Futures 143 (2022) 103024

Contents lists available at ScienceDirect

Futures

journal homepage: www.elsevier.com/locate/futures

How to visualise futures studies concepts: Revision of the futures cone

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ARTICLE INFO

Keywords:
Futures studies
Futures cone
Scenario planning
Uncertainty
Cone of possibilities

ABSTRACT

Futures studies concepts are complex and challenging to communicate and elaborate on. Visual artefacts exist to aid this process. Variants of futures cones, plausibility cones, or cones of possibilities are most common. Yet, the is a lack of scientific discussion and consistency. A review of what does exist can lead to a more coherent communication of concepts. This aids futures literacy and enables more targeted theoretical elaborations using the cone as an intermediary object. We pose the questions (1) how futures cones have been used so far to visualise concepts of futures studies and (2) how characteristics can be consolidated into a revised version. We compiled 14 representations and compared and analysed them. We identified and described 14 characteristics, including three shared between most cones, eight derived from existing ones, and three newly proposed ones, namely black swans, unknown unknowns, and exponential growth. This culminates in a revised futures cone that shall:

(1) Act as a more accurate depiction of futures studies concepts in their uncertainty, ambiguity, and multiplicity.

(2) Strengthen the applicability and understanding within and outside the futures studies field.

(3) Refine the futures cones as a canvas for conceptual and theoretical discussions of futures studies concepts.

1. Introduction

To prepare for, plan, or alter the future, one must understand it first. For centuries, anticipating or studying what comes next has

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https://doi.org/10.1016/j.futures.2022.103024
Received 15 July 2021; Received in revised form 4 July 2022; Accepted 12 August 2022
Available online 23 August 2022
0016-3287/

been integral to human societies. References can be found across religions and old scriptures, ranging from future predictions to early 'futurists' in the shape of oracles. Despite its early starting point, which attributes can be easily contested, futures studies, futures research, or futurology have gained increasing interest and support since the beginning of the 20th century (Dator, 2019; Fergnani & Jackson, 2019; Gordon et al., 2020). While various contesting positions prevail, some core characteristics of futures studies appear largely established. First, a non-deterministic, or more precisely, non-pre-deterministic understanding is underlying any normative, transformative, or strategic foresight approach (Amara, 1981). Only if the future is not determined through preceding actions it can be altered and thus justify any attempt to do so. This does not negate the influence of the past and present but highlights the possible modification of the future. Secondly, futures studies are about foresight and not predicting or modelling the future, even if the latter can support foresight. On the other hand, multiple futures can inform decision-makers and help prepare, anticipate, and develop, e.g., robust policies. Thus, futures studies cannot and do not intend to predict what will come next (Godet & Durance, 2011; Inayatullah, 2013).

Dator (2019) argues that 'the future cannot be predicted because the future does not exist', 'but alternative futures can, and should be forecast', and 'preferred futures can and should be envisioned, invented, implemented, continuously evaluated, revised, and re-envisioned' and finally, 'any useful idea about the futures should appear to be ridiculous. […] what is popularly, or even professionally considered to be "the most likely future" is often one of the least likely futures' (Dator, 2019, p. 4) or, in other words, 'the most likely future isn't' (Kahn, 1982). Thus, there is no future but *multiple futures* with varying likelihoods or levels of preference (Rowland & Spaniol, 2015). Additionally, the unpredictability and unconventionality of futures studies are highlighted. This corrects an understanding often mistakenly assumed to be at the core of futures studies: There is usually no likely future; hence the attempted prediction or forecast thereof is prone to failure. Or in other words: Futures studies is not about finding the one likely future, but the multiple possible futures. Despite variance within the field, a consensus lies on the focus on foresight instead of forecasting, referring to methods that can identify possible alternative futures and using them strategically instead of trying to predict the future.

Visual aids were produced to explain this and related concepts. A common one is the futures cone. It has been in circulation since the early 1990s (Fig. 1), with early published versions from Taylor (1993) or Hancock and Bezold (1994). Its basic shape shows a cone with its tip at the current moment and an opening along the temporal axis towards the future, representing a broader range of possible futures. In most cases, the more probable futures are situated in the centre of the cone, and less plausible ones are in the outer areas. Before going into the details of the cones, we expand on the fields of application. Most importantly, the futures cone should not be confused with a method to develop scenarios but instead as an aiding visualisation or representation of concepts to be used with other methods (Voros, 2017).

Three key applications of the futures cone are prevalent. Foremost, the futures cone can be used to explain the overall idea behind multiple futures in an ever-expanding possibility space (e.g., Hancock & Bezold, 1994; Taylor, 1993; Voros, 2003, 2017). Secondly, the futures cone can – in addition to broader futures literacy capacity development – help to contextualise specific components, characteristics, or events during workshops or training that aim to, for example, co-create different scenarios or map trends (Dunne and Raby, 2013; Garret, 1999; Levrini et al., 2021; Voros, 2017). Thus, despite not being a method, it can fulfil the role of explaining and contextualising specific elements. Therefore, making the theoretical context of futures more accessible to the audience (e.g., Levrini et al., 2021). Other possible applications expand into using the cone as a workshop roadmap that showcases steps of the process, an adapted board for gamified applications, or an interactive and 3-dimensional environment in the context of virtual and digital applications. Lastly, the cone can be a canvas for professional discourse within the conceptual and theoretical domains of futures studies (e.g., Candy, 2010; Christofilopoulos, 2021).

Since its first occurrence, the cone has evolved and has been continuously updated and discussed by experts in the field of futures studies (Candy, 2010; Fischer & Dannenberg, 2021; Voros, 2003, 2017). Therefore, its simplicity and graphical-reductionist character allow constant adaptation, evolution, and reconfiguration. Both within the field and in exchange with other domains. Despite its widespread use, there has been little discussion of the various versions, their characteristics, and further development potentials. We aim to address this gap by responding to the research questions (1) how the futures cone has been used so far to visualise concepts of futures studies and (2) how existing and potential characteristics can be consolidated into a revised version. This provides a basis for continued conceptual discussion within the futures field. Further, it can improve the communication of concepts like the increasing

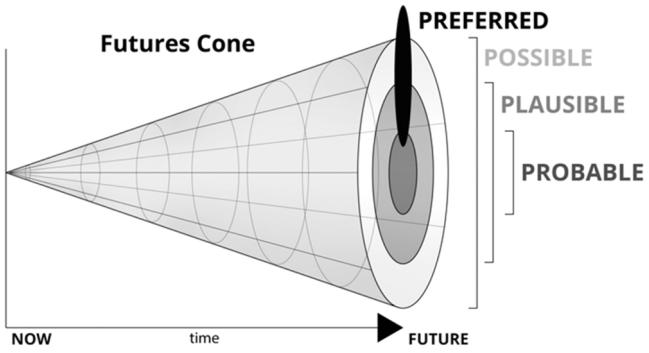


Fig. 1. Basic futures cone (based on Voros, 2003, 2017).

uncertainty and futures' multiplicity to other fields for purposes such as teaching futures studies or strategic foresight.

