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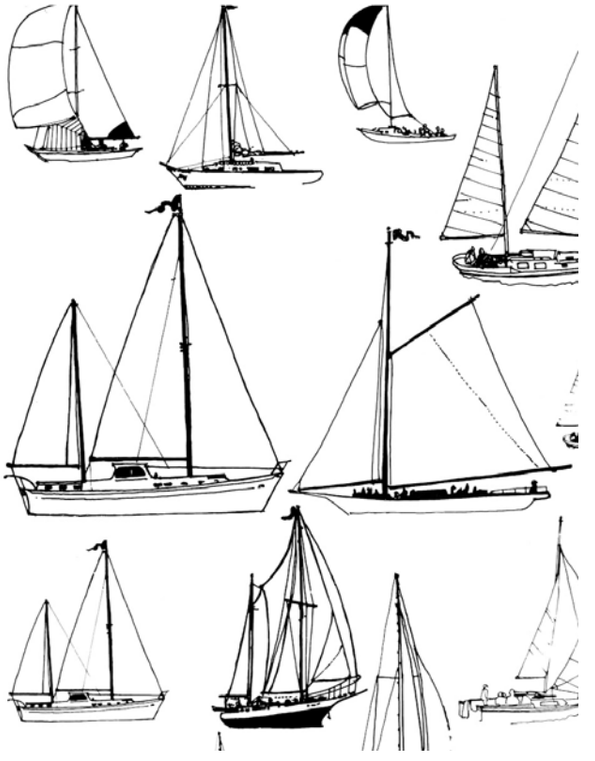

Tobias Revell

Joseph Voros' *Futures Cone*[1] is a cornerstone of the western theorization and visualization of the future, having become the vogue of the design and technology worlds in discourses about the future. The cone shows both a fixed point in the present and a cone that expands away from the present into the future. The Cone describes how – as we progress further in time – the range of things that could happen increases, while certainty about them decreases. Within this cone are sub-cones: probable, plausible, and possible cones, or some variation thereof. As designers, we could describe the volume of Voros' Cone as "imagination space" in that it claims to encompass the possible phenomena, technological advances, social and political changes, and new things imaginable to the observer from the fixed point of the present.

Occasionally – but increasingly often – things come along that are outside the 'imagination space' of the observer that make the limitations of that space clear. Nicolas Taleb famously dubbed these kinds of phenomena as "Black Swans."[2] Although, I prefer science-fiction author Iain M. Banks' pithier term: "Outside Context Problems."[3] These events

[1] Joseph Voros. "A Generic Foresight Process Framework." Foresight 5, no. 3 (2003): 10–21. https://doi.org/10.1108/14636680310698379.

[2] Nassim Nicholas Taleb. *The Black Swan: the Impact of the Highly Improbable*. (New York: Random House, 2016).

[3] Iain Banks and Paul Youll. *Excession*. (New York: Bantam Books, 1998).

demonstrate the futility of ever trying to map or predict the future and, in doing so, expose the limits of our "imagination space."

The "imagination space" is a construct of what is immediately imaginable, given our lived experience so far. Take, for a recurring example, the car. Because of the car, it is easy for most folks to plausibly imagine more eco-friendly cars, autonomous cars, or even flying cars. The car produces the imaginable future variations of the car within the limits of our own personal *Futures Cone* or "imagination space." However, these imaginable futures are also confined and structured by the car. So, it is much easier to imagine marginal improvements on the car (such as making it safer, more environmentally friendly, or more efficient) than it is to imagine cities without cars.

