An updated scenario typology

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Abstract

Scenario analysis has evolved notably in its 50-year history and today there is a large diversity in the scenarios that are developed. Establishing an overview of this diversity would be useful for the further development of scenario method. However, such an overview cannot be generated without the use of a shared understanding of the typical features of scenario development and of the relevant terminology. A broadly shared scenario typology can provide this common understanding but existing typologies do not capture the diversity of scenario types. To this end we propose an updated typology, the presentation of which is the focus of this paper. We also explain how the typology was tested for its robustness in a comparative analysis of recent scenario projects.

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1. Introduction

In its 50-year history scenario analysis has been applied in an increasing number of sectors and disciplines [1,2]. Today a diverse group of decision-makers, consultants, and researchers develop and use scenarios in a variety of ways [2,3]. In light of the evolution of scenario analysis it is worth establishing an overview of the approach's current state of the art and the developments that brought the evolution about. However, given the observed diversity of scenario analysis one can only analyse and compare scenarios in a credible and consistent manner when there is a shared understanding of the typical features of contemporary scenario development and of the relevant terminology associated with it. Such common understanding can be generated by a typology for scenarios.

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Earlier typologies such as those proposed by Ducot and Lubben [4], Duncan and Wack [5], Godet and Roubelat, [6] and Postma et al. [7] and more recently by Heugens and Van Oosterhout [8] put forward fundamental distinctions between scenario types. However, typologies reflect a field's state of play at a fixed point in time. Consequently, classifications become outdated as the field they address evolves. In the case of scenarios, existing typologies do not sufficiently capture the diversity in contemporary scenario analysis. No existing classification is detailed enough for an in-depth analysis yet broad enough to do justice to the large variety of today's scenarios. One drawback of existing typologies is that their categorisation of scenarios is rather broad. Consequently, a variety of scenario types are often clustered within the same category. For example, much variation is possible in what is considered an alternative scenario. To illustrate, the large level of deviation between the various DocuWorld visions [9] hardly compares with the 'alternative' nature of the recent emissions scenarios [10] by the Intergovernmental Panel on Climate Change (IPCC)[1]. Another drawback is the limited scope of typologies. For example, business-oriented classifications hardly acknowledge the fundamentally different macro-economic and environmental scenarios, and vice versa.

In the following sections we will first outline the methodology used to develop the updated typology. Second, we will explain the typology in detail. Third, the test for the typology's robustness or whether it is strong enough to withstand intellectual challenge is described. The test involves a comparative analysis of recent scenario projects. The analysis of scenario projects using the typology is illustrated by means of the VISIONS project [11–17] that developed scenarios for the future of Europe. We close with observations concerning the test of the typology.

2. Methodology

This paper's observations are derived from an extensive review of scenario literature from a variety of sources such as management, economics, environmental science, and policy science. Furthermore, a large variety of approximately 70 scenario studies were examined. The case studies were used to distil the features common to most scenario development processes. Together these features form the basis of the typology presented here. In view of the observed variety in scenario approaches a basic assumption in this paper is that there is no 'correct' scenario definition or approach. However, the typology uses the following broad working definition: scenarios are descriptions of possible futures that reflect different perspectives on the past, the present and the future [17]. The typology, like other scenario typologies, has a retrospective as well as a prospective function. On the one hand, the typology can be used to compare and learn from past scenario studies and to improve scenario methodology. On the other hand, it can be used to help specify the type of scenario

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[1] The final report on the IPCC scenarios came to be known as the SRES-report after the official title, the Special Report on Emissions Scenarios.

study that should be conducted when considering the project goal and the available resources.

The typology reasons from three **overarching themes** that comprise the key aspects of scenario development. The themes apply both to sets of scenarios as well as to individual scenarios. We identified the themes in terms of the why? the how? and the what? In other words, the project goal, process design, and scenario content. A rudimentary comparison of scenario analyses might confine itself to the use of the themes. A more in-depth comparison demands a greater appreciation of detail, which is provided by the **scenario characteristics**. An overview of the overarching themes and the scenario characteristics is provided in Fig. 1.

The diagram demonstrates the strong connections between the themes. The project goal influences the process design that, in turn, influences the scenario content as denoted by the arrows in the figure. The connection between the scenario content and the project goal depends on whether scenario development is an on-going, cyclical process or an ad hoc affair. The arrow in the figure is dotted to denote the relative infrequency of on-going scenario processes and thus the weak link between scenario content and project goal.