This paper's research agenda is the compilation of principles and concepts of futures studies to enable improved visual communication and application across different fields. A short literature review on futures studies provides the foundation (Section 2). Building on that, existing versions of the futures cone are collected, analysed, and compared (Section 3). Finally, we discuss the findings and describe a revised model of the futures cone (Section 4). We contextualise the research in the broader attempt to increase futures literacy, referring to the shared understanding of key principles and concepts of futures studies.

2. Concepts of futures studies

A brief introduction of some key ideas and scenarios is necessary to discuss the cone as a representation of concepts of futures studies. In this chapter, we present some of Dator (2019) principles of futures studies. Further, we structure different concepts through the six pillars of futures studies (Inayatullah, 2013). This includes an in-depth discussion of alternative, multiple futures – or in other words, scenarios. Scenarios are defined here as possible and plausible futures, 'taking the proper form of a story or narrative description […and] exist in sets' (Spaniol & Rowland, 2018, p. 1). We chose this approach to provide a general overview. Finally, we focus on scenario planning as the element most often linked to the futures cone. This builds the basis for the subsequent elaboration of existing futures cones in Section 3.

2.1. Pillars of futures studies

Inayatullah (2013) suggests an organisation of futures studies into six pillars. The first is **(1) Mapping** of trends, events, or pushes – from the past, present and potentially the future. Inayatullah highlights that this is crucial to understand 'where we have come from and where we are going' (2013, p. 46). One possible approach is identifying the 'Shared History' by collectively mapping trends that resulted in the current moment to identify trajectories and (dis)continuities (Inayatullah, 2013). While mapping focuses more on the past and present, the pillar of **(2) Anticipation** aims at looking into the future. This can encompass areas of innovation, potential causes of problems, or identifying arising opportunities, as well as potential future disruptors. Comparisons can be drawn to the concept of weak signals (Börjeson et al., 2007) from fields such as innovation design, niches from transition theory (Geels, 2011), lead users, referring to the early adopters or ambassadors of products or services (von Hippel, 2005), or first followers from social behaviour studies. Further, the pillar of **(3) Timing** describes the identification of patterns of change and its stages, hence deriving assumptions of future behaviours from it (Inayatullah, 2013). This can be found extensively in financial markets or climate studies. Inayatullah names three possible behaviours: (1) Stage-like linear futures; (2) Cyclical futures with ups and downs; and (3) Spiral futures. In the context of the latter, he also refers to the fact that futures are often 'driven by a creative minority' (Inayatullah, 2013). He points out that there are brief moments in human history with significant potential global impact, the current period being such (Inayatullah, 2013). The fourth pillar is about **(4) Deepening** the future through, e.g., Causal Layered Analysis. Inayatullah (2013) identified four layers: (1) Litany; (2) System; (3) Worldview; and (4) Metaphor. Litany (day-to-day future) is the surface-level, daily and short-term future image. The second layer looks at systemic elements such as the issue's social, economic, or political causes. In the third layer, the culture or worldview are addressed, referring to the big picture, or the paradigm that defines the real or not real and accompanying 'cognitive lenses we use to understand and shape the world' (Inayatullah, 2013, p. 52). The last dimension is the narrative or the myth or metaphor. As deeper changes go, the longer the transition takes, the less tangible and quantifiable changes become. The fifth pillar focuses on methods to **(5) Create alternatives**, or more precisely, alternative, multiple futures. The most widespread associated methodology is scenario planning. In Inayatullah's words, scenarios 'open up the present, contour the range of uncertainty, reduce risk, offer alternatives, create more flexible organisational mindsets, and even better, they predict' (Inayatullah, 2013, p. 54). After introducing the sixth pillar, the following paragraph delves further into scenario planning and development. **(6) Transforming** constitutes the final pillar. Futures studies often intend to take a transformative role, either indirectly or directly. This can range from directly impacting the future to reaching a specific goal or transforming the current situation to prepare for potential future shocks. Inayatullah distinguishes between three types of transforming: Visioning, backcasting, and transcending. Visions can be an integral element of scenarios, mainly in the case of the normative notion. Visions aim at bringing people together in a shared perspective of a positive future and inspire, push, and impact behaviours. Visions can be found across fields, including company visions, as well as from the public sector (Tanum et al., 2019) or in broader practical fields (e.g., UN-Habitat, 2012). If a vision has been identified, backcasting (the reverse of forecasting) can be applied to see what would need to happen and which actions would be needed to be taken to reach the preferred future (Dreborg, 1996). As Inayatullah (2013) phrases it, 'backcasting fills in the space between today (the future) and the past' and transforms abstract futures into actionable insights. The latter can inform strategic planning processes and policymaking or build the basis for strategies and action plans. The last element for transformative purposes is transcending. This approach can be applied if two (or more) contesting futures or future trends exist. Instead of looking for an in-between or compromise, contesting elements are identified and attempted to be combined into a new, mutually benefitting scenario (e.g., Green Growth; see Inayatullah, 2013).

After this overview, we focus primarily on scenarios. Many futures cones are used in the context of scenario planning (for example, Goodspeed 2020). Therefore, its principles are relevant for the discussion of the cone. With early applications by the military through the think tank RAND (Kahn & Wiener, 1967; see Abella, 2008 for an extended overview) and Shell Group Planning (1971) in the 1960s, scenarios started as a tool to prepare countries and businesses for (future) trends or shocks (such as the 1973 oil crisis). They were quickly taken on by other sectors and think tanks around the globe.

Today, we can find scenario-based approaches in a variety of domains, ranging from spatial planning or innovation management to

public administration (Budman & Khan, 2018). In the case of strategic foresight, scenarios can be used as one of the alternative-building methods of futures studies. Scenarios can inform and guide decision-makers by creating normative, descriptive, or exploratory alternatives, expanding cognitive limitations from bounded realities and formulating relatable and plausible future narratives (Crawford, 2019; Stapelton, 2020; Weidema et al., 2004).

Parson et al. (2007) describe scenarios as stories that narrate potential futures and the process to get there, thus fulfilling various purposes, such as informing decision-making. Further, they state a few key determinants of scenarios: (1) They are 'holistic (i.e., multi-dimensional), (2) schematic, (3) come in sets of two or more, and (4) claim less confidence than other types of future statements' such as simulations or extrapolations (Parson et al., 2007). Further, van Notten et al., (2003) compiled various characteristics for future scenarios, grouped into (1) Project Goal, (2) Project Design and (3) Scenario Content. The project goal or purpose of scenarios is broad, ranging from creating alternative pathways, allowing for imagination (sometimes strengthened by personas), or creating fear/urgency or hope (visions). Further, they can support the testing of assumptions of impacts of today's decisions, make policies 'future-proof'/robust, or inspire, enable, or enforce product, service, or policy design. Scenarios can be rational/objectivist, e.g., through the cross trends impacts approach, or social constructivist, e.g., through the approach inherited and developed by the Shell Intuitive Logics school of scenarios (van der Heijden, 2004; Wack, 1985a, 1985b). Finally, they can be normative/deterministic, e.g., as developed by the school of La Prospective (Crawford, 2019; Godet & Durance, 2011; Weidema et al., 2004; Wilkinson and Eidinow, 2008).

