Erzsébet Nováky – Andrea S. Gubik

Handling Uncertainty in Futures Studies

Erzsébet Nováky, Doctor of the Hungarian Academy of Sciences, Professor Emerita of Corvinus University of Budapest
Andrea S. Gubik PhD, Associate Professor of University of Miskolc

Abstract

Futures studies deals with processes that have not yet occurred, have not yet developed or do not even exist. Uncertainty is necessarily an essential element in the study of the future and also in futures studies. Uncertainty cannot be eliminated, just mitigated. This study aims to explore the interconnection existing between futures studies and uncertainty from several aspects (dual uncertainty, determination, chance, unexpectedness, information, stability, instability).

This study also shows how uncertainty can be reduced by reasonably applying and combining methodological principles of futures studies (for example, complexity, participatory, alternativity), by identifying and managing unstable situations, as well as by identifying weak signals and wild cards (low-probability, high-impact events) and incorporating them in forecasting/foresight. Focusing on actual forecasts/foresights and practical examples, this study attempts to contribute to understanding how the continuously existing uncertainty about what the future will hold can be reduced through a conscious use of these principles and methods.

Keywords: Futures Studies, uncertainty, certainty, security, chance/unexpected, stability, instability, chaos theory, weak signals, wild cards

Foreword

Uncertainty is necessarily an essential element in the study of the future and also in futures studies. If we associate security with the future, then, first of all, we face a vision of uncertainty on account of the open nature of the future. That a futures researcher can seldom tell the future with certainty, or, in other words, can seldom make a prediction – that is, a single version of the future that is the most probable to occur – is rooted, first and foremost, in the mutability and instability of our world. The present can shape the future in many ways, and the future may have favourable as well as unfavourable, even disastrous

versions. Futures research attempts to mitigate this uncertainty, even though it cannot be eliminated completely.

In terms of our study, *certainty and safety can be interpreted as mitigation/diminishing of uncertainty related to the future*. In this interpretation, dealing consciously with the future in the form of futures studies assists the players of the society and economy greatly in formulating a sustainable strategy that responds forecasted changes affecting their future, and helps them to act accordingly. In this way, they create a solid foundation for mitigating uncertainty and increasing safety.

Futures studies and uncertainty[1]

Dual uncertainty

Uncertainty manifests itself in futures studies in a dual form: as ontological and gnoseological uncertainty. Uncertainty stems, in part, from the fact that in the present we are unable to tell exactly which of the possible alternative futures will come to pass: this is the root cause of *ontological uncertainty*. Often we are even unable to say with a high degree of certainty which version of the future is the most likely to take shape. Also, our knowledge of the future is also uncertain as we cannot tell exactly how extensive our entire knowledge pertaining to the future is, and we find it difficult even to tell how much of the future we have already covered with our knowledge – this is the root cause of *gnoseological uncertainty*. The fact that there is value attached to the development of possible alternative futures further increases uncertainty. However, sometimes it can also reduce uncertainty if we manage to approach the future in an actively future-oriented and positive way.

When dealing with the past (in history and archaeology), the uncertainty factor is only gnoseological. Events that happened, processes that came to an end and established conditions are solidified as part of recorded history. Thus their existence is a given fact. The only source of uncertainty in their case is that our knowledge of them is never complete, and often we re-evaluate not only the future but also the past: in part, when new information becomes available, and in part, because we ask questions arising from different contexts about the past in order to address our problems in the present and the future. And we usually get different answers to different questions.

Outside futures studies, dual uncertainty is also present in other scientific disciplines. It is also a characteristic feature of scientific disciplines that are relatively independent of the passage of time. For example, since the discovery of Heisenberg's uncertainty principle it has become evident in modern physics that the subject of its studies is phenomena that have probabilities and are shaped in the experiment by the interaction of the object and subject (observer). Thus the relevant laws are statistical laws. We can find similar situations in biology, psychology and social sciences. As regards society, the special form of interaction between object and subject in connection with the future stems from the fact that due to their purposeful activity, humans can influence the anticipated or previously assumed future.

[1] This part of the study is mostly taken from the article of Erzsébet Nováky, entitled *Jövőkutatás és a biztonság* (Futures Studies and Security) (Nováky, 2011).

In futures studies, emphasizing dual uncertainty is especially warranted because this is the reason why the possibility of studying the future with scientific methods is doubted by many. However, as we have shown it, it is not an exclusive feature of dealing with the future. In regard to futures studies, there are two things that follow from this: on the one hand, the *future can only be studied on the basis of probabilities*, and on the other hand, *proving and verifying statements based on knowledge of the future is a special process as it only ends when the future becomes the past*.

Uncertainty will necessarily appear in dealing with the future. The subject of futures studies is a domain and a perception of the future which is always related to the actions of the people and the society affecting the future as well as the scope of those actions and the overarching correlations between them. For this reason, the subject of futures studies is the changes in the slices of reality containing the human element – complexities that take shape along the Homo sapiens line (Mannermaa, 1991) – over time as well as their determination, mutability and shapeability. This fact excludes regular recurrence and immutability, and substitutes them with renewal, change, and often unpredictability.

Uncertainty manifests itself in different ways in the various domains of the future. In the basic future domain called constant future (Doxiadis, 1972) appears the part of the future which remains relatively unchanged from the past, and for this reason we have a great chance to make a prediction in regard to its emergence, which means that it is not particularly characterized by objective uncertainty. The domain of the declining future consists of phenomena and processes that gradually cease to exist during the forecasting period – for example, individuals in the current population or fauna –, and as a result, the domain of the declining future does not carry any significant uncertainties. Components of the continuing future are reproduced in some form, which ensures their survival, however reproduction may also introduce certain new attributes. It is another important domain of the future that is mainly characterized by quantitative changes, and where objective and subjective uncertainty equally arise. The most uncertain future is the one created and represented by newly emerging or produced elements with qualities that differ from those they possess in the present or possessed in the past (so-called creative future). This domain of the future is characterized not only by ontological but gnoseological uncertainty. Its proportion to the other domains is a key indicator of a society's ability to evolve and its creative power.

Uncertainty and determination

Uncertainty of the future is also a result of the fact that *it is always the resultant of a combination of various determinants – causal, statistical, teleological, and dialectical*. For a long time it was believed that only phenomena determined in the Laplacian sense (clearly calculable in advance) could be forecasted. However, the world does not work like a Laplacian daemon and yet it is still possible to forecast future events and trends in several alternative versions. In order to achieve this goal, futures studies resorts to applying deterministic chaos theory to instable systems. In futures studies involving human elements, the laws of statistics are the most useful for detecting objective and subjective uncertainty. These laws do not allow us to determine events and trends in detail, but they can help us to explore and forecast common characteristics and attributes that can be generalized. They also indicate

the general trend and the interval limits (probability limits) between which the examined phenomenon will probably occur. Thus they provide a complete arsenal of methodologies for dealing with both forms of uncertainty and their sources.

Differences in the determination of the past, the present, and the future. The past is final and unchangeable, the present is determined to a great extent, and the future is determined only in regard to its main trends and general characteristics. Future reality is not determined in its details, but as a totality. How and in what form will one of the several possibilities be realized within the interval between the limits of probabilities without violating the general characteristics of the future depends on the resultant of various interactions. This is how the probabilistic nature of the future can be interpreted. When certain objective conditions are met, only a single version of the future is realized, the probability of which lies within the [0,1] interval and indicates the probability of the future to become reality. This correlation can be applied to the description of single possible futures, because the only difference between futures that come to pass and possible futures is in their probability. The impact of multiple possible futures on probability is reflected in the fact that the processes connecting the past, the present, and the future still point to multiple outcomes at the time (during the period) of the preliminary observation, and the strength of the interaction between the processes determining the individual outcomes varies. A process may have multiple evolution tendencies or future states because none of the possible evolution tendencies or future states carries such a strong genetic determinant force and relationship in itself that it could ensure a predetermined outcome of the process. This means that the possibility and probability of future changes are determined by the nature of correlations between the past, the present, and the future. The different degrees of stability and strength of these correlations provide the basis of the different probabilities of these futures.