Dimensions indicating the poles of the themes and characteristics provide further detail. The poles represent the possible extremes in scenario types. In practice hybrid forms are common, however as examples in this paper will show. The detailed version of the typology that includes the polarities is represented in Table 1.
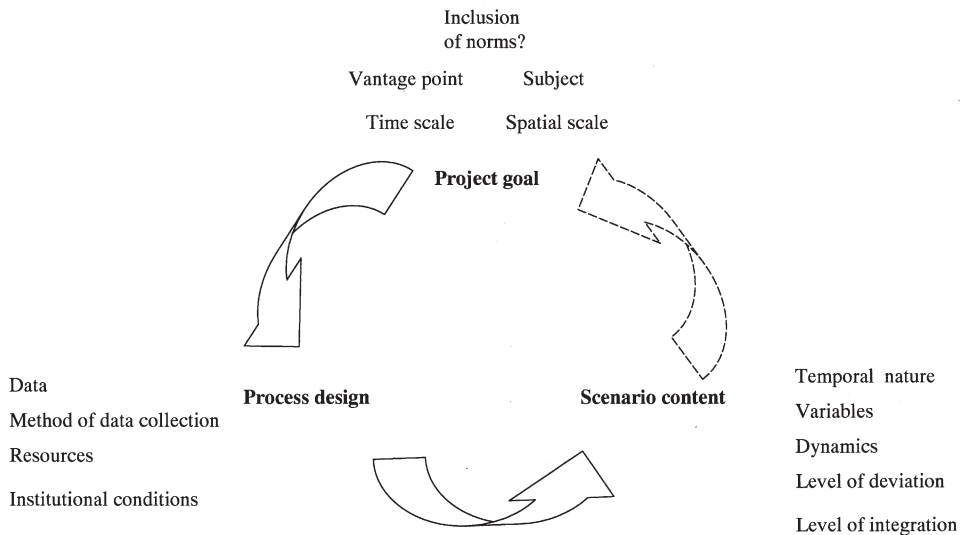

Fig. 1.   The scenario typology in brief.

Table 1
The scenario typology in detail

Overarching themes		Scenario	characteristics
A	Project goal: exploration vs decision support	I.	Inclusion of norms? : descriptive vs normative
		II.	Vantage point: forecasting vs backcasting
		III.	Subject: issue-based, area-based, institution-based
		IV.	Time scale: long term vs short term
		V.	Spatial scale: global/supranational vs national/local
B	Process design: intuitive vs formal	VI.	Data: qualitative vs quantitative
		VII.	Method of data collection: participatory vs desk research
		VIII.	Resources: extensive vs limited
		IX.	Institutional conditions: open vs constrained
C	Scenario content: complex vs simple	X.	Temporal nature: claim vs snapshot
		XI.	Variables: heterogeneous vs homogenous
		XII.	Dynamics: peripheral vs trend
		XIII.	Level of deviation: alternative vs conventional
		XIV.	Level of integration: high vs low

3. Themes for classifying scenarios

The first theme addresses the scenario analysis' **project goal**. This theme describes a scenario analysis' objectives as well as the subsequent demands on the design of the scenario development process. On the one end of the theme' s spectrum is the project goal of *exploration*. This goal might include awareness raising, the stimulation of creative thinking, and gaining insight into the way societal processes influence one another [2,3,16–19]. In an exploratory scenario exercise, the process is often as important as the product. In certain cases the product—the scenario or set of scenarios—is even discarded at the end of the process. The aptly entitled study *Which World?: scenarios for the 21st century* [20] is one of many examples of an exploratory project[2].

At the other end of the spectrum is the project goal of *decision support*. Here scenarios are used to examine paths to futures that vary according to their desirability. The scenarios might even propose concrete strategic options. Decision-support scenarios often contain value-laden combinations of scenarios that are described as preferable, optimistic, high road, or utopic; conventional or middle-of-the-road; and disagreeable, pessimistic, low road, dystopic, or doom scenarios. For example, high and low road scenarios were developed in the *Scenarios for Scotland* project [21–23] and they are implied in the Mont Fleur [24,25] and the Destino Colombia scenarios [26].

In practice the two types of project goals can be combined [6,19]. In a first phase, scenarios are developed in an exploration of certain topics. The resulting scenarios

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[2] The *Which World?* scenarios were not discarded but were published to much acclaim.

are often too general to function as a basis for decision-making. Therefore, new scenarios are developed by using the broad exploratory basis of the first phase to zoom in on aspects relevant to strategy development. For example, at Royal Dutch/Shell, global scenarios are developed on a corporate level [19]. These scenarios are then used as input for the development of a second set of scenarios that focus on the strategic issues most relevant to individual Shell operating companies.

Process design, the second overarching theme, addresses aspects such as the degree of quantitative and qualitative data used, or the choice for stakeholder workshops, expert interviews, or desk research [27]. On the one end of the dimension there is the *intuitive* approach. The intuitive scenario process leans strongly on qualitative knowledge and insights from which scenarios are developed. Creative techniques such as the development of stories or storylines are typically intuitive approaches to scenario analysis [11,18,19]. Interactive group sessions with a high variety of people are often central to storyline development. The storyline approach is flexible and can easily be adapted according to the needs that emerge from earlier steps in the scenario development process [7,19]. The intuitive school considers scenario development as an art form as illustrated by publication titles such as *The Art of the Long View* [18] and *The Art of Strategic Conversation* [18,19].

At the other end of the dimension is the *formal* approach. Contrary to the intuitive approach, the formal school such as the French *la prospective* [6,28] regards scenario development not so much as an art form but as a rational and analytical exercise. The formal school tends to work from quantified knowledge and often uses computer simulation techniques in its scenario development. Examples of computer simulation models include TARGETS and Threshold 21 [3] that perform integrated assessments of sustainability, and WORLDSCAN [3,29], an macro-economic oriented model that can be applied to economic, energy, transport, trade, and environmental policy[3].

