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# Science Fiction Prototyping as a Tool to Turn Patents into Innovative Marketable Products

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**Abstract.** Science Fiction Prototyping (SFP) has a lot of potential as a tool to help turn patents into innovative marketable products. The underlying assumption of this paper is that many patents from research institutions and corporations alike lie idle when it comes to their actual realization and commercialization as real products. The conceptual paper focuses on patents that are already application-centric and constitute a technology prototype. Despite technological foresight and trend analyses gaining increasing momentum and attention in theory and practice, we anticipate a lack of creativity and future context in opportunity identification following invention. Whereas traditional methods focus on product prototypes and technological foresight, context prototypes gain substantially less attention. The paper derives a conceptual framework that addresses this gap and introduces SFP as a tool to foster commercialization efforts and business innovation. Its contribution is threefold: We explore new ways of how to spot new capitalization opportunities on patents, suggest SFP as a strategic tool to provide a more structured way of creative thinking to seize future market opportunities and aim at supporting SFP as an increasingly sophisticated method in technology forecasting and future science.

**Keywords.** science fiction prototyping, invention, patents, technology, opportunity recognition, marketable product, commercialization

## Introduction

The impact of public science at research institutions and universities on technological progress has long been of political interest [1]. Moreover, the attention to the transfer of knowledge from an academic setting to industry settings has increased substantially in the past three decades [2]. At research institutions, science has priority over commercialization of inventions. Inventors strive for peer recognition and career rewards such as tenure, publishing and maybe even patenting their invention [1]. Interest in the private sector however is set on commercialization and investing in R&D and failing to commercialize on the developed technology can lead to critical losses [3]. Spinning out from academic institutions is thus a topic that is gaining increasing interest in the theory and practice alike. Technology transfer offices (TTO) are one means to foster commercializa-

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tion of academic research into marketable products (e.g. [4]). Focus is often set on sole patenting and not making the next leap into licensing and advancing commercialization efforts. An underlying assumption of this paper is that due to multiple incentive structures and governmental initiatives a substantial amount of inventions and patents from research institutions and corporations alike are created. However, when it comes to the actual commercialization as real marketable products, we can assume that many patents lie idle. This notion is supported for the European context by recent research by Giuri, Munari and Pasquini [2], who find that a large share of university and public research organization patents remain actually commercially unexploited. Whereas patents can cover a wide range from basic research, material science, device, processes and applications to fully functional prototypes, this paper focuses on the latter two categories. Patents, or more explicitly the number thereof, are often used as an indicator of innovation[5]. But what about marketable products that are generated from patents or patent applications? How do we actually figure out what to do with a technology or technology prototype once it is in place? What are barriers to commercialization and how can they be overcome?

The role of SFP in promoting creative thinking and innovation is increasingly discussed in the literature (e.g.[6,7]). The underlying goal of SFP is to present new perspectives on a technology that can actually feed into its real development [8,9]. More explicitly, the prototype is not a thing that is actually built but a rough approximation of a desired thing we hope to build in the future [10]. In this paper, we follow a more integrative approach by proposing that SFP can be used in combination with real prototypes in form of application-centric patents and has a huge potential to advance current technology and design by putting technology patents into possible future context space. We thus contribute to an increasing literature base that more and more establishes SFP as an integrative method. Wu [6] introduces imagination workshops that are based around a set of feedback loops. Their approach describes SFP as an iterative evolutionary co-creative process. Grimshaw and Burgess [11] suggest a mixed method approach in which researchers follow the development of a design prototype through a forward simulation scenario. They base SFP on an empirical case study, which is then extended. Potstada and Zybura [7] highlight the intersection of creativity, technologies and future context. In order to commercialize on a patent (product/ application-centric), which we see as a proxy for a real product prototype, a future entrepreneurial opportunity has to be recognized. We consider SFP as a highly valuable method to make this leap.

In this paper, we will follow-up on the previous development to further emancipate SFP as a method. We will first derive a framework that is based on the opportunity recognition process by introducing possible future contexts to loosely coupled technology prototypes. Then, we will explicate the framework by providing examples that have already been realized in application-oriented patents but still lack full commercialization potential. Discussing the future context of the technology can be led into a positive feedback loop or virtuous cycle of discussion till the actual pull factors from the demand side become more and more concrete and needed competences to develop the envisaged application into a marketable product can be determined.