In this way, in futures studies the *ontological meaning of probability,* indicating that probability expresses how great the chance of a process or phenomenon to exist, decay, or come into being is, appears. In this case, the emphasis is on the uncertainty related to the object. In addition, *futures studies* (considering that it is a mental, noetic activity) *includes the gnoseological meaning of probability too.* In the gnoseological meaning of the notion of probability, probability refers to probabilistic statements related to knowledge or, in other words, the indetermination (uncertainty) of knowledge about a certain object. The ontological and gnoseological meaning of probability are intertwined with the two components of the so-called dual uncertainty.

Chance, unexpectedness, uncertainty

In the emergence of future uncertainties, chance has a key role. Chance, unexpectedness, and uncertainty are not the same notion since "unexpectedness is a characteristic of a random event, while uncertainty is linked to a random variable" (Rényi, 1976: 54.). The probability of an event occurring (p), its uncertainty (h[p]) and unexpectedness (v[p]) are correlated. Uncertainty depends on the unexpectedness of events and the probability of their occurrence.

As regards the relationship between unexpectedness and uncertainty, out of the probability values of the occurrence of an event, three are worth mentioning. If the probability

of occurrence is 0.5, then the value of uncertainty and unexpectedness is 1, which means that the most uncertain and unexpected events is the one that is as likely to occur as not to occur. If the probability of occurrence converges to 1, then unexpectedness and uncertainty converge to 0. If the value of probability is 1, uncertainty becomes uninterpretable. If the value of probability is 0, then unexpectedness converges to infinity, while uncertainty to 0. Therefore, uncertainty is the greatest when probability is equal to 0.5, and it decreases to 0 as the probability value decreases (or rises). Unexpectedness is reduced as the probability of occurrence increases, and when the latter decreases, its value grows without limit. *The lower the probability of an event to occur, the higher its unexpectedness is. And the higher the probability of an event, the less unexpected it is.* Examining uncertainty and unexpectedness in the [0.5;1] interval we can draw the conclusion that increasing the probability of occurrence will cause unexpectedness to drop more quickly in the first half of the interval than uncertainty. Thus, an increase of probability has a greater impact on the reduction of unexpectedness – in this interval section – than on uncertainty.

Environmental disasters and general uncertainty brought low-probability (<0.5) events into focus that emerge suddenly and have a great impact on the society. As discussed above, the unexpectedness of these events is high. In general, the society has difficulty preparing for such contingencies, and subsequent remedial activities may take a long time (for example, the consequences of the nuclear disaster that occurred at the Chernobyl nuclear power plant in 1986 still linger). Low-probability events are paradoxical in that unexpectedness may be reduced by increasing their probability to occur. However, this might not be desirable, especially in the case of incidents having a huge adverse impact on the society. An increase of the probability of occurrence also entails an increase in uncertainty in the [0; 0.5] interval, which leads to loss of information. The closer the occurrence value gets to 0.5, the closer the probability of occurrence and non-occurrence of the event converges. Thus, we have less information about whether or not the even will occur. By reducing uncertainty, we could get more information, however, due to the characteristics of the interval, it is only possible by reducing the probability of occurrence. A lower probability of occurrence will also increase the value of unexpectedness, and as a result we come full circle.

Uncertainty and information, stability and instability

The correlation between uncertainty and the volume of information is characterized by the statement that "a reduction of uncertainty can always be interpreted as information" (Rényi, 1976: 56.). In contrast, changes in unexpectedness cannot be regarded as information: only the expected value of unexpectedness represents information. However, it is the same as a reduction in uncertainty. Information related uncertainty can be rated according to the below grades on the "uncertainty scale" (Kaufmann, 1982: 168.):

- unstructured uncertainty: the states of the system are unknown at any point in time other than the current one,
- structured uncertainty means that the states of the system are known, but it is not possible to predict the state of the system,

- chance means that not only the states of the system are known, but its probabilistic principles too, which characterize a point in time other than the current, but the actual outcome of the event is unknown,
- certainty means that the states are known and they can be described at any point in time.

A good example of unstructured uncertainty in the society is the number of cars travelling on the roads of the country. Economic phenomena and processes are mostly characterized by structured uncertainties, while chance plays a role in most of the societal processes and certainty in the malfunction of technological equipment. When making forecasts regarding the society as a complex system, events and correlations will appear everywhere across the uncertainty scale. As the volume and quality of information increases and our knowledge of unknown phenomena improves, we can progress across this hierarchical scale. If structured uncertainty is properly specified, using statistical principles we can progress to level three. Applicability of deterministic hypotheses allows for stepping up to the highest level. Of course, it is only applicable to stable systems.

Uncertainty under stable conditions – when uncertainty is properly structured – can be effectively mitigated by the increasing volume of information. *Under unstable conditions*, however, this is not the case because uncertainty is an inherent property of instable system, which cannot be reduced by increasing the amount of information. A lot of unstructured uncertainties can be detected in the society and the economy, however, they can be managed more or less by extending our knowledge of the unknown.

Reducing uncertainty also reduces risk as the latter covers a set of uncertainty factors the probability of which can be inferred and estimated. Risk are associated with actions the results of which are always seen as negative but they have not come to pass yet even though they might in the near or distant future, which means that their occurrence is uncertain. Therefore risk can be seen as a measurable part of uncertainty according to the interpretation of Knight and Keynes (Knight, 1921; Keynes, 1921) so statistical methods can be developed to measure it. If probability distributions and expected values are known, then the behaviour can be described with functions, and the measure of risk can be approximated with a distribution or variance value.

We encounter risks and efforts to deal with them almost everywhere. The notion of economic risk is usually associated with corporate activities, while attention to environmental risks was drawn by adverse effects produced by large technological facilities and the fear of new ones. There are other types of risks such as political, social, genetical, and medical risks that can be mitigated to a varying degree through making forecasts. Applied statistical solutions are suitable for revealing existing trends and making forecasts based on them, but they cannot handle weak signals and wildcards. These can break trends or create new ones, and for this reason forecasts solely based on statistical methods can be erroneous even if they include several alternative futures.

Methodologies and tools of futures studies reducing uncertainty

Futures studies is meant to reduce uncertainty. Future studies may be used to mitigate, on the one hand, objective uncertainties related to processes, events, correlations, and states that do not exist yet but are expected to emerge in time, and, on the other hand, subjective uncertainties based on knowledge that can be gained about the changes. Futures studies and their results influence our actions and decisions today, and they help us to investigate the effects of our previous decisions. As part of this process, futures studies may intensify the future orientation of experts and laymen studying the future as well as individuals and groups involved in and affected by decision-making, increasing the certainty of future development of certain topics of the future.

Principles of methodologies in futures studies

In order to reduce uncertainty and to improve safety, we can invoke three interrelated principles from the methodology of futures studies: complexity, participativity, and alternativity. Why do these three principles reduce uncertainty and increase safety?

Complexity plays a positive role in reducing uncertainty because researchers engaged in futures studies who employ it add several – in fact, as many as possible – facets of reality to their investigations. In this way they can ensure that none of the key determinants of the future are omitted so the scope of knowledge obtained can be more or less comprehensive. Complexity can also save researchers of the future from studying only the elements of the future that look important in the present, ignoring the investigation of the future development of phenomena that are seen as weak signals (Veigl, 2010) at the time. Thus, applying the complexity approach also ensures that futures researchers can analyze phenomena not only from the perspective of the present but also of the future. Only by applying the principle of complexity can the modes of action and interaction between phenomena and future domains be explored as fully and thoroughly as possible.