Recently there have been examples of scenario analyses that combine intuitive and formal process designs. The latest IPCC emissions' scenarios first developed storylines that were incorporated in quantified output from models before undertaking a consultation process with experts on a global scale [10]. Other examples include the VISIONS scenarios [16] and last year's GEO-3 scenarios [30] developed by the United Nations Environmental Programme (UNEP)[4].

The third and final overarching theme, the **scenario content** looks at the composition of the developed scenarios. The theme describes the nature of variables and dynamics in a scenario, and how they interconnect. Variables can be actors, factors, and sectors [16]. Actors are individuals, organisations or groups of organisations such as governmental bodies, companies, NGOs and scientists. Factors are societal themes such as equity, employment, consumption behaviour, and environmental degradation. Sectors are arenas in society where factors and actors interact. Examples are water, energy, transport and consumer products, Information and Communication

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[3] TARGETS and WORLDSCAN are acronyms for Tool to Assess Regional and Global Environmental and Health Targets for Sustainability and WORLD model for SCenario ANalysis respectively.

[4] GEO is an acronym for Global Environmental Outlook. GEO-3 is the third in the GEO series of UNEP-outlooks.

Technology (ICT)[5]. Scenario dynamics are the events and processes that make up the story in a scenario.

With regard to scenario content we distinguish between *complex* and *simple* scenarios. A multitude of interpretations of the term complex exists. The Merriam-Webster's dictionary definition that comes closest to the meaning used in this paper is the adjectival form: "consisting of interconnected or interwoven parts" [31]. Synonyms are "intricate, involved, tangled, and knotty". Funtowicz et al. [32] contend that complex systems are characterised by " the presence of significant and irreducible uncertainties of various sorts in any analysis … [and] the multiplicity of legitimate perspectives on any problem". Van Asselt [33] argues that a decision-making process is complex when the following conditions apply:

- There is not one problem, but a tangled web of problems (multi-problem)
- The issue of concern transcends numerous disciplines (multi-dimensional)
- The processes that underlie the issue interact on various scale levels (multi-scale)

Applied to the context of scenario analysis, a complex scenario is one that is composed of an intricate web of causally related, interwoven, and elaborately arranged variables and dynamics. Complex scenarios manifest alternative patterns of development consisting of a series of action-reaction mechanisms. They often draw on a broad range of actors, factors, and sectors, and use multiple time or spatial scales.

In contrast, simple scenarios are more limited in scope. The subject of simple scenarios might focus on a particular niche such as chipmaker AMD's scenarios to anticipate the possible reactions of its competitor Intel to the introduction of a computer chip [34]. Alternatively, simple scenarios may limit themselves to the extrapolation of trends such as the European Environment Agency's baseline scenario on the future of Europe's environment [35]. The term 'simple' in the context of scenario analysis does not indicate poor quality. To illustrate, a scenario analysis with a narrow focus or a short-term perspective may not require the relatively lengthy and demanding undertaking of developing complex scenarios. Furthermore, a simple scenario can be more effective in communicating its message than a complex scenario.

4. Scenario characteristics

The overarching themes are not sufficiently detailed for an in-depth examination of scenario development. This detail is provided by the 14 scenario characteristics that are described in the following paragraphs. They are categorised according to the overarching theme with which they are closest associated.

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[5] For economic issues, sectors are also referred to as markets or industries.

4.1. Project-goal characteristics

4.1.1. Inclusion of norms?

A first characteristic focuses on how *normative* a scenario is. The influence of norms and values has been a source of debate in various fields such as the philosophy of science, science policy studies, and sociology of scientific knowledge for many years [36]. Within the context of scenario development, the issue of norms is contentious since it can be justifiably argued that all scenarios are normative as they consist of the interpretations, values, and interests of the scenario developers. Consequently, for our typology we distinguish between *descriptive* scenarios that explore possible futures, and *normative* scenarios that describe probable or preferable futures. In the literature descriptive scenarios are also referred to as baseline, reference, or non-intervention scenarios though interpretations of these terms vary [4,6,7,36,37]. Similarly, normative scenarios are also referred to as prospective, strategy, policy or intervention scenarios depending on one's interpretation. Most current scenario studies have a descriptive character or are at most implicitly normative [16]. For example, Shell International's 2001 global scenarios entitled *Business Class* and *Prism* are descriptive [38]. An example of a normative scenario study is *The Netherlands in Triplicate* [39]. The explicit aim of the *Balanced Growth* scenario in the study was to show that given certain conditions economic growth could go hand in hand with environmental protection.

4.1.2. Vantage point

An often-cited scenario characteristic describes the *vantage point* from which the scenario is developed. With this characteristic we distinguish between what the literature describes as exploratory or *forecasting* scenarios, and prescriptive, anticipatory or *backcasting* scenarios [3,4,6,16,36,37,40–42]. Forecasting scenarios take the present as their starting point. Forecasting scenario analyses are often exploratory rather than decision-support exercises. One of the many examples of forecasting scenario studies is the *Scenarios Europe 2010* project [3,37,43,44] that presents five possible futures for Europe. Backcasting scenarios reason from a specific future situation. Backcasting scenarios explore the paths that need to be taken to arrive at desirable future situations and are thus normative by nature [36,40–42]. An example of a backcasting study is the POSSUM project [3,45] in which sustainable transport goals for the year 2020 are formulated. These serve as a point of departure for scenarios that explore strategies to reach the goals.