The car is also accompanied by other "future imaginaries" that join the "imagination space:" Modernist notions of liberal freedom, personal identity, sex appeal, and the suburbs. It became part of pop culture, made iconic through movies, television, and pop music which lent it glamour and aspirational qualities beyond the practical operation of a vehicle. These narratives were crucial in concretizing the car in Western society, but they also served to reinforce our dependency on the car. Thus, the car produced the future of the suburbs. Once

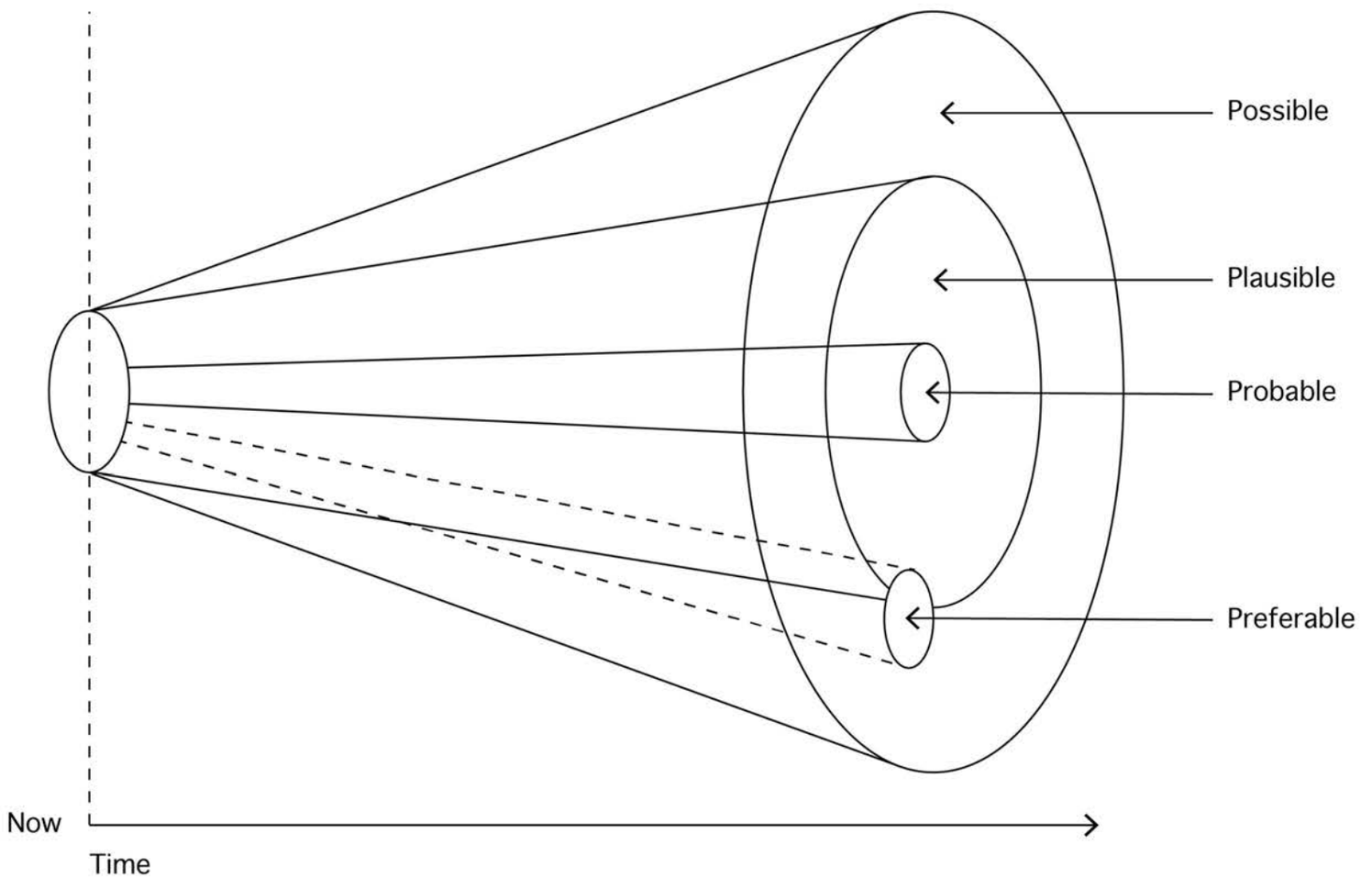

Image 139

Image 140

people moved to the suburbs, the future of the car was reproduced. The takeaway from this and the *Futures Cone* is that things and ideas produce futures which, in turn, structure our "imagination space." We imagine *through* and *with* the car.