Different classifications have been developed to organise the various approaches that evolved in scenario making. For example, Crawford (2019) classification focuses on the objective behind the use of scenarios. She distinguishes between two main types of predictive scenarios (what will happen?). These are forecasts looking at what will happen as the probable developments occur. Further, normative scenarios (what can happen?) are concerned with achieving future objectives. The latter comes in two sub-categories, mainly preserving and transforming scenarios (cf. Wilkinson and Eidinow, 2008). The resulting scenarios are often labelled. These labels range, for example, from possible, plausible, and probable (the '3-Ps') to preferred (or preferable) and likely scenarios (Henchey, 1978, cf. Voros, 2017). While the term 'preferred scenario' is often followed by the questions of being preferred by what standard and by whom, defining one or several preferred scenarios is necessary if a normative notion is followed (Godet & Durance, 2011; Goodspeed, 2020). The earlier introduced term of (most) likely scenario is still used but contradictory due to the discussed challenge of predicting the future. A similar and widely used term is the Business-as-Usual (BAU) scenario which overlaps with the contestable notion of a predicted or likely scenario (Dator, 2019; Godet & Durance, 2011). Both terms are primarily used when projecting or extrapolating an individual future, opposing partially the underlying concept of utilising multiple futures.

In conclusion, various types of methods are linked to working strategically with the future. Scenario planning is one of the more common ones, with relatively coherent core characteristics such as the varying levels of probability and the multiplicity of considered futures. In practice, such scenarios are, for example, used to prepare businesses or public entities for changing conditions and needs of uncertain futures, to explore viable pathways to sustainable futures, or to inspire designers and innovators to develop new solutions for new markets. Regardless of the purpose, in many cases, three reasons lead to the effective use of the futures cone:

1. Scenarios are often co-created with stakeholders. This requires that the core ideas behind them are effectively and clearly communicated to various audiences.
2. Resulting scenarios are frequently published in reports, thus requiring a visual and clear communication of their relations and context (e.g., year, considered trends/variety).
3. Scenario exercises can also target improving overall futures literacy without a strong focus on the actual futures.

When such mindset transformation of participants is aimed for, clear communication visuals of complex topics such as the multiplicity of futures are paramount. For each of these applications, the futures cones is one of the most frequent tools, justifying our choice to focus on its versions in this paper.

2.2. *The futures cone*

The previous section briefly outlined the background of future studies. The introduced scenario methods find applications across fields and, in many cases, involve the co-creation with external stakeholders. The futures cone (Fig. 1) has widespread application to communicate some ideas, such as a widening possibility space over time or various levels of plausibility. It is also referred to Cone of Plausibility(ies) or Cone of Possibility(ies) with the same meaning, or confusingly[1] Cone of Uncertainty (Fig. 2) which, however, represents the decreasing level of remaining uncertainty as closer one moves towards a future timeframe, commonly used in project management.

Using the futures cone as a basis does not originate from its ability to represent every element of futures studies. For example, the cone has been criticised for its linearity or abstractions as outlined further below. Nevertheless, it remains to be used widely and appears as the *least inadequate* mental model to communicate multiple futures (Candy, 2010; Voros, 2017).

The first version of the 'cone of plausibility' was most likely developed in late 1986 within the US Department of Defense by a group of researchers and personnel and published by Taylor first in 1990 and a revised version in 1993 (Taylor, 1993). Another early cone is

[1] The Cone of Uncertainty is also relevant as it describes reducing uncertainty as closer one gets to a particular status and finds application in futures studies as well. It originates from optimising accuracy in cost estimations (Bauman, 1958) and is widely used in fields such as project management. However, the shape is reversed; and has a very different message than the Futures Cone and should be seen separately.

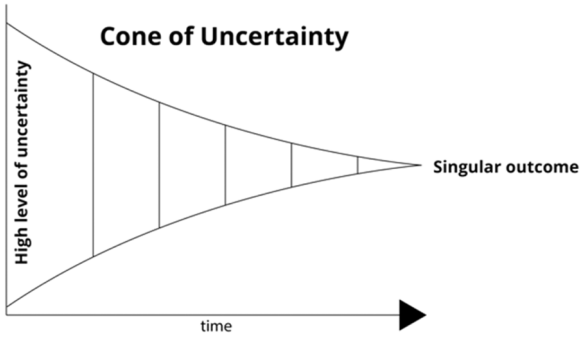


Fig. 2. Cone of uncertainty (based on Bauman, 1958).

commonly attributed to Hancock and Bezold (1994), which closely resembles most versions today – but also Taylor's prior version. Regarding one of the key attributes of the distinction between probable, plausible, possible, and preferable futures, Voros refers to the taxonomy of Henchey (1978, in Voros, 2003) and the first integration in the futures cone by Hancock and Bezold (1994). Other references to the cone's origin are made to Hawkins' future and past light cone in A Brief History of Time (Hawking, 1988). This emphasises the cones' utility of simple representation (Candy, 2010).

Despite its qualities, the cone has been criticised for its rigid categorisation of the 3Ps, its outer boundary excluding the ridiculous or preposterous, its inability to part ways from a probabilistic, deterministic approach, or its linear time representation (see, for example, Candy, 2010; Miller, 2011; Selkirk et al., 2018; Voros, 2017). The strict distinction between probability, within or via the cone boundary, is an intrinsic feature. However, it has been partially addressed by different or no sub-divisions within and a porous border. The linear direction, implying both a linear temporal development and a continuous and connected pathway towards the future (instead of, e.g., replacements or ruptures), is the foundation of the core. There might be ways to integrate it into variations of the core. However, we did not come across versions of the cone that achieved this or other visualisations that would allow a more precise visualisation. For these reasons, we acknowledge the criticism but regard it for now as an inherent limitation.

Despite its limitations, the representation has survived, evolved, and still appears in various slide decks, reports, and articles (e.g., Draeger, 2017; Goodspeed, 2020; Gustafson, 2010; Timpe & Scheepers, 2003). Further, its value in representing key conceptual components has been highlighted in studies on the application of futures studies in higher education (Branchetti et al., 2018; Levrini et al., 2021). We have repeatedly tested various versions of the cone outside the futures field throughout the development of this paper with great success. The next section presents the findings from analysing variants of the futures cone. Afterwards, we compare them to identify how the various cones incorporate different futures characteristics.