## 1. Theoretical Background

Novelties created by newly emerging technologies also capture a substantial amount of promises around their transformative character. It is hard to actually forecast future demand of a technology when actual market applications are still in the realm of technological promises and associated expectations but are not yet realizable [12].Technology forecasting helps to anticipate the direction and rate of technology change. Priority setting, resource allocation and risk reduction are highly important in this process. Analyzing industry trends via patent data analysis is one way to approximate future technological innovations [13,14]. As one facet of forecasting, Martino [15] describes environmental scanning. This process constitutes searching the relevant literature (such as technical, trade and business literature) to identify events that might give an inference about later developments. This perspective considers waves of basic research at the start followed by applied research, development and application phase, and social impact, which each overlap slightly in the later stages of each phase over time [15]. In order to benefit from new technology, it has to be successfully commercialized into innovative products. This needs new ways of thinking and breaking out of the status quo [16].It is hard to assess the true value of a patent without knowing the future market and having exact market information. Thus, a profound evaluation of patents is necessary to support management decisions concerning R&D projects and commercialization strategies [17]. The work by Malanowski and Zweck [17] states that Germany has reached a good position in the supply of primary products (e.g. nanotechnology, information communication technology) but companies in the US appear to be faster at transforming research results into products.

Quite some prior research addresses understanding and quantifying the contribution of academic research to actual commercialization in form of industrial applications from an economic perspective (see e.g. [18,19]). Legislative reforms such as the Bayh-Dole Act in the United States have played a significant role in providing incentives to commercialize on patents [20]. Also in Europe, reforms aim at providing incentives for universities and public research organizations (i.e. increased ownership certainty and returns) to advance their technology transfer capabilities by investing in commercialization structures [21]. These incentives also promote the establishment of technology transfer offices (TTOs). TTOs professionally manage and strengthen technology transfer and evaluate which invention or idea to patent and license. Anticipated commercialization potential may play a vital role in whether to pursue the patenting process or not. Commercialization efforts usually have three forms: patent licensing, patent sale and spin-off formation [2]. But if a significant share of patents remain actually commercially unexploited [2], how can we make an inference on which ideas and patent applications have potential to be turned into marketable products? What are potential ways to foster more innovative and application-oriented thinking to transform inventions to spot these opportunities?

Having the right patents combined with effective commercialization promises returns in product sales and licensing income. Assessing the true value and future opportunities may be particularly hard for academic patent applications generated from research projects that are far from ready to enter commercialization [13]. Scientists have strong incentives to invent and to publish the results of their inventions and maybe patent them. However, they often lack business expertise and future vision. TTOs can only partially compensate for this shortcoming, as the patent application filed to them should ideally already comprise an assessment of commercialization potential. Also not all companies achieve to realize the full potential from their patents[13], which fuels the assumption of a lot of patents being idle (i.e. in a folder ”on the shelve”). Limitations in human resources and financing surely play a role but also an inability to identify and seize busi-

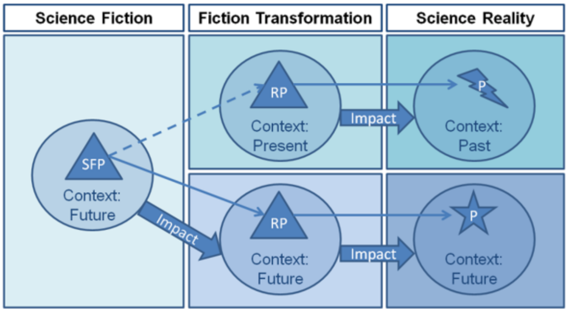


**Figure 1.** SF Prototypes (SFP), Real Prototypes (RP) and Products (P) in their respective context. Illustration according to Potstada and Zybura [7]

ness opportunities [14]. The creation of successful businesses follows a successful opportunity development process.

While some people tend to notice information related to what they already know more easily [22], others are very sensitive to sensing market needs or problems around them. They continuously perceive possibilities for new products (or solutions) in any environment in which they find themselves [23]. In most literature, the entrepreneurial process is investigated after opportunities have been discovered [24]. Shane [25] however analyzes opportunity recognition at hand of a sample of companies using an early version of 3D printing and respective patent applications, the 3DP$^{TM}$ process that was invented at MIT in 1989. He finds that even though the technology of 3DP$^{TM}$ is known and available in patent applications, has been introduced at relevant conferences, and has been dealt with in a variety of mainstream journals only few entrepreneurial opportunities in this domain have been discovered. Entrepreneurs seem to discover these opportunities without actively searching for them and will most likely discover those opportunities that are related to their prior knowledge and experience. The findings are more in line with Kirznerian thought and hint at that the discovery of entrepreneurial opportunities depends on the distribution of information in society [26,27]. Technological change (at hand of 3DP$^{TM}$) and associated patents thus does not necessarily lead to entrepreneurial opportunities being recognized right away. Consequently, entrepreneurs have to discover opportunities in which the new technology can be exploited and consider an opportunity to be valuable in order to generate entrepreneurial profit [25,28].