When invoking the principle of *participativity,* futures researchers engage the population, the laymen, and the interested and affected parties in the development alternative futures. Ensuring that as many of them as possible are actively participating is especially important when dealing with significant changes in the society and unstable socio-economic processes. In such situations, individuals as well as communities recognize that they need to actively contribute to the shaping of their own future. By doing so the interested participants can reshape the expert's forecast of the future, and actualize activities that they would also be willing to perform for the future. *Application of participatory futures studies is the new answer to challenges arising from instability.*

The positive impact of participativity can be measured by the reduction of uncertainty, because involving the *stakeholders* invested in a certain set of issues in the development of future alternatives, and later in the decision-making process may provide additional knowledge that can complement the forecasts of futures researchers, and enhance the creative approach to the future. The laymen's opinion may also serve as a check on expert opinions: representatives of scientific disciplines often suffer from "blindness" – they lose themselves

in the details and they fail to spot the turning points that occur as a necessity in the future or changes that the members of the society consider important.

According to the principle of *alternativity*, futures researchers do not outline a single future or vision but different possible scenarios and future alternatives. To formulate them, first we must interpret the double-bind of the present. Consequential futures arising from the past create the initial state or situation that can be modified, shaped, or overridden by expectations and anticipation. In this way future alternatives that take into account both the attributes that can be derived from the past and the requirements of the future can be drawn up.

Applying the principle of alternativity may reduce uncertainty and increase certainty and safety because it offers experts and those who consider shaping the future their duty an area for decision-making and, within that area, room to manoeuvre. This approach can have credibility because in this room to manoeuvre possibilities that can be derived from the past can be balanced against expectations and requirements stated in regard to the future.

The synergy of the three futures methodologies ensures above all the mitigation of uncertainty related to the future and the increase of safety, because it contributes to producing future possibilities (scenarios and alternatives) in many ways and in many versions, with the involvement of the interested parties/stakeholders. This way not only the probability of making a mistake is reduced but there is a chance to outline new futures that represent a different level of quality.

Recognizing and handling unstable states

Unstable states are profoundly different from stable states. In a stable state, using the classic mathematical and statistical methods/procedures of futures studies one can make fairly reliable forecasts (that offer a sound basis for decision and strategy-making), thanks to continuity and, more or less, permanence in the first place. Under unstable conditions different approaches must be found.

If we learn how to handle instability then we will not expect a phenomenon or an event that is in an unstable state to "behave" as if it were stable, but we will understand that *its future is incalculable, but not unpredictable.* Under unstable conditions, a lot of versions of the future/future alternatives can be worked out, because in a badly structured, complex system, a lot of various futures may come to pass. Therefore we should not focus on reducing the number of future versions/future alternatives but rather on exploring the widest range of them. This is absolutely necessary because in an unstable situation the individual elements (phenomena, events, trends) are extremely sensitive to minor changes, and at certain critical points, futures that are markedly different from the previous ones can form as a result of such minor changes, along so-called *bifurcation branches*. If we treated them as components of a stable system, then we would not be able to interpret the new kind of future, the so-called created future that arises from these bifurcation points, and we would lose the possibilities stemming from the fact that a system is in an unstable state.

When dealing with an unstable state *we need to accept the existence of uncertainty*, we need to try to understand it, and we also need to get accustomed to the possibility of facing markedly different new futures. For this reason, efforts should be made to draw up as many

possible or currently not regarded as possible but imaginable future alternatives. Recognition of unstable conditions can reduce uncertainty if we do not squeeze the progression of a phenomenon/process in the future into the Procrustes bed of stability, but handle them in whatever form they emerge. *Reduced uncertainty and a higher degree of certainty can be achieved by treating the extraordinary and the most unexpected elements* (the so-called weak signals and wildcards that we will discuss later) *as an integral part of future alternatives in addition to the clearly observable ones when we make forecasts for a wide range of future alternatives. Application of chaos theory, chaos calculations, and the scenario method in addition to the weak signals and wildcards that are barely recognizable in the present may help us identify and handle unstable states.*

Application of chaos theory to social sciences draws attention to processes and events the behaviour of which is prone to mutability, instability, and chaos where a minor intervention can have a significant effect. The more unstable a system (its components), the less force you need to dislodge it from its current state and vice versa. Due to the workings of the bifurcation force, the direction of change can be positive or negative with the same probability, and the forces set into motion can produce a new state at an exponentially accelerating rate. This is why it is especially important to recognize that we can get into situation fairly quickly in which we will not have any control over the consequences. For this reason, we should be particularly careful when we outline the events triggering the change and when we intervene.

The *scenario method* (Kristóf, 2002) places the emphasis on critically uncertain (unstable) factors, indicating that these are the ones that futures researchers should first and foremost focus on as their development in the future carries a great deal of uncertainty. In order to reduce uncertainty, we need to understand the dynamics and structure of the studied processes.

Recognizing weak signals

Weak signals are signals in the present that are difficult to recognize and, as a result, identify, and the occurrence of which can be barely deduced. Their significance, however, cannot be neglected because they often indicate a new trend as they can trigger a change of trends or contribute to the emergence of completely new trends. A conventional mindset has difficulty grasping them, but future-oriented thinking may help here. In this case, conventional thinking that focuses only on the past and present should be replaced with a future-oriented mindset that is willing to think "outside the box".

As weak signals may trigger significant changes in the future while they remain barely visible, discovering them requires that persons with a future-oriented mindset should look for them consciously. Another difficulty arises from the fact that you can find an uncountable number of signals that may even contradict each other, and it is impossible to determine which of them will be important in the future. To resolve this problem, Kuosa (Kuosa, 2005, referenced by Hiltunen, 2010) suggests that weak signals should be handled as pieces of a puzzle where every piece forms a building block of the whole. Signals that do not fit in to the large picture are invalid, and are not related to the given change but to another one. The solution is, therefore, that the more signals we collect and monitor, the better grasp we

have on whether or not there is a common pattern. This common pattern or change is what we need to evaluate.

Another difficulty with recognizing weak signals is that they are often so unrealistic as a scene from a science fiction movie, or they break an existing trend that we consider such a long-lasting one that we do not question it and therefore we do not take the signal seriously. Remember the views about 3D printing and the recognition of its inherent potential at the end of the 1970s. The technology did exist at the time, but it was in a primitive form, which means that it represented a weak signal. In the same way, the potential of the Internet or the spreading of social media and its influence on the society and economy could not be foreseen in the early 1990s. Just like we (or at least the majority of the population) failed to recognize the significance of these signals, we might also ignore events that are indicative of the future, but today only exist as weak signals. So we should not shrug off signals that seem to be impossible or ridiculous, rather we should address them in a critical and future-oriented manner.

Where can we find weak signals? According to Hiltunen's research (2008), future-oriented persons may mostly find weak signals coming from scientists, futures researchers, colleagues, professional and scientific journals, and papers from research institutions. Depending on the type of weak signal (economic, societal, technological, political, etc.) the sources differ somewhat. A very surprising result of the research, which might not even be valid today, is that the Internet is not a dominant source when one is looking for weak signals. The research did not find any significant differences based on the proportion of personal, online and printed solutions. Some of the interviewed persons emphasized in their responses to open-ended questions that interaction, openness and the discussion of questions are an important part of finding weak signals. They also found that *simultaneous use of multiple sources* that cover different areas of our lives is beneficial to identifying weak signals.

In addition to these sources, we can gather creative and future-oriented ideas from a lot of other places. A number of movies and tales also include future alternatives that could have been identified as weak signals at the time of their release. Remember the perfect humans envisioned in the movie *Gattaca* (with Ethan Hawke, Uma Thurman, and Jude Law, 1997) who were genetically designed to possess excellent capabilities and health thanks to the genetic modifications. The foundations of this technology – the modification of the DNA – already exist today (CRISPR-Cas9 allows for targeted genome editing), although its everyday application may be a bit further down the road. In the same way, electric cars in the movie could be part of our reality, because the technology is already available. Norway pioneers their introduction with a plan that would only allow electric and hydrogen powered cars to be used in road transport from 2025.

