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The future imagined: exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options

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Abstract

European science policy (so-called Horizon 2020) is guided by Grand Societal Challenges (GSCs) with the explicit aim of shaping the future. In this paper we propose an innovative approach to the analysis and critique of Europe's GSCs. The aim is to explore how speculative and creative fiction offer ways of embodying, telling, imagining, and symbolising 'futures', that can provide alternative frames and understandings to enrich the grand challenges of the 21st century, and the related rationale and agendas for ERA and H2020. We identify six ways in which filmic and literary representations can be considered creative foresight methods (i.e. through: creative input, detail, warning, reflection, critique, involvement) and can provide alternative perspectives on these central challenges, and warning signals for the science policy they inform. The inquiry involved the selection of 64 novels and movies engaging with notions of the future, produced over the last 150 years. Content analysis based on a standardised matrix of major themes and sub-domains, allows to build a hierarchy of themes and to identify major patterns of long-lasting concerns about humanity's future. The study highlights how fiction sees oppression, inequality and a range of ethical issues linked to human and nature's dignity as central to, and inseparable from innovation, technology and science. It concludes identifying warning signals in four major domains, arguing that these signals are compelling, and ought to be heard, not least because elements of such future have already escaped the imaginary world to make part of today's experience. It identifies areas poorly defined or absent from Europe's science agenda, and argues for the need to increase research into human, social, political and cultural processes involved in techno-science endeavours.

Keywords: Cinema, Literature, Warning signals, Grand Societal Challenges, Science policy, Horizon 2020, FLAGSHIP

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1) Introduction: framing challenges and research agendas

Today's historical context of multiple, interrelated crises, underpins a widespread concern, curiosity and interest about the future and its challenges. This research is premised on the idea that the way challenges for the future are framed determines – to a large extent – how we search for answers and solutions, and what we decide to prioritise in terms of public and private funding for research and policy implementation. Research agendas are called upon to find solutions that can deliver a more sustainable common future (UN, 2012; UNESCO, 2014). They are an exercise in future thinking with the aim of identifying what is wanted (e.g. employment), and not wanted (e.g. pollution). Research agendas thus help to shape preferable futures by planning to create the knowledge that will bring about desired change and transformation (Keenan et al., 2013; Voros, 2001).

The Grand Societal Challenges (GSCs) or Grand Challenges (GCs)¹ approach is widely referred to in European policy-making and is one of the principles guiding Europe's research area (ERA) and agenda: Horizon 2020. The GSC approach has been developing over the last decade, starting with a Green Paper (*The European Research Area: New Perspectives*, EC, 2007) identifying six 'ERA dimensions', and subsequently defining ways to make ERA meaningful and relevant to Europe's citizens and political leaders:

'to focus continued effort on ERA by engaging with a series of Grand Challenges that capture the political and public imagination and connecting ERA with these challenges... These challenges are both economic and more broadly concerned with social and environmental goals. This approach can shift perceptions as well as focus from deficit to opportunity' (EC 2008: 5, 36).

The identification of GSCs for the future of Europe came from the Bureau of European Policy Advisors of the European Commission (BEPA), with contributions from institutes including the Joint Research Centre-Institute for Prospective Technological Studies (JRC-IPTS). The aim was to map the 'main trends ahead and possible disruptive global challenges in the future and to examine how the EU could position itself to take an active role in shaping a response to them', adapting to situations before they occur and, crucially, to be able to 'shape the future' (Boden et al. 2010: 1). More contributions came from research projects such as *iKnow*, an FP7 project aimed at 'interconnecting Knowledge on issues and development potentially

¹ We will use the generic 'GSC' to refer to both, throughout the paper.

shaking or shaping the future of science, technology and innovation (STI) in Europe and the world' (Ravetz *et al.*, 2011: 9), which proposed 21 GCs. Eventually, the new research agenda for ERA, known as Horizon 2020, was structured around seven Societal Challenges for H2020 (EUCO, 2013: Article 3, 3).²

1. Health, demographic change and wellbeing;
2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
3. Secure, clean and efficient energy;
4. Smart, green and integrated transport;
5. Climate action, environment, resource efficiency and raw materials;
6. Europe in a changing world - inclusive, innovative and reflective societies;
7. Secure societies - protecting freedom and security of Europe and its citizens.

Focus on GSCs is meant to provide orientation for science, technology, and innovation policies, seeking to address multi-level complexity of actors, trends and tensions (Kuhlmann & Rip, 2014). In doing so, GSCs also invoke and establish notions of human and social progress, hence, the way they are framed matters significantly. Challenges are organized as open-ended missions concerning the socioeconomic system as a whole, inducing or requiring system transformation. As an approach, they presuppose and reinforce the central role of science and technology in the shaping of the societies of the future, and for this reason '[t]he agenda-setting, coordination and conduct of science, and the ways in which scientific knowledge is diffused and used, are critical' (Keenan *et al.*, 2013).

Given that research agendas contribute to shaping futures, they are necessarily subject to detailed scrutiny, and H2020 is not without criticism. Many have noted its narrow innovation-focused utilitarianism, or insufficient focus on Social Sciences and Humanities (Keenan *et al.*, 2012; Levidow and Neubaue, 2012; Mayer *et al.*, 2013), and the Vilnius Declaration emphasizes the narrowness of the concept of innovation itself, which should be 'driven not only by technological advances, but also by societal expectations, values and demands' (Mayer *et al.*, 2013: 25).

This inquiry makes an original contribution towards a pluralistic critique of the way EU GSCs are framed and of the progress principles they represent: it investigates fiction in the form of filmic and literary representations of 'futures' as a form of forward-looking technique (hereafter: foresight), capable of providing

² See also: <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges>. In this paper we will refer to all challenges as GSCs.

alternative insights into what challenges lie ahead.³ The idea is to engage with fiction as significant inspiration for future 'possibilities' and 'warning signals' (Bergman et al., 2010; Lombardo and Ramos, 2015; Miles, 1990; 1993; Polak, 1973; Popper, 2009; Stableford et al., 1993). The aim is to see how speculative and creative fiction can provide alternative frames and understandings to enrich the so called-GSCs of the 21st century (Boden et al 2010; 2010a; EC 2010; EC 2012; EUCO 2013)⁴ and the resulting agendas for ERA and H2020. Beyond the more traditional and techno-scientific fields of foresight, cinema and literature offer ways of embodying, telling, imagining, and symbolising 'futures' (Lawler 1980; Miles, 1990) that can provide alternative views of how the main challenges facing societies in the present and into the future are being understood and framed (Stableford et al., 1993). Crucially for this inquiry, by identifying a range of films and novels that have had a significant impact on how the future is imagined, we can explore how these influential texts have framed the challenges of imagined future societies, identifying 'other' major trends, paradoxes and emerging issues, that can further enrich research policy-making, namely by (re)establishing priorities, as is traditional in scenario building (Schultz, 1995).

In the next section we explain the conceptual basis for the inquiry examining the role of fiction in shaping futures and as creative forward-looking technique, and describe the process of selection and analysis of the material. Section 3 describes the results of a qualitative and quantitative content analysis revealing the range of humanity's concerns and challenges envisaged in fiction, and their similarities and differences compared to GSC policies. Section 4 discusses the implications of these findings as potential warning signals of relevance to Europe's research agenda.

³ The research presented here is part of a European funded project: *Forward Looking Analysis of Grand Societal Challenges and Innovative Policies* (FLAGSHIP) www.flagship-project.eu

⁴ Most recently defined here: <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges>.

2) Fiction matters and methodological approaches

2.1) *Future visions and foresight: fiction's place*

The starting point for our inquiry is that speculative fiction (mostly labelled as 'science fiction' – hereafter 'fiction')⁵, foresight and the broad field of future studies share the 'future' as their topic (Miles, 1990). First we review ideas of fiction's complex range of 'social functions' (Stableford et al., 1993), second we discuss the relationship between fiction and foresight and third, we consider fiction from the perspective of foresight.

The science of fiction

Scholars associate a wide range of goals (Miles 1990), benefits (Lawler 1980) and functions (Stableford et al., 1993) to fiction. There is a close link between fiction and technology and innovation, at the heart of research agendas: fiction has the capacity to identify and assess innovative concepts and technologies, shaping fields of development such as genomics and cloning, and leading scholars to talk about mutual engagement and co-constitution of innovation (Bassett et al., 2013; Raitt and Battrick, 2001; Robinson et al., 2013). These authors suggest that fiction helps identify what research is needed in terms of new knowledge, techniques, and materials.⁶ It implies a sense of possibility of social and technological change, widening the repertoire of possibilities (Stableford et al., 1993), and helping to shape the future (Miles, 1990), or at least our thinking about it and our imaginative processes. In this sense, Lawler (1980: 12) talks of 'epistemic' benefits of fiction and fantasy, as they change our ways of imagining and the representations of collective imagination, leading to possible 'new realities'. It can also explain where we have come from, point to where we are going and inspire us towards the future recurring to archetypal units of meaning and heroes (Polak, 1973).

By drawing on the desire to reflect upon the past and present, artists imagine more or less plausible futures, often resulting from the extrapolation of tendencies and trends in their social, environmental and economic context. These texts of

⁵ While a significant part of our material can be labeled as science fiction, we prefer to use the term speculative fiction (after Lawler, 1980 – who also speaks of futures fictional narratives), acknowledging that the 'sci fi' genre remains mutable (Rieder, 2010) and not homogenous (Stableford et al., 1993).

⁶ The European Space Agency reviews past and present science fiction (literature, artwork and films) in order to identify and assess innovative technologies and concepts described there, which could be possibly developed further for space applications (Raitt and Battrick, 2001).

popular art, which in our study arise from both novels and films, can offer a form of social and historical critique through their account and analysis of social structure, power, politics, and agency. Moreover, filmic and literary representations convey future visions to a much broader public through their narrative configuration, compared to more theoretical approaches (Ricoeur, 1990). They transmit cultural codes and values, thus they reflect cultures and ideologies of specific historical moments and societies. '[They] not only provide a conveniently simple model for describing the general direction of society, but at the same time, they supply a framework for understanding historical and current events.' (Clardy, 2011:44). Their imaginary and narrative configuration (the building of a plot) helps us make sense out of the 'chaotic' experience of daily life.

Jameson's (1982: 148) critique, goes further, supporting the idea of fiction as a vast 'pensée sauvage' about history itself, whether personal or collective, capable of contributing "'concepts" like progress or cyclical return, which can somehow be tested for their objective or even scientific validity', rather than being limited to 'a reflection of collective past or future as "'merely" mythical, archetypal, and projective'. Polak (1973) views this art as a movement towards the future, not limited to the expression of its time.

These arguments link to acknowledgements of this art's transformative power through storytelling (Stupart and Dillon 2015) and the educational nature of fiction. Suvin (1970) contends that science fiction characters both reflect and transform humans, promoting considerations on the nature of problems and where these might be heading. Fiction is, in Suvin's words, an educational literary form, operating through imaginative frameworks that are alternative to the author's empirical environment, promoting a fruitful interaction between 'estrangement' and 'cognition'. In a more direct sense, fiction and mass media content are seen as a major source of information about science for non-expert audiences (Dahlstrom, 2014).

Fiction can also be useful in recognizing and foreseeing technology's social consequences (Bergman et al., 2010; Birtchnell and Urry, 2013; Fowles, 1978; Miles, 1990; 1993). It can be designed to undermine, or show the 'dark side' of established views of the future (Miles, 1990). Fiction can be propaedeutic to ethics because it presents imaginary and plausible situations in which we can imagine ourselves facing dilemmas, options, having to envision possible solutions in adverse scenarios (Ricoeur, 1990). Lawler (1980: 5) talks of 'normative' benefits of fiction, viewing the 'admonition' in these narratives as an encouragement 'to examine our present goals

and priorities not only in terms of their all too probable effects in the future but also in terms of their moral character’.

The fiction-foresight relationship

This is where **fiction and foresight come together**. Having reviewed some of the most prescient views on fiction’s social function and how these contribute to ways of knowing, we now turn to explore its relationship with foresight. There is wide support for the idea of strong and mutual multi-varied influence, including in terms of theory and methods (Bassett et al., 2013; Lombard and Ramos, 2015; Miles, 1990; 1993). Notably, two authors included in our empirical review (Appendix A), H G Wells (*The Time Machine*, 1895), and John Brunner (*Stand on Zanzibar*, 1968) – published works in both fiction and foresight (Miles, 1990).

Fiction provides the medium to **guide, inspire, predict and warn** about the future, leading to potential action in the present – and, as we go on to argue, contributing to reveal knowledge gaps (beyond those serving innovation, above) and research priorities. Despite recognised limits of imagination in speculative fiction (it can demonstrate ‘our incapacity to imagine the future’ according to Jameson (1982: 153)), its **predictive** qualities can help avert possible futures, and serve as ‘a sort of **early warning** system’: the ‘cautionary’ benefit according to Lawler (1980: 5).

For Bergman and colleagues (2010) science fiction is a statement about the future, that makes **explanatory** rather than truth (i.e. it will happen) claims, delving in mechanisms that can cause events ‘forecasted’ and thus offering possible explanations of the imagined phenomena. Its archetypal, mythic, cosmic qualities, informed and inspired by science, can inspire and warn (Lombard and Ramos, 2015). It also provides a powerful way of **experiencing and engaging** with the future that allows us to live, feel and intimately connect with the story, gaining meaningful insights (Lombard and Ramos, 2015; Schultz, 1995).

The foresight methods perspective

From foresight’s perspective, fiction can be considered one of its methods. Popper (2009: 72) proposes a way to classify foresight methods by ‘considering their ability to gather or process information based on *evidence, expertise, interaction or creativity* (see also Slaughter, 2012). These attributes are the building blocks of the Foresight Diamond’. Within the Diamond, ‘science fictioning’ is included among the

category of 'other methods', together with 'genius forecast', 'acting/role playing', 'benchmarking' and others – and is located very close to the top end characterised by creativity methods, including: 'gaming, the identification of wild cards and weak signals, and the exploitation of science fiction literature' (Popper, 2009: 76, see Figure 1). Creativity refers to:

'the mixture of original and imaginative thinking and is often provided by artists or technology 'gurus', for example. These methods rely heavily on the inventiveness and ingenuity of very skilled individuals, such as science fiction writers or the inspiration that emerges from groups of people involved in brainstorming sessions' (p. 73).

Methods intended to examine the future include three main approaches: predictive techniques (a more quantitative approach) inquiring about future scenarios through calculation tools, based in the information we have now; exploratory techniques, envision what future will be like, by extending into the future the present trends, and normative procedures, designing more desirable futures and conceiving the best ways to achieve them. As discussed above, artistic discourse can contribute in predicting and exploring potential risks, identifying warning signals, and it can also identify promises and threats in normative terms, harnessing the capacity for imagination and speculation beyond reason and instrumental analyses – by tapping into emotional and overtly subjective ways of knowing (Slaughter, 2012; Voros, 2001). It creates an immersive simulative experience that can enrich our understanding of 'risks and opportunities involved in... strategic issues' and scenario narratives (Ogilvy and Schwartz 2004: 1).

Fiction as a foresight method can thus embody simultaneously a warning dimension representing future risks, by taking things to an extreme form, and an innovative potentiality, giving us 'often divergent, images, options, arenas of possibility that lie beyond reason and instrumental analysis... and feed our capacities for speculation, imagination and social innovation' (Collie, 2011: 425). By providing a detailed picture of the type of future being envisioned, these narratives can form collective imaginaries, and provide alternative meaningful visions able to support policy-making, or to help question assumptions and ideals of progress. As Booker (1994:3) states, 'imaginative literature is one of the most important means by which any culture can investigate new ways of defining itself and of exploring alternatives to the social and political status quo'.

Based on this three-parts review we identify six ways in which fiction can contribute to enrich foresight practice (Box 1): creative input, detail, warning, reflection, critique and involvement.

Box 1. Fiction's contributions to foresight

Creative input	<ul style="list-style-type: none">• To balance the use of methods based on evidence, expertise, interaction, with creative inputs; strengthening the power of inspiration and widening the repertoire of possibilities;
Detail	<ul style="list-style-type: none">• To offer detailed insights of daily lives or events (embodying, telling, imagining, and symbolizing) which add richness to proposed futures;<ul style="list-style-type: none">○ it overcomes the tendency to decouple future research agendas (which tend towards abstraction) from the individual experience and understanding;○ it offers a narrative that counters the macro systemic perspective with a micro scale description of human lives and what it means to be human;
Warning	<ul style="list-style-type: none">• To provide anticipatory knowledge, contributing to predict and explore potential future risks, identifying possible warning signals;
Reflection	<ul style="list-style-type: none">• To help reflect on cultural codes, values and ideologies;• To help a culture to investigate new ways of defining itself, and to explore alternatives to the social and political status quo;
Critique	<ul style="list-style-type: none">• To offer a social and historical critique of social structure, power, politics and agency;• To help decision-makers to consider the ethical implications and dilemmas raised by alternative futures;
Involvement	<ul style="list-style-type: none">• To reach a wide audience and thus amplify participation in the debate and reflection of what future we want;• To identify dimensions and themes that resonate widely with the public (in the case of popular films and novels).

The rise of neoconservatism and neoliberalism have been near-fateful to utopia, speculative fiction and even to foresight and future studies. Miles (1990: 89) suggests that utopian fiction was a casualty of the 'war on the 1960s', and that the political climate of the 1970s and 1980s 'stemmed the growth of [future studies], and even undermined established FS institutions'. However, as he anticipated back in 1990, in recent years the rise of global ecological challenges is giving both fiction and foresight a new lease of life:

'...the growing importance of literature, film, and art for how individuals and groups figure, imagine, or anticipate what is to come. Indeed, as future scenarios have taken greater significance in public life, the line separating science from fiction has become

increasingly blurred, reflected in the emerging genre of “cli-fi,” the proliferation of apocalyptic novels and film, and the reemergence and redeployment of utopian and dystopian fiction... the recent works of Canadian novelist Margaret Atwood... open opportunities for exploring political imaginaries of climate change, blending utopian and dystopian imaginations of socioecological transformation while developing explicitly feminist themes... the science fiction of Ursula Le Guin... provide[s] critical perspective on the growing “degrowth” movement’ (Braun, 2015: 241).

These are additional reason why this study is an important reflection of our times: the GSCs require innovation and creativity, including the masterful use of the imagination through the arts. Given the six contributions of fiction to foresight, we now propose to explore a set of films and novels on speculative futures, to question the framing of the EU challenges (GSCs) themselves, and of ERA and H2020’s research agendas meant to provide solutions to them.

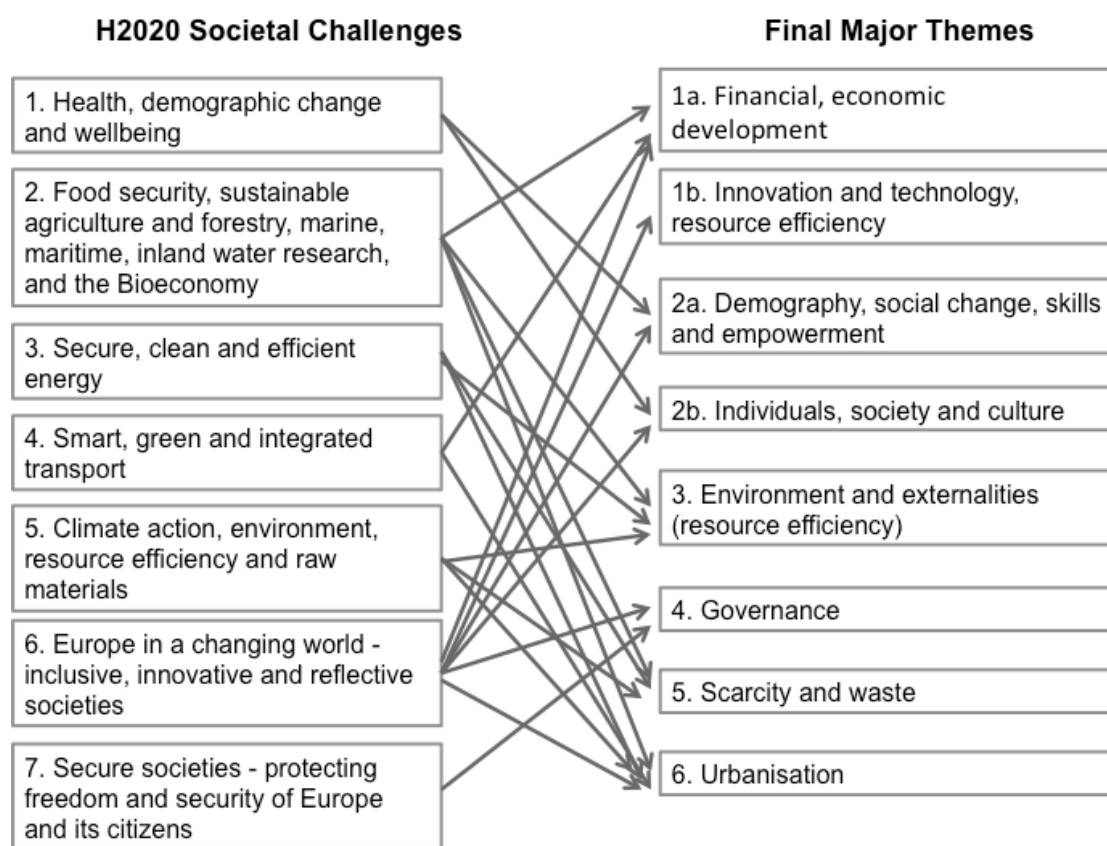
2.2) Methodology for selection and analysis

Fictional films and novels about the future are a prolific field. We therefore defined a methodological framework that combined and pondered different kinds of criteria, in order to ensure the relevance, quality, influential character and diversity of the final list. We focused on novels and films that interpret the future of humanity on Earth. These were initially listed using relevant online sources with large datasets, and then classified and ranked according to quality, influence, regional diversity and thematic coverage, and organized historically (Table 1). This produced a first list of 120 novels and 126 films covering the period from 1815 to 2013. A rigorous process of progressive focusing led to the final choice of 64 texts as the basis for this study. The procedures ensured a wide coverage, and guaranteed the conditions to select among major literary and cinematographic works, those which have had a very significant and lasting impact on the public imagination.⁷

⁷ Relevance was guaranteed by the presence of the films and novels on specific online databases, the reference on thematic lists and articles, and by the coverage of specific identification parameters. Texts were initially identified using online sources. *IMDB*, *LUMIERE*, *Cineuropa* and the *National Film Preservation Board* were the sources used for films. With respect to novels, sources were *librarything*, *goodreads*, and *isbndb*. Other criteria was used to score each of the texts identified: quality (number of nominations and awards concerning literary or film merit); influence (countries of release, editions, translation languages), regional diversity (the diversification of contexts of production was intentionally a pursuit) and thematic coverage (number of topics covered within GSCs). The final score of each text considered the sum of all the previous indicators and allowed the ranking of the texts and the final selection.

Through the consultation of abstracts, resumes and plots, texts were scrutinised and classified for their relevance to a list of major themes, which combined GSC-related topics as framed in FLAGSHIP (2013) and in H2020 (EURO, 2013). Texts with high coverage of these major themes were prioritised. The same list of themes, enriched with relevant futures topics arising from the texts themselves, provides the core structure for the overall analysis. The connection between H2020 GSCs and the final list of major themes is shown in figure 1.

Figure 1 connection between H2020 GSCs and major themes



A historical timeline was also introduced to establish the correspondence and influence of major socio-political events on fiction (Table 1),⁸ and consider how fiction is partly a critique of historical moments. The final selection corresponds to the best classified 27 novels and 37 films (see appendix A), covering six historical periods, with a particular incidence on the last decade (30% of the texts) considered

⁸ This historical map follows the theories of Mayer (1981) who envisages the 19th as a long century and Hobsbawm (1994) who argues that the 20th was a short century; we also draw from Koselleck with his studies on Utopia, Progress, Emancipation (2002) and the works of Enzo Traverso on the violence in the 20th century (2007).

particularly relevant for our reflections on science policy. The previous five periods provide an important –if quantitatively limited- perspective on the changing and/or persisting concerns explored in fiction (see section 3).

Table 1: Texts by major theme and historical timeline

Major themes	1815-1917 Conservative Order to Ancient Regime's Fall	1918–1944 Between the wars and II World War	1945–1973 Cold War period to Oil Crisis	1974 –1988 Oil Crisis to the Fall of Berlin Wall	1989–2000 Post- communist period to September 11 attacks	2001– 2013 Post- 9/11 till nowadays	Total texts within GSC
1a. Financial, Economic Development	5	4	7	11	9	14	50
1b. Innovation and technology, resource efficiency	6	4	12	13	10	19	64
2a. Demography, social change, skills and empowerment	6	4	10	12	8	17	57
2b. Individuals, society and culture	6	3	11	13	8	18	59
3. Environment and Externalities (resource efficiency)	5	3	9	11	7	18	53
4. Global & Territorial Governance	5	4	11	11	8	17	56
5a. Scarcity	4	3	9	10	5	15	46
5b. Waste		1	3	4	2	6	16
6. Urbanization	4	4	11	13	10	15	57
Total texts within historical timeline	6	4	12	13	10	19	64

Content analysis methods were used to examine systematically both the explicit and the implicit meanings of the 64 selected texts. The guidelines for the content analysis were set through a list of content descriptors developed from the list of major themes. These were broken down into a matrix with 42 dimensions and 212 sub dimensions, providing a template for the content analysis of the 64 texts. The content analysis was focused on the representations as defined and reflected by the authors, taking into account both the historical moment of production of the fiction and the overall text and the ways in which it illuminates and explores future societies (Denzin, 2004). The templates allowed for an interpretative analysis, building hierarchies of themes and accounting for major patterns within each dimension (Berg, 2001). The resulting list of final patterns is rooted in the observed data, and was debated and agreed between four members of the interdisciplinary team, incorporating different views and theoretical references. It expresses the ways in which the major themes are represented and describes and synthesizes major characteristics and tensions of the future societies portrayed in fiction.

Final categories describing observed patterns were registered in an overall database that linked all the information collected concerning each one of the texts, using *SPSS* software. This allowed the analysis of their observed frequency, the relative weight of each theme, and pattern (positive or negative orientation or portraying of the topics) in each text. This combination of the qualitative and quantitative methods allowed for a meaningful, articulated picture of the way GSC-related patterns are expressed in future's fiction. It enabled a reflexive interpretation of results, where we sought to comprehend, rather than quantify, topics, and to note prevalent patterns through history.

The rigorous selection criteria applied, guarantees the level of representativeness and importance of each text selected, providing an in-depth overview of key themes. Inevitably, due to the limited number of novels and films, generalizations should not be extrapolated beyond the defined set of texts. Finally, given the purpose of this inquiry, we did not seek to engage with the cultural production and rich variety of types and sub-genres in future fictions.

3) Results: major patterns arising from fiction

Having collected detailed records for each text, we identify arising patterns related to 42 dimensions and 212 sub dimensions. Table 2 presents the 23 most significant and frequent (defined in section 2.2) patterns of concern. These are organised under four 'Core Challenges':

1. *Individuals, society and culture*, expressing the patterns connected with individual dignity, values, wellbeing, rights, and identities.
2. *Science/Technology and society*, concerning the purposes, roles and centrality of technology in the ways societies will organize itself in the future.
3. *Environment - Technology versus Nature*, related with the complex and contradictory relationships between humans and nature, ranging from fulfilment to destruction.
4. *Society and social change*, concerning social conditions, discrimination and the ways societies are structured and hierarchical.

Table 2: Major patterns describing future societies portrayed in fiction, grouped according to their relevance to four core challenges

1. Individuals, society and culture	%*	2. Science/Technology and society	%
<ul style="list-style-type: none"> • Scarcity of human values • Dehumanizing processes • Disrespect of Human Rights • Strong homogenization of identities • Social control and subjective distress 	<p>50 39 38 38 27</p>	<ul style="list-style-type: none"> • Advanced technology • Technology as a socio-political instrument of control • Technology use restricted to specific ends or for/by elite groups • Technology used for social domination and manipulation • Science as a tool for manipulation, control and rationalization 	<p>42 39 39 27 27</p>
3. Environment -Technology vs Nature	%	4. Society and social change	%
<ul style="list-style-type: none"> • (Near)impossibility to breathe in open air • Technology used for control of nature • Extreme urbanization and vertical density • Interconnectedness and resulting fragility • Species extinction and decline in biodiversity • Aesthetic/ Spiritual Value of Nature • Food scarcity, replacement & lack of choice 	<p>39 39 34 34 34 31 28</p>	<ul style="list-style-type: none"> • Socioeconomic discrimination (based on propriety, education or other) • High stratification and unequal societies • Existence of resistance and opposition movements • Women inequality • Stratification of workers & occupations • Absence of consumption 	<p>34 33 31 31 28 27</p>

* the percentage refers to the proportion of the 64 texts engaging with each pattern

Many of the 23 patterns interconnect with different core challenges, exemplifying the complexity of the extrapolations made by the futures' narratives. We discuss each core challenge in turn, summarising results and reflecting on their implications for GSCs agendas.

3.1) *The other side of 'scarcity': a dehumanized future?*

The most frequent pattern found in fiction is the '*scarcity of human values*'. Literature on scarcity is closely linked to economic theory over centuries, and more recently to environmental studies (Bina, 2013). Resource scarcity is increasingly perceived as one of the greatest security risks of the 21st century, and when related with competition for natural resources, is considered a global challenge (Mildner et al., 2011). Here we propose a broader definition of scarcity, observing instead the ways in which future societies emphasise any kind of insufficiency, rarity or limited supply.

As a result, patterns of insufficiency are found in relation to: natural resources, human values, vital human needs, but also civil and political liberties and human capital. The scarcity of human values is observable in 32 texts, and can be further explained in terms of the absence of values such as:

- self-direction (*1984; The Handmaid's Tale; Logan's Run; Twelve Monkeys*), dignity (*The Tomorrow File; A Clockwork Orange; The Hunger Games*)
- hope (*Soylent Green; On the Beach; Blade Runner; Children of Men*)
- sentiments and emotionality (*We; Do Androids Dream of Electric Sheep?; The Giver*), love (*The Handmaid's Tale*)
- identity (*We; Uglies; Twelve Monkeys*), privacy (*Stand on Zanzibar; Minority Report*), idealism and creativity (*Paris in the Twentieth Century; Brazil*)
- freedom (Escape from L.A.), security and protection (*The Time Machine; Mad Max*), equality (*Metropolis; Elysium*), peace (*Appleseed*), justice (*Elysium*).

This pattern (*scarcity of human values*) speaks of individual dignity, values and wellbeing, creating a strong link with the 'Individuals, society and culture' theme. Closely linked to this are *dehumanizing processes* depriving individuals or societies of their human qualities. This pattern synthesizes the following situations: the human being is seen as means to an end (e.g.: seen as consumer or as a source of energy); situations of submission to mechanical power; and situations of submission to ideology, social control or repression. The most relevant aspect of this nihilistic situation (defined by the collapse of traditional moral values and of religious/spiritual known references) is not the collapse itself, but the resulting loss of meaning and inability of give meaning.

In the core challenge 'Individuals, society and culture' we also find reference to violation of human rights (38%), strong homogenization of identities (38%) and social control and subjective distress (27%). The latter condenses the following multiple forms of social pressure:

- a) Overcrowded spaces, where demographic growth and lack of space conflicts with the need for individual privacy (*The Fifth Element or Blade Runner*);
- b) The need for individuals to conform to the main social standards, in order to be accepted and recognized as a member of it, (*Uglies*);
- c) The strong individualistic culture of very complex societies, where competition produces a huge strain over personal performance (*Infinite Jest*);
- d) Manipulation and mind control becomes more pervasive, through the use of technological tools: cases where permanent surveillance creates very poor psychological conditions, (*V for Vendetta, Minority Report*).

These stories speak of damage to psychological wellbeing, including individuals being affected by feelings of anxiety, fear and even madness:

'War, terror, disease. There were a myriad of problems conspiring to corrupt

your reason and rob your common sense. Fear got the best of you.' (V for Vendetta, 2005)

Lastly, *disrespect of human rights and loss of citizenship* depicts the crisis of democratic systems leading to exclusion and disrespect of citizens, through the avoidance of anti-discrimination laws and the replacement of citizen with consumers. Two systems are represented: those where political repression leads to disrespect of human rights and those in which, under the pressure of corporate power, civil rights are cancelled to reinforce a logic of profit.

What do the patterns reveal of today's framing of GSCs? The core challenge 'individuals, culture and society' is both the most significant in fiction, and the one where the greatest discrepancy between H2020 and fiction is revealed. While in H2020 challenges cultural values are addressed as important dimensions in the construction of inclusive societies, contributing to social cohesion, future fiction is concerned with the detailed nature and limits of the human condition. Fiction reveals important patterns pointing out the harmful effects of repressive and/or extremely technological societies over the life of individuals. 'Social control and subjective distress' and 'strong homogenization of identities' are just a few examples of the warning signals (sections 1 and 2.1) arising from fiction, and which are largely unaddressed in H2020. The human community may already be facing disruptive situations where the absence of meaning and ethics may expose the fragilities of the contemporary human condition.

According to H2020 challenges, the mechanism to promote smart, sustainable and inclusive growth is described as implying 'substantial changes in the way growth and societal well-being are defined, measured (including through the measurement of progress beyond the commonly used GDP indicator), generated and sustained over time' (EUCO, 2013: 1023). We note that H2020 challenge 6, 'Europe in a changing world', reflects already awareness of the need to understand societal wellbeing beyond the GDP indicator, and to recognise 'human, social, environmental and economic costs'; however, the warnings arising from fiction, provide support to recent critiques (section 4.3) whereby more should be done to address social, cultural and human dimensions of GSCs.

While H2020 challenges address concerns related with security, democracy and the role of civil society to the construction of open and transparent institutions and societies, future fiction portrays the results of societies where all these values

are in danger or completely absent. Fiction about the future warns us about the fragility of such democratic values through rapid change and the risk of collapse of political institutions.

3.3) The future is technology

The 'Science/Technology and society' core challenge (quadrant of Table 2), reveals the classic theme of fiction. 27 of the 64 texts rely heavily on technological advancements, namely in the fields of biotechnology, cybertechnology, genetics, robotics, computing and other advanced technologies. These themes are distributed throughout all six historical periods, but are particularly frequent in texts from 1990 onwards.

The positive impacts of the pattern on *advanced technology* are imagined and described in terms of empowerment and performance improvement (in the economy or health), echoing specific ideals of progress. Technologies contribute to correct problematic aspects of reality, such as depressive moods and unhappiness, genetic traits, nature's limits, and survival challenges (e.g.: *The Lathe of Heaven*, *Neuromancer*, *The Diamond Age*, *Logan's Run*, *Code 46* or *Minority Report*). They can lead to new forms of determinism and inequality: what Atkinson (2007) calls *genetic utopianism*, or utopian states through the removal of unwanted elements, genetic abnormalities and crime, rather than through the fulfilment of positive ideals.

Despite its many utopian projects, fiction tends to be critical of techno-science developments, highlighting both planned and un-wanted negative effects, resulting from the use of technology for specific ends and for/by restricted elite groups (which happens in 25 of the 64 texts). Such uses are centred around military and security needs (and to a lesser extent, transportation), often serving exclusively specific elite groups, like the rich and high-powered *Elysium* inhabitants, the dominant corporations of *The Space Merchants*, the oppressive military state in the *Handmaids Tale*, the genetic oppressive state in *Uglies* or *Gattaca*, or the security utopia of *Minority Report*, among others.

Harmful impacts of techno-science in imagined futures are further recorded in the pattern on *social domination and manipulation*. 17 texts portray technology as a means of social domination, rationalization and manipulation by governments and corporations, leading sometimes to the loss of rights and privacy. All this takes place in societies, sometimes depicted as utopic, where everything can be seen and,

consequently, where nothing is outside the aegis of the state or the corporation's (Atkinson, 2007); societies with new and higher possibilities of genetic discrimination, social fragmentation, totalitarianism, surveillance, environmental degradation, addiction and mind control (Dinello, 2005).

The concern with social domination through techno-science seems mostly significant in fiction since the beginning of the cold war, but persists into the present. It applies to all domains of social life, such as birth, healthcare, and even pleasure (*Tomorrow File*), and to surveillance and capture systems (*Fahrenheit 451*). Science contributes to the reengineering of humanity and to the rational organization of all systems, may it be genetic, reproductive, social, administrative, economic, or others, (*Brave New World*). In *The Lathe of Heaven*, technology can control the content of individuals' dreams. This is also illustrated in the novel *Feed*, where technology guarantees appropriation of mind and emotions: 'Everything we think and feel is taken in by the corporations' (p. 48).

Another predominant pattern concerning science/technology in futures fiction relates with *control of nature*, within core challenge: '3. Environment & Technology vs Nature' (Table 2). In these texts, technology controls nature and promotes increasingly artificial forms of life, sometimes leading to destruction and chaos. In some cases, technology replaces landscape with an entirely built and controlled environment where nature is rendered invisible, and where technology itself has become a landscape (Fukuyama, 2002), as shown by the existence of 'farm' landscapes of artificial meat production, or artificial weather (*Feed*). This pattern is found continuously throughout the project's historical timeline. Humanity's increasing alienation from nature is emblematically illustrated early in the 20th century by Forster's *The Machine Stops* (1909):

'the civilization that had mistaken the functions of the system, and had used it for bringing people to things, instead of for bringing things to people. Those funny old days, when men went for a change of air instead of changing the air in their rooms!' (p. 5).

In these narratives, science and technology assumes an almost mystical role, enabling the total reshape of society and absolute control and separation from nature. Illustrations include the neutralization the earth's diurnal revolution (*The Machine Stops*), the growing of human beings in artificial wombs (*Brave New World*), Earth-forming technology (*The Diamond Age*), or climate weather and air regulation (*Feed*).

Returning to core challenge 2, we also find reference the pattern of *science as a tool for manipulation, control and rationalization* (27%). In our texts, science is primarily presented as a system at the service of ruling structures (either governments or corporations), for manipulation, control and rationalization. Politics and science are essentially merged and the notion of a nation is shaped by its scientific and technological performance (e.g. *The Tomorrow File*, *We* and *Brave New World*). Science blurs the boundaries between the human and non human, the natural and artificial, and in doing so, as Danny Witwer, the skeptical character in *Minority Report*, explains: '*Science has stolen most of our miracles.*'

Science is what distinguishes the 'work of men' from the (imperfect) 'work from nature', a way to dehumanize the subjects, accomplish a project of human improvement, abolish chaos and build perfection (*The Giver*, *Gattaca*). This pattern is present in all the historical periods covered, but is more frequent from 2001 onwards, reflecting increasing rationalization and centrality of science systems in dealing with contemporary challenges, including H2020. A new understanding of the inherent dangers of science and technology seems to become paradigmatic along the years, especially with the rise of consumer capitalism (Hall, 2009).

Futures narratives show, overall, a central tension between control, production and intentions (who produces science and technology, and why?), access (who benefits from it) and impacts (either beneficial or harmful). In fiction, innovation and technology become risks, not solutions. The described patterns express the harmful impacts of science and technology over individual life and social systems: instead of contributing to a real emancipation process, science is mainly oriented to the development of technological applications. It 'seeks not knowledge but information, not understanding but practical application. It thus leads not to genuine enlightenment but to re-inscription within the new myth of the power of technology' (Booker, 1994: 12). Governance emerges as a central question: science and technology are controlled either by corporations or by states, citizens tend to be passive or absent from political life, and are essentially portrayed as victims both of (intended and unintended) harmful decisions, and of increasingly sophisticated manipulation. Major concerns expressed through novels and films include (the lack of) ethics and the possibility of growing inequalities (old and new).

Turning back to science and technology in GSCs literature (section 1), these are generally aimed at solving problems and serving the economy and society's needs (notably, Challenge 4: Smart, green and integrated transport, aimed at tools to

improve urban infrastructures, services, and housing). In H2020 (EUCO 2013) ICT and digital inclusiveness (digital economy and digital technologies) are central tools for key societal challenges such as community relations, consumer behaviour, political participation and public governance. H2020 'will promote inclusive ICT solutions and the effective acquisition of digital skills leading to the empowerment of citizens and a competitive workforce' (EUCO 2013: 1024).

However, the oppression, inequality and the ethical issues that fiction envisages as central to, and inseparable from innovation, technology and science, are almost absent from GSC formulations. In futures fiction scientific and technological developments emerge less as conditions for economic growth and resource efficiency, and more as the solution for increasingly complex health and environmental problems, and they often transform from solution into an even greater problem, leading to anti-utopian futures (see patterns in Table 2). Science and technology are mainly portrayed as directed to power, profit, order and control (exemplified by the pattern: 'science as a tool for manipulation, control and rationalization', with 27% of incidence), with significantly negative impacts on human beings and society.

There is a strong link between the warning signals raised by fiction in terms of techno-science, and in those discussed above in terms of scarcity. The GSC-driven research agenda recognises problems such as the growing digital divide, an insufficient digital literacy, and the safety and security risks associated with the digital world. But it tends to address some of the potential negative 'side effects' in reductionist ways, calling for more innovation and multi-disciplinarity, and reiterating that technology and the growth of the ICT industry are seen as the fundamental drivers for the knowledge society (and economy) and empowerment of the citizens. A more explicit and comprehensive consideration of potential anti-utopian effects of techno-science would seem, at least welcome precaution.

3.4) *Humans and nature: will we be able to breathe in the future?*

Turning to the 'Environment - Technology versus Nature' core challenge, we find 25 texts (39% of all texts) contributing to a pattern that exemplifies the dramatic degradation of the relationship between humans and nature: categorized as '*(near)impossibility to breathe in open air*'. A complex range of human choices in managing nature – often leading to disastrous events linked to industrial production resulting in severe air pollution (references to nuclear disasters, acid rain or climate

change), underpin the imagined future (*The Machine Stops*, *The Space Merchants*, *Cloud Atlas*, *Logan's Run*, *Avatar* or *The Day After Tomorrow*, just to mention a few). The common trait of these 25 texts is that humans will find it almost impossible to breathe naturally in the open air. This dominant aspect of the future in fiction is remarkable given the symbolic nature of breathing as the act that ensures life, and to our ability to be conscious of ourselves. It seems to represent the ultimate alienation from nature, and from our nature.

Another major pattern has to do with urbanization, and relates to the extreme density of urban spaces, associated with the verticality of the buildings, and wide development of urban and/or industrial areas (present in 22 of the 64 texts). It condenses recurrent visions related with futuristic and high-tech scenarios, wide industrial landscapes, and artificial cities, landscapes and features over our six historical periods. *Alphaville*, *Logan's Run*, *Minority Report* and *Blade Runner* are some of the examples of the ultimate vision of a technological city, in mainly the late capitalist settings, where the urban fabric is the visual mirror for technological progress and, or, industrial achievement. The city can also become an entirely artificial environment, where cities are under glass domes, with no contact with the exterior (*The Machine Stops*, *Logan's Run*, *Cloud Atlas*), or where natural elements were replaced by artificial green (*The Tomorrow File*, *The Space Merchants*).

Thus, the analysis of fiction reveals a profound connection between built environments, individual alienation and social collapse. Future urban settings are not only visual backdrops of the eminent social collapse, but also, and most importantly, they are at the very origin of the hostile, awkward, absurd systems in themselves. This finding is confirmed by the critiques of urban scenarios and science fiction (Collie, 2011: 428) stressing 'the alienation produced in subjects in and by built environments; the relationship between built environments and nature; the effects of a centralization of oppressive or controlling power upon individual freedoms (...)'.

Another pattern in this core challenge is 'aesthetic/ spiritual value of nature'. It is depicted in 20 texts, nine of which belong to the post 9/11 fiction (2001 to nowadays). Where Earth has fallen victim of what we might call the Anthropocene and its devastations (*Avatar*, *Elysium*; and *Waterworld's*), nature is the paradise lost. Invisible, and yet absolute annihilation of nature is suggested in *The Matrix*: images of 'reality' show desert and urban destruction, suggesting that man-made (or natural) catastrophic events have led to current destruction: *Morpheus*: 'Welcome to the desert of the real' (*The Matrix*). In this pattern, nature is a synonym of escape,

renewal and eternity, where nature is valued as an end in itself (*The Road*), as a source of peacefulness (*Mad Max*), as an experience of redemption:

'It was possible Richards would take him outside to do it. Wolgast hoped he would, someplace he could see trees and feel the touch of sunlight on his skin, before Richards put a bullet in his head. Maybe he'd even ask. Would you mind? he'd say. If it's not too much trouble. I'd like to be looking at the trees.' (*The Passage*, 2010, p.478-479).

It is seen as an idyllic, poetic dimension, and valued in an aesthetic and spiritual sense, as in *We*, *Fahrenheit 451* or *The Space Merchants*; or envisaged as the last non-corrupted domain, as in Winston's dreams and experience in 1984. Nature represents an occasional and brief escape from the oppression of the system (*The Handmaid's Tale*). There is a theme of hope and return: hope that one day one might find the way back to the surface of planet earth, for the enjoyment of the contact with nature, a place of comfort, a return to the origins – *The Machine Stops*; hope to restore the link between humans' rational and intuitive nature (*Children of Men*, *Brasil*, *Twelve Monkeys*). Nature is the last non-corrupted domain that needs no human intervention to exist and be beautiful: *'Nature, at least, didn't need an operation to be beautiful. It just was.'* (*Uglies*); it is the embodiment of interconnectedness and continuity:

'A network of energy that flows through all living things', 'Energy is only borrowed, one day you have to give it back' (*Avatar*).

Nature also becomes the embodiment of utopia: an imaginary representation to help 'sell' a new colony, outside planet earth:

'a whole planet to sell... a highly imaginative series of shots of Venus as it would be when the child grew up —verdant valleys, crystal lakes, brilliant mountain vistas' (*The Space Merchants*).

Imagined futures relating to this core challenge also promote reflexions about themes high on today's environmental policy agendas: increasing environmental interconnectedness and resulting fragility (34%), species extinction and decline in biodiversity (34%) and the threat of food scarcity, as well of its artificial replacement and lack of choice (28%).

The prevailing pattern of 'food scarcity, replacement & lack of choice' can be found in 18 texts, and has strong links with the idea of the 'end of nature' and technological solutions. Fiction vividly depicts worlds with limited or no natural food: food synthesized from petroleum (*The Tomorrow File*; *We*); food derived from soya (*The Lathe of Heaven*) or artificially created from all kind of waste (*The Diamond*

Age); genetically modified (*The Passage; Feed*) and engineered (*Soylent Green*); food as pills (*Vexille*) or in the shape of an illusion: in *The Matrix* no traditional forms of food are left, except as illusions in the world created by the *Matrix*, while in the real world a soup is described as a 'bowl of snot'. In *The Tomorrow File* we have petrol-based food: 'I ate my prochick and, drank my petrowine, and asked myself no questions.' (p.53)

In terms of scarcity, several stories illustrate it, for example: delicacies such as bean curd, ripe peaches, cheese costs two weeks' salary and bottles of wine are secured in safe boxes in banks (*Do Androids Dream of Electric Sheep?*); food is rationed (1984) or scarce (*Windup Girl*); raw meat and canned food (*District 9*); famines are sometimes central to the narratives (*The Tomorrow File; We; The Lathe of Heaven*).

This core challenge embraces aspects from three of H2020's GSCs: 2, 4 and 5, and once again, fiction offers warning signals and raises issues that are absent from H2020 framings of the challenges. It shares, in particular, H2020's emphasis on food's (in)security when projected into the future. And yet, the significant overlap of issues discussed, is characterized by major differences in the way these are conceived and developed. The focus of GSC 2, Food security, which seeks to promote bioindustry, biotechnology, new sources of food and agribusiness, compares with the far more multidimensional discussion in fiction: including quality and availability with issues of control, manipulation and denial of real choice at the expense of human health. Fiction also emphasizes impacts such as 'loss of biodiversity' and the 'growing interconnectedness and resulting fragility' of future worlds. The last decade's debate surrounding genetically modified organisms, and the food scarcity uprisings in the late 2000s are just two cases in which fiction warnings are matched in daily news.

H2020 GSC 5, Climate action, environment, resource efficiency and raw materials, emphasises efficiency and sustainability of energy production/consumption and the transition towards a more green economy and society. In contrast, fiction engages with the issues of this GSC through, inter alia, three of the highest frequency patterns identified throughout our study: 'Interconnectedness and resulting fragility', 'Species extinction and decline in biodiversity', and '(Near)impossibility to breathe in open air' are among the most represented patterns depicted by the analysis of the texts. The tendency is to conceive of the problems in a highly interconnected and interdependent manner, shifting the more traditional

focus on environmental implications, towards the broader theme of the impoverished relationship between humans and nature.

In stark contrast with the prevailing tone of H2020 priorities, fiction reveals a high frequency pattern: 'Aesthetic/ Spiritual Value of Nature' which stands out for the depth and breadth of themes and concerns embraced. In future imaginaries, the balance of natural environment is not only represented as essential condition to the survival of the human species but as a value in itself, adding an aesthetical and spiritual value to human life, which – fiction emphasizes – the urban fabric cannot provide. This sense of alienation from nature echoes with critiques of the dominant socio-economic model that seek to go beyond the immediate implications of ecological disruption, to reveal a deeper but possibly more pervasive impact on quality of life, and meaning of life (Washington, 2013).

3.5) Future societies are highly stratified and unequal

The fourth core challenge 'Society and social change' reveals how speculative and science fiction portrays societies with high levels of 'stratification and inequality' (pattern present in 21 texts) resulting from: 1) granting importance to intrinsic traits such as: genetic raking, IQ measures, and ability; 2) external appearance; and 3) being labelled as primitive or evolved, human or not human (*The Tomorrow File, We, Brave New World, Stand On Zanzibar, The Windup Girl, Gattaca, Distric 9, and Applesed*). In some of these texts individuals are 'produced' and conditioned for specific social positions, as is the case described in *Brave New World*:

'I suppose Epsilons don't really mind being Epsilons,' she said aloud. 'Of course they don't. How can they? They don't know what it's like being anything else. We'd mind, of course. But then we've been differently conditioned. Besides, we start with a different heredity.' (chapter 5)

Or biological stratification in *Do Androids Dream of Electric Sheep?* :

'classed as biologically unacceptable, a menace to the pristine heredity of the race. Once pegged as special, a citizen, even if accepting sterilization, dropped out of history. He ceased, in effect, to be part of mankind.' (p.15)

Overall, futures fiction offers a strong representation of the continuity and deepening of the social inequalities, namely through the effects of classic institutions and structures such as property and education, leading to significant loss of human dignity. 22 narratives portray societies where individuals are differentiated according

classic socio-economic conditions: wealth, professional status or consumer profile, access to knowledge, information, sometimes consciousness and critical thinking (*Infinite Jest, The Swarm, Matrix or Minority Report*).

Another pattern ('stratification of workers and occupations') reveals a future of labour within hierarchical structures and cultures (*Paris in the Twentieth Century; 1984*), with elaborate criteria for job allocation, including being fit-for-purpose (eg. moral, age, sex and biological characteristics), belonging to caste systems (*Metropolis; The Time Machine; We; The Handmaid's Tale; The Giver, Brave New World*); or being genetically manipulated, or created for a specific task (*Cloud Atlas; Do Androids Dream of Electric Sheep?; The Windup Girl; The Tomorrow File*). These criteria are often accompanied by the lack of freedom to choose one's occupation, and conditions leading to highly differentiated workers and occupations by genetic traits, age, gender, moral, perceived ability or political position. Humans will be competing with robots or clones for available jobs; wage levels will be used to manipulate and control: robots, clones or aliens replace natural 'pureblood' human beings in heavy duty jobs (*District 9; Vexille; Paris in the Twentieth Century; Cloud Atlas; The Windup Girl*), or services (*Do Androids Dream of Electric Sheep?*).

Women inequality is another important pattern. Gender has been scrutinized in the fields of future studies and popular art, namely through ecofeminist perspectives (Hurley, 2008, Gunnarsson-Östling, 2011), emphasizing the persistent domination of masculinist images of the future, and a limited imagination concerning the depiction of new female roles. The patterns found in 20 of our texts portray women in unequal conditions and roles, including asymmetrical treatment and gender binary systems, submission or confinement to the domestic sphere (*Paris in the Twentieth Century; Stand on Zanzibar, The Handmaid's Tale*, and the more contemporary *The Swarm, Soylent Green, Fahrenheit 451 and Blade Runner*).⁹

Absence of consumption reflect fiction societies organized in ways that do not include consumption and tend to be totalitarian (*Avatar; Things to Come; The Giver; We; 1984; The Machine Stops; Brave New World*); or include stories that envisage the end of consumption due to the collapse of society (*The Handmaid's Tale; The Stand; Z for Zachariah; The Passage; The Road; La Jetée; Twelve Monkeys*) or due

⁹ Women in predominant and leadership roles are also portrayed in fiction, though to a lesser extent. References to gender inequality occur across all our historical timeline (Table 1) but women in a protagonist or leadership role emerge clearly in the seventies and became a more frequent feature in the last decade, pointing to an evolution in the gender representation. This evolution is even more visible in the texts targeting younger audiences, as *The Hunger Games, Feed or Uglies*.

to impoverishment (*The Hunger Games*; *Soylent Green*; *Metropolis*). In *Twelve Monkeys* there is no advertising, no private consumption:

'Cole: I've never seen the ocean. Raily: It's an advertisement, Mr Cole. Cole: What? It's an advertisement. You understand that, don't you? It's not really a special message to you, Mr Cole.'

Fiction's patterns of consumption and labour raise warning signals that echo trends observed in today's economies and societies. Today's critiques of consumption and consumerism, coming from the perspective of wellbeing, psychology and ethics (Bauman, 2007; Dervis, 2014; Ferraro and Reid, 2013; Frey and Stutzer, 2005; Hamilton, 2010; Jackson, 2002), are all reproduced in the vivid images and texts reviewed here. The extreme stratification of workers and occupations is often linked to induced patterns of consumption, and both entail varying degrees of genetic and artificial manipulation and a loss of individual human rights. The prevailing impression is one linking consumerism with control and manipulation, at the expense of human dignity, partly achieved through biotechnology and other artificial interventions on human beings and partly the result of authoritarianism. Thus, fiction raises warnings that include and surpass notions of, for example 'excess capitalism' (Urry, 2010).

Finally, a pattern of 'resistance and opposition movements', offers a reaction to stratification and inequality, and the underlying lack of democratic systems. Circa 31% of our texts describe the existence of opposition movements to the establishment: groups fighting exploitation by corporate power, and underground movements trying to escape repressive political systems. Futures fiction thus combines representation of risks and warning signs with the construction of 'new imaginings' and alternatives through political opposition as an important engine for social change and individual emancipation, fulfilling the functions of creative input, detail and warning highlighted in Box 1.

In summary, fiction envisages increasing and deepening stratification and inequality (both old and new: genetic and biological) in the societies of the future where human dignity is largely expendable. These are socio-economic systems that thrive in non-democratic contexts. GSC 6 (Europe in a changing world), addresses poverty reduction, the need to combat inequalities and tackle social exclusion, combined with underlying processes associated with inequality, such as employment or education; the reversing of inequalities by understanding and reducing differences between groups of society, by studying social unrest, extremism and xenophobic behaviour. Yet fiction's emphasis on multiple stratifications and erosion of dignity,

and their link to eroded or absent democratic systems where techno-science becomes a socio-political system of control, is almost absent in H2020.

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4) Discussion and conclusions

This inquiry's premise is that European science policy is guided by Horizon 2020 challenges (EURO, 2013) with the explicit aim of shaping the future, and that the analysis of 64 texts from fiction can enrich our understanding of these challenges, through creative input, detail, warning, reflection, critique, involvement (Box 1). We now discuss results in terms of what shape our future is likely to take, when we combine insights from fiction and science.

4.1) *Joining the dots: scarcity, techno-science, society and responsibility*

Based on a detailed analysis of the material presented in Section 3 we argue that the patterns underlying the four core challenges (Table 2), are tied together by one dominant trait of the future in fiction: control and manipulation of the people by those holding power, in socio-political contexts where democratic values are eroded or absent. The dimensions within 'Science/Technology and society' are found to be a major factor in facilitating such control and affecting 'Individuals, society and culture'. In fiction, techno-scientific projects promote social inequality and stratification, a loss of human values and widespread dehumanisation processes. In turn, control and manipulation (often served by powerful technology) affect the 'Environment' and the 'Demography and Social Change' core challenges, leading to potentially anti-utopic and dystopic futures, or collapse.

In this overview, scarcity – understood here in the orthodox way – is a major trigger. It is scarcity, real or perceived, that drives innovation and technology in fiction's futures, while also directly affecting the patterns of social inequality and dehumanization processes. In real world policy discourses, scarcity is central to GSCs framing, but with different interpretations and with an essential link to the economy and growth. In fiction, the interplay between these dimensions can trigger a complex series of choices and events leading to collapse, dystopian and anti-utopian futures defined by control and manipulation. Recent and growing reference to the Anthropocene (Griggs *et al.* 2013; Noone 2013; WBGU 2014) echoes archetypal concerns expressed in fiction over the last 150 years. This study thus provides an alternative perspective to the call for more attention to the economic, social and environmental implications of the Anthropocene.

Art envisages (and represents) the possibility that irresponsible use of power, influence and control of human beings over nature would have irreversible consequences on the natural systems supporting life on Earth. According to Hans

Jonas (1984), the unpredictability and irreversible consequences of our action, in this 'Anthropocene' age, requires an ethics of precaution and responsibility. The extent of our power over nature implies that responsibility is no longer confined to our lifetime: 'Act so that the effects of your action are compatible with the permanence of genuine human life' says H. Jonas (1984: 11). Fiction illustrates what loss of nature and of 'genuine human life' looks like, and what might trigger it. Science policy has the responsibility to understand and prevent such futures.

4.2) Warning signals and weak or absent priorities

Results confirm the strong relationship between fiction and foresight notions of warning, possibility and desirability, reviewed in section 2.1. They show that fiction can contribute to research policy debates in two ways.

First, raising what might be considered 'warning signals' (sections 1 and 2.1) in relation to dimensions present in both fiction and within the H2020 challenges. Such warning signals confirm concerns raised in the existing literature on social criticism and future visions in popular culture (Booker, 1994; Braun, 2015; Lawler, 1980; Miles 1990), revealing two interconnected traits: 1) the praise of the technological, scientific, rational model, with its mystification of science and faith in computer science to explain life, present in utopian texts; 2) the nihilistic and critical tendencies underpinning dystopian and anti-utopian texts.

Second, highlighting areas and dimensions that are either poorly defined or absent from current H2020 challenges, and detailed in Table 3. Futures fiction suggests there is a need to increase research into human, social, political and cultural processes involved in techno-science endeavours. Patterns identified in Table 2 suggest the framing of GSCs may be too narrow in relation to: 1) the risk of increased and renovated processes of control and manipulation, technology based, affecting the relationship with and between nature/environment, individuals and societies; 2) the threat of dehumanization processes and loss of meaningful lives and of human values; 3) the increase of social inequalities and discrimination. Insufficient attention to these dynamics may hasten society's fall into anti-utopia and dystopia or collapse.

Table 3. Overview of concerns (patterns) discussed in the 64 texts (novels and films) and not in H2020

Major Themes	Dimension	Concerns (patterns) discussed in the 64 texts (novels and films) and not in H2020	
1.a) Financial, Economic Development	Consumption and behavior	Absence of consumption* Radical consumption and control	
1.b) Innovation and technology, resource efficiency	Information	State control over information Corporations control over information Machine control over information	
	Technological development	Technology used for social domination and manipulation* Technology use restricted to specific ends or for/by elite groups* Absence of technology	
	Science	Science as a tool for manipulation, control and rationalization* Science for profit Science as a way to control nature Science is suppressed or non-existent	
2.a) Demography, social change, skills and empowerment	Population development	Controlled growth	
	Family and fertility	Family constitution as government regulated High fertility Infertility Regulated fertility & artificial human reproduction	
	Health	High "pharmaceuticalization"	
	Migration	Migrations for planned repopulation Restricted migrations Unrestricted migrations	
	Education and human capital development	Education as indoctrination programme Enforced illiteracy	
2.b) Individuals, society and culture	Happiness and wellbeing	Loss of meaning and values	
	Systems of beliefs	Social control and conformity Security and survival	
	Connectedness	Interest and utilitarian dimension Loneliness and Isolation Distrust and abuse	Distaste of physical contact Sense of community Mediated interaction
	Progress and future	Dehumanization processes* Progress as control and conformity	Future time as hope Impossible future
	Identity	Strong homogenization* Discrimination and social violence Collapse of collective references	Collective projects and values Fight for personal project
	Meaning of life and existence	Loss of meaning Repression/ absence of personal projects Self-consciousness and personal project	Survival and security Sense of Community and/or nature related values Power and hedonistic values
	Conceptions of the human	Dehumanization processes Human nature traditional definitions Freedom versus control tools	Trans and post-humanism Human versus non-human
	Entertainment and art	Entertainment as manipulation tool Sex and drugs as recreational activities Prohibition and/or destruction of artistic objects	
3) Environment and Food (resource efficiency)	Ecological systems disruption and air quality/ pollution	Artificial systems replace natural ones	
	Representations of Nature	Aesthetic/ Spiritual Value of Nature* Alienation from Nature Nature as the Un-civilised	Control & Exploitation of Nature Scarcity/ Absence of Nature
4) Governance and Security	Political systems	Technology as socio-political instrument of control	
5) Scarcity and Waste	Scarcity	Scarcity of human values* Scarcity of physical resources Scarcity of civil and political liberties	Scarcity of vital human needs Scarcity/ absence of Nature
6) Urbanisation	Expression and representation of architectural elements	Architecture as sign of power Stratification elements	

Note: * Indicates a MAJOR concern in fiction (i.e. a high frequency pattern)

4.3) Fiction's contribution towards researching and shaping desirable futures

At a time when the future imagined by bureaucracy, government policy and business is strongly shaped by a 'single technology-centred trajectory' (Torgerson in Rickards *et al.*, 2014: 589), and when most scenarios 'eschew extreme futures... in order to increase their perceived relevance to decision makers [allowing] scientists to adhere 'to the scientific norms of restraint, objectivity, skepticism, rationality, dispassion, and moderation'' (Bryse in Rickards *et al.*, 2014: 596), fiction may be in a position to 'speak its truth to power' – in ways that science is not.

One of the purposes of establishing GSCs has been to map the main trends and possible disruptive global challenges, and the 64 texts examined provide an extremely vivid map of imagined challenges of an imagined future. We argue that this is especially relevant given that most of H2020's challenges are explored throughout these stories, but in significantly different ways. To the extent that utopian traits are represented, they tend to shrink within the boundaries of technological fixes. Thus, the initial notion of utopia from the 16th century, representing the confidence in the human ability to build a different and better social order (Vieira 2010), makes way to an increasingly reductionist interpretation of utopia, often degenerating into anti-utopian conditions.

Thus popular art offers a wealth of 'scenario-like' material, mainly focused on the archetypal future of systemic breakdown and socio-political-ecological collapse: what Raskin and colleagues (2002) call the archetypal worldview of 'Barbarisation'. In other words, it provides an excellent service to decision makers engaged in prioritizing challenges and the research of solutions, by elaborating on the question of 'what if': suggesting that many of the potential solutions to today's challenges, as envisaged in H2020's agenda, might 'shape' a less-than-desirable future of control and manipulation at the expense of human dignity. The texts present us with stories that often elaborate, and provide a vivid description of what the Council Decision on implementing H2020 (EUCO 2013: §6.1.1)', calls the 'number of important human, social, environmental and economic costs' resulting from 'the constant quest for economic growth'. Their resulting warning signal is compelling, and ought to be heard, not least because elements of such future have already escaped the imaginary world to make part of today's experience.

Both H2020 and future's fiction emphasize techno-scientific solutions and applications while envisioning progress. However, while H2020 tends to embrace these in relatively unproblematic terms, fiction raises far-reaching questions

concerning the consequences of the technological development, and in particular, draws attention to the social aspects and implications of techno-scientific solutions. Combined with the fear of the 'impersonal', of 'man's ability to be turned into a machine', and the need to fight to retain one's humanity (Sontag, 1965: 47), these fictional anticipations raise the question of what it means to be human in the 21st century.

The answer that we find in these anticipatory imaginative discourses is not reassuring. Most of the analyzed dimensions under core challenge 1 (Individuals, society and culture), reveal complementary patterns that describe states of isolation, indigence, bewilderment, and lack of meaning that leave individuals in an under-human condition. The described situations of a living without dignity are reinforced by the annulment of self-consciousness and critical thought, under the stress of manipulation and control (exercised by the power agents through the uses of technology), preventing people to act and promote change. In addition to the warning of the existential risks that humanity as species may be facing (the risk of annihilation of intelligent life in the planet), fiction also warns us about the risk of an existence where individuals and communities stop being agents of their own destiny.

Greater priority should thus be given to the understanding of societal processes linked to the introduction and widespread use of advanced technologies, and to research into the human, social and demographic dimensions of technological progress, reorienting H2020 towards human rights, ethics, justice, public participation and acceptability – acknowledging the increasing anxiety of contemporary existence. The investment in the *Innovation Union*, and thus in innovation through technological solutions ought to be accompanied by an equally intense commitment to debate its social implications, and the dimensions of reciprocity and equality: European citizens should be empowered with the tools to critically assess and debate science, technology and innovation development. This is especially urgent given the exponential pace of technological change and advances (Diamandis 2012; *The Economist* 2014; 2015).

Fiction (but also contemporary commentaries in mainstream media) brings us vivid illustrations of what happens when science interlocks with political and mostly commercial interests, suggesting that far greater effort and care ought to be devoted to understanding the implications of increasingly privatized research and innovation. However, when compared with the rich exploration of apparently similar themes and dimensions in fiction and in H2020 GSCs, we find that the latter tend to be framed in

more narrow, competitive-driven and technologically focused terms, consigning risks of social and environmental injustice to a second plan. We thus concur with scholars who find that current H2020 priorities assume that 'all innovation is socially beneficial' (Levidow and Neubaue, 2012). It seems that 'grand challenges have been generally framed in ways favouring capital-intensive technoscientific solutions, at the expense of other approaches'; even when the possibility of promoting alternative research agendas is perfectly viable (Levidow and Neubaue, 2012).

Our research identifies specific areas of inquiry that would benefit from greater attention in any future European research agenda (Tables 2-3), especially relating to the nexus of individuals-society-culture, and a wider framing of scarcity. The insights and suggestions arising from this analysis support, and add urgency, to arguments favouring a more balanced and inter and transdisciplinary research agenda capable of promoting a meaningful engagement between the natural sciences, the social sciences and the humanities (section 1). They also raise the less evident but perhaps more fundamental need to engage with the notion of societal progress, and hence with what purpose (and future) we might want innovation and technology to serve. Ultimately, fiction about the future points to our tendency to seek problems and solutions outside of ourselves, in the external spaces and dimensions we inhabit and in techno-scientific projects. It tells us stories of a time when technology will either be unable to solve our problems, or will become itself the problem, suggesting that it may be necessary to rethink, both today's problems and tomorrow's science challenges.

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Appendix

List of analyzed texts (films and novels in chronological order)

Novel Film	Title of film or novel	Author	Original year	Country
N	Paris in the Twentieth Century	Jules Verne	1863	France
N	The Time Machine	H. G. Wells	1895	UK
F	Le tunnel sous La Manche	Georges Méliès	1907	France
N	The Machine Stops	E. M. Forster	1909	UK
F	La police en l'an 2000	no credits	1910	France
F	Verdens Undergang aka The End of the World	August Bloom	1916	Norway/Denmark
N	We	Yevgeny Zamyatin	1921	Russia
F	Metropolis	Fritz Lang	1926	Germany
N	Brave New World	Aldous Huxley	1932	UK
F	Things to come	William Cameron Menzies	1936	UK
N	1984	George Orwell	1949	UK
N	The Space Merchants	Frederik Pohl and C.M. Kornbluth	1953	USA
F	On the Beach	Stanley Kramer	1959	USA
N	A Clockwork Orange	Anthony Burgess	1962	UK
F	La Jetée	Chris Marker	1963	France
F	Alphaville	Jean-Luc Godard	1965	France
F	Fahrenheit 451	François Truffaut	1966	France
N	Stand on Zanzibar	John Brunner	1968	UK
N	Do Androids Dream of Electric Sheep? /Blade Runner	Philip K. Dick	1968	USA
N	The Lathe of Heaven	Ursula K. Le Guin	1971	USA
F	Solaris	Andrei Tarkovsky	1971	USSR
F	Soylent Green	Richard Fleischer	1973	USA
N	The Tomorrow File	Lawrence Sanders	1975	USA
N	Z for Zachariah	Robert C. O'Brien	1975	USA
F	Logan's Run	Michael Anderson	1976	USA
N	Ender's Game	Orson Scott Card	1977	USA
N	The Stand	Stephen King	1978	USA
F	Dawn of the Dead	George Romero	1978	USA
F	Mad Max	George Miller	1979	AUST
F	Blade Runner	Ridley Scott	1982	USA
N	Neuromancer	William Gibson	1984	USA
F	The Terminator	James Cameron	1984	USA

N	The Handmaid's Tale	Margaret Atwood	1985	Canada
F	Brazil	Terry Gilliam	1985	UK
F	RoboCop	Paul Verhoeven	1987	USA
F	Total Recall	Paul Verhoeven	1990	USA
N	The Giver	Lois Lowry	1993	USA
N	The Diamond Age, or A Young Lady's Illustrated Primer	Neal Stephenson	1995	USA
F	Twelve Monkeys	Terry Gilliam	1995	USA
F	Waterworld	Kevin Reynolds	1995	USA
N	Infinite Jest	David Foster Wallace	1996	USA
F	Escape from L.A.	John Carpenter	1996	USA
F	The Fifth Element	Luc Besson	1997	France
F	Gattaca	Andrew Niccol	1997	USA
F	Matrix	Lana e Andy Wachowski	1999	USA
N	Feed	M.T. Anderson	2002	USA
F	Minority Report	Steven Spielberg	2002	USA
F	28 days Later	Danny Boyle	2002	UK
F	Code 46	Michael Winterbottom	2003	UK
N	Cloud Atlas	David Mitchell	2004	UK
N	The Swarm	Frank Schätzing	2004	Germany
F	Appleseed	Shinji Aramaki	2004	JAP
F	The Day after Tomorrow	Roland Emmerich	2004	USA
N	Uglies	Scott Westerfeld	2005	USA
F	V for Vendetta	Lana e Andy Wachowski	2005	USA
N	The Road	Cormac McCarthy	2006	USA
F	Children of Men	Alfonso Cuaron	2006	UK/USA
F	Vexille	Fumihiko Sori	2007	JAP
N	The Windup Girl	Paolo Bacigalupi	2009	USA
F	District 9	Neill Blomkamp	2009	USA, NZ
F	Avatar	James Cameron	2009	USA
N	The Passage	Justin Cronin	2010	USA
F	Hunger Games	Gary Ross	2012	USA
F	Elysium	Neill Blomkamp	2013	USA