From a SFP perspective, Wu [6] puts strong emphasis on workshops as an exploration form of SFP to foster technology-based business innovation. Wu [6] introduces a methodology that centers on a modified evolutionary model of the Science Fiction Prototyping creation process (cyclic SFP), which is based around a series of feedback loops. It is an iterative evolutionary co-creative process inking imagination, creativity and technology. They form the three components of technology innovation in Wu's innovation triangle [6].

Linking creativity, entrepreneurship and opportunity recognition has also been of prior research interest [29,30]. Hills, Schrader and Lumpkin [31] have found that creativity is significantly related to opportunity recognition. The economy rests to substantial degree on knowledge based activities. While knowledge and the application thereof have long been recognized as vital, scholars argue that imagination, creativity, entrepreneurship and innovation form a next level [16,32,33]. Creativity is seen as a source of rec-

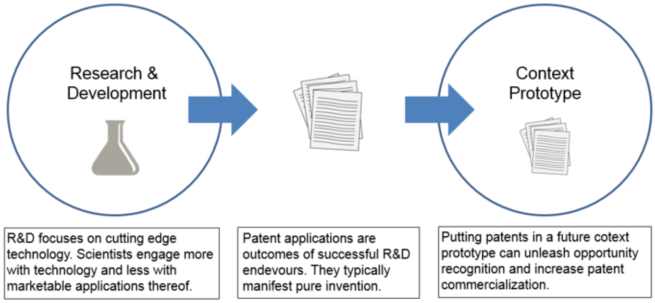


**Figure 2.** Enriching R&D and resulting patents with dedicated context prototypes to foster opportunity recognition and commercialization.

ognizing opportunities that develop under the influence of altering environmental conditions [34]. We observe that creativity, imagination, entrepreneurship and innovation are increasingly gaining momentum [6,16]. Following this logic, Potstada and Zybura [7] highlight the intersection of creativity, technologies and future context (Figure 1). They further provide a context prototype and technology prototype perspective, which they put up for further debate. Central to their argument is that a sole focus on the technology prototype leads to a disconnection with the relevant future context and a consequential mismatch. The real product prototype then does not live up to its future context in science reality and consequentially the product (if developed at all) solves the problems of yesterday. The framework starts with SFP as an inspirational source, which leads to real prototype (RP) realization in a fiction transformation stage. However, SFP and especially the context dimension can also benefit already existing and patented product prototypes. Bringing them into future context enables to think about commercialization potential from a technological and societal perspective (i.e. how will future users interact with technology). In the next section, we will further elaborate on this notion.

## 2. Framework & Discussion

In this section, we will further build on the capability of SFP to help in detecting entrepreneurial opportunities by highlighting its role as a source for creativity and inspiration. We consider entrepreneurial thinking as pivotal in the exploration of commercialization potential. Moreover, we assume that entrepreneurial opportunities are not solely discovered because people rest on what they already know from their experience. But how to reach beyond when Shane [25] finds that discovery almost solely rests on prior knowledge? We suggest that profound discourse enabled by putting patents in a future context prototype can unleash opportunity recognition outside the own area of expertise and beyond past context. The underlying logic is depicted in Figure 2.