Another good example of weak signals is be the movie *Truman Show* (Jim Carrey, 1998), which is about a man who does not know that the world he lives in is an artificially created reality show. Not only did the movie predict the popularity of reality shows that are quite prevalent today, but it also foresaw surveillance activities affecting our everyday lives. We just need to think about click-based advertisements, surveillance cameras and the use of face recognition programs! According to a survey by CSC in 2015, 74% of the retailers in the United Kingdom use various surveillance technologies (big data, face recognition programs, security surveillance).

A further excellent example from the world of fairy tales is *Big Hero 6,* in which the protagonist, a small boy called Hamada Hiro, is helped by a soft, cuddly robot, Baymax, who, as a personal medical assistant, can do body scans, make a diagnosis, and heal illness. The story envisioned the wide-spread adoption of robots, and chiefly the friendly relationship between robots and humans. The list of examples is endless. The morale is that *we need to be open to weak signals, and we should not expect them only from professional sources, but also from other, sometimes surprising fields of our lives.*

Why is it important? Because *recognizing weak signals may reduce uncertainty, and it may also help us pick what appears to be the most suitable one out of the possible strategies.* This may be true for an individual's career-related decision or the shaping of a company's strategy. As early as in the 1970s, Ansoff realized what role weak signals played in corporate strategy making (Ansoff, 1975), and he tried to develop a solution that would allow for drawing up plans even in an uncertain environment. *A proactive approach will not only render the future predictable but also creatable*, because weak signals can be augmented by the faith in their occurrence. Self-fulfilling predictions, as they can change behaviour, can come true, and for this reason desirable signals are worth paying special attention to them.

Wild cards as extraordinary events

A wild card is a possible event the probability of occurrence of which is very low, but its impact is great (Petersen, 1999). You may recognize wild cards from sports. For example, if the winner of a gold prize at the Olympic games is found to have used prohibited drugs, then the silver medallist may suddenly become a gold medallist, or if a sportsman qualifies for the Olympic games or any other respected sports events because one of the higher ranked sportsmen before them withdraws or get disqualified, then the sportsman in question is given a huge opportunity. Unlike a weak signal, a wild card will not necessarily start a new trend that carries the seed of the future, but it is mostly associated with conjecture and opinions. In unstable systems, emergence of wild cards is more likely than in stable systems.

Wild cards can lead to a favourable or unfavourable outcome. An example of the former can be an invention that opens up new perspectives in medical sciences, of the latter an economic crisis that starts unfolding. In addition to their obvious effects, these wild cards might break the current trend, preventing the future that was forecast as probable by mathematical-statistical predictive methods from coming to pass. Using these methods alone cannot yield success. For this reason, it is critical to establish if emergence of wild cards in the future has any visible signs and who are the persons that are sensitive to such signs. When outlining realistic alternative futures, it is surely reasonable to apply to the wisdom of the crowd in addition to employing experts, because the masses can be often more successful in decision making and problem solving (Surowiecki, 2007), and possibly in outlining the future too.

Researchers are divided in regard to the predictability of wild cards. Some believe that there are early warning signs or early indicators (Petersen, 1999; Hiltunen, 2006) that can foreshadow the occurrence of a wild card. We can stumble on such signs when we are looking for weak signals. Others (e.g. Barber, 2006) maintain that wild cards are not indicated by any signs that would leave enough time for preparations. The truth lies probably

somewhere between the two contradicting approaches. In order to reduce the uncertainty of the future, we need to strive to find any possible signals and to take wild cards into account when we draw up scenarios.

When evaluating the effect of wild cards, beyond their predictability, their reversibility is also highlighted, which indicates whether or not it is possible to return to the original trend, and if so, how long it takes. A significant part of the wild cards produce such a profound change that prevents the events from unfolding as they did before. Out of the incidents of the past few years, key examples that clearly indicate the unexpectedness and significance of wild cards include the 9/11 terror attack or the accident at the Fukushima nuclear power plant. Both have a long lasting effect even a long time after their occurrence. A comparable example from our country is the red mud deluge at Ajka.

Today the range of action of wild cards is often global due to the interdependence and strong interrelations. Although the terror attack on 11 September 2001 targeted the United States, security measures were upped at many other airports, indicating that the lessons learned from the incident were taken into consideration by a winder group of actors, and other states have also acted on this wild card to make their future more secure. Fukushima sparked lively debates about nuclear power plants, and increased demand for the use of alternative power sources.

This means that in addition to predicting wild cards another *key issue is whether or not their occurrence is followed by a learning process that can lead to avoiding similar wild cards in the future.* It is also important to ensure that decision makers can see the root causes and intervene at the correct level. For example, if there are wildfires due to extreme drought (this is a wild card), it is not necessarily enough to rethink strategies aimed at successful firefighting (where to place firefighting stations, how much equipment they need, etc.), it is conceivable that the root cause, the climate change-induced warming should be regarded as an omen.

The notion of wild cards is similar in many ways to the *black swan phenomenon* introduced by Nassim Nicholas Taleb (Taleb, 2007). In his book, the author described the black swan with three characteristics. The first one is that the event is an *outlier*, which means that it falls outside the scope of usual expectation. The second characteristic is that they have a significant impact, the third is that after their occurrence it is possible to come up with a clear explanation of their root causes, which makes them explicable and predictable. Black swan phenomena go beyond (normal) expectations related to science, finances, and technology. Their probability of occurrence (statistical, econometric) cannot be calculated with scientific methods, we cannot predict them by monitoring previous trends. Understanding of black swan phenomena is made difficult by the fact that individuals as well as groups tend to be blinded by psychological preconceptions regarding uncertainty and the role that rare events played in past occurrences, often underestimating chance and luck when they analyze incidents. The same characteristics are also applicable to wild cards.

Practical means of reducing uncertainty related to the future

Literature in futures studies has put forward numerous examples to demonstrate that the principles and tools of futures studies can be used to reduce uncertainty. Here we will

highlight two approaches from Hungarian research projects: the results of research related to the use of modern futures research methodologies and chaos theory/chaos calculations. We will review the results of two Hungarian research projects (these were led by Erzsébet Nováky in the capacity of project leader and we will show the results that can be achieved by applying the principles of complexity, participativity, and alternativity to the reduction of uncertainty in the future and to extend the scope of future alternatives. In regard to the application of weak signals and wild cards, we will use examples taken from literature and practice to demonstrate that they can be recognized in many areas.

Application of principles used in futures research methodologies

We will demonstrate the practical application of principles used in futures research methodologies in connection with a specific forecasting task – a research project aimed at forecasting the societal-economic state of Hungary in 2025 (Nováky, 2010). According to the principle of *complexity*, in the academic research project entitled *Magyarország 2025-ben* (Hungary in 2025) we strived to scrutinize as many facets of reality as possible and look for the possibility of changes at the widest possible level. Topics dealing with demographic, societal, economic, technical/technological, environmental, and settlements related issues were also part of the analysis. We put a special emphasis on studying areas that are subject to rapid changes, and therefore can initiate new processes within a relative short period of time. It is important to learn how experts view the future development of these areas and whether new phenomena that may break existing tendencies and reinforce cooperation and coordination between these areas will appear.

We looked for changes that we have or can have a strong influence on and we can and/or we want to influence. These include population, healthcare and nutrition, fitness, mental disorders, education, sustainable households, crime and law enforcement, social governance and public administration, and settlement development. The Hungarian population's power to shape its future manifests itself most markedly in these areas. We also studied changes over which we have little control, that may have a significant impact on the society, economy and/or environment of Hungary in the future due to the changes that are expected to occur. Such changes include the phenomenon of globalization that we will need mostly to adapt ourselves to. In the selected areas, experts, including futures researchers and representatives of other disciplines, created futures studies in which they made forecasts about expected changes as well as positive and negative development trends until 2025. The studies focused on exploring the options and limits of social and technical/technological renewal, and on discussing the related hopes and dangers/traps (fears).

