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Strategic use of Design Fiction in Technology Innovation Management

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ABSTRACT

The paper proposes to analyse the role of anticipatory practices in understanding the processes of technological evolution for the definition of innovation strategies within organizations. To support decision-making processes in technology innovation management, it has been proposed that the rapid transformations of the fourth industrial revolution could be framed through interpretive models such as the Hype Cycle. In order to guide the development processes within organizations, it is argued that it is necessary to further articulate such interpretative frame through the Advanced Design model. An approach based on Advanced Design is intended to assist the evaluation of the potential impacts of technological innovations in complex environments under the influence of multiple factors. The paper discusses the potential and the opportunities that design fiction can bring to decision-making in research and development processes.

Keywords: Strategic Design, Technology Innovation Management, Design Fiction

INTRODUCTION: EXPERIMENTING AND VALIDATING NEW MODES OF TECHNOLOGY INNOVATION MANAGEMENT WHEN INNOVATION IS EXPONENTIAL

Digital technology is profoundly and pervasively changing the industrial economy, just as industrialization changed the agricultural economy. This observation is not a hyperbole.

Digital technology is an innovation domain that intersects (as General-Purpose Technology) with three other innovation domains: biology, nanotechnology, and neuroscience. These four domains together converge to create the platform of the Fourth Industrial Revolution (4IR) (Schwab, 2016).

All this is generating changes that we can already see in the way economic activity is conducted, in the type and modes of value exchange (cryptocurrencies and Non-Fungible Tokens, for example), and in the definition of new digital and networked spaces experienced by users through real-time rendering, virtual and augmented reality technologies.

These phenomena occur following trends that are no longer linear (as was the case in the previous three Industrial revolutions) but exponential in nature (Diamandis & Kotler, 2012). Humans have developed an interpretive capacity based on linear-type changes, during their evolution. As Espindola and Wright (2020) note, our minds are focused on managing conservation processes, considering threats, and seeking pleasures, leaving us with very few attentional resources to understand the impacts of phenomena that assume exponential trends:

> Picturing in our minds how technologies move imperceptibly across what appears to the brain as distant and slowly approaching horizons -- only to be surprised as they suddenly explode in front of us at speed and volume -- is one of the great mental conundrums of the Exponential Era. These explosions in the growth and the unprecedented rates of adoption of new technologies are leaving most of us unprepared and in wonder. We find ourselves trying to set our minds to a view that is capable of constantly adapting to the sudden appearance of new technologies and digitally driven transformations. [...] Humans have difficulty observing and responding to the future. We have trouble extrapolating meaning or even putting energy into understanding a time period that appears to be far away. While some of us can marshal and focus our brain's processing energy on "futures," most of us can't. In fact, very few of us can focus for extended periods on our future. The reason is fairly simple. Our brains are not comfortable with diverting energy from human self-preservation and survival. In order to survive, we are careful with how we allocate our finite brain energy; and it is very much "in the moment!" (p. 122)

The "Exponential Era" calls for a need to change the cognitive posture underlying decision-making and strategic planning processes to adapt to the new exponential transformative configurations triggered by the 4IR. Otherwise, if adaptations that occur assuming linear trends persist, then errors will be just as persistent resulting in difficulties, crises, and transition costs (Figure 1).