Image 139: Joseph Voros, Futures Cones

In discussing future production here, I'm referring to the way images and imaginations of the future are produced, rather than the technical realization of those images and imaginations. In this context, the future is an ever-receding set of imaginable realities, not merely a thing brought into being. We're interested in how the *idea* of, say, the flying car is produced and disseminated, rather than the technical means of its production.

The ways that images of the future are created and distributed are incredibly important in shaping our perception of the future, as well as our ability to critically challenge it. In 2020, we find ourselves at the beginning of an industrial revolution of semi-autonomous image production. In this revolution, the process of image creation and dissemination is increasingly automated through technologies from computer-generated imagery

(CGI) software to machine learning. These technologies enable the rapid production of futures, which go on to shape the "imagination space" of those that encounter these same technologies. Through a feedback loop of aspiration and expectation, images of the future shape our imagination, and, thus, our imagination reshapes them. Yet, in doing so, we end up with homogenized futures that reinforce present biases and expectations, rather than open up genuinely new possibilities.

In this broad bracket of 'semi-autonomous industrial future image production,' I include a whole range of technologies. At one end of this range, we might find desktop publishing software like the Adobe Suite. These may not appear automated, with most control in the hands and eye of the creator, but even standardized processes like blend modes, templates, gradients, selections, strokes, and standardized output formats have pre-disposed us to certain types of image production. At the end, we might find machine learning and Generative Adversarial Networks (GANs) – the favorite in the creation of convincing 'Deepfakes' – creating almost fully artificially generated but convincingly real video or image content. Somewhere in the middle is the broad remit of CGI, drawing on years of advances in Hollywood cinema and architecture. Consequently,

CGI, through the dominant influence of cinema and future product and development renderings, is the kind of image of the future that most people encounter.

This middle is the area of most interest and the most emergent aesthetic phenomena. While the field of machine learning and 'deep fakes' deserves and receives much critique, the developments in the field are mostly, with notable and obvious exceptions in art, about faking or replicating the present as opposed to visualizing futures and developing new practices and aesthetics. The center-ground of CGI, becoming desktop-friendly and aesthetically normalized, skirts the edge of the future — the real and the hyper-real. This makes CGI technology a contested space for the aesthetics of futurity that are used in cinema, architecture, advertising, and product development.

The Shazam Effect and the Feedback Loop From the Future

Image 140: Still from DS029

The production of futuristic images builds certain expectations of the future. These, in turn, serve as the imaginary basis of new images of the future that are produced, thereby reinforcing that feedback loop. We'll dig into this feedback loop here with an example from music. This feedback loop flattens the "imaginary space" of the *Futures Cone*, homogenizing it around self-reinforcing "future imaginaries." However, the feedback loop often approaches realization, as the imaginary futures are gradually brought into being. However, their context is often forgotten. To return to the car: the flying car may soon – regrettably – enter the realm of technical feasibility, but the underlying imaginary of the flying car is out of context: a hangover of the early 20th century, when we might otherwise have imagined cities without cars at all… if we'd known how.

In 2014, Derek Thompson of *The Atlantic* investigated why pop music was starting to all sound the same.[4] The notion that pop music "all sounds the same" had, up until this point, existed somewhere in the range of hyperbole and nostalgia. Yet, structured data analysis shows dwindling variation in elements, such as tempo, timbre, tone,

[4] Derek Thompson, "The Shazam Effect," The Atlantic, December 2014, https://www.theatlantic.com/magazine/archive/2014/12/the-shazam-effect/382237/.

and pitch.[5] What was once a vague feeling had become a serious proposition; pop music was becoming more homogenous. *The Atlantic*'s focus was on why this might be happening; why were all the songs that were charting starting to demonstrably sound the same? Thompson described the "Shazam Effect," as the data-driven feedback loop that exists between listeners, record companies, and musical artists. As record companies are able to gather more and more data on listeners' habits and interests, through the use of digital platforms, they are better able to write and promote songs that conform to those habits and interests. These newly written and promoted songs are then listened to, and the listening data is gathered and fed back into the loop to, once again, promote music that sounds like what people have already listened to, and so on and so on.