Forecasts made by experts between 2007 and 2010 established that demographic processes were critical in Hungary, and the situation of families did not improve. These studies were dominated by fears: birth rate was decreasing (the overall fertility rate would stabilize somewhere between 1.2 and 1.3), the population, the number of families, and the average family size would diminish, and partnerships would be pluralized. However, there is still hope that the acceptance of traditional values and the desire for a big family and having multiple children will increase in the young generation, and this may allay fears. Another reason for fears arises from the forecast that the population's interest in sports and healthy

living will diminish, wellness will be marginalized in societal thinking, and the ratio of overweight children who exercise too little will increase by about 25%. However, the fact that the health awareness of the society and the popularity of recreational sports activities are on the rise, and new community platforms are being created that have potential for community building.

Members of the Committee on Futures Research[2] of Section IX of the Hungarian Academy of Sciences consider the deepening and growing digital gap as the greatest problem: a significant difference has developed between the various layers of the society that is further augmented depending on age, education, and geographical location. The hopelessness of those who are lagging behind carries the risk of an emerging social conflict. It inspires hope, however, that if the danger of a split in the society is recognized and widely known, then experience of the past and recognition of new situations can contribute to restoring social harmony.

In bio and gene technology the dangers of using these technologies are becoming evident as the first negative consequences are encountered. Research projects that are incomprehensible for laymen fan the fears of the population, which are also stoked by the media. It brings hope that biotechnology can increase the efficiency of agriculture, leading to considerable economic gains. Widespread application of gene technology improves productivity, ripening is faster, production is simpler, losses are reduced, and agriculture may become more sustainable.

In regard to sustainable households, the experts fear that consumers may become trapped by hypermarkets and entertainment centres while consumerism is spreading without control. The environmental load of nutrition (from shopping to the production of waste) is increasing, but in the sustainable households of the future new consumer habits (e.g. selective collection of waste) are being amplified, and the sustainability oriented mindset and way of life will appear in our everyday lives (e.g. economic use of power). All this is facilitated by the spreading of eco and bio trends.

According to the principle of *participativity*, we mapped the individual's options for social renewal: we used a questionnaire to examine the thoughts of the youth – the determinant generation that will assume decision making positions in and around 2025 – about the future. We were interested in learning how millennials whose lives are dominated by the experience of globalization, digitalization, and virtual reality, see their relationship to the future. To get this information, we explored what our secondary school, university, and college students think about the next 15 to 20 years, based on a sample of 1000 high school and 500 university and college students. What are their expectations, hopes, and fears in the various areas of their lives, what do the future employees and citizens expect, and how do they imagine their personal lives, what kind of a family do they expect to have, how many children are they planning, what will they do to make their hopes come true and to mitigate their fears. We were able to form various groups: the group of individuals in the network of the community, the individualists, the worriers and the lost, and those who are aimless. These groups had different attitudes concerning the future.

The principle of *alternativity* dictates that different versions of our future will come true depending on which layer of the society will absorb the experts' fears and hopes. If the

[2] Today: Scientific Committee on Statistics and Futures Research

"individual in the network of the community" scenario meets the experts' hopes, a positive future may be formed. However, if the scenario of the lost and the worriers is combined with the fears of the experts, not much progress can be expected.

We used expert forecasts mostly to explore future possibilities, and laymen's opinion mostly to discover what expectations of the future the residents who will be in a decision making position have. *We avoided the trap of explaining future exclusively from the past or controlling it only from the domain of desires.* In the present, we looked for the future in the space generated by this two-pronged approach, taking into account the future ideas and desires that may alter the scope of possibilities – however, the scope of possibilities can be extended on the basis of expectations. Thus, using this two-pronged approach, we produced scientifically established futures that represent the balance of the past, the present, and the future, based on which the explored alternatives were *elevated to real future alternatives. In this way, we managed to reduce greatly the uncertainty resulting from the trap of getting stuck in the past and attempting to escape into the future.*

The use of chaos theory and chaos calculations in the prediction

The first time we attempted to use chaos theory and chaos calculations to further our forecasts at the beginning and in the middle of the 1990s (Nováky, 1993; Nováky et al., 1997) when we used these methodologies to demonstrate the behaviour of Hungarian macro processes and the options to forecast them. Redoing these studies after the millennium allowed us to compare the results from the two eras (Nováky–Orosz, 2015).

Our initial assumption in the study was that at the time of the change of the political system unstable phenomena shaped our society and our economy, the forecasting of which is not possible with classic futures research methods. A new approach had to be found that can handle uncertainty resulting from instability. We regarded chaos theory as a suitable theoretical basis, and chaos calculations as a suitable method to explore if the key Hungarian macro indicators exhibit a behaviour that is typical of instability, and if so, what future can be forecasted for our country.

Our studies show that the Hungarian economy was not in a state of chaos in the 1990s, but we did find some macro indicators of the society and the economy that were characterized by strongly, moderately or weakly chaotic behaviour. These were mainly societal indicators. For example, these indicators included the number of persons who died from cardiovascular diseases, the number of registered alcoholics, criminal acts, hospital beds, and doctors. In the area of economy, the number of homes built, the gross national product, the economically active population, and the investment volume index showed chaotic properties. Tendency to behave chaotically was not typical of the majority of the studied 39 macro indicators, and for this reason, as we established, the renewal of the society and the economy is only possible with great efforts. Based on calculations we also concluded that more than one way is open to the Hungarian economy and society, and there was a chance of progress but also of stagnation and decline.

Calculations performed again in 2010 showed that our society is not in the state of mathematical chaos, and certain indicators started to stabilize and become constant. We are slowly moving away from the possibility of making a change, which means that it will be

increasingly difficult to set certain processes on a more favourable course. Future changes are expected in the services sectors of the economy, the number of homes built, the students attending secondary education, the patients died from cardiovascular diseases, and the number of commercial accommodation establishments. The key to the future, therefore, should be sought in education and in the state of the population's health. The renewing, creative power of chaos is required for the Hungarian society and economy to undergo qualitative changes and rise to a higher level, opening the way to a harmonic civil society.

Examination of unstable states contributed to the mitigation of uncertainty by *seeking an extensive range of future alternatives according to the nature of phenomena without excluding low-probability events*, through the use of the correct methodology, employing the tools of the applied method – chaos calculations.

Weak signals in practice

In the following, we will describe weak signals that can be observed in the different areas of society and economy, that are expected to become determinant, or at least accepted characteristics.

1. Big data
Big data will outgrow the world of IT and reshape commerce, healthcare, the public sector and the industry (Manyika et al., 2011), but it will also affect all the other industries. It can lead to the creation of hundreds of thousands of jobs in the future, and sets profoundly different requirements for future leaders and managers in regard to the interpretation and use of data provided by the data sources. It may also open up a niche market for companies providing big data related services.

2. Use of alternative power sources
There are several research projects focusing on the use of alternative energy sources that may lead to renewable energy sources assuming a key role in the future. For example, these research projects aim to transmit solar energy from space to the surface of the earth, or use osmosis based power plants to utilize energy produced by the contact of salt water and sweet water, and they have also been successful in producing fuel using coli bacteria.

3. 3D printing
3D printing appeared in the 1980s. The potential of the process that was in limited use then and rather expensive was unknown to most people at the time. Thanks to its favourable properties, this technology is becoming more and more popular today. It will revolutionize a lot of areas by offering the capability of producing a lot of inexpensive high quality products quickly. Examples include healthcare where promising results were achieved in organ transplantations and with protheses, but this technology was also used to create a house, and NASA is even testing 3D printing in space. Automotive industry, construction, dentistry, jewels, food industry: these are just a few examples of the versatility of this solution (Harrop-Gordon, 2015).