4.1.3. Subject of scenario study

Scenarios also differ according to the *subject* of the scenario study. Here we distinguish between *issue-based*, *area-based*, and *institution-based* scenarios. The subject provides focus to a scenario analysis. Issue-based scenarios take societal issues as the subject of study. Examples of issue-based scenario analyses are those on the future of television [46], the future of crime [47], and on the future of women [48]. Area-based scenarios explore a particular geographical area such as a country, region or a city. An example of an area-based scenario analysis is the study on the future

of Japan [49]. Institution-based scenarios address the spheres of interest of an organisation, group of organisations, or sector.

The institution-based scenario can be broadly sub-divided into so-called macro, global, archetypal, framework, external, or contextual scenarios on the one hand; and focused, decision, internal, or transactional scenarios on the other [5,7,19,37,50]. The contextual scenario describes the institution's macro-environment: the variables and dynamics that are not directly influenced by the institution that conducts the scenario analysis. Contextual analyses can be used to explore unfamiliar or expansive terrain such as Shell's global scenarios, for example [19]. A transactional scenario describes the institution's meso-environment [6,19]. This type of scenario focuses on the interactions between variables and dynamics within a particular field. In some cases transactional scenarios include normative elements as with the earlier-mentioned AMD scenarios [19,34]. Whether an issue addresses the contextual or transactional environment is determined by whether the institution can directly influence the issue under study. The institution-based spheres are illustrated in Fig. 2. However, the distinction between the contextual and transactional environments is sometimes as vague as it is controversial [8].

Overlaps between issue-based, area-based, and institution-based scenarios are possible. For example, the VISIONS scenarios [16] are both area-based and issue-based; and the drinks company United Distillers' scenarios of India and South Africa are both institution-based and area-based [2].

4.1.4. Time scale

Another characteristic is the temporal or *time scale* that scenarios address [3,16]. This characteristic distinguishes between a *long-term* and a *short-term* perspective. Whether a study takes a short or long-term view significantly depends on the context of study. However, as a general rule a long-term scale for a scenario is 25 years or
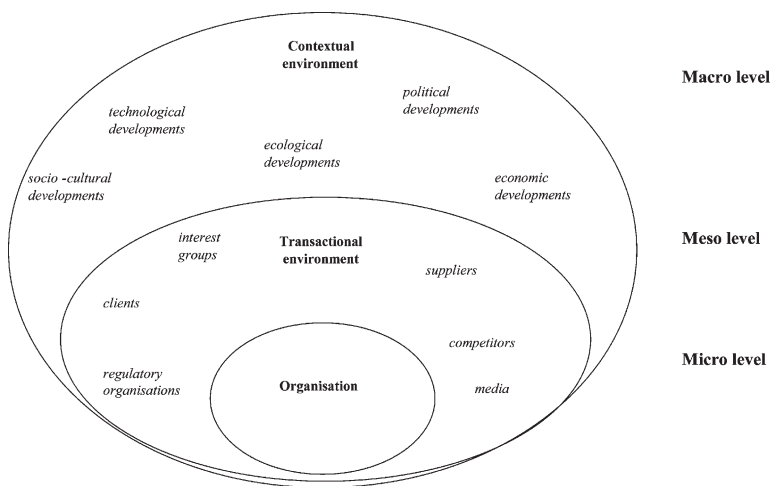

Fig. 2.   Break down of institution-based spheres.

more whereas a short-term scale is 3–10 years. An example of a long-term scenario analysis is the World Business Council for Sustainable Development's (WBCSD) study on the possible futures for businesses until the year 2050 [51,52]. An example of a short-term scenario analysis is the study of the food and beverage market for the year 2005 by a Dutch nutrition company [53,54].

4.1.5. Spatial scales

Scenarios can be developed according to different geographical or *spatial scales*, ranging from the global scale to supranational areas, to national, to sub-national or regional areas, and finally to local areas [3]. Examples of scenarios that address the global scale are the OECD scenarios *The World in 2020* [3] and the IPCC scenarios [10,37,55]. There are also a large number of scenario analyses that address the national level such as the Destino Colombia scenarios [26]; and *The Netherlands in 2030*, a study that developed scenarios of possible spatial planning futures [26,56,57]. An example of regional scenarios is the Dutch study *Scenarios for agriculture and land-use in Noord Brabant* [57]. The integration of multiple scales in a scenario is possible though only relatively simplistic efforts at integration have been made until now. However, the integration of multiple scales was a key objective in recent scenario studies such as VISIONS [16] and UNEP's GEO-3 [30]. Both scenario analyses integrate global, supranational, and regional information through a synthesis between a top-down approach where global developments are input for regional scenarios, as well as a bottom-up approach where regional developments are used to enrich European and global scenarios.