Thompson named this the "Shazam Effect" in reference to the Shazam app, which enables users to discover the name and artist of a song they are listening to from merely its sound profile, but this dynamic also resembles phenomena from other fields. The well-worn "filter bubble," first prophesied by Eli Pariser in 2010, is a similar but more

[5] Donna Jean Murch. *Living for the City: Migration, Education and the Rise of the Black Panther Party in Oakland, California* (The University of North Carolina Press, 2010).

comprehensive theory. The "filter bubble" stems from somebody's ability to curate their own information environment from the structure of the Internet, meaning that they inevitably gravitate towards information sources and platforms that conform to their worldview. More contemporaneously, the "filter bubble" has been updated to include the micro-targeting of advertising that this self-curation elicits from spam bots, companies, and political campaigns, thereby further cementing the feedback loop of expectation and reality-as-presented to the viewer.

Anthropologist James C. Scott has studied this feedback loop of models and reality from a wider and more historical perspective. In his seminal work, *Seeing Like A State*, he writes that "The utopian, immanent, and continually frustrated goal of the modern state is to reduce the chaotic, disorderly, constantly changing social reality beneath it to something more closely resembling the administrative grid of its observations."[6] Scott's work describes the sociological phenomena of modelling, mapping, and other forms of reducing reality to something measurable by states and large organizations. His book describes the feedback loop

[6] James C. Scott. *Seeing Like A State: How Certain Schemes to Improve The Human Condition Have Failed*. (New Haven, Connecticut: Yale University Press, 1998).

between these models and reality, where the world inevitably fails to conform to the map or the model and so must be rebuilt to resemble it. First, the state or another large organization observes and builds a model of the world, extracting the key data points they want from it; this might be in the form of spreadsheets, simulations, or maps. They then adjust the model and the variables in the system to maximize the outcome they desire. Finally, they inevitably attempt to rebuild the world to match the model. This manifests in everything from urban master plans to shipping containers, autonomous farming, and forest management. However, in Scott's model, we see the same issues arise that we see in pop music: chiefly, a development of models that require homogeneity while eschewing complexity. Shipping containers need to be the same; masterplans treat humans the same; farms require standardized products; the over-management of forests decrease the diversity of species.

Why does the plight of the music industry or autonomous farming concern the industrial production of the future? As futurist, science-fiction author, and design critic Bruce Sterling once said "Whatever happens to musicians, happens to

everybody."[7] Thus, we seek to examine the same feedback loops between models, tools, platforms, and data that shape the way we conceive of, imagine, and produce the future. In all examples, we end up with homogeneity as a result of forcing present expectation to conform with "future imaginaries" and vice-versa in a feedback loop. Pop music starts to sound the same; your "filter bubble" shows you things you already know or agree with; the Earth is reduced and flattened into measurable units.

Science-fiction, Imagination, and Expectation

In considering how computer-generated images of the future influence the way we imagine the future, an obvious place to start would be in science-fiction, where imagination and expectation are often birthed and fed into developing aesthetics, as enabled by technological advances in image production.

The relationship between science-fiction – particularly in cinema – and innovation has been

[7] Bruce Sterling, "MyCreativity Sweatshops: What Happens to Musicians, Happens to Everybody, Institute of Networked Cultures," November 20, 2014, video, https://vimeo.com/114217888.

well-documented. Scholars have highlighted how the ambitions of technical innovation often respond to popular sentiment, as sculpted by science-fiction.[8] Scholars have also shown how science-fiction works to critique and explore technological futures imaginable in the present and the ways that they reflect social or cultural ambitions. David Kirby has also explored how formal relationships between research labs and Hollywood studios afford a reciprocal relationship between the public engagement needs of scientists and the needs of film-makers for "realism."[9]

Image 141: Minority report interface still

A notable example for its impact on the production of futures and technological development is 2002's *Minority Report*, directed by Steven Spielberg. Despite being almost twenty years old at the time of this writing, it continues to shape

[8] Caroline Bassett, Ed Steinmueller, and George Voss, "Better Made Up: The Mutual Influence of Science Fiction and Innovation," Nesta Working Paper, No. 13/07 (March 2013): https://www.academia.edu/3132030/Better_Made_Up_The_Mutual_Influence_of_Science_Fiction_and_Innovation.