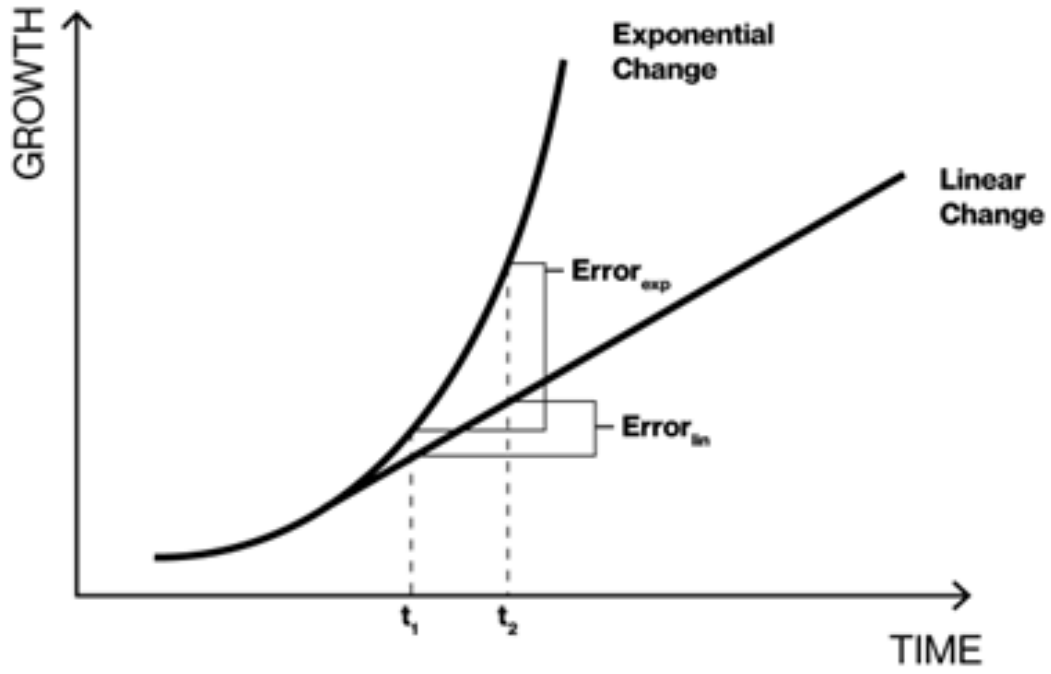

Figure 1. Error in exponential and linear transformation

Interpretive models of changes within the 4IR have been described following functional dynamics of the Hype Cycle model, an interpretive framework proposed by the consulting firm *Gartner Inc.* that describes the path taken temporally, in terms of expectation or visibility, of the value of technology. According to the Hype Cycle model, most innovations-technologies, services, and disciplines progress through patterns of overenthusiasm and disillusionment, followed by phases of mainstream adoption and productivity. The Hype Cycle model describes what has been dubbed the "First Law of Technology" according to which "we invariably overestimate the short-term impact of a truly transformative discovery, while underestimating its long-term effects" (Collins, 2010).

When new 4IR technologies promise bold changes, how can the hype be discerned from what is commercially feasible for an organization (public or private) or even a professional? When will these promises prove profitable? Will they be?

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Gartner's Hype Cycle suggests an interpretive mode of exponential change. It dynamically builds along 5 sequential stages, these same stages constituting the life cycle of a new technology characteristic of 4IR:

1. **Innovation Trigger**: identifies a potential technological breakthrough that kicks off new things. Early Proof-of-Concept experiences, on the one hand, and media interest, on the other, trigger significant visibility. At this stage, however, there are no usable products yet, and their commercial viability is unproven.

2. **Peak expectations**: initial promotion produces a series of success stories, often also accompanied by failures (less visible to an inexperienced and/or inattentive observer from the prevalence of daily work routines).

3. **Chasm of disillusionment**: interest wanes when experiments, implementations and investments, particularly supported by venture capitalists, fail. Technology manufacturers withdraw or go out of business. Investment progresses only if surviving vendors improve their products to meet the expectations of early adopters.

4. **Enlightenment ramp**: at this stage, cases or situations where technology can be useful to the organization begin to crystallize and become more understandable. Technology providers are introducing second and third-generation products to the market. More companies are willing to fund pilot projects.

5. **Productivity plateau**: This is the final stage, where mass adoption begins to prosper. Criteria for assessing supplier profitability are more clearly defined. The technology's broad applicability and market relevance are paying off.

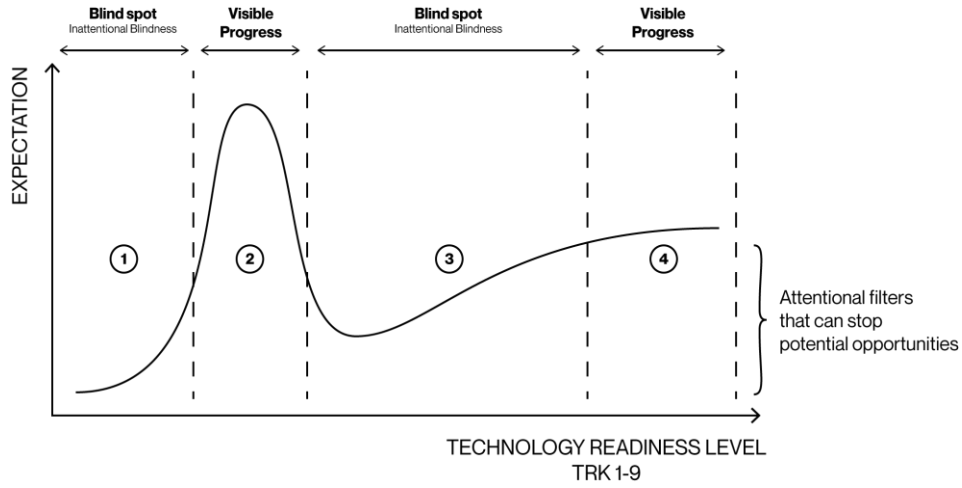

Figure 2. Hype Curve and attentional filters. Adapted from Fenn and Raskino (2008)