4.2. Process design characteristics

4.2.1. Nature of the data

Scenarios can be also be characterised on the basis of the *nature of the data* conveyed in the scenarios. The data can be *qualitative* or *quantitative* [3,16,37]. Qualitative or narrative scenarios are appropriate in the analysis of complex situations with high levels of uncertainty and when relevant information cannot be entirely quantified. For example, information that relates to human values, emotions, and behaviour is invariably incorporated in qualitative rather than quantitative scenarios as with telecom company KPN's scenarios on the consumer in 2015 [58]. Quantitative scenarios, often using computer models [59,60], have been used to develop energy, technology, macro-economic, and environmental forecasts [3,35,61,62]. Respective examples of the latter two are scenarios developed by the Netherlands Bureau for Economic Policy Analysis (CPB) and by the IPCC [10,63].

A combination of qualitative and quantitative elements can make a scenario more consistent and robust [3,16,64,65]. A quantitative scenario can be enriched and its communicability enhanced with the help of qualitative information. Likewise, a qualitative scenario can be tested for plausibility and consistency through the quantification of information where possible. However, the fusion of quantitative and qualitative data in scenarios remains a methodological challenge. A promising technique in this regard is agent-based modelling that aims to incorporate qualitative elements

such as actors' behavioural patterns in the otherwise quantitative realm of computer simulation [66–68].

4.2.2. Method of data collection

The *method of data collection* describes the 'fact-finding' process in scenario development. The poles regarding data collection methods are the *participatory* approach on the one hand, and *desk research* on the other. In the former case data is collected though a participatory process between individuals [27,69]. A participatory approach might draw on experts in the field such as with the development of the KPMG scenarios on the future of the Dutch job market [65]. However, expert input is more and more complemented by stakeholder-input in today's scenario projects. For example, a stakeholder workshop that included local inhabitants was part of the Green Heart scenario analysis in the VISIONS project [13,70]. Other examples of participatory techniques include focus groups, citizens' juries [27,69] and envisioning workshops [71]. Desk research includes analysis through computer simulations and scientific journals, for example. An example of a desk researched scenario study is the Netherlands Bureau for Economic Policy Analysis' s scenarios on transport in a globalised world [63].

4.2.3. Nature of the resources

The process and content of a scenario analysis is influenced by the *nature of the resources* [19,64,72]. The nature of the resources describes a scenario analysis' financial resources, research resources, time invested in the project, available manpower and its competencies. The resources can be *extensive* as in the VISIONS project [16]. The resources can also be *limited* as in the yearlong KPMG scenario project [65] and its 0.5 full-time-equivalent project team.

4.2.4. Nature of institutional conditions

The *nature of the institutional conditions* is related to the nature of the resources [19,57,64,72]. Institutional conditions address the room for manoeuvre that a scenario project is given[6]. For example, informal aspects such as personal relations, and the political sensitivity to an analysis determine institutional conditions. Formal aspects such as institutional constraints also establish boundary conditions. For example, the Questa scenario analysis suffered from the consequences of a reorganisation in the Dutch Ministry of Transport where the project was conducted [64]. Institutional conditions can be *open* or *constrained*. An example of how external intervention constrained a scenario analysis is the *Netherlands in 2030* project commissioned by the Dutch Minister of Housing, Spatial Planning, and the Environment [57]. After three descriptive scenarios were developed and presented to the minister, she requested that a fourth and normative scenario be included in which current strategy was incor-

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[6] It can be argued that room for manoeuvre is a resource and that therefore we should combine the nature of the institutional conditions and the nature of the resources' categories. The reason for separating them, however, is that the resources tend to be transparent whereas the institutional conditions are often more illusive.

porated. The inclusion of the normative scenario constrained the exploratory character of the study.

4.3. Scenario content characteristics

4.3.1. Temporal nature

There are two types of scenario when addressing its *temporal nature*: developmental or *chain* on the one hand, and the end-state or *snapshot* on the other [73]. Chain scenarios such as the *Scenarios Europe 2010* [3,37,43,44] are like films. They describe the path of development to a particular end-state. Snapshot scenarios are like photos. They describe the end-state of a particular path of development but only implicitly address the processes that result in that end-state. Examples of snapshot scenarios are those developed in the NIVE scenarios on leadership in the 21st century [9,74].

4.3.2. Nature of the variables

Another characteristic addresses the types and numbers of variables in a scenario. The range in this characteristic's dimension is indicated by *heterogeneous* and *homogenous* sets of variables. UNEP's GEO-3 scenarios [30] are examples of scenarios that address a heterogeneous set of variables[7]. In contrast, the KPMG scenarios [65,75] consider only five variables: employers, employees, 'intermediaries', ICT, and the job market.

4.3.3. The nature of the dynamics

The *nature of the dynamics* within a scenario is related to the types and number of variables. Here we distinguish between contrast or *peripheral* scenarios and surprise-free or *trend* scenarios [4,7]. Peripheral scenarios describe a discontinuous path to the future. Examples of peripheral and trend scenarios are the VISIONS [16] and the IPCC scenarios respectively [10,17]. According to Ducot and Lubben [4], a trend scenario extrapolates from existing trends, while a peripheral scenario includes unlikely and extreme events. Using Ducot and Lubben as a basis, we consider trend scenarios to be linear trajectories. Schwartz [18] addresses trend scenarios when he warns against the "unbroken line—conditions that change, but do not engender any response". In Schwartz's view, trend scenarios do not recognize the " undertow of resistance" that often slows down a particular development.