[9] David Kirby, *Lab Coats in Hollywood; Science, Scientists, Cinema* (Cambridge, Massachusetts: MIT Press).

discourse in the media around technology.[10] *Minority Report*, based on the Philip K. Dick short story of the same name, premiered visions of various technologies that, at the time, were speculative prototypes or even unimaginable to popular audiences, such as predictive policing, eye-tracking, autonomous vehicles, and gestural interfaces.

The production designer, Alex McDowell, a renowned designer and world-builder in his own right, took a Kubrick-ian approach to the film, making the technologies and characters' interactions with the technologies of the film to be as believable as possible. Spielberg and McDowell worked with John Underkoffler, then at MIT's Media Lab, on the gestural interface seen throughout the film. This gestural interface involves the character standing in front of a transparent screen with science-fiction-blue interface elements, which are then manipulated with special gloves. Fundamentally, the interface is not too dissimilar to the contemporary Graphical User Interface with windows, files, cascading elements, and so on. The main difference is that instead of a keyboard and mouse, the user input is done via grabbing, pointing, pushing, and pulling with the user's hands.

[10] Jonathan Gorczyca, "Minority Report — 15 Years Later; How the film defined the Future of Interface design," Medium, June 20, 2017, https://medium.com/helm-experience-design/minority-report-15-years-later-328b15a7845a.

To further aid in the believability of the interface, McDowell and Underkoffler took active decisions to add realism through glitchy, broken interactions. For example, the interface uses tracking to keep elements in front of the user's view. At one point, another character approaches Tom Cruise while he is working at the interface. He reaches out his hand to shake Tom Cruise's, and the interface temporarily shifts attention to this new character, pulling interface elements magnetically away from Tom Cruise and toward this new hand. As this new hand withdraws, realizing the mistake, the interface elements continue to follow it, until Tom Cruise grabs and pulls them back to his field of view. We've all been in situations like this; someone overwrites you in a shared document, closes something you're working on, or the computer maximizes the wrong window; there are all sorts of daily inconveniences in our interfaces. McDowell and Underkoffler, as good designers, understood this awkwardness and put in this simple, missable detail to cement the believability of the interface. The detail on the glitchy interaction in the film is not simply a charming plot device that exposes tension between characters, it's also a clever way of making the interface feel real and, thus, possible. The interface is stunningly visualized through CGI, like a lot of the technologies in the film, with sophisticated

motion tracking to make it feel real in the lives of the characters.

But there's a reason we don't have gestural interfaces. There is a reason I'm not currently gesturing this essay into existence on this computer now, a reason that you didn't gestural-interface your way through most of your computer interactions today: Bad Design. Gestural interfaces are tiring to use. In filming *Minority Report*, Tom Cruise had to take breaks every few minutes. Compare waving your arms around in front of an enormous screen to using a keyboard and mouse. Most prototypes of the device have, so far, proven to be inaccurate and difficult to use. Compared to the reducible, pixel-level fidelity and detail achievable by a mouse and keyboard, a finger or hand is a stubby, brutal thing when it comes to working on a flat surface.

Despite this, the gestural interface from *Minority Report* went on to spur a popular interest and real financial investment in these interfaces that continues twenty years on. Following the success of the film, Underkoffler himself established Oblong Industries and developed the interface with the support of Fortune 500 companies. A watered-down and more pragmatic version of the interface – Mezzanine – was developed but mostly serves as a show piece for corporate conference calls, rather

Image 141

than an everyday interface.[11] Beyond Underkoffler's own innovations in gestural interfaces, dozens of other companies and startups also sprung up, and continue to spring up, to capitalize on what apparently is a public and corporate hunger for waving your hands around in front of a large screen.