The Hype Cycle curve runs along two main Cartesian axes (Figure 2). The horizontal axis describes how an innovation goes through each phase with the passage of time. Hype Cycles related to a single topic aim for predicting the future path of a technology. The vertical axis describes expectations. Expectations for an innovation vary (positively and negatively) as the degree of maturity of the technology progresses. The level of change in expectations for an innovation fluctuates with the assessment of its expected market value (not just the monetary one). This axis highlights the changing sentiment of adopters (potential and actual) and the changing pressures affecting investment decisions.

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The Hype Cycle curve incorporates two key factors of rising expectations: hype and an innovation maturity level. When market hype for an innovation rises, it begins its ascent toward the peak of (inflated) expectations. The excitement surges, creating unrealistic expectations that are not met because of the innovation's low level of maturity. With high expectations and low maturity, innovations fall into the abyss of disillusionment.

As innovation matures, it ascends the slope of enlightenment. Early adopters realize the real benefits of the innovation, causing organizations to raise their expectations until the innovation reaches mainstream adoption at the so-called “Plateau of Productivity”.

If we overlay to this step-by-step model the idea of attentional deficits and cognitive biases that block awareness about potential opportunities, individuals and organizations develop blind spots, making this interpretative model problematic to use. In particular, blind spots emerge in the initial stages of innovation triggering and in the "chasm of disillusionment" stages that require special attention, lest we suffer the disruptive effects of technological change. As known from neuroscientific research, humans exhibit a limited ability to distribute and sustain attention, show difficulty in retaining detailed information in memory, and struggle to simultaneously manage or switch between goals when these are in competition with each other. Moreover, inattentional blindness occurs when one fails to notice an easily visible but unexpected visual stimulus (Simons, 2000). This temporary inattentional blindness is probably due to the abundance of visual stimuli worth noticing. The best-known scientific experiment demonstrating inattention blindness is called the "Invisible Gorilla Test," conducted by Daniel Simons and Christopher Chabris (1999). A group of participants were asked to watch a video of people dressed in black and white passing a basketball to each other. Participants were asked to count the number of times the team in white passed the ball. During the video, a person dressed in a black gorilla costume walks between the two teams. Next, participants were asked if they had seen anything unusual in the video. Almost half of the participants responded they had not. The sight of the gorilla, despite its obvious salience, had escaped the attention of many observers, who were focused on the challenging task of following throws and passes. Because participants were so focused on the number of times the white team passed the ball, they completely ignored other visual information.

Technology transformation rates are often misaligned with organizations’ capability to adapt. Organizations need to identify strategies to anticipate the future impact of innovation on their reference sector. The adoption of Advanced Design (Celaschi et al., 2018; Celi & Formia, 2015; Iñiguez Flores et al., 2014) approaches within organizations addresses such issues combining future sciences, trend analysis, anticipatory and visualization practices (such as design fiction) with organization’s TIM needs. Advanced Design is based on anticipation, extreme design, shelf innovation and design without client (Celaschi et al., 2017).

The main components of Advanced Design application within organization involve:

- Analysis reports on emerging technologies contextualized within the extended organization’s reference market system and industrial sector.
- Creation of Living Labs in which both expert and non-expert are involved in a design-driven participatory process in which insights are gathered from field research and users’ or participants’ experience.

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- Definition of “anticipation scenarios” as representation the future socio-economic, environmental, and technological landscape in which business models for product-service system innovations and opportunities are drawn.
- Support knowledge generation activities within the organization that provide insight into trends and weak signals by experts at the forefront of specialized research domains.
- Develop knowledge transferring programs within the organization.
- Use of design fiction to enhance the ability to envision preferred and plausible futures in transformative ways that diegetic prototypes enable a more articulated and participated speculation of future scenarios.
- Development of open laboratories where innovative concepts can be shared with selected stakeholders and the potential applications of emerging technologies can be explored.

