness (from a given list of several strategies).

We briefly present here a few examples from the iKNOW collection of wild cards. We chose examples that have some "science fiction flavour" (and were probably partially inspired by SF, although weak signals possibly pointing to them may be found in current "embryonic" research or in emerging trends).

"Invisibility spray" available in high street stores. An invisibility spray is developed and the technology refined until it becomes available in most retail outlets and is affordable to the general public. Initially, this is seen as fun,

however there are strong implications for security and the military as applications for warfare are exploited.

Automatic learning through neuro-data transfer. Automatic neuro-education is technologically possible but at a price - and therefore available only to wealthy people (or those singled out by powerful institutions). Techniques are developed for neuro-implants with cognitive targeting for subliminal learning. Wealthier schools and colleges build virtual environment 'learneries' where 'in-house' pupils and students can be kept in suspended animation, wired up to intensive edutainment systems. There are benefits for educational attainment levels, but at the cost of social mobility and segregation in EU society. There are also growing concerns about the use of such facilities for "brainwashing" and correcting unwanted behaviours, and about possible negative impacts on creativity and divergent thinking.

Nano-lab inside your body. Chips and micro-robots are inserted into the human body at birth, to monitor vital functions and inner conditions, prevent diseases and heal the body if necessary throughout the person's entire life. They can communicate with a health centre and ask for medical intervention and healing. People no longer need to visit the doctor. Healthcare is individualised and cheap.

The lottery: the way to a perfect world. Reducing the population to a sustainable level becomes a major objective in many people's mind. This leads to programmes of voluntary sacrifice in the name of saving the world. In the US, the leading political party creates a lottery, the winners of which have the opportunity to experience a period in their lives without worries, in which all desires are satisfied. The price is a sweet death, by the injection of a drug, giving very pleasant feelings of happiness. This helps to decrease the population and helps other citizens to maintain greater prosperity. The benefits of the lottery diffuse and other countries start to adopt similar methods, especially in overpopulated regions.

Nano dreams – more than a reality? Brain-computer interfaces are created to manipulate dreams. Parts of society become addicted to this quest for utopia, and false states of euphoria are created. Dream manipulation becomes a priority for parts of society and reality is neglected. People spend less time socialising as they are spending more time in the "dream world". The population decreases as there is limited opportunity to date, marry or have children.

Revolutionary space propulsion. New space propulsion technology (not based on chemical rockets) enables a dramatic reduction in the cost per pound

payload to send a satellite into orbit or to propel a spacecraft to its destination in space. This is achieved because the need to carry fuel with the rocket is eliminated. Instead, the energy for propulsion is supplied from the ground (e.g. laser beams) or from space (e.g. solar "wind" or "scooping" hydrogen molecules).

Algae pathogen suddenly destroys the new energy foundation of humankind. Step by step all human kind becomes dependent on algae biofuel production. Transportation relies almost entirely on algae biofuel, but heating and electricity production rely heavily on it as well. Use of oil goes down. Suddenly, a new type of airborne algae pathogen emerges and starts to spread around the world. The new energy foundation of humankind is suddenly destroyed.

An important observation stemming from the iKNOW results is the pronounced gap between the importance of wild cards and the preparedness of policy makers (according to the judgment of experts). Evidently, in general the preparedness of decision makers to wild cards is very low (in many cases non-existent), even in cases where the importance of the wild card and in particular its impact on STI policy is perceived as very high. This observation accentuates the importance of raising awareness of the WI-WE approach amongst policy makers.

Example: FESTOS scenarios as an exercise in imagination

Similar to many SF stories, wild card scenarios are constructed according to the "What if…" principle. The starting point is the wild card as the "novum" in Suvin's terminology (Suvin 1979). Like the plot of a story the scenario evolves on the line of possible implications of the wild card, progressing from the near and immediate reactions to the wild card all along the chain(s) of causes and effects to far implications that become more and more hypothetical.

In the case of the FESTOS scenarios, it is more than some (perhaps superficial) structural similarity. The FESTOS scenarios belong to the special type of narrative scenarios, told – narrated – like a story, be it SF or not. In difference to more abstract, descriptive scenarios they are formulated in a literary way, as very short fiction about some protagonists, people or an organisation.

The starting point for the FESTOS scenarios[6] was technology horizon scanning: What technologies (with relevance for future security issues) are just now in their first "embryonic" stage of development? Which visions about their

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[6] For more about the FESTOS methodology see Peperhove pp. 189-204 in this volume. For more about writing narrative scenarios see Gaßner & Steinmüller, pp. 37-48 in this volume.

potential uses and abuses are discussed in the scientific community? What are the possible implications not yet discussed? Based on this scanning, three broad categories of potential threats were observed: *Disruption* of certain applications, *increased accessibility* to technologies that once were confined to the military sector or to unique laboratories, and were prohibitively expensive, and *surprising malicious uses* of new technologies that are being developed for benign, beneficial purposes. For the FESTOS scenarios the project team decided to concentrate on the third category, as a source of signals to wild cards on which the scenarios would centre. Selected technologies were assessed by experts in terms of their likely time of realisation, the easiness of their abuse (by terrorists or criminals), their likelihood to actually pose a threat (in different future time-frames), the severity of the threat involved, and which societal spheres would be most threatened. The results enabled ranking the technologies by their so-called "abuse potential" and "threat intensity" (Hauptman & Sharan, 2013). The combination of relatively low likelihood with high severity (i.e. high impact) may signal potential wild cards.