4. Teleportation
The National Institute of Standards and Technology (NIST) achieved considerable successes in teleportation. Quantum information was successfully transmitted to a distance of 100 kilometres. This beat the previous teleportation record (2014) of 25 kilometres (Takesue, 2015). Quantum communication technology is far from commercial application, but it has tremendous potential.

5. Smart devices, data storage
Extension of the areas of application of smart devices and their increasing popularity among consumers are expected in the nearest future. New research aiming to enable DNA data storage will give this technology momentum. This solution that was developed by Microsoft and the University of Washington is extremely dense and durable.

6. Popularity of self-driving cars
Adoption of self-driving cars may lead to faster, smoother and, above all, safer road traffic. Due to shorter commuting times and a decrease in the number of traffic accidents, it would provide significant financial and social benefits. The technology for the manufacturing of self-driving vehicles is already available today – the most recognized self-driving cars are made by Google and Tesla, but there are still a lot of outstanding issues in terms of regulations. Despite these problems, the first models that offer an almost complete set of driving *assistance* functions have already appeared, but for now these functions only work if the presence of the driver is detected. Examples include the ProPILOT technology of Nissan and the products of premium manufacturers.

7. Use of robots in all walks of life
As early as 2005, a robot was planned to be marketed in Japan as a chat partner for elderly people. Robotics has improved a lot since those days, and Erica, a robot from the University of Osaka, can send non-verbal signals in addition to verbal communication, and bears an uncanny resemblance to a real person. In the future, as manufacturing becomes cheaper, the use of robots may be widely adopted. In Japan, there are a lot of real-life examples of their use, including a robot called Otonaroid that was introduced as a museum guide, while NAO operating as a bank information kiosk can communicate in 19 languages with the clients. But there is also a robot that was developed to assist in studying languages or to accelerate recovery from illness (Paro, a therapeutic robot). There is already a hotel where robots receive the guests, and in a few years the first farm run exclusively by robots will start to operate.

8. Alternative educational solutions
Due to easy access to materials, the significance of lexical knowledge has declined. Further spreading of alternative educational solutions and their increased recognition are expected due to their flexibility and the cost advantage they offer. New technologies support experience based education. The holographic smart glasses called MetaPro, which can be used, among other things, to visualize our bones, making it easier to learn about them using graphical imagery is a good example of such use.

9. Medical technologies
The development of medical technologies improves the conditions and chances of healing. A bionic eye provides people who would otherwise be unable to restore their vision with the ability to see, and printed organs give people who waited for transplantation in vein a chance. It will be possible to alter the structure of the DNA. CRISPR-Cas9 allows researchers to perform the targeted editing of the DNA accurately and in a way that is more flexible than ever before. Big data improves efficiency and reduces costs in many areas of application. For example, its use improves the productivity of research and development, and allows for the design of decision support system that rely on thousands of data entries (Manyika et al., 2012). Costs can be reduced by the introduction of diagnostic applications that will use mobile phones to perform simple examinations (blood sugar, blood pressure measurement) (Topol, 2015). In addition, dietetic applications and home pages (e.g. WebMD) provide assistance in resolving certain situations without medical intervention.

10. Artificial food
Both the shrinking potable water supplies and the increasing population drive the future towards the production of artificial food. Artificial meat produced with an otherwise simple technology is expected to have a profound impact on agriculture and foodstuff industry in the future (Post, 2012). 3D printing is also in the limelight: NASA is currently planning on providing food for astronauts with this technology, but the success of the project will sooner or later followed by its widespread adoption. Robotics in agriculture opens up new horizons – the previously mentioned automated farm is a good example.

11. Space travel
Researchers are working on designing rocket engines that use much less energy, weigh the quarter of the engines that have been used to date, and can operate without fuel. If further testing is successful, it can turn space travel upside down, and maybe even make it accessible for ordinary people. The discovery of gravitational waves opened new perspectives in astronomy. This research is particularly noteworthy because more than 1000 researchers from 15 countries collaborated as part of the international LIGO Scientific Collaboration project. As a side effect, the project may also offer never before seen opportunities in scientific cooperation.

12. Cyber attacks
Most certainly security policies and future wars will be dominated by bioweapons and cyber-attacks. Even now we can read about the development of viral weapons with high fatality rates. Cyberattacks disrupt energy supply as it happened in Ukraine in December 2015, but they may also target financial services and any major players of the economy.

Future changes in the environment may also have serious detrimental effects that will affect the security of all countries, and have an impact on the security forces of the future. For example, global warming may affect water management, pose energy security risks, cause floods, mass migration, and medical disasters, and lead to loss of productivity in agriculture (Kovács, 2008). Advanced technologies also find their way into the world of law enforcement as they become part of the everyday criminal activity. For example, face recognition systems are becoming ubiquitous, just like the various methods of predictive analytics thanks to the emergence of big data.

Examples of wild cards

Although in literature the two phenomena tend to be used interchangeably, it is reasonable to make a distinction between wild cards and gradual changes. The difference is demonstrated with a spot-on example by Hiltunen (2006: 67.). The example makes a distinction between the two types of changes at the individual's level, but the difference is equally applicable at global level to real-life wild cards. If a person is diagnosed with a terminal disease such as cancer, the family members will still have some time to prepare for the inevitable. This change can be characterized as a gradual change. However, if the family member dies suddenly in a traffic accident, there is no time to prepare for the loss. In both cases, the outcome is the same, but in the latter case the occurrence of the event is entirely unexpected, which means that a wild card is generated. Even if a wild card is encountered, there may be weak signals that foreshadow the occurrence of the event. According to the presented example, such a signal could be the driving style or the lifestyle of the person.

Below we will list a few examples of wild cards according to STEEP. Consequently, we will handle the *social*, *technological*, *economic*, *environmental*, and *political* fields separately, even though the complexity of the effects often complicates classification.

In society

A scientific discovery may significantly prolong life expectancy at birth. If it comes with an increase of the years lived in good health, this wild card will also have an economic effect due to, for example, the reduction of healthcare expenditures or the rise of the ratio of economically active population.

An increase in the frequency of terrorist attacks can be forecast with a high degree of certainty. The attacks themselves are unpredictable and difficult to prevent. Their nature is also changing, they cause more and more societal and financial losses, and they are becoming global. As a result, people feel less secure and xenophobia is on the rise in the affected countries. The spreading of new types of attacks such as cyber-attacks that target politi-

cians, the media, but also the ordinary citizens should also be considered. The information technology network of the Hungarian government and the Swedish news portals faced such an attack in 2016, or the Ukrainian population in 2015 (in the latter case, the energy supply was targeted). Deployment of biological weapons can also be a wild card in the future. Beyond influencing the direction of development efforts aimed at improving security, the new types of threats have an impact on other areas, including the voluntary restriction of human rights in an effort to protect them.

A nuclear war is becoming a real threat. The experts of the *Bulletin of the Atomic Scientists* set the doomsday clock in 2016 to 3 minutes to midnight (the number of minutes to midnight represents the degree of threat, which was 17 minutes back in 1991) (Mecklin, 2016). According to the experts, the struggle against climate change also increases the threat as commitments to reducing the emission of greenhouse gases cannot be met without resorting to atomic energy.

Epidemics may break out and cause global problems. Tourism and international trade may contribute to the rapid propagation of dangerous viruses on several continents, and beyond their obvious medical implications, they can also affect the level of international tourism, the selection of travel destinations, and the people's overall perception of safety. Also, the effects may last longer than the viral threat itself.

In technology

In technology, research produced several results that may lead to significant changes in social life. Unexpectedness may be present in how quickly the results produce an impact and in the nature of the results: the latter may also be greatly influenced by chance. There may be a fundamental change in the sources of new scientific discoveries and technological developments. New players may enter the scene, and new types of joint cross-border research projects may be organized.