3. Futures cone in literature

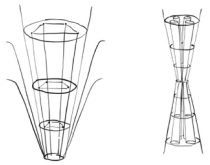
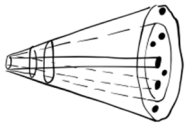
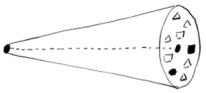
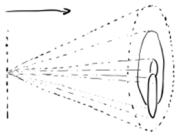
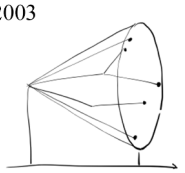
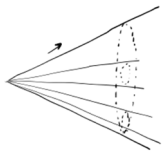
The research team, consisting of the three authors, compiled 14 cones through a purposive sampling of either representative or original versions of the most commonly appearing cones to better understand existing cones and their variations. They appeared both in scientific and grey literature.[2] We collected them in parallel to ongoing related work between late 2019 and early 2022. We supplemented the organically growing database through a systematic search for the terms 'futures cone', 'futures funnel', 'plausibility/ies cone', and 'cone of possibility/ies' on Google Scholar (103) results and Web of Science (2), as well as via the Google search engine. The first author compiled and analysed the cones in regular exchange with the other research team members. All cones in the scientific literature were included if they did not simply show the cone of another author that has been already included. The majority of cones in reports and presentations did not differ from existing cones in literature, even if oftentimes not referenced. In those cases, they were not included either. This resulted in 13 different cones, supplemented by two that were further referenced in the other articles. The recent cone of Christofilopoulos (2021) was not included as it does not propose a different cone but instead takes the existing cone and extends it towards another field of application, namely, to contrast futures studies with special relativity theory.

This results in 14 analysed cones (Table 1), from which six are from scientific literature (five articles, one dissertation), six from grey literature (reports and books), and two from online sources. Through their compilation, we intend to ensure that characteristics and components of existing representations are considered. All underlying cones are sketched in Table 1 and accessible via the corresponding author. Despite the attempt to include all relevant cones, the sample does neither claim to be comprehensive nor representative regarding the distribution or occurrence of the cones. As such cones have been used throughout various types of presentations, reports, books, and papers, often with varying or no names, there are inherent limitations. Further, the visual comparison might be affected by the subjective choices of the research team and might lead to different categorisations in a different context.

The application context of the cones (Table 1) varies from scientific discussions (e.g., Candy, 2010; Hancock & Bezold, 1994; Hines

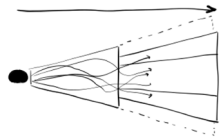
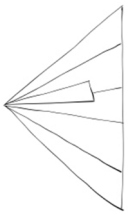
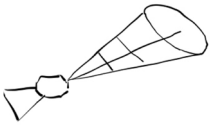
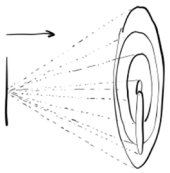
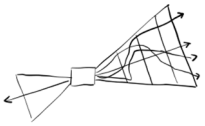
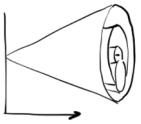
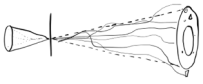
[2] 'Information produced on all levels of government, academia, business and industry in electronic and print formats not controlled by commercial publishing' (Definition from International Conference on Grey Literature, 1997, extended in 2004).

Table 1
Overview and description of set of futures cones.[a]

Sources & Sketch	Context	Description
Taylor (1993) Taylor, 1993 	The earliest trace of the then 'cone of plausibility' acted as a visual reference to explain the process of developing different scenarios for a 'new world order of nations' to decision-makers.	The cone, the only one oriented vertically, opens from the today to a larger range of plausible futures, containing the linear pathways of four scenarios, associated to four dimensions (sociological, economic, political, and technological). Outside the cone, four wild card scenarios (aberrant, disruptive, catastrophic, anomalous) are shown. The temporal scale is ranging from 'today' (1990) to 35 years (2025). A second, simplified version shows the past via a second cone, including the equivalent number of plausible pasts.
Hancock and Bezold (1994) Hancock and Bezold, 1994 	Hancock and Bezold, following a consultation for the WHO, published a scientific article on possible and preferable health futures, explaining simultaneously concepts of futures to an external audience and discussing health-related elements, naming it the 'futures cone'.	The cone is oriented horizontally with the time axis from left to right. The cone opens, showing various scenarios at the final plane, including wildcards and alternative futures (possible futures, plausible, and probable futures, as well as one preferable future). The time axis shows a short-term interval at 1–3 years, and a medium-term interval without timeframe.
Garret (1999) Garret, 1999 	A few years after the article from Hancock and Bezold, Garret produced a similar cone, titled the 'cone of possibilities', also for the context of health futures in a guidebook, yet with significant differences.	The cone shares the same overall characteristics. However, it defines the inside of the cone as 'all believable futures', has an 'extrapolated future' at the centre, as well as a randomly distributed combination of several wild-card and other probably futures, as well as one 'most likely future' (not the extrapolated future) and one desired future. There is neither the graphical distinction of probability as in the previous version, nor anything between the present and the futures plane, except a straight line connecting the present to the extrapolated future.
Voros (2003) Voros, 2003 	Referencing Hancock and Bezold, Voros brought the revised futures cone to the scientific literature of futures studies as part of 'a generic foresight process framework'.	The cone goes from the 'now' to the future and distinguishes between possible, plausible, and probable futures. At the centre is the business-as-usual (BAU) future. Spanning the BAU to possible area, an area of preferable futures is shown. Outside of the possible futures appear to be the 'potential' futures, thus forming five instead of three Ps as well the BAU.
Timpe and Scheepers (2003) Timpe and Scheepers, 2003 	Without any reference, Timpe and Scheepers present the 'scenario funnel' for a research deliverable on distributed energy generation scenarios for the European Commission.	The cone, despite the lack of a reference, resembles previous version insofar as it has the 'today' at one side, and a futures plane at a later point. Within that plane, several plausible future states are visualised. An interesting addition is the portrayal of non-linear pathways between the 'today' and each future state, with path deviations due to 'disruptive events' and bifurcations at 'decision points'.
Candy (2010) Candy, 2010 	Candy used a simplified version of the futures cone in his dissertation to discuss the permeable limits of the possible, named the Clarke-Dator boundary.	The cone starts from the 'now' and distinguished between probable, possible, and preferable futures. The outer boundary is portrayed as permeable, and the preferable futures are spanning the possible and 'non-possible' futures.
	Gustafson shows a more elaborated cone, referring to the work on global strategic trends by the Development, Concepts and Doctrine Centre (DCDC) of the UK Government. He does so as part of a review of horizon	The cone shows a time-axis of 30 years. The first 15 years are shown in one colour, while the next 15 years are divided into plausible, alternative, and probable futures, resulting in 'divergent outcomes'. The focus lies on various non-liner trends within the cone, as well as shocks/events shown as

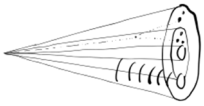
(*continued on next page*)

