Critical Futures Today: Back-casting speculative product design towards long-term sustainability

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ABSTRACT

The age of climate breakdown brings with it an uncertain future, even within our collective imagination we are presented with increasingly dystopian visions of the future. This tendency towards dystopian futures can also be seen in Speculative and Critical Design (SCD) process which emerged as a disciplinary response to challenge commercial design by envisioning radical futures scenarios and artefacts that so far has been limited to museum exhibits. This paper suggests a solution-driven SCD method exploring a 'designerly' reimagining of existing solar technology as a "back-casted" design solution into the present—a 3D printed optical solar cell. The solar cell is proposed as a possible, speculative alternative for existing solar cells exploring the "what if" possibilities of technological forecasting in a futures-oriented practise, ways in which product design can contribute to climate action today while still looking towards visions of better, more thriving paradigms of futures beyond 'business as usual'.

Key Words: Future, Speculative Design, Climate Change, Sustainability

1. INTRODUCTION

With the onset of cataclysmic climate breakdown and the sixth mass extinction, organised human life is presented with a bleak future. Anthropocentric climate change brings with it an existential threat—an unquantifiable *hyperobject* (Morton, 2016) that has sent ecological systems into a tailspin. There is enough compelling evidence[1] that much of this pervasiveness is an unleashing of the primal forces of nature only responding to the violent systems of extraction sustaining modern human civilisation[2], triggering the sixth mass extinction[3], melting the arctic ice cover[4] and degrading soil fertility[5] due to industrial activity on a global scale. According to the latest IPCC reports[6], we have 12 years to act in order to limit the global average temperatures to 1.5^{o}C—if we want to avoid triggering irreversible feedback loops. Even *if* we manage to reduce our carbon emissions, we will end up failing to meet the targets of the Paris agreement which is projected to result in a 2.7^{o}C increase[7]. While clean energy for a clean civilisation means a shift to 'clean' renewables from 'dirty' fossil fuels, it is important to understand that technology alone will not create the change we hope to see. Even when alternatives are introduced it is found that it is bound in a paradox—increasing the capacity for further growth and even more consumption (York, 2017). The shift to renewables such as solar is inherently dependent on depleting global reserves of several crucial minerals[8] such as copper and lithium (García-Olivares & Solé, 2015). Further, even when it comes to our cultural imagination of the future in science fiction, climate change creates echoes of dreadful dystopias, as a comfortable "warning of things to come" (Slaughter, 1998). If we are to avoid these self-fulfilling "mythical path dependencies of dystopias" (O'Brien, 2018)—we need alternatives to avoid a "defuturing"(Fry, 1999) of human civilisation itself. Insofar as the future is not yet determined, better visions of the future are not just required, they are essential. How we humans envision futures, is very much in the domain of design (Margolin, 2007)—a form of "designerly way of knowing"(Cross, 1999) the future. Designers could possibly be trained to conceive a *wicked* subject of climate change, and in the attempt at *concreteness* take the "wickedness" out of the problem (Buchanan, 1992). This paper looks at how speculative product design can make *concrete* the alternative design solutions of long-term sustainability today through "designerly ways of futuring". Speculative and Critical Design (SCD) as a practise attempts to "dream up alternative futures" by posing "what if" questions, in order to open up alternative future visions—not how things are but how they *could* be (Dunne & Raby, 2013). However, SCD as design research is under-articulated as a methodology (Bardzell et al, 2012) and offers little to no insight about *how* to make things[9]. The claim that SCD engages in "problem finding" as opposed to "problem solving" inadvertently leads to the provocations depending heavily on dystopian narratives, leaving the audience helpless and without a vision for action. This paper proposes an SCD method for a solution-driven, 'rigorous' imagining for long-term sustainability in the case of a 3D printed, optical solar cell as a speculative concept vision for climate action.

2. SPECULATIVE METHOD FOR 'DESIGNERLY' FUTURING

Foreseeing radically different futures beyond 'business as usual' depends on being able to visualize a future that doesn't yet exist. Designing for such a future context depends on garnering valuable foresight that through certain design tools can help create a vision both desirable and feasible. The premise of this SCD process explores an iterative method that combines future studies, design fiction and product design to create speculative future artefacts that are focussed on creating a design solution; in this paper this solution is focused on creating a solar cell. Design fiction is

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[1] Terms like "biological annihilation" and "insect apocalypse" have often been used. In essence, it is the collapse of whole ecosystems as a result of variations large or small in climate patterns that organisms cannot adapt to and perish.