Implementing the technology of energy transfer from space is a possible wild card, which would represent a huge step towards a cleaner source of power. It is conceivable that the energy revolution will take place here on earth when a new, cheap, clean, oil-free technology emerges that can reduce the randomness and the environmental load of the current solutions (we just need to consider the unpredictable fluctuation of the wind power output and the considerable environmental load of technology). A futuristic element of wild cards in technology, which is quite interesting for many people is the question of what role artificial intelligence will play in the future. Some of the scientists believe there is a real chance that AI will take control of the human race, which may also lead to the extinction of humanity.

In the economy

A typical wild card in economy is the onset of a financial crisis. It is typically global due to the high degree of interdependence between the countries (we just need to recall the crisis unfolding in 2007). Beyond the decline of economic performance, it produces several social

problems, but may also have positive effects through the reformation of markets and financial products and the rethinking of the applied models.

The bursting of stock exchange bubbles resulting from the overvaluation of securities or a change in the political situation may lead to the collapse of stock exchanges. Artificial manipulation of the market may also trigger such processes. Due to interdependencies, the effects usually spread beyond a single stock exchange. In 2010 it was believed that an attempt to manipulate the market led to investors trading in American, European and Asian security markets losing 1,000 billion dollars within a few minutes, but the foreign currency and raw material markets were also hit.

In the environment

Several wild cards may emerge that can lead to a natural disaster. Natural threats include floods, groundwater, earthquakes, drought, extremely hot or cold weather, and volcanic eruptions. Most of these wild cards are localized, and affect the population and the economy of a given country. Beyond their immediate effects, they can also amplify demand for the development of early warning systems and for coordinated efforts, they influence the direction of technological development, and in this way they play an important role in the process of learning and in avoiding similar wild cards in the future. The introduction of stringent new environmental regulations can also be considered a wild card. If new environmental regulations are adopted, it transforms the industries involved. For example, CO_2 emission reduction initiatives adopted in Paris in 2015 in connection with climate policies have a significant impact on the energy sector, and represent tremendous business opportunities for certain stakeholder groups.

One group of wild cards deals with the probabilities of events in the universe, and handles profound changes in our knowledge of the universe. Such an event could be the discovery of evidence of extra-terrestrial life or a planet that supports human life. A collision with an asteroid deflected accidentally towards the Earth (the number of such asteroids in the Solar system exceeds 1 million) or with a planetoid would be an extreme example of a wild card.

In politics

Wild cards may also appear in politics. An example could be the victory of extremists at the elections or the outbreak of a civil war. Politics is a special field because it has a strong influence on wild cards appearing in *other* areas. The problem is caused by the fact that the ordinary citizens have a significant influence on public policies while they do not possess the knowledge required for contemplating certain issues and making decisions about them. Relaying the experiences of one of the advisers who worked for George Bush, Posner (2007) mentions, as an example, that the threat posed by asteroids was effectively ignored. According to the advisor, sufficient funds were not allocated to this research because the average American was not worried at all about such a potential catastrophe (even though the number of asteroids makes it a real threat). Another issue is the time horizon. For example,

the probability of a biological attack is very high in a 10-year period, but it is very low in the next 6 months. The same is true for other wild cards. And the politicians are known to be reluctant to make costly decisions without clearly outlined results.

An argument that supports political decisions is that preventive measures or a response to wild cards may benefit several areas at the same time. For example, measures intended to prevent a biological terror attack can be useful in handling an epidemic that broke out due to natural causes. Also, measures aiming to reduce demand for crude oil may not only play an important role in the fight against global warming, but they can also reduce the probability of depleting the fossil energy sources and mitigate energy dependency (Posner, 2007). The number of wild cards will probably grow in the future. As the examples demonstrate, these cards may appear in several areas, and they can be often quite specific (e.g. environmental issues), but their effects and subsequently the handling of the issues in order to avoid similar wild cards in the future may be a complex problem. For example, cooperation against natural disasters has political, economic and technological aspects.

It is important to note that even though the emergence of a wild card is often linked to a specific geographic location or settlement, but the produced effect and the subsequent process of learning may be global. For example, the outbreak of an epidemic may encourage other countries to develop vaccines and introduce other preventive measures. In addition to their spatial character, wild cards also differ in their temporal nature. Certain incidents have a lasting effect that linger for a very long time after their occurrence (for example, a disaster at a nuclear power plant) – in other cases the time window may be a few years or even less. A particularly dangerous situation may develop if wild cards of different types produce a combined effect.

Summary: reducing uncertainty and striving for security

Our studies based on theoretical and practical approaches show that uncertainty of the future can be reduced by applying the methods of futures research, and in this way security may also be improved by carefully adapting the aspects of the theoretical/methodological issues of futures studies – dual uncertainty, determination, chance, unexpectedness, information, stability, instability – to specific tasks, clarifying the applicable futures research methodologies and principles accordingly, employing the correct methods, and exploring weak signals and wild cards with an emphasis on the search for all things new will bring us closer to mitigating uncertainties that still exist in regard to the future. As it stands, these efforts facilitate exploring the capacity for renewal represented by these processes, tendencies and the events that change them, and the correlations that often form circular processes.

Futures studies draws the attention to the fact that on the one hand we need to adapt to the given conditions, and on the other hand we need to strive to change them, which means that the approach and methodology of futures studies rely on *the understanding of objective conditions and the recognition of the necessity of subjective changes*. Futures studies encompasses the recognition of economic and natural conditions as well as the efforts to exert a positive influence on the population's views of the future. This task can be achieved by reinforcing the future-oriented attitude of the youth and their readiness to act (Nováky, 2006), improving tolerance towards nature and each other, and by acting together

and cooperating with each other. This is the goal we intended to further with the subjects discussed and the examples – *best practices* – presented in this study.

As shown, uncertainty, lack of structure, and instability have benefits we can exploit so we should not try to avoid them but rather we should leverage the advantages they offer. We need to learn – and we need to teach it to the young generation – that *uncertainty is often a pre-requisite of achieving a new state that is preferable to the previous one*, but we need to manage our available assets carefully, and apply a strategic approach to determining the future changes in our course of action. *Security may only be achieved by travelling on the bumpy road of uncertainty to the end in order to understand its causes, employing a future-oriented approach with determination, and shaping our future carefully with positive acts.*

References

Ansoff, H. Igor (1975): Managing Strategic Surprise by Response to Weak Signals. *California Management Review,* Vol. 18, No. 2. 21–33.

Barber, Marcus (2006): Wildcards – Signals from a Future Near You. *Journal of Futures Studies,* Vol. 11, No. 1. 75–94.

Brady, David A. – White, Harold G. – March, Paul – Lawrence, James T. – Davies, Frank J. (2014): *Anomalous Thrust Production from an RF Test Device Measured on a Low-Thrust Torsion Pendulum. NASA Lyndon B. Johnson Space Center, Houston. Source:* http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140006052.pdf (2016. 07. 19.)

CSC (2015): *Next Generation In-store Technology: Where do Shoppers and Retailers Stand? Research Report. Computer Sciences Corporation. Source*: https://csc.turtl.co/story/55ee93d8bbfd077f2d4e22ee (2016. 07. 19.)

Doxiadis, Constantinos A. (1972): *The Two-Headed Edge. From the Past to the Future of Human Settlements.* Lycabettus Press, Athen.

Harrop, Jon – Gordon, Rachel (2015): *3D Printing 2015–2025: Technologies, Markets, Players Current usage, future applications and market forecasts.* IDTexEx, New York.

Hiltunen, Elina (2006): Was It a Wild Card or Just Our Blindness to Gradual Change? *Journal of Futures Studies,* Vol. 11, No. 2. 61–74.

Hiltunen, Elina (2008): Good Sources of Weak Signals: A Global Study of Where Futurists Look For Weak Signals. *Journal of Futures Studies,* Vol. 12, No. 4. 21–44.

Hiltunen, Elina (2010): *Weak Signals in Organizational Futures Learning.* Aalto Print, Altao.