### *2.1. Science Fiction Prototyping to put Patent Applications and Patents into Future Context*

Opportunities are highly dependent on the context in which they are embedded. This applies especially to those opportunities that have a game changing character or, in Schum-

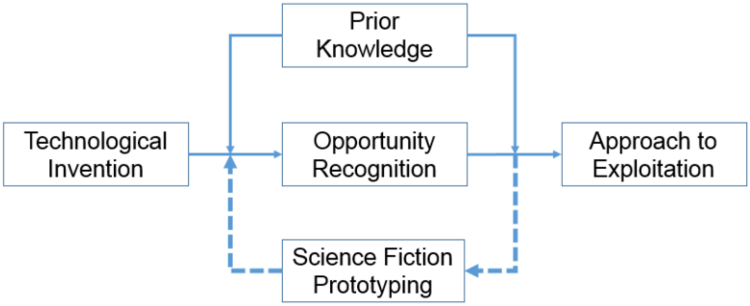


**Figure 3.** Including a SFP loop to enrich prior knowledge with future context.Illustration adapted from Shane [25].

peterian terms, are highly disequilibrating [35]. Cognitive limits and knowledge specialization can prevent entrepreneurs from identifying the complete set of opportunities enabled by a given technology [25,36]. Hence, we propose that to leverage the enabling technology (real prototype, patent) to its full potential in terms of commercialization, entrepreneurial opportunities need to be regarded in their future context.

There is usually a significant time lag between when a patent is filed for application and commercialization attempts, so that business implications and marketable applications are hard to define [13]. Thus, it is especially difficult to obtain market information and to get feedback, as both potential markets and potential customers are hard to determine. Invention and innovation do not go hand in hand. To mitigate this gap, Hsieh [13] suggests business plan contests to stimulate more ideas for commercialization. We are of the opinion that business plans should come into the game once the market can be defined and consider SFP as a more suitable tool of exploratory analysis. This tool rests on imagination and creativity.

Entrepreneurial creativity is dependent on the social environment and advanced by individual decision makers. It is important to recognize that it exists prior to, during and even subsequent to the lifetime of a business [37]. Following Amabile [38], entrepreneurial creativity captures the generation and implementation of novel, appropriate ideas to establish a new venture. Uncertainty is not resolved by creativity due to a lack of certain calculable information to start from. Nevertheless, creativity has been studied with respect to its role in handling ambiguity [39]. Creativity strongly supports the process of resolving conflicting interpretations of the environment. Thus, it helps to derive novel solutions in problem solving and can help anticipate problems before they occur. What is more, creativity helps to connect previously unconnected ideas and concepts and advocates freedom to think outside the boundaries of existent knowledge. We regard SFP as a source of creativity [6,7]. Accordingly, we add a SFP loop to the framework by Shane [25], as illustrated in Figure 3. This connects to SF prototypes and their context dimensions. The context dimension offers scenarios in which a current technology or advancement thereof is applied to a fictional future setting (Figure 1). This helps fulfilling anticipated future needs and facing respective future challenges before they occur. Via the SFP loop, we facilitate bringing technical capabilities of the real prototype (i.e. a technology filed for patent application) from present into future context and thus advance the transformation from a technological vision into a product that meets market needs several years ahead of its times. We thus help to prevent a potential mismatch that comes into being when real prototypes fall short of commercialization because they get stuck in prior knowledge instead of being leveraged to new potential licensing or spinout activities that lie beyond what past knowledge prescribes. While the limitation that we cannot foresee the future, real customer needs and cannot quantify demand prevails, the suggested approach enables a sophisticated discussion about the future. It shall serve as inspirational source to think beyond the past or present context to discover new application opportunities in the future that hopefully prevent patents ending up in folders on the shelves. Following Grimshaw and Burgess[11], one could refer to the suggested methodology as a mixed-method approach. By introducing a SFP loop into technology development we foster opportunity recognition and thus help to advance commercialization efforts. When application-based patents are put into future context, new ways of commercialization can be explored. In order to explore commercialization potential in terms of opportunity identification, we suggest to use an imagination workshop setting and a cyclic SFP approach as suggested in prior research by Wu [6]. The SFP workshops ideally involve participants with a diverse background such as the inventors, technology experts, industry experts, legal experts, designers and potential users. Potential questions asked should e.g. address the future living environment, how people will be like and how they interact, what kind of lifestyles people will have, what technologies will dominate life, what business will be like and how it is conducted, and how society will evolve [6]. We have introduced a future context dimension enabled by SFP that should both enable and serve as a feedback loop to the opportunity recognition process and facilitate approaches to exploit technological invention.

### 2.2. *Framework Application to Potential Use Cases*

Often, our way of thinking or what we know is based on reflections of past experience and the full potential of new base technology eludes our imagination. One very famous quote in this respect is ”I think there is a world market for maybe five computers.” by Thomas Watson, president of IBM in 1943 [2]. One has to mention that back then computers where the size of houses, whereas we have highly powerful smart phone computers in our pockets today. New potential use cases are also limited in our thinking due to the way we interact with technology we know. The world of exploring new possibilities enabled by a base technology rests on incremental changes, innovation and reaching beyond what we are used to in our current habits. The following use cases are corporate examples of application-centric patents with an existing technological prototype.