[2] The extractive forces that create our cities, infrastructure, industrial systems of agriculture, manufacture, etc. are all dependent on scouring the natural world of "resources. Resources that are in fact being shifted on continental scales. "Earth's 'technosphere' Now Weighs 30 Trillion Tons, Research Finds." n.d. Accessed April 22, 2018. https://phys.org/news/2016-11-earth-technosphere-trillion-tons.html.

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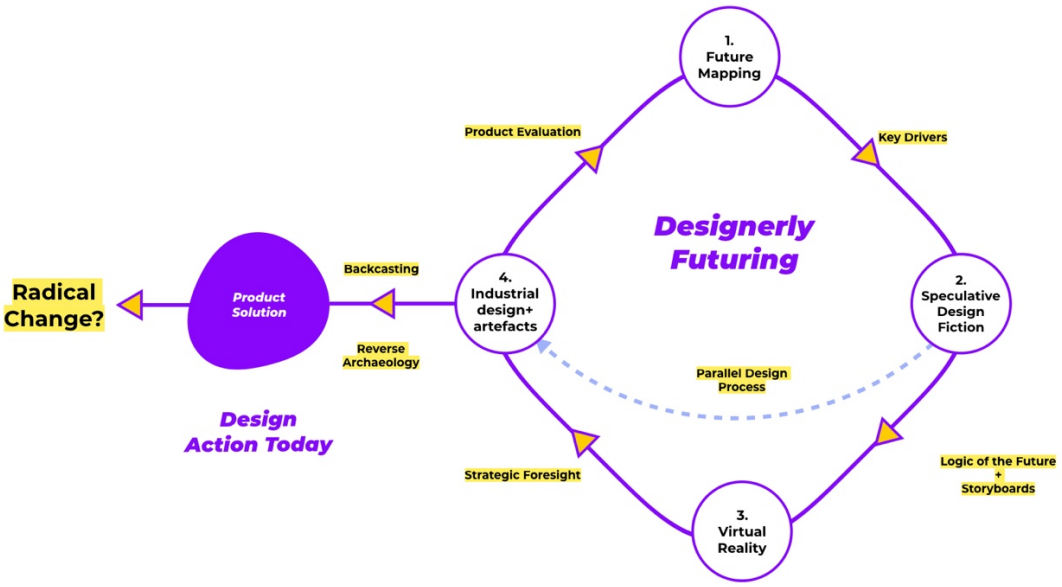
[8] Mulvaney, Dustin. "Solar Energy Isn't Always as Green as You Think." IEEE Spectrum: Technology, Engineering, and Science News, November 13, 2014. https://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think.

[9] Bardzell et al. observe that SCD uses Critical Theory for the provocations and thus has a general anti-method stance, which emphasizes meanings and effects of the artefact and not that of its creation. It ignores the individual agent of creation that is the author, ignoring his/her intention, the authors find out that this is a limitation to its application to design. This perhaps could be why critical design becomes an 'elitist mystery' like art itself.

explored here for a focused and creative way to think about possible future scenarios that broaden the solution space through designed artefacts. In this case, it is used to deliberate on the "real" possibilities of near and far future technologies of solar cells through narrative fiction. These fictional accounts create the "what-if" scenarios and frameworks similar to film production, that make fictional worlds possible in cinema (Wille, 2015). The possibilities of these artefacts follows a certain narrative logic or *diegesis* that allows for the suspension of disbelief whereby the audience can believe the performative role of the artefact[10], even if it cannot be *proven* to be real(Raven & Elahi, 2015). These so called "diegetic prototypes" create desirable technological possibilities as a "performative artefact" made real by contextualizing technologies through a narrative within the frame of speculation (Kirby, 2010). Designers thus enter these future narrative as archaeologists of the future, learning from and producing the artefacts from this imagined future (Candy, 2013). The future scenarios are chosen to envision better solutions to what exists today by garnering foresight from these speculative far future scenarios that are brought back and manifested in the here and the now, in this case, a solar cell. So long as the aim of the fiction is to *discover* an artefact from the broad solution space, apologetics can be used as a creative tool[11] to strategically justify or apologize for anomalous inconsistencies in the future scenarios without discarding possibilities (Shedroff & Noessel, 2012). Thus, in telling a compelling narrative of radically different futures, an encounter with a conflicting artefact may lead to a creative speculation of its own.