Table 1 (*continued*)

Sources & Sketch	Context	Description
Gustafson (2010) Gustafson, 2010 	scanning and forecasting in the British intelligence community.	lightnings in the cone. The trends are divided into dimensions, namely 'resource', 'social', 'political', 'technological', and 'military'. In contrast to, for example, Timpe and Scheepers (2003) cone, the focus is thus on trend trajectories instead of scenario pathways.
Dunne and Raby (2013) Dunne and Raby, 2013 	Dunne and Raby published a book on speculative design in which they present various tools and ideas around design fiction. They showcase a cone in reference to a presentation of Stuart Candy in 2009.	The cone resembles the standards cones by opening from the 'present' to possible, plausible, and probable futures, in this case with preferable futures at the interface of probable and plausible futures. A major difference is the 2-dimensional representation. The cone became a triangle.
Hines and Bishop (2013) Hines and Bishop, 2013 	Hines and Bishop present the futures work the 'Houston way', and refer among others to their futures cone which thus might be from an earlier age. The main goal appears to be the showcasing of various levels of plausibility, as well as the contrast to 'baseline futures'.	The cone starts from the 'present' and goes towards 'alternative futures', with a 'preferred future' and 'baseline future' very close to each other (not evident if meant as the same). The cone is bordered by the 'limit of plausibility'. The first time since Taylor's cone in 1993, the cone extended to a 2-dimensional past cone, yet without explanation.
Voros (2017) Voros, 2017 	In an extended version from his first (2003), Voros developed a more elaborated cone which today appears in various publications and presentations. It serves primarily to communicate overall concepts, as well as better distinguishing between different levels of plausibility of futures.	The futures cone again has the key characteristics, with 'everything beyond the present moment' being a 'potential future'. Voros distinguished from outer to inner cones between 'preposterous', 'possible', 'plausible', 'probable' and within the probable 'the "projected" future'. The 'preferable' future spans all areas. The porous boundary refers also to the Clarke-Dator boundary introduced by Candy in 2010 and adds the term for it: the preposterous future.
Draeger (2017) Draeger, 2017 	In an online article, Draeger describes scenarios for disaster preparedness and introduces different concepts, including a cone, referencing Voros and Taylor.	The cone (or rather two 2-dimensional triangles), show 'the present' and the future with different temporal sub-steps, the bordering 'limits of what's plausible' and four scenario pathways (alternate future 1, expected future, preferred future, alternate future 2), each with a non-linear trajectory. The past cone is contained by 'limits of evidence' and 'limits of interpretation' and points towards 'historical facts.'
van Dorsser et al. (2018) van Dorsser et al., 2018 	In an article that aims to improve the link of the futures field to policymaking, van Dorsser et al. present a cone that refers to Voros (2003, 2017) and Hancock and Bezold. The cone acts again as a tool to distinguish between different levels of plausibility of futures.	The cone starts at the 'now' and divides between the 'possible', 'plausible', 'probable', and 'projected' futures, the latter being at the centre and within the 'probable'. The 'preferable' future spans 'probable' to 'possible' futures.
Sumaiya (2018) Sumaiya, 2018 	This cone appears in an online, explanatory video, that cannot be clearly attributed. Its variations justify nevertheless the inclusion.	The cone opens with a porous cone towards the future, with the 'limit of possibility' at the outside and 'driving forces' in the inside. An intermediary 'planning horizon' is portrayed at three years. At the futures plane, different scenarios are shown with varying but not clearly defined levels of plausibility. A variety of non-linear trajectories are shown

(*continued on next page*)

Table 1 (*continued*)

Sources & Sketch	Context	Description
Levrini et al. (2021) Levrini et al., 2021 	The last cone is used in the context of climate change and futures teaching.	within, even crossing the cone limits. The past is portrayed as a cone with several trajectories. The cone resembles the other insofar that it shows the 'today' and 'possible', 'plausible', and 'probable' futures. It shows 'desirable' futures between the 'plausible' and 'possible' futures. Scenarios are shown in each area. One bifurcation point is portrayed on the otherwise linear pathways. The highlight of the cone is the signal that is sent back from the desirable future towards today, referring to backcasting and the role of defining desirable future.

[a] All cones were publicly available at the time of publication. If this is not the case anymore, their compilation can be requested from the authors.

& Bishop, 2013; Voros, 2003), thematic scenario exercises (e.g., Draeger, 2017; van Dorsser et al., 2018; Garret, 1999; Gustafson, 2010; Taylor, 1993; Timpe & Scheepers, 2003), as well as basic communication of futures studies (Dunne & Raby, 2013; Levrini et al., 2021; Sumaiya, 2018; Voros, 2017). Aside from the compiled sample of cones, we came across most nearly identical simplified cones in presentations and reports to briefly explain how the possible space of the future expands and how scenarios, events, or pathways are situated. Most of them build on Hancock and Bezold's cone from 1994 or one of the versions of Voros (2003, 2017).

After compiling and analysing the characteristics of each cone, we developed a comparative matrix that contains all characteristics found in at least one of the cones (Fig. 3). All cones are based on (1) linear temporality and (2) a widening range of possibilities, and most make (3) a distinction between various levels of probability. However, the characteristics 4–11 are only made explicit by some, implicit by others, and are absent in the remaining ones (Fig. 3). The comparison highlights that most identified characteristics can be represented in the cone. However, simultaneously all representations vary in 9 out of 11 criteria and thus demonstrate little consistency.

4. Discussion

This paper aims to analyse the existing versions and make recommendations for possible improvements – primarily to enable its more widespread and standardised use. We combine the earlier introduced set with proposed characteristics (Figs. 4 and 5) to support this process. They include the three (mostly) common characteristics (1–3), the eight characteristics from the sample set of cones (4–11), and three newly proposed ones (12–14). None of the existing characteristics was left out as the goal was to produce a comprehensive representation of concepts. Even if this might lead to a rather complex visualisation, the proposed cone acts as a version that can be simplified according to the case of application.

The newly proposed ones are (12) Black Swans and (13) Unknown unknowns, as well as an (14) Exponential growth of possible futures. Black swans are included as the concept has been used extensively in the futures field (Candy, 2010; Gustafson, 2010; Inayatullah, 2013; Sanhueza-Aros et al., 2022; Taleb, 2007; Tiberius, 2019; Voros, 2017), often in combination with wild cards. The introduction of unknown unknowns follows the same logic as black swans: An existing concept in futures studies that so far was not visualised. Further, it corresponds with preposterous futures, outside the Clarke-Dator boundary and thus complements another existing component of the cone.

The last characteristic, exponential growth, is introduced primarily as a geometrical correction aligning the concepts with the graphical visualisation. It is translated into a shape that changes from a traditional cone (exponential growth of cone opening surface area) to an exponentially expanding cone if seen in a section view. This allows for a higher representative accuracy as the trajectory within the space of possibility can change its direction continuously and always 'carries' a traditional cone along (see Fig. 6). Thus, the exponentially expanding cone appears as a possible adaptation that considers several trajectory reconfigurations within the overall cone. It provides continuously more possibility space across multiple axes.