*Smartwatch Patents*

In July 2013, Samsung has filed a patent for a digital wrist watch named ”Galaxy Gear”. The official description as filed at the U.S. Patent & Trade Office (USPTO) is ”Wearable digital electronic devices in the form of a wristwatch, wrist band and bangle for providing access to the Internet and for sending and receiving phone calls, electronic mails and messages; wearable electronic hand-held devices in the form of a wristwatch, wrist band and bangle for the wireless receipt, storage and transmission of data and messages and for keeping track of and managing personal information; smart phones; tablet com-

[2]for more examples see *http://www.techhive.com/article/155984/worst_tech_predictions.html*

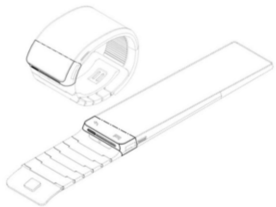

**Figure 4.** Patent drawing by Samsung associated with patent serial number 86022079 at USPTO.

puters; portable computers" [3] While it is still questionable whether the market is really there for smart watches, the technology is definitely on the rise. Smart phones resemble mobile central computing hubs rather than just phones. Calls and texting are becoming more and more secondary applications browsing the web, media applications and getting work done on the way.[4] The patent drawing in Figure 4 reveals a flexible screen bending around the wrist. This would be realizable with a flexible OLED display. The version entering the market next to the Galaxy Note and first being shown officially to the customer on September 4, 2013 resembles a more conventional digital watch with a SuperAMOLED display. We claim that the patent itself serves as a source of inspiration and captures way more innovation and commercialization potential than has been realized so far. SFP would be a great tool to explore future potential and user interaction with such a technology and can also shed light on caveats such as e.g. privacy concerns. Next to the pure call and messaging functionality, this watch has a huge potential to be combined with biometrics (quantifiable self). Also medical application such as measuring blood pressure and blood sugar are high potential. The SFP loop can serve as a highly exploratory tool in order to derive potential future use cases and challenges in anticipating future business innovation concerning the base technology and resulting licensing opportunities.

### *2.3. Augmented reality Head Mounted Display (HMD) glasses*

Whereas Google Glass is already available via an Explorer Program [5], Apple has filed augmented reality Head Mounted Display (HMD) glasses in mid-April of 2008. The patent 20080088937 appeared next to "Enhanced image display in head-mounted display" found under application number 20080088529 and "Peripheral treatment for head-mounted displays" found under application number 20080088936. OLED displays were a likely option to be used in the display.[6] In July 2012, "Peripheral treatment for head-mounted displays" United States Patent 8212859 (first applied for in 2006) was granted and it was ruled that it does not directly describe a device like the head-mounted display (HMD) augmented reality glasses currently under development by Google[7]. The

[3] see USPTO TSDR, case id 86022079 *http://tsdr.uspto.gov/*

[4] for more information see "Samsung smartwatch patents revealed Samsung Galaxy Gear" on Clove http://blog.clove.co.uk/2013/08/09/samsung-smartwatch-patents-revealed-samsung-galaxy-gear/

[5] http://www.google.com/glass/start/how-to-get-one/

[6] Source: Patently Apple; http://www.patentlyapple.com/patently-apple/2008/04/ apple-preparing-a-cool-ipod-visual-head-display-system.html

[7] Source: Appleinsider.com;
*http://appleinsider.com/articles/12/07/04/apple_granted_patent_for_head_mounted_display_tech*