[Figure 1] *A iterative, back-casting Speculative Design Method proposed for creating alternative product solutions today (credit: Author)*

3. CASE STUDY: 3D PRINTED OPTICAL SOLAR CELLS

3.1. Imagining Better Futures: Three Horizons, Design Fiction and VR

A speculative design fiction titled "Blockchain Radioactive" was created by projecting the "symptoms" of a radically hopeful future over sweeping horizons in the Three Horizons framework (Curry & Hodgson, 2008). The technological and socio-economic drivers projected here are research areas being pursued *today* while allowing possibilities for speculation. Using these future horizons as the backdrop, a futures poker game[12] was created for building radical future scenarios by forcing combinations of these symptoms of the future that would undercut, amplify or interplay with each other. Apart from written fiction, "Blockchain Radioactive" addresses the question of solar energy in a speculative future as been *solved* in the form of an "energy harvest", visualized in virtual reality and film[13]. Each of them an exploration of the future scenario that is set in the post nuclear wasteland of Chernobyl. The

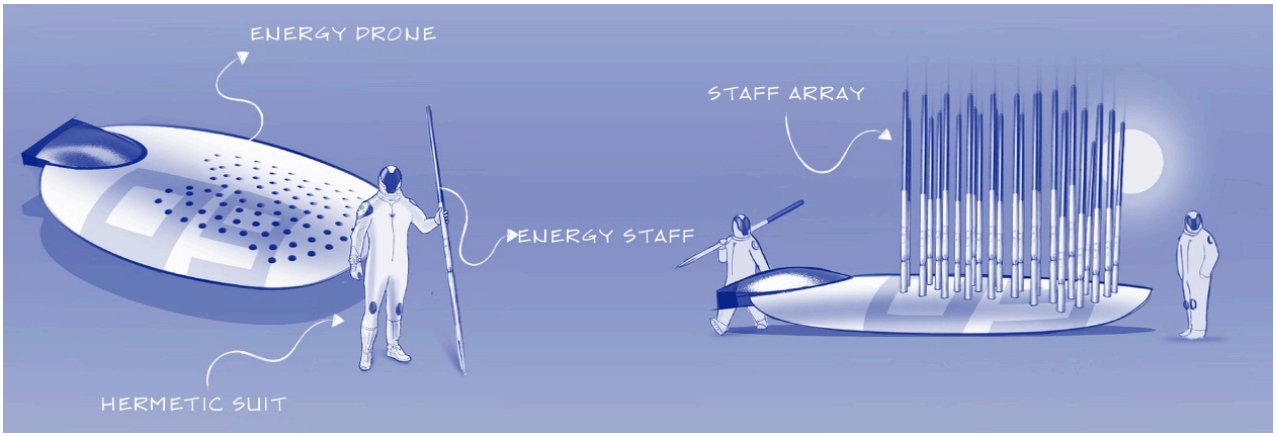
[10] Taken from film theory, a diegetic artefact embeds within it the narrative diegesis/narrative logic. So, a lightsaber in Star Wars may not real in the *real* world but it is real in the narrative world. A lot of this depends on suspension of disbelief and narrative strengths of the world-building that the film plays with.

[11] In the book *Make it So*, the authors found themselves using the method in the cases where they looked at an interface that couldn't work the way it was shown and "apologised" for it by thinking of ways that the interface could work the way it was depicted. Thus, in telling a compelling narrative of a radically different future, an experiential encounter might not need to provide a heavy burden of proof to begin with and sometimes conflict may lead to a speculation of its own.

[12] The card game was inspired by Futures Poker, a game created by Strange Telemetry, a London based studio. "Projects." n.d. Strange Telemetry. Accessed January 19, 2018. http://www.strangetelemetry.com/projects/.

[13] Link For Blockchain Radioactive: A VR Experience concept Film: https://youtu.be/6ZQrbOBcWxk

narrative goes on to explore how an "energy staff" and a sentient "energy drone" together create the ritualistic "energy harvest" from sunlight, wind and radioactive soil. Being the designer here, the fiction provoked me to apologize (Shedroff & Noessel, 2012) and *solve* the design of the "energy staff", by projecting existing technology from today. Thus, the solution was speculated to use a transparent solar ink canister with graphene electrodes[14] at the top, a carbon nanotube muscle[15] 'hinge' that bends in the wind in the middle and a mycelium (fungal) electrode that feeds on radioactive soil[16] at the bottom. The arrangement of these energy staffs would be inspired by the properties of a polar bear's hair that allows for absorption and internal scattering of light (Stegmaier, Linke, & Planck, 2009).