1. COMMUNICATING COMPLEX CHALLENGES THROUGH DESIGN FICTION

Contemporary global challenges, such as climate change, social and economic crisis, and the spread of infectious diseases, prospect complex future scenarios due to their nonlinear and often unpredictable evolution. Such challenges are called wicked problems *(Rittel & Webber, 1973)* because of the wide uncertainty involved in understanding and dealing with them. Moreover, describing such problems in an understandable and comprehensive way to both experts and non-experts represents an additional complexity, especially in the contemporary communication landscape characterized by rapid transformations in communication and media.

Designers have developed tools and practices to represent data in relation to its context in order to make it more accessible and understandable. With the growing production of data generated by digital tools, from consumer devices to specialized sensing technologies, the use of computational methods to analyze such data allows researchers to identify emerging patterns and trends. Application, for example, can be found in the social sciences and humanities (Manovich, 2020). However, the complexity of the framework before us is overwhelming, and the interconnections and overlapping dependencies among its components are often hidden and counterintuitive.

Understanding these complex dynamics is the first step toward picturing their possible evolutions and designing strategies to mitigate their unwanted impacts. Futures studies suggest that by observing mega trends and listening for weak signals, it is possible to identify possible, plausible, and probable futures (Voros, 2001). The use of speculative practices in design can help open a collective debate to define what preferable futures we should aim for and what influencing factors may lead toward such desirable scenarios (Celaschi et al., 2018; Celi & Morrison, 2019).

The practice of constructing design fiction is a world-building process in which each designed element represents an access point to the fictional world (Celi & Formia, 2015; Coulton et al., 2017). In designing such narratives, the focus is not on the story but on the wide variety of interactions (between humans and/or objects) that can emerge from the fictional world. In

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constructing this speculative scenario, the designers' goal is to prototype the possible future environment in which to analyze the development of new potential interactions mediated by future products and services.

Such prototypes are intended to provoke debate and should foster interest and motivation for organizations (Boer et al..., 2013) to invest in research and innovation. The goal of design fiction is not to produce market-ready products or services but to open a space for discussion triggered by the prototypes that populate the plausible future worlds that are being investigated by the speculative inquiry (Lindley & Coulton, 2015). By harnessing the potential of cinematic representation, diegetic prototypes can activate organizational innovation processes and promote societal acceptance and interest in technological advances and applications (Kirby, 2010).

There is a growing interest in how diegetic tools can help stimulate discussion on such complex topics. In this sense, design fiction and diegetic prototypes (Bleecker, 2009; Sterling, 2013) have the ability to enable people to shape possible future scenarios by broadening the audience to non-specialists (Celi & Formia, 2015). Different types of media have been used to construct design fiction narratives: short films, novels, physical prototypes, and installations. Design fiction has phantasmagorical ability to translates concepts, ideas, and data into deeply evocative and thought-provoking narratives. Design fiction narratives are designed in collaboration with researchers, scientists, fashion designers, 3D artists, and sound designers to produce short movies, installations, and exhibitions that speculate about futures scenarios. Using video game and movie technologies makes it possible to visualize such speculations in which diegetic prototypes become the driving narrative force aiming to start the critical reflection.

2. DESIGN FICTION TO DESIGN ALONG THE HYPE CYCLE

As noted above, the hype cycle interpretive model proposes to read the evolution of expectations regarding a technological innovation with respect to its level of development (TRL). However, it should be noted that the model has uncertainties with respect to its actual ability to describe the trend of hype when compared with empirical data. Dedehayir and Steinert (2016) identify three theoretical foundations on which the curve proposed by Gartner is built that constitute the source of the inconsistencies that emerge with respect to their quantitative analysis: the mathematical construction of the curve, resulting from the sum of the bell curve representing the peak of expectations introduced by a new technology, and the S-curve describing the maturity of a technology with respect to performance (Dosi, 1982); the imprecision in the definition of the y-axis; and the lack of a specific target of stakeholders against which to report the level of hype (firms, governments, NGOs). In analyzing the phenomenon of expectations, the authors suggest taking into consideration three elements, namely, the "innovation," the "media," and the "social system," all of which evolve dynamically with respect to the progress of time. Indeed, the time factor happens to be decisive in technology and innovation management (TIM) strategies. In order to assess the future impact that technology might have on production processes, the market, and user behaviors and usage habits, we believe that the reading of the curve must be contextualized with respect to different reference systems representative of a plurality of plausible future scenarios.