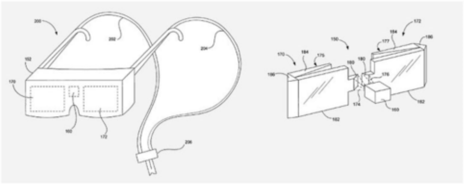

**Figure 5.** Patent drawing associated with Apple's augmented reality Head Mounted Display (HMD) glasses.

**Figure 6.** More product-oriented interpretation of Apple HMD as found on gamesalfresco.com

official description reads as follows: "Methods and apparatus, including computer program products, implementing and using techniques for projecting a source image in a head-mounted display apparatus for a user. A first display projects an image viewable by a first eye of the user. A first peripheral light element is positioned to emit light of one or more colors in close proximity to the periphery of the first display. A receives data representing a source image, processes the data representing the source image to generate a first image for the first display and to generate a first set of peripheral conditioning signals for the first peripheral light element, directs the first image to the first display, and directs the first set of peripheral conditioning signals to the first peripheral light element. As a result, an enhanced viewing experience is created for the user." For a schematic drawing see Figure 5. This being only the broad description, SFP could help discovering a wealth of future applications by shaping technology futures via sophisticated imagination. Figure 6 already provides us with a more indicative future scenario: Will the glasses combine augmented reality with our brain waves as loosely suggested? Potstada and Zybura [7] have developed a SFP in which consumers can discover highly adaptable consumer electronics and other goods in virtual stores. What they describe as "going virtual" has huge potential for HMD: A virtually real shopping or also gaming environment that is three dimensional in space and voice, motion and emotion-controlled would indeed open up totally new markets to the glasses. It would also change the way society interacts with technology fundamentally when thought-controlled head-up displays became widespread. We assume that inspiration in terms of potential application can spur innovation starting from the patent briefly sketched above.

### 2.4. Implications

Researchers or potential technology entrepreneurs who want to patent or even license their invention or need future outlooks can benefit from the proposed use of SFP in manifold ways. How to explore so far undetected use cases and future markets that will evolve from a new technology prototype (e.g. an application-centric patent) is challenging. Associated calculations of market potential are most likely tentative and ”back of the envelope”. We suggest to have patents and patent applications as a starting point to lead an exploratory discussion. A major implication of the SFP loop around opportunity recognition following invention (Figure 3) is that it enables a sophisticated discourse about new opportunities, the future and potential social change enabled by the new technology.

Next to patent applications, the approach also supports the use of existing patents getting stuck in the current science fact and their past context without potential future context assessment. We thus suggest that patents ’getting dusty on the shelve’ should be re-assessed with the more creative future assessment methodology suggested in Figure 2 and Figure 3. These existing patents are usually based on current science fact in form of a real prototype (Figure 1) and in present or even past context, which leads to a mismatch and thus stagnation in exploring potential product applications. Bringing these existing application-centric patents into future context can then unleash new commercialization potential and might attract investors and potential licensees.

In a pilot workshop setting, we have let master students develop SFPs around base technologies in organic electronics (OE). This emerging technology has substantial implications for digital fabrication and printed electronics. In combination with new printing technologies, the promise of new products and applications is huge.The environment is highly complex and patent-intensive and well-suited for a showcase of our conceptual model. Following a base technology presentation by a leading organic electronics consortium representative at Mannheim University, 11 SFPs have been developed in total (similar to the approach by Wu [6]) and are currently under further investigation. The participant groups had diverse backgrounds, and a group size of 5-7. They were made familiar with SFP, story vignettes and the 5-step SFP creation process. Future research should test the applicability of the suggested framework in practice and further look into the suggested SFP loop around opportunity recognition.

## 3. Conclusion

When a patent application is filed, the future market and how consumers will interact with the technology is largely unknown. This could lead to promising potential patents being rejected by e.g. TTOs in the application process but also to full innovation and commercialization potential of those patents that are filed being largely undiscovered. We consider SFP as a very powerful tool to address these shortcomings.

This idea paper introduces a conceptual framework on how SFP can potentially serve as a tool to promote the exploitation of technological invention in form of commercialization on patents. It thus constitutes an extension to prior work by Potstada and Zybura [7], who suggest that we should think about SFP and its application in a more strategic fashion. Both, exploring potential future markets of patent applications and putting existing patents ’on shelf’ into future context reflect a more strategic use of SFP to foster business innovation and commercialization of technology invention. The SFP loop is moreover likely to advance a better product market fit and to ensure a better adaptation to customers due to the creative process and discourse. Anticipating how customers interact with technology in the future is thus a powerful exercise.

Our showcases and workshop results hint at a possible approach. Once creative thinking is enabled and interdisciplinary discourse has been sparked by science fiction prototypes, high value future applications can be identified by letting workshop participants map the SFPs. This ideally leads to a prioritization. A possible way of mapping would be e.g. following a matrix representation suggested by Potstada and Zybura [6], who suggest a classification of SFPs according to their extent of future technology and context specifications. Future research should further investigate barriers to technology commercialization and how they can be overcome. Furthermore, the suggested framework needs application and validation.

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## A. Biographical Endnotes

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