[Figure 2] *Energy Harvest Ritual from the Design Fiction "Blockchain Radioactive" (Sketch credit: Author)*

[Figure 3] *Left: Experiential future VR scenario produced using the design fiction. Right: Concept Film shot in VR (Design and Image credit: Author)*

3.2. Back-casted Solar Cells

Having explored a speculative future of solar energy, the challenge was to create a solar cell that could contribute to a solution and *still* point to a vision of long-term sustainability. This is where this project diverges from a traditional SCD project. In this case, the intention was to pursue a "pragmatic" back-casting that would point to a radical solution for solar energy *today*. The back-casting was done in order to manifest a solar cell that could allow for internal reflection and refraction of light within a 3D printed optical structure and that could be coated with graphene and produce energy from heat and sunlight. In keeping with existing technology, the concept here proposes making solar cells out of fibre optics[17] by coating the optic surfaces with solar inks such as dye-sensitized solar inks or perovskite

[14] "Electrons Flowing like Liquid in Graphene Start a New Wave of Physics." n.d. Accessed March 11, 2018. https://phys.org/news/2017-08-electrons-liquid-graphene-physics.html.

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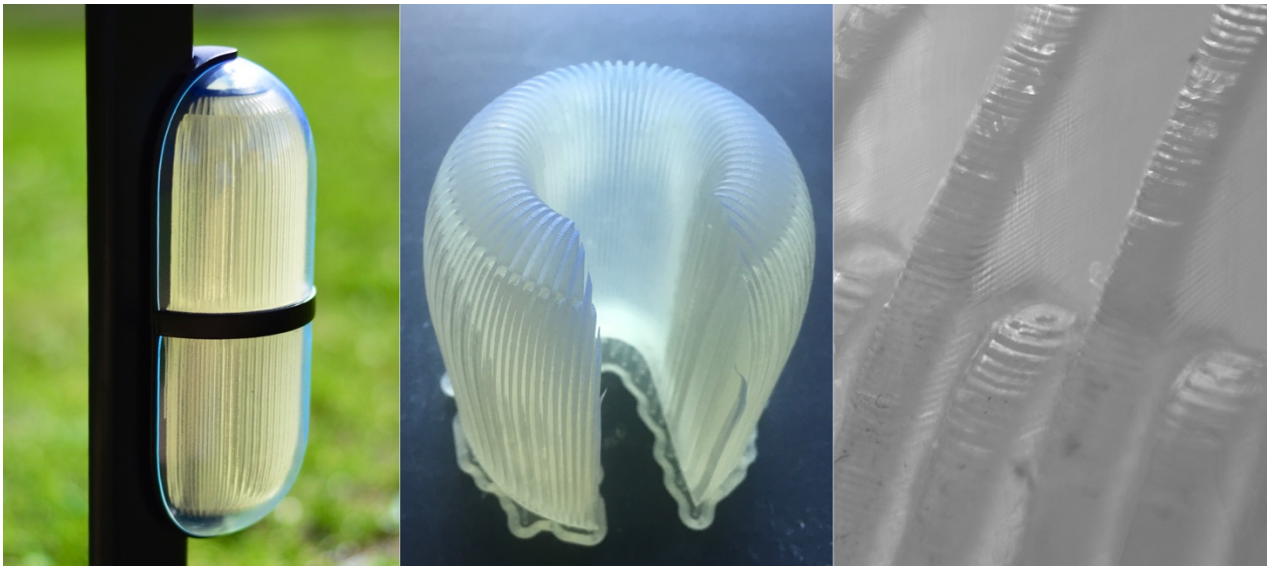
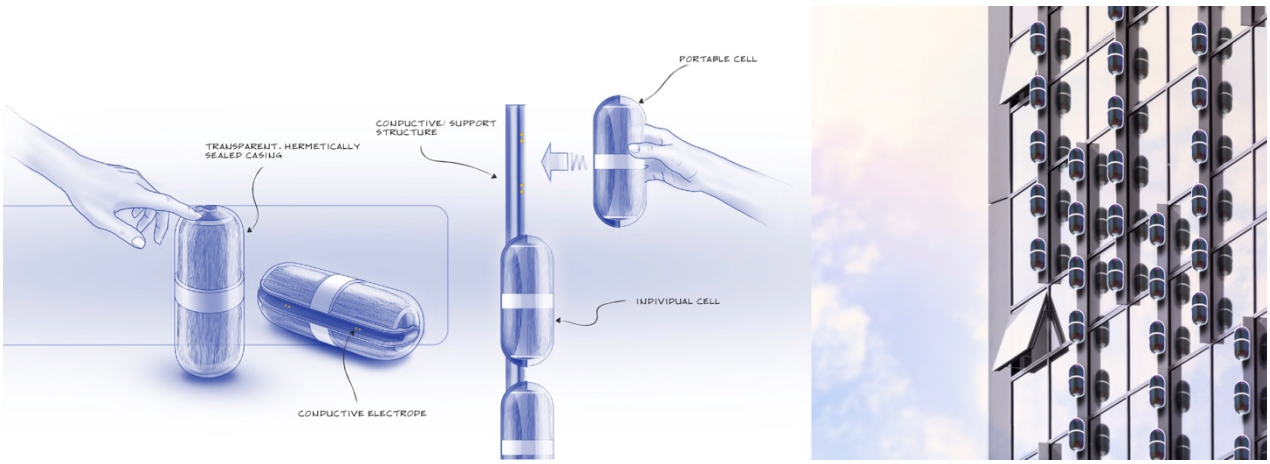
[17] Bourzac, Katherine. n.d. "Wrapping Solar Cells around an Optical Fiber." MIT Technology Review. Accessed March 14, 2018. https://www.technologyreview.com/s/416052/wrapping-solar-cells-around-an-optical-fiber/.