For a more detailed description, each characteristic is explained in detail in Table 2.

4.1. Combining characteristics into a visualisation

We developed a combined visualisation (Fig. 6) building on the key concepts, characteristics, and existing cones. In agreement with the earlier shown cone (Fig. 1), it keeps the temporal x-axis, the widening scope, and the distinction of the possible, plausible, probable, and preferred as a category spanning each of the previous. It further incorporates a range of the described characteristics. We integrated the additional category of *preposterous* as well as the *porous Clarke-Dator Boundary* from Voros (2017) and Candy (2010). We extended the *preferable/preferred* with *'by Group X due to Reasons Y+Z'* to emphasise the significance of who makes the choice of the preferred future based on what assessment method. We added *multiple non-linear trajectories* to represent the path from the now to each defined future scenario. More than one trajectory can end in the same scenario (cf. Gaziulusoy et al., 2013). The outer boundary can be crossed by a pathway, ending in a *Black Swan* scenario. We included an *Unknown unknown* without a trajectory due to the impossibility of the anticipation of the pathway or outcome. Finally, we added *Wild Cards* along the pathways at particularly stark bifurcation points

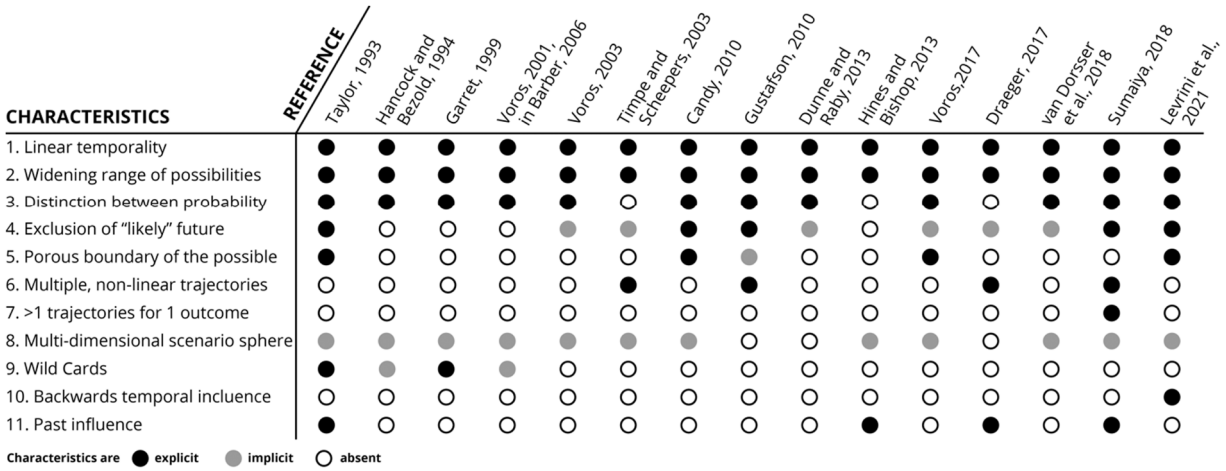


Fig. 3. Comparative matrix of inclusion of scenario characteristics in various futures cones.

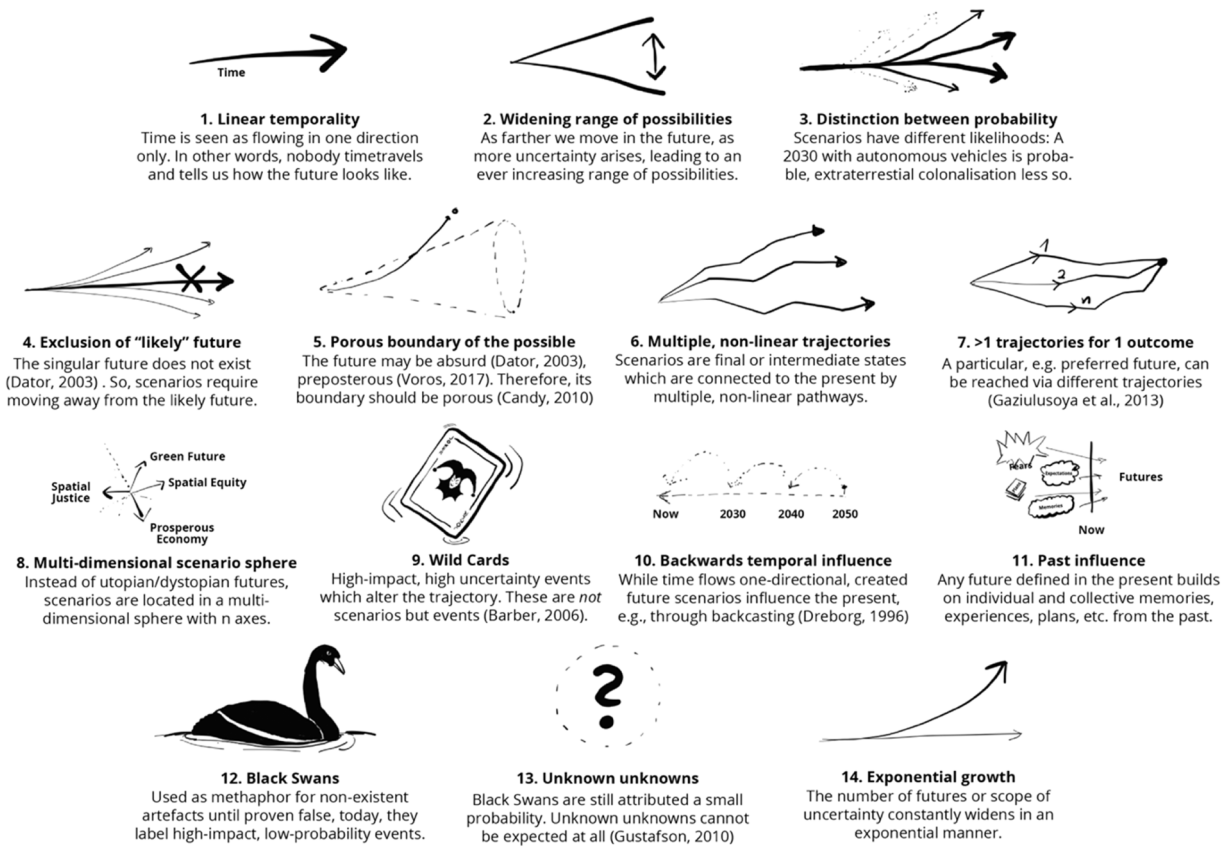


Fig. 4. Identified key characteristics of futures cones (1–3 shared, 4–11 existing, 12–14 proposed).

(Barber, 2006).