The gestural interface from *Minority Report* took the lead role in its own feedback loop: an obscure idea from MIT's Media Lab catapulted to Hollywood success and reinforced by compelling and believable visual interactions on the cinema screen, which then created a guiding light for innovators and corporate investment. As more and more of these prototypes found their way into the world, they began to influence "future imaginaries" again. 2008's *Iron Man*, a Marvel adaptation, took many of the tropes of *Minority Report*'s interface, including the forms of movement and element arrangement, while adding intermediate technical advances to create a holographic version without the screen. In 2013, Elon Musk was inspired by *Iron Man* (obviously) to develop and demo his own

[11] Tom Ward, "The mind behind Minority Report is giving PowerPoint a sci-fi overhaul," WIRED, December 3, 2019, https://www.wired.co.uk/article/oblong-minority-report-john-underkoffler.

holographic gestural interface.[12] Gestural interfaces continue to be developed by playboy billionaires (fictional and real), human-computer interaction research labs, and startups all over the world. Apple, Google, and Microsoft all have their own projects that explore gestural interaction but mostly micro-gestures for simple things like smart watches. The future of the interface has become homogenized around this idea, despite its general uselessness. The possibility of alternative forms of future interfaces have become unimaginable in the 'aesthetic conditioning' of gestural interfaces, as made believable by Hollywood. (There are of course specific circumstances in which gestural interfaces would be extremely useful; beyond broadening accessibility, they have *specific* applications in everything from architecture fly-throughs to surgery.) In all of these cases, even a cursory google search will reveal the ever-present image of Tom Cruise hovering his hands in front of some glowing blue lights.

[12] Andrew Moseman, "Elon Musk's New Project: Iron Man's Gesture-Based Interface," Popular Mechanics, September 6, 2013, https://www.popularmechanics.com/space/rockets/a9369/elon-musks-new-project-iron-mans-gesture-based-interface-15892338/.

Aesthetic Conditioning and Computer-generated Images

The longevity of films like *Minority Report* is as much due to their good design as it is to the technologies that enabled these visualizations of the future. Minority Report conforms to the Hollywood standards of the science-fiction thriller genre: fast and tense cuts, moody and high-contrast lighting, blue screens, and translucent holograms — all of which are aesthetic decisions that contain the imprint of the specific software of computer-generated images. These aesthetic decisions normalize the film, making it easy to consume and, thus, further enhance the believability of the future image.

Where other fields or media might have struggled to convince an audience of previously unimaginable futures or technologies, cinema has decades of experience in the 'suspension of disbelief' business. Through stylistic and technical methods, cinema has perfected the art of compelling audiences to buy into fictional characters, motives, scenarios, and technologies. Writer and theorist Erik Davis reflects that

science-fiction has a hyper-realistic character that makes it inherently easy to believe:

> [H]uman reality possesses an inherently fictional or fantastical dimension whose "game engine" can – and will – be organized along various visionary, banal, and sinister lines. Part of our obsession with counterfactual genres like sci-fi or fantasy is not that they offer escape from reality – most of these genres are glum or dystopian a lot of the time anyway – but because, in reflecting the "as if" character in the world, they are actually realer than they appear.[13]

This 'as if' quality is made real and extended by the rich aesthetics of computer-generated images. Lev Manovich agrees that the painterly qualities of CGI and post-production lend plasticity to the realism of cinema, allowing them to stretch the existing protocols established by photographic cinema, as reality objectively captured into the realm of the unbelievable.[14] Here, we should recontextualize CGI cinema (and video games) as painterly or animation

[13] Erik Davis, *TechGnosis: Myth, Magic, and Mysticism in the Age of Information* (North Atlantic Books: Reprint Edition, 2015), 375.

[14] Lev Manovich, "What is Digital Cinema?", Manovich, 1995, http://manovich.net/index.php/projects/what-is-digital-cinema

practices, rather than photographic or cinematic processes. Most