4.3.4. Level of deviation

The *level of deviation* refers to the range of possible futures that is taken into account. *Alternative* scenarios describe futures that differ significantly from one another. These scenarios are often developed in an effort to raise awareness and understanding about new or uncertain issues, and as an exercise for challenging

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[7] The variables include demography, economic integration and liberalisation, social inequality, consumer culture, ICT, biotech, environmental degradation, and political decentralisation.

assumptions [18,64,73,76]. Porter [77] states that a high level of deviation is a pre-requisite for scenario development. A scenario should 'stretch' thinking about the future and widen the range of possible alternatives. *Conventional* or business-as-usual scenarios adhere to the status quo or to present trends and their extrapolation into the future [3,4,7,37]. No disruptive events or developments occur in conventional scenarios and overlap between the scenarios is possible. Conventional scenarios are developed when the aim is to fine-tune current strategy rather than to develop new strategy, for example. We observe many examples of scenario exercises that claim to develop alternative scenarios whereas in fact they are at best only marginally unconventional.

4.3.5. Level of integration

Finally, scenarios can be characterised by the *level of integration* that addresses the extent in which components relevant to the subject of a study are incorporated and brought together to form a whole [3,16,78]. A scenario study with a *high* level of integration unifies in an interdisciplinary [60] and transparent manner the relevant variables and dynamics across time and spatial scales, and across relevant social, economic, environmental, and institutional domains [59][8]. Integrated scenarios demonstrate a high degree of interaction between its variables and dynamics, like balls on a billiard table rebounding off each other [3,6]. Examples of scenarios with a high level of interaction are the Destino Colombia and Mont Fleur scenarios [24–26]. The alternative is a *low* level of integration such as the study *Sustained risk: a lasting phenomenon* [79] carried out by the Netherlands Scientific Council for Government Policy (WRR). Different sectors like the water, food and energy sectors are addressed in the study but the interconnections between them are negligible.

5. Testing the robustness of the typology

The typology was used in a comparative analysis of recent scenario studies to test whether the typology was strong enough to withstand intellectual challenge. The studies used in the comparative analysis were selected from sources on 70 case studies carried out since 1991. Together the cases form a sufficiently large and diverse group of studies to test the typology's robustness. The screening of the case studies resulted in the selection of 18 scenario projects that provided information about all the aspects addressed in the typology, and approximately 20 cases that were used to illustrate parts of the typology. The information about the 18 case studies was drawn from primary and secondary sources ranging from reviews of recent scenario analyses to interviews with people involved in the scenario analyses as documented in this paper's reference list. A research constraint was the limited

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[8] According to Schneider, interdisciplinarity implies an original combination derived from the integration of multidisciplinary ideas or methods that permits explanation or assessment not achievable of non-integrated application of multidisciplinary ideas or tools.

number of scenarios developed for commercial organisations that were available for analysis. A possible explanation is commercial organisations' reluctance in sharing information for fear of revealing sensitive strategic material. The 18 studies are summarised in Table 2.

The case studies were analysed using the scenario characteristics as a checklist.

Table 2
The 18 scenario studies used in the comparative analysis

A brief review of the cartwheel case studies

British Airways: a 1994 explorative scenario analysis that examined societal developments and their implications for the airline industry.

NIVE: the Dutch management society's 1999 scenario analysis that addressed 'what will leadership look like in the 21st century in view of growth and sustainability?'

Mont Fleur: the renowned scenario process designed to stimulate debate about the shape of post-apartheid South African society.

Questa: the study conducted by the Dutch Ministry of Transportation that developed quantitatively underpinned scenarios on mobility issues.

The Future of Women: the question of whether men and women will be equal by the year 2015 is addressed and what the implications of achieving or failing to acheive equality will be.

Which World?: Allen Hammond of the Global Scenario Group describes three global scenarios from the perspective of the year 2050.

ICL: the British computer systems and services company's scenario analysis on the future of the information markets in 2005.

IPCC: an extensive and recently completed scenario analysis that addressed greenhouse gas emissions' impact on climate change on a global and a regional level.

Visions: three scenarios for the future of Europe developed in an innovative three-year project under the auspices of the European Commission.

Possum: scenarios for achieving sustainable development and to assist the European Commission in future decisions about the Common Transport Policy.

KPMG Ebbinge: scenarios on the future of the Dutch job market and of intermediaries such as job agencies, recruiters and headhunters.

Destino Colombia: a scenario analysis with the aim of defining alternative routes for Colombia to the year 2015 and to develop a shared vision that allowed for the drafting of long-range policies.

DocuWorld: intuitively developed visions that give an insight in the perspectives of high school students around the world of how they see the future. Development was so intuitive that some would dispute whether these are scenarios at all.

Biotechnology Scenarios: a year 2000 study by the World Business Council for Sustainable Development (WBCSD) and participants from large food and chemical companies that developed three scenarios on the role of biotechnology in society between 2000 and 2050.

European security beyond the Cold War: UK's Royal Institute of International Affairs developed four scenarios for the year 2010 in an effort to explore the possible outcomes of change and disorder in European security at the end of the eighties.