solar solutions[18]. These optical structures are then etched with graphene nanotubes[19] that capture a large spectrum of visible and infrared solar energy vastly increasing efficiency. The modularity of the solar cells is inspired by glass sponges in the sea that *grow* scalable and resilient hierarchical optical structures called 'spicules' in different scales. The concept also incorporates digital fabrication for these cells that allow for 3D optical structures to be printed with precision and in a decentralized manner. As a manifestation of the radical future solution in the present, a 3D printed optical solar cell was produced by the author using existing resin based 3-D printers that can print at a resolution of 100 microns, structures that possess the 'speculative' optical properties.



[Figure 4] 3D Printed Optical Solar Cell Concept showing optical structures with layers resolution 100 microns and made using existing SLA printers with clear resin, without any surface treatment. (Design and Image credit: Author)

On the question of climate action today, the solar cell can contribute to transforming our existing cities into solar power plants, without the need for massive infrastructure overhaul. When mounted vertically on dense urban skyscrapers, the cells could also additionally capture the reflections and scattered incident sunlight off of other buildings in addition to direct sunlight. At night, the 'urban heating effect' becomes a possible source of infrared radiation that the 'graphene ink' could capture thereby greatly enhancing the efficiency of these cells. If we challenge the notion of the 'rooftop approach' to solar, a possibility opens up where the vertical facades of existing buildings can be transformed into solar panels and cities thus become net *generators* of energy instead of net consumers.



[Figure 5] *When mounted on vertical facades of buildings, these 3D solar modules capture reflections and scattered incident sunlight from other buildings as well. These cells could thereby transform cities into net generators of renewable energy. (Design and Image credit: Author)*

[18] "Printable Solar Cells Just Got a Little Closer: Research Removes a Key Barrier to Large-Scale Manufacture of Low-Cost, Printable Perovskite Solar Cells." n.d. ScienceDaily. Accessed January 2, 2018. https://www.sciencedaily.com/releases/2017/02/170216142800.htm.

[19] "Proof: Graphene Can Convert Sunlight to Electricity." n.d. Sciencenordic.Com. Accessed March 6, 2018. http://sciencenordic.com/proof-graphene-can-convert-sunlight-electricity.

4. REFLECTIONS

Weaving different future scenarios around the position of "what if", the future of solar cells questioned here was to engage not with how things are but how they "could be" and thus create a design intervention that facilitates long-term sustainability today. When dealing with the uncertain future, it makes sense to put forth speculations that may otherwise seem absurd from a 'business as usual' perspective since the proposed SCD method uses a far future scenario to construct a fragment from a world yet to be. In that respect the designed artefact allows for a form of inter-dimensional time travel that can probe, sense and respond to the fictional world as a normative everyday object that projects the designer's values into a context of the future; a complex unknown. The point of this speculative method is to open up space for new possibilities for such 'designerly' visions and as such does not attempt to "prove" the solutions. The possible solution suggested here, a 3D printed optical solar cell, points to an infinitely scalable, modular solar cell that can be deployed in complex and varied combinations to create resilience for renewable energy transitions. While it is important to dispel the myth that merely shifting to renewables from fossil fuels will be enough to transition to a sustainable future, the *rigorous* imaginings of the future of solar cells presented here suggests that speculative narratives built around technological artefacts can create a point of departure for technologies to overcome the framing within 'business as usual'. Industrial Design praxis thus creates discursive spaces that strive towards, better long-term sustainable visions of the future not just by speculative "problem finding" but also by "problem solving". In such an SCD process, posing the question "what if" provides for possibilities that today's research might take in creating the technological futures we want and *still* imagine possible alternatives to our existing solutions. In the absence of a perfect world with perfect solutions, this paper looks towards opening an alternative space in acting towards long term futures and sustainability decoupled from the dystopian visions of 'business as usual'.

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