Kaufmann, Arnold (1982): *A döntés tudománya. Bevezetés a praxeológiába.* Közgazdasági és Jogi Könyvkiadó, Budapest.

Keynes, John Maynard (1921): *A Treatise on Probability.* Macmillan & Co., London.

Knight, Frank H. (1921): *Risk, Uncertainty, and Profit.* Hart, Schaffner & Marx – Houghton Mifflin Company, Boston.

Kovács Beáta (2008): Az éghajlatváltozás biztonságpolitikai következményei, nemzetvédelmi vonatkozásai. *Bolyai Szemle,* Vol. 17, No. 1. 55–80.

Kristóf Tamás (2002): *A szcenárió módszer a jövőkutatásban. Jövőtanulmányok 19.* Budapesti Közgazdaságtudományi és Államigazgatási Egyetem, Budapest.

Kuosa, Tuomo (2005): Heikko signaali vai merkityksetön kohina: Pattern management: Ontologisesti uusi lähestymistapa heikkojen signaalien tarkasteluun ja tulkintaan. (A weak signal or meaning-

less noise: Pattern management: An ontologically new approach to examine and interpret weak signals.) *Futura,* Vol. 24, No. 4. 115–120.

Mannermaa, Mika (1991): In Search of an Evolutionary Paradigm for Futures Research. *Futures,* Vol. 23, No. 4. 349–372.

Manyika, James – Chui, Michael – Brown, Brad – Bughin, Jacques – Dobbs, Richard – Roxburgh, Charles – Hung Byers, Angela (2011): *Big data: The next frontier for innovation, competition, and productivity.* McKinsey Global Institute Report. McKinsey Global Institute.

Mecklin, John (ed.) (2016): *It is still 3 minutes to midnight 2016 Doomsday Clock Statement.* Source: http://thebulletin.org/sites/default/files/2016%20doomsday%20clock%20statement%20-%20final%5B5%5D.pdf (2016. 07. 19.)

Nováky Erzsébet (1993): Jövőkutatás és káosz. *Magyar Tudomány,* Vol. 38, No. 4. 512–517.

Nováky Erzsébet (2006): Action oriented futures studies in Hungary. *Futures,* Vol. 38, No. 6. 685–695.

Nováky Erzsébet (2010): *Magyarország 2025. Tanulmánykötet a Magyarország 2025 című akadémiai kutatás alapján.* Gazdasági és Szociális Tanács, Budapest.

Nováky Erzsébet (2011): Jövőkutatás és a biztonság. *Polgári Szemle,* Vol. 7, Nos. 5–6. 32–49.

Nováky Erzsébet – Hideg Éva – Gáspárné Vér Katalin (1997): Chaotic Beaviour of Economic and Social Macroindicators in Hungary. *Journal of Futures Studies,* Vol. 1, No. 2. 11–33.

Nováky Erzsébet – Kristóf Tamás (eds.) (2000): *Summer Course of the WFSF. The Youth for a Less Selfish Future.* Papers of the I. Budapest Futures Course. Department of Futures Studies Budapest University of Economic Sciences, Budapest.

Nováky Erzsébet – Orosz Miklós (2015): A hazai társadalmi-gazdasági mutatók vizsgálata a káoszelmélet módszerével. *Statisztikai Szemle,* Vol. 93, No. 1. 25–52.

Petersen, John (1999): *Out of The Blue. How to Anticipate Big Future Surprises.* Madison Books, Lanham.

Posner, Richard A. (2007): Thinking about Catastrophe. *Blindside, How to Anticipate Forcing Events and Wild Cards in Global Politics,* Fukuyama, Francis (ed.), Brookings Institution Press, Washington, DC.

Post, Mark (2012): Cultured meat from stem cells. Challenges and prospects. *Meat Science,* Vol. 92, No. 3. 297–301.

Rényi Alfréd (1973): *Napló az információelméletről.* Gondolat, Budapest.

Surowiecki, James (2007): *A tömegek bölcsessége. Miért okosabb a sokaság, mint a kevesek?* Napvilág Kiadó, Budapest.

Takesue, Hiroki – Dyer, Shellee D. – Stevens, Martin J. – Verma, Varun – Mirin, Richard P. – Nam, Sae Woo (2015): Quantum teleportation over 100 km of fiber using highly efficient superconducting nanowire single-photon detectors. *Optica,* Vol. 2, No. 10. 832–835.

Taleb, Nassim Nicholas (2007): *The Black Swan. The Impact of the Highly Improbable.* Penguin, London.

Taleb, Nassim Nicholas (2008): *The Fourth Quadrant: a Map of the Limits of Statistics.* Source: www.edge.org/conversation/the-fourth-quadrant-a-map-of-the-limits-of-statistics (2016. 07. 19.)

Topol, Eric (2015): *The Patient Will See You Now. The Future of Medicine is in Your Hands.* Basic Books, New York.

Veigl Helga (2010): Gyenge jelek, szabadkártyák, bifurkációk. *Magyarország 2025. Tanulmánykötet a Magyarország 2025 című akadémiai kutatás alapján,* Nováky Erzsébet (ed.), Gazdasági és Szociális Tanács, Budapest.

Internet sources

Aszteroida világnap – Tudósok szerint a kisbolygóktól kell igazán tartanunk. (2016) Source: http://24.hu/kulfold/2016/06/30/aszteroida-vilagnap-tudosok-szerint-a-kisbolygoktol-kell-igazan-tartanunk/ (2016. 07. 19.)

CRISPR, the disruptor. (2015) Source: www.nature.com/news/crispr-the-disruptor-1.17673 (2016. 07. 19.)

Humanoid robots join staff at Tokyo science museum. (2014) Source: www.telegraph.co.uk/news/worldnews/asia/japan/10924594/Humanoid-robots-join-staff-at-Tokyo-science-museum.html (2016. 07. 19.)

Diesel On Demand – E.Coli Bacteria Engineered To Produce Pure Diesel Fuel. (2013) Source: http://cleantechnica.com/2013/04/24/diesel-on-demand-e-coli-bacteria-engineered-to-produce-pure-diesel-fuel/ (2016. 07. 19.)

Don't Fear Artificial Intelligence. (2014) Source: http://time.com/3641921/dont-fear-artificial-intelligence/ (2016. 07. 19.)

Meta Pro Space Glasses. (2014) Source:Source: http://smart-glasses.ireviews.com/meta-pro-space-glasses-review (2016. 07. 19.)

Nissan ProPilot leads the way for aAutonomous technology at Ise-Shima G7 summit in Japan. (2016) Source: http://nissannews.com/en-US/nissan/usa/channels/us-united-states-nissan/releases/nissan-propilot-le*ads-the-way-for*-autonomous-technology-at-ise-shima-g7-summit-in-japan (2016. 07. 19.)

Space-Based Solar Power. Source: www.esa.int/gsp/ACT/nrg/projects/SPS.html (2016. 07. 19.)

Stephen Hawking warns artificial intelligence could end mankind. (2014) Source: www.bbc.com/news/technology-30290540 (2016. 07. 19.)

The audacious plan to end hunger with 3-D printed food. (2013) Source: http://qz.com/86685/the-audacious-plan-to-end-hunger-with-3-d-printed-food/ (2016. 07. 19.)

The Ukrainian Blackout and the Future of War. (2016) Source: www.defenseone.com/technology/2016/03/ukrainian-blackout-and-future-war/126561/?oref=d-river (2016. 07. 19.)

What is Pepper and Why Do I Need a Personal Robot? (2014) Source:s: www.ibtimes.co.uk/what-pepper-why-do-i-need-personal-robot-1451461 (2016. 07. 19.)

World's first "robot run" farm to open in Japan. (2016) Source: http://phys.org/news/2016-02-world-robot-farm-japan.html (2016. 07. 19.)

The manuscript was closed: 31st July, 2016.