Telecom 1: the year 2000 scenarios of a telecommunications company that analysed three futures for mobile phone commerce in 2005.

The Port of Rotterdam: the 1996 Port of Rotterdam scenario and strategic options for the year 2010.

Nutrition 1: a year 2000 project that developed scenario and strategic options for the future of the nutrition market.

References: [2,9,10,16,24,26,45,48,53,65,74,82–88]

Temporal nature	Chain			Snapshot
Level of deviation	Alternative			Conventional
Nature of variables	Heterogeneous			Homogenous
Nature of dynamics	Peripheral			Trend
Level of integration	High			Low

Fig. 3.   The scenario content of the British Airways scenario project.

Per case study a table for each overarching theme was made in which findings from the comparative analysis were registered. An example of such a table is provided in Fig. 3[9].

In Fig. 3 more of the left column that the right was filled. This implies that the scenario is complex, in accordance with the left position on the theme's dimension in Table 1.

The case studies are presented on a visual representation called the scenario cartwheel in Fig. 4. The cartwheel uses the three dimensions that underpin the themes to make fundamental distinctions between scenarios visible. Scenario studies can be plotted around the cartwheel according to their main features. The cartwheel has the limitation that the categories are absolute; gradations are not possible. For example,
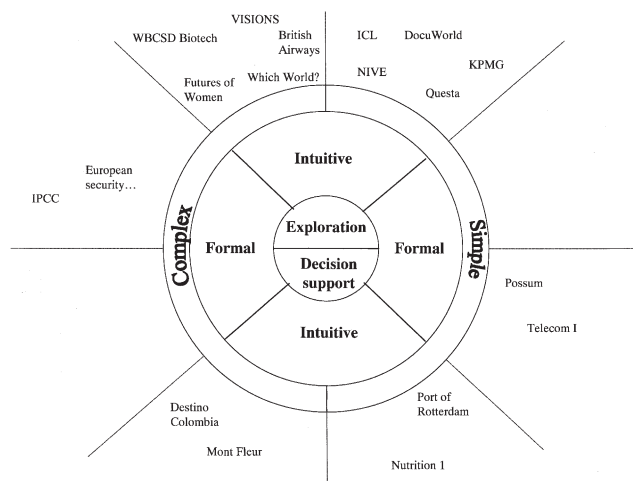

Fig. 4.   The scenario cartwheel.

[9] The figure illustrates the hybrid forms of scenario techniques that can be applied such as with the nature of the input, the method of data collection, and the time scale in this example.

one case study cannot be represented as being more intuitive than another since an attempt to do so might mean cutting across other boundaries denoted in the cartwheel.

The examination of the VISIONS scenarios for the future of Europe is presented to illustrate the typology's use in the comparative analysis. VISIONS is described here because the project represents a type of exploratory scenario analysis that has become popular in recent years [2,3]. Furthermore, the VISIONS scenario development process is well documented and ample material is available for analysis.

6. The VISIONS scenarios on the future of Europe

The VISIONS [11–17] project ran from March 1998 until March 2001 under the auspices of DGXII of the European Commission[10]. The scenarios described here focus on the European scenarios as opposed to the three sets of regional scenarios that were also developed. The aspects related to the dominant types of themes and scenario characteristics in the case study are denoted in bold and in italics respectively.

6.1. Project goal

VISIONS' overall ambition was to raise awareness of paths to sustainable development for Europe. Therefore, VISIONS's project goal was **exploratory** rather than decision supportive. A *forecasting* and *descriptive* approach was chosen in order to demonstrate effectively the links between socio-economic and environmental processes, and possible consequences for Europe from an integrated perspective. The scenarios would address *multiple time and spatial scales*. The scenarios would include staggered time intervals that run 50 years into the future. Global developments would provide input for European scenarios, and for three sets of regional scenarios for the North West UK, the Italian city of Venice, and the Dutch Green Heart respectively[11]. Therefore, the scenarios were to be *area-based* as well as *issue-based* due to the sustainable development theme.

Another goal of the project was to use the scenario process as an experimental arena so that lessons learned from the project could improve policy-making for sustainable development.

6.2. Process design

The objectives of the experimental arena were:

- To test new and existing scientific tools and participatory methods for scenario-building

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[10] DGXII is the Directorate-General is responsible with the Commission's research activities and was renamed the Research Directorate-General when VISIONS was still in progress.

[11] The North-West UK refers to the Greater Manchester area. The Dutch Green Heart is an area of countryside bordered by the cities of Amsterdam, Utrecht, and The Hague.

- To develop a framework for the integration of tools for sustainable development
- To evaluate consensus and conflict between the alternative perspectives incorporated in the scenarios

On the basis of these objectives a process was designed where formal techniques such as computer simulations supported an **intuitive** process. Storylines were developed with *qualitative* information and then underpinned with quantitative information where appropriate. However, the integration of qualitative and quantitative data proved difficult and with sometimes unsatisfactory results. These difficulties confirm the methodological challenge of the fusion of the two types of data.