During a subsequent workshop, technology, security and foresight experts were invited to share their ideas about specific technology areas. Special attention was given to potential combinations of technology trends. As a case in point, the internet of things could in combination with programmable matter and molecular manufacturing give rise not only to a revolution in manufacturing but also in the use of "intelligent", "nano-enabled" everyday objects. Such sophisticated future objects could be capable of self-healing and self-reconfiguration or automated recycling; they could receive a remote upgrade etc. But what if a virus or a malicious remote signal transforms self-healing into self-destruction?

This wild card "Disassembling of nano-enabled products by remote signal" was the basic technological idea that finally led to the scenario "At the flea market" (see Steinmüller, pp. 222-228 in this volume). During the workshop, in a breakout session called "security café", one of the participants mentioned that "nano-enabled" products could be sold on the black market. In the beginning, this was not much more than a word in a discussion. But after the workshop, when the FESTOS team reviewed the results, this idea gained momentum. At this stage, the main question was: How to expose all the technological ideas and security issues in one plausible and convincing storyline, that allows an integration of all the content and also provides a plot that everybody may understand and follow? Not a black market, but a flea market with old "pre-nano" things that did not fall victim

to the virus, turned out to be the right setting. Still the protagonists, their motives and their interactions within an overarching plot had to be invented…

Science fictions stories of the "idea as hero" type are constructed this way, around a central idea. According to the "What if…" principle, a broad variety of possible consequences of central ideas had to be fathomed – in much more depth than is possible in a workshop. Thus, the creativity of the workshop participants and their specific knowledge as a precondition to stay within a reasonable frame is combined with the imagination and the narrative skills of the scenario writer(s).

The fictional style in itself has many advantages. It is not only very well suited to communication, it forces the scenario writers to be the utmost realistic with all the small items needed to create an atmosphere of credibility around the setting, the protagonists – the flea market has to come to life. The writers are forced to think about the characters they introduce, about their wishes and fears, how they use (nano-enabled or "old-style") technology, about everyday life in the assumed future: What occupations should they follow? How do they earn their living (if they do)?

Putting the wild card (nano-enabled products go "to dust and ashes"[7]) into context implies fathoming plausible social, political, economical, and cultural consequences, counter-intuitive findings and surprises included. In a way, the imagination of the futurist who derived the main features of the scenario is complemented at this point by the artistic imagination of the writer who does not only fill in the details but brings in the human aspect. And last but not least, the writer always aims at making the story compelling, with tension and suspense, a forceful beginning, a dramatic middle part, a surprising, maybe twisted ending. Of course, futurists are not necessarily born fiction writers, and not all narrative scenarios are built on a dramatic conflict; some are told in the way of old utopias and only lead their readers from one station to another, at best ending with a little smile.

Imagination, however, can go astray. There is always the danger to invent much more than is needed for the narrative scenario, to embellish it with arabesques that do not contribute to the subject but distract the reader. Imagination, moreover, can betray you; it can – in a well-hidden manner – introduce implicit value statements, not to speak of prejudices. One has to be careful with metaphors,

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[7] "To Dust and Ashes" was first discussed as a title for the scenario. It seemed too pathetic. Titles should convey the main idea of the scenario, they should be easy to remember and provoke associations focused on the topic of the scenario. Finding the right title for a scenario is sometimes very challenging.

with adjectives, embellishments of any kind. In our case, one should avoid "denigrating" nano-enabled products…

Therefore, a narrative scenario that is based on a process with many participants, who contributed their ideas, should go through some review process, where a small editorial team or experts involved earlier in the process have a look at the scenario. Such feedback is also needed to create ownership. In our experience, feedback has to be handled with care. Too much feedback, in particular with contradicting opinions, can either lead to endless review iterations or even tear the scenario to pieces. If all ends well, the scenario will still bear the handwriting of its author(s).

Conclusion

Foresight generates images of the future in a methodologically controlled way, based on the best available knowledge of the realms of the possible. Creativity and imagination are needed for several reasons: to overcome the myopia of "presentism", to integrate the human aspect into the image of the future and to bring in some of the wild chances the future is fertile with. The very thinking of such "unthinkable" wild cards may counter the natural tendency to deny major disruptions/surprises. Whereas identified and forecasted trends narrow down the scope of possible futures, wild cards (and weak signals hinting to them) broaden it up and create new vistas. They are the harbingers of fundamental changes. Without them foresight is almost blind to the future.

Imagination in foresight is a collective as well as an individual affair. It springs up in team brainstorming and it is deepened in individual reflection, perhaps a kind of "thought experiment" of "focused daydreaming" fiction writers are proficient at. Imagination, seen this way, is an irreducible dimension of foresight. However: It is quite certain that the future will surprise even the most visionary futurist and the most imaginative science fiction writer.

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