Further, we propose a few variations. First, we extend the time axis into the past. This has been done before (e.g., Draeger, 2017; Bishop and Hines, 2006, Sumaiya, 2018; Taylor, 1993) but by adding a cone widening towards the past. The cone is used for different purposes in the past (e.g., limits of evidence/interpretation by Draeger, 2017) and future (limits of possibility), which we consider confusing. In that case, the spatial dimension of the cone represents various concepts in the same graphical visualisation. Hence, we represent the past as an impacting element but not a cone. Further, we show an individual past trajectory, which is at its bifurcation point at the 'present'. Another addition is the temporally backwards-directed influence towards intermediate time frames (e.g., every

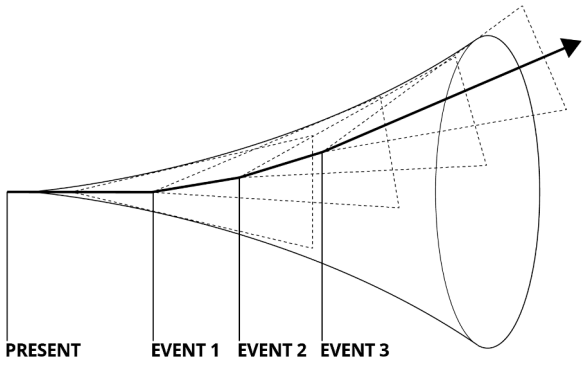


Fig. 5. Simplified geometrical representation behind idea of the exponentially expanding cone.

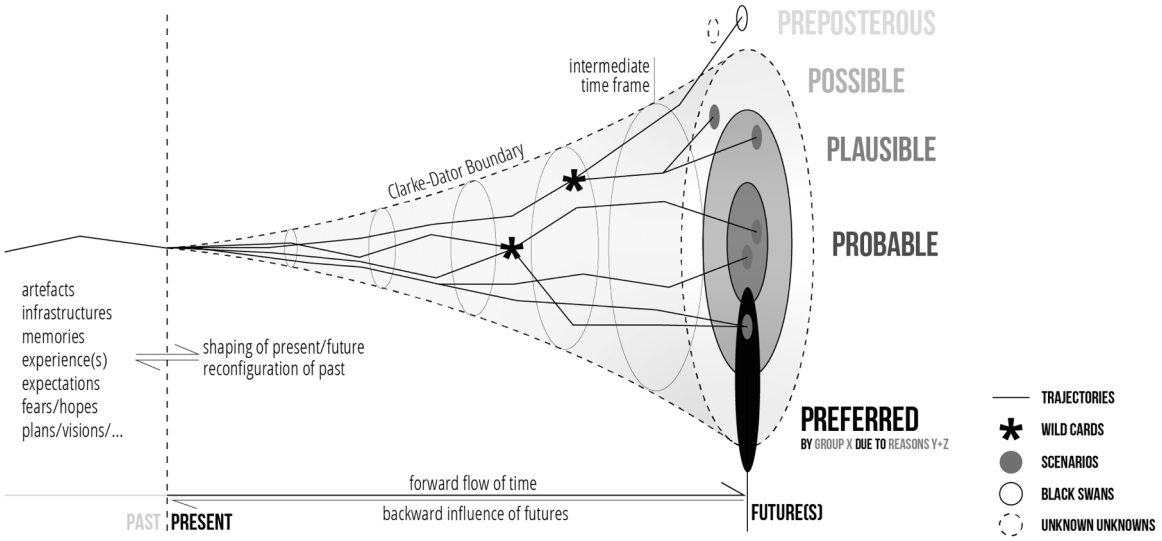


Fig. 6. Revised futures cone.

five years) and the present. This builds on the transformative concept of backcasting (Dreborg, 1996) and the cone of Levrini et al. (2021).

The resulting cone is not meant to be absolute but instead attempts to combine the conceptually consistent characteristics of the 14 analysed cones. This shall provide a foundation for further extensions and adaptations. Further, it shall do justice to the history and contributors to the futures cone. It continues the motivation of many earlier versions of emphasising the non-linearity and uncertainty of futures, for example, via Black Swans and Unknown unknowns, contextually framing scenarios, and making multiple futures visually more tangible. We consider the review of existing cones and their characteristics as our primary contribution. However, we believe the proposed futures cone acts as a more detailed, complete, and aligned visualisation of many of the core concepts of futures studies compared to previous versions. We argue further that it can support the more accurate explanation and teaching of futures concepts. For example, the cone can help explain the increasing possibilities over time, various scenarios as pathways across time, and the role of specific elements such as black swans, unknown unknowns, or wild cards. Lastly, the futures cone combines most qualities of previous versions while introducing previously ignored ones. It can thus act as a more complete intermediary object as the foundation for conceptual discussions in the futures field.

4.2. Direction of future works

While we incorporated the key concepts, further developments remain inevitable. First, the futures cone is seen as a high-level conceptual representation. A subsequent step could be the zoom-in on individual elements such as the scenario pathways or trajectories. The Multi-Level Perspective (Geels, 2011) and concepts from transition management theory bear the potential for valuable extensions to detail these further. This could allow considering, for example, scenarios as socio-technical regimes situated within a socio-technical landscape and fed by niche developments. In this context, the futures cone could nourish related fields while being strengthened by elements from their respective concepts. Additionally, the multi-dimensionality of the sphere of final scenarios is

Table 2
Description of characteristics of futures cone.

	Characteristics	Descriptions
Core characteristics	1. Linear temporality	The first of the three common characteristics is that time is seen as flowing in one direction only, namely forward. While various discussions around this exist as well, futures studies, planning, design, and most other disciplines are building on this. Thus, it is seen as key element and – aligned with traditional representation of time series – visualised as a linear flow from left to right.
	2. Widening range of possibilities	The starting point for the 'cone' was the representation of an ever-increasing range of possibilities. In five years, various futures are possible. However, in 50 years, the possible range is a multiple thereof. Thus, the cone opening towards the future allows to represent one of the key ideas of futures thinking.
	3. Distinction between probability	The last core characteristics is the differentiation between probabilities or plausibility. Regardless of the field, different likelihoods are oftentimes assigned. In the case of the futures studies, it appeared in Henchey (1978) and was integrated in the second cone in 1994 by Hancock and Bezold, intensively discussed by Voros (2003, 2017) and appears today in nearly all visualisations.
Compiled characteristics	4. Exclusion of 'likely' future	One key concept of futures studies is the non-existence of the singular most-likely or expected future, expressed famously by Herman Kahn as 'the most likely future isn't' (Kahn, 1982; cf. Dator, 2019). Thus, scenarios require moving away from the likely future. However, the forecasting and foresight often overlap in practice. Therefore, many most-likely futures or Business-as-Usual scenarios continue to exist, even in distant future contexts. This is a fact that we consider one of the most challenging inconsistencies in existing visualisations.
	5. Porous boundary of the possible	While the idea of the cone is to provide ample space for future possibilities, from its first version (Taylor, 1993) the cone was not seen as a strictly limiting boundary. As Dator (2019) argues, the future may be absurd, or to follow the P-vocabulary logic, preposterous (Voros, 2017). Therefore, its boundary should remain porous (Candy, 2010) to not limit possible thinking within a restricted geometrical shape.
	6. Multiple, non-linear trajectories	Some cones do not show scenarios at all, some visualise them in various places at the finale futures plane or as linear or non-linear pathways. We understand scenarios as alternative and intermediate states which are connected to the present by multiple linear pathways representing the trajectory that would need to be followed to reach a particular future state. As the 'present' is not seen as an object that once in motion does not change anymore but one that is constantly realigned, the trajectory can be considered non-linear (cf. Draeger, 2017; Levrini et al., 2021; Timpe & Scheepers, 2003).
	7. More than one trajectory for one outcome	The previous point discussed the purpose between portraying trajectories between the 'today' and a possible future state. Gaziulusoy et al. (2013) among others argues, that different trajectories can potentially lead to the same outcome. Thus, we are looking at and integrating cones that consider more than one trajectory for any particular scenario.
	8. Multi-dimensional scenario-sphere	While some scenario sets are made of one BAU, and two extremes on a singular scale, most scenarios – primarily in the futures field – do not discuss dichotomous futures such as utopias and dystopias. Instead, they look at scenarios that have different characteristics across dimensions (e.g., social, environmental, economic). We summarise this element as a visual representation of scenarios on a multi-dimensional sphere/plane.
	9. Wild Cards	Wild card scenarios appeared already in the first cone by Taylor (1993). In other contexts, wild cards refer to high-impact, high uncertainty events which alter the trajectory (e.g., Barber, 2006). They can theoretically be co-located with the scenario at a specific time in the future. However, more likely is the wild card occurrence at any point along the trajectory, Thus, wild cards are primarily not understood as scenarios but events.
	10. Backwards temporal influence	As visualised by Levrini et al. (2021) and connected strongly to backcasting (Dreborg, 1996), time flows one-directional but possible futures can influence the present. A fear of a future may lead to certain actions, or a preferred one can cause directed action. Thus, the backwards temporal influence is included.
	11. Past influence	Even though most futures start at the 'now' without consideration of the past, the development of scenarios, underlying knowledge, experience, paradigms, and trends, among many others, all stem from the past. Thus, the visualisation of the influence of the past can contribute to a more accurate temporal contextualisation of the trajectories of futures.
Proposed characteristics	12. Black swans	Black swans are used as metaphor for artefacts that are assumed to be non-existent until proven real. In the futures context, they are used to label high-impact, low-probability scenarios. A black swan scenario is thus one that is not very likely but if it would become reality, it would have a high impact.
	13. Unknown unknowns	We can still attribute black swan scenarios a small probability and thus considered them a possibility in the scenario making process. On the other hand, 'unknown unknowns' cannot be expected at all (Gustafson, 2010). Their visual inclusion can nevertheless make sense as – without being able to predict them – the awareness of their potential manifestation can inform the process through acknowledged uncertainty.
	14. Exponential growth	The last characteristic is proposed in conceptual continuation of multiple, non-linear pathways. If we assume this as a likely concept, at each future time along one possible scenario trajectory, various 'sub-cones' become possible, oriented within the cone as new cone that is oriented in parallel to the initial, non-horizontal trajectory. Thus, the scope of uncertainty could be conceptualised as constantly widening in a rather exponential manner than a traditional cone.

impossible to represent accurately. Nevertheless, it is seen as crucial to attempt. Practical comparisons may be drawn to the Principal Component Analysis and related conceptual approaches to work with more than three dimensions. Explorations of digital three-dimensional visualisations or interactively dismantled versions could provide further prospects. Lastly, the futures studies field operates between very abstract and challenging theoretical perspectives on the one hand and very tangible strategic foresight

methodologies on the other. While the goal cannot be to involve everyone in the depths of the field, increased utilisation of key ideas and approaches across disciplines can contribute to overall futures literacy. To exemplify the use of the revised futures cone, we could envisage working in a team with existing scenarios archetypes (Fergnani & Jackson, 2019). In the first step, we could situate the scenario archetypes within the futures cone. Next, wild cards and black swans could be generated through a creative exercise. Finally, the participants could collectively imagine possible trajectories which are combining wilds cards and black swans to scenarios pathways. This can support the immersion in scenarios as trajectories between today and a set future timeframe. On the other hand, using the cone could allow for continuous validation and expansion of the existing model, as well as widening the input for joint conceptual elaboration.

5. Conclusion

This work resulted from the intent to map key concepts of futures studies and visualise them to discuss them with peers and communicate them to external audiences. Our research questions were how the futures cone has been used so far to visualise concepts of futures studies, and how existing and potential characteristics can be consolidated into a revised version. To answer these, we identified 14 futures cones with a wide variety and inconsistency. Further, we provided a contextualised analysis of representations of core characteristics of futures studies.

As a result, we proposed a set of characteristics and a revised futures cone to showcase core components of multiple futures and provide an updated visual reference emphasising nonlinearity and uncertainty. The resulting cone can contribute in three ways:

1. It provides a more detailed graphical review of the futures cones of the past, thus providing an easy starting point for new cones.
2. The revised cone is the most complete visualisation to date, thus allowing the easy communication and teaching of numerous concepts of futures studies.
3. The underlying data and cones are made accessible to nourish conceptual and theoretical discussions as a canvas and visual platform.

We have used the cone throughout the past years effectively for teaching, explaining, and elaborating futures context, and we hope it will allow doing the same for others. Nevertheless, various limitations and further work directions are evident and require additional attention. The primary limitation is that every model or visual artefact is inherently restricted by its level of abstraction. A representation of endless possible futures across theoretically all scales and domains is most likely more subject to this than many other models. Nevertheless, while futures studies have no homogenous body of knowledge, different principles, concepts, and perspectives are primarily consistent across literature and time. We attempted to focus on these and showcase them in the revised futures cone. Its simplified visualisation – even if disputable from various lenses – has proved useful in communicating these common ideas to non-experts. For all still contested concepts, the visual artefact of the cone – and future revisions thereof – can act as a canvas to discuss them further.

Funding

The research work was supported with public funding within the scope of the French Program 'Investissements d'Avenir'.

Declarations of interest

The authors declare that there is no conflict of interest of any kind.

Acknowledgements

This research work has been carried out in the framework of the Technological Research Institute SystemX, and therefore granted with public funds within the scope of the French Programme 'Investissements d'Avenir'. However, all statements represent the authors' views alone. We sincerely thank the two anonymous reviewers for the in-depth and highly constructive comments, Sylvie Douzou, Ana Peric, the co-presenters of the AESOP YA Conference 2021 and others who have provided valuable input.

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