In the scenario development extensive use was made of *participatory* methods such as stakeholder-based scenario workshops. Much effort was needed to find a group of participants sufficiently diverse to achieve the desired variety of knowledge and perspectives for the scenario process. The participants ultimately involved in the European and regional scenario development included representatives from the science community, regional, national, and international businesses, governmental institutions, NGOs, as well as citizens and artists from a variety of EU-member states. The participants' expertise ranged from energy, telecommunication, and environmental science to automotives, chemicals, and water. The diversity of participants ensured a high level of input though it proved a challenge to manage so varied a group of people. Valuable input was also gained from expert sources such as scholarly literature and an expert workshop on European governance.

The project had *extensive resources* at its disposal in terms of funds, manpower, and expertise. For example, around 15 people made up the scenario team for the four scenario projects, and the nine project partners provided a high quality group of scientists from a broad range of disciplines. With the exception of the mobilisation of workshop participants, the gathering of information was relatively easy thanks to the resources and professional networks of the parties involved in the project. The VISIONS-project's *institutional conditions were open*. They were only compromised by difficulties that arose from working with a large and diverse group of partners and the relatively passive involvement of DGXII, VISIONS' commissioner.

6.3. Scenario content

The final VISIONS scenarios are **complex**. The three *chain* scenarios describe the interaction between 12 *heterogeneous* variables divided equally over actors, factors, and sectors and range from employment and consumption behaviour, to businesses and scientists, energy, and transport. The variety of input allowed for the development of *peripheral* and *alternative* scenarios. This is demonstrated by the inclusion in the scenarios of action-reaction mechanisms and severe disruptions in societal trends. The action-reaction mechanisms counter the danger of the scenarios merely describing relatively linear processes and exclude deviations from a particular line of development. The breaks in trends were referred to as bifurcations and examples in the VISIONS scenarios include extreme climatic change and the failure of European integration. The bifurcations are presented next to the scenarios and act as teasers

to stimulate the imagination although the choice of bifurcations was criticised for being somewhat arbitrary [80]. The scenarios have a *high level of integration* thanks in part to the use of multiple time and spatial scales in contrast to the single scale approach common to most scenario analyses. Yet, there was some criticism regarding the apparently inadequate incorporation of political and global perspectives in the scenarios [81].

7. Observations about the typology's robustness

The description of the VISIONS project illustrates how the typology acts as a checklist when analysing scenarios. The typology was used in similar fashion in the comparative analysis of all 18 case studies. The goal of the comparative analysis was to test the typology for robustness. The comparative analysis showed that, while overall the typology remained intact, some aspects of the typology needed refinement.

A first observation regarding the comparative analysis is the necessity we found to include new elements, and adapt or exclude some of the earlier elements proposed in the draft typology. For example, the question arose whether or not the dissemination of scenarios should be included as an overarching theme. This idea was rejected because dissemination, though important, can be viewed more as part of the packaging than an essential component of the scenario development process itself. Similarly, a scenario characteristic in the draft typology that addressed the duration of a scenario project was dropped since the characteristic in itself reveals very little.

A second point of attention was nuance. The comparative analysis demonstrated that a scenario analysis does not easily break down into neatly defined components, that techniques in scenario development are often combined, and that scenario processes differ from one to the next depending on context. Furthermore, some of the characteristics overlap or cancel each other out. For example, a backcasting scenario is invariably normative, and a quantitative scenario is unlikely to be developed in a participatory manner. As a consequence, any typology that aims to address all types of scenario must compromise on detail in order to avoid becoming unwieldy. The tension between striving for detail on the one hand and comprehensiveness on the other can be seen in the visual representation, the scenario cartwheel. The introduction of more elements in the cartwheel in order to capture more nuances might lead to the deterioration of its communicative power.

Third; it was challenging to find terminology precise and clear enough to communicate successfully the distinctions between the typology's elements. Some of the terms used in the draft typology could be interpreted in several ways. For example, ambiguity in the nature-of-the-input-characteristic required an additional characteristic to describe the method of data collection. Although we feel we have established more clarity in the large array of scenario terminology, some terms in the typology remain illusive when viewed in isolation.

Some aspects of the typology survived the comparative analysis because, first, the typology demonstrated that it is sufficiently detailed to scrutinise scenario analyses

in an in-depth manner. Second, the typology proved broad enough in its scope to scrutinise a wide variety of scenario analyses. Therefore the typology seems sufficiently comprehensive in its identification of important scenario elements and its categorisation of scenarios according to shared characteristics. The typology has also proved itself to be flexible. It can be used for both an in-depth comparative analysis as well as for a broad, more superficial analysis.

8. Summary

In this paper we argue that development of an updated typology is justified because the scenarios have evolved and previously developed classifications do not sufficiently capture the current diversity in scenario development. The paper proposes an updated typology to analyse and compare scenarios. The typology centres on three overarching themes—project goal, process design, and scenario content—and on 14 scenario characteristics. A comparative analysis of several case studies demonstrated that the typology is robust although some refinements of draft versions were necessary. The case studies are presented in the visual representation called the scenario cartwheel that reflects conclusions drawn from the comparative analysis. The comparative analysis proved that the typology is both broad and detailed enough to analyse and compare the diversity in today's scenarios. We hope that the updated typology will encourage scenario analysts to reflect on the scenario past and present with a view to improving the future of scenario methodology.

Acknowledgements

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