The need to contextualize technological innovations to assess their possible impacts and to guide TIM choices is necessary because the actual ability of technology to spread and be

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transformative is not only due to the level of development achieved by the technology itself but is also determined by the characteristics of the scenario in which it is made available. Technology might have a low impact if, for example, the infrastructure needed to make it work is not yet widely available or if environmental conditions altered by climate change will have rendered it inefficient. Changing cultural context might mean that society is unwilling to accept the use of a particular technology because it is outside shared ethical norms or conversely, changing social conditions might make hitherto uncommon technologies viable once again. Competing technologies may, meanwhile, have emerged as industry standards, putting the one being analyzed out of the market but opening the possibility of evaluating integration models and strategies. The target market to which the technology refers could evolve by defining new types of users with new needs and modes of consumption.

The construction of "what if" scenarios through virtual representations is one way to start the debate on the possible future impacts of adopting or developing a particular technology. The media that can be used to produce design fiction are numerous and can include a multitude of expressive media: short stories, novels, graphic novels, audio-visual productions, and video games. Between 2019 and 2020, the New York Times published in its "op-eds from the future" series (https://www.nytimes.com/spotlight/future-oped) several opinion articles set in future scenarios and written by scientists, philosophers, and science fiction authors. These articles offer fictional debates on the impacts that new technologies, actualized in the speculative future timeframe, are having on political, social, and economic issues. Topics range from the installation of neural chips to genetic editing. Of particular interest is the use of journalistic language and the newspaper medium, which help make the proposed speculative content more easily referable to a plausible scenario.

The use of prototypes contextualized in the future to investigate technological innovations to be implemented in present products is widely used in the automotive industry. Concept cars can be made not only to explore new formal languages but also to investigate new ways of using vehicles, especially in a transition phase such as the current one in which consumption models are changing and electric motors are gradually replacing thermic ones. Such evolving dynamics are determining the need to innovate products and production processes in the automotive industry. The use of narrative media to explore future ideas about the transportation industry can be found in the project "City of Tomorrow", developed in collaboration between Ford and Experimental Design firm between 2017 and 2019. “City of Tomorrow” explores the future relationships between users, mobility, and smart cities through immersive installations that investigate the relationship between the mobility infrastructures and the sensing and computational technologies of the smart city. Another case study that blends the difference between the physical and the digital world is the 2022 presentation of the Ferrari Vision Gran Turismo virtual concept car. Designed for the Gran Turismo 7 (Polyphony Digital, 2022) video game, the concept car uses the video game medium to develop formal concepts and engineering solutions, some of which are patented for real-world manufacturing that can be faithfully reproduced in the driving simulator.

The potentialities introduced by enabling technologies make the creation of physical and digital prototypes quick and cost-effective. In particular, real-time rendering software and virtual and augmented reality technologies enable credible and immersive worldbuilding in which the interactive component can be an effective tool for speculative co-design. The diffusion of advanced and, at the same time, more accessible technologies allow for the inclusion of more stakeholders in the confrontation processes triggered by the collaborative

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construction of design fiction scenarios, fostering the development of more participatory and shared decision-making processes.

3. CONCLUSIONS

For strategic planning in TIM, it is necessary to assess the role and potential of a specific technology, at a given level of development, in a range of plausible future scenarios. Advanced Design approaches within organizations that leverage open innovation can support decision making through the inclusion of a wider range of stakeholders and through the participation of observers from outside the organizations. Design fiction represents a strategic tool to navigate the hype curve of technology innovation by allowing for a more nuanced understanding of the system of constraints and variables. The implementation of strategies based on Advanced Design and open innovation act on several levels:

- Facilitate participation across the organization's departments to articulate the discussions on strategic innovation issues from multiple specialized perspectives;
- Integrating cross-sectorial innovation processes through the contribution of participants from within and outside the organization;
- Opening discussion about the organization's positioning with respect to complex issues both from business and cultural perspectives;
- Fostering the transmission of knowledge between departments;
- Enabling processes of continuous and shelf innovation;
- Creating a favorable condition for the development of start-ups and spin-offs from the interaction with cross-sectorial contexts;
- Bring the organization into the public debate on major social, economic and environmental issues.

An organization's ability to understand and anticipate the future impacts of emerging technologies is a necessary strategic resource in technology and innovation management. Models such as the hype cycle offer a partial view of future scenarios that are characterized by increasing levels of complexity in which technologies alone do not represent an element of disruption. Rather, they constitute together with the articulated techno-socio-environmental system, a component that can be designed and planned. Therefore, the continuous mapping of technological development must be coupled with observation and analysis of macro trends and weak signals that contribute to outlining a range of possible future scenarios. This approach of continuous observation and critical analysis can be effectively synthesized and enhanced through design fiction. In this sense, the use of immersive visualization and interaction technologies can represent a broad field of development on which to direct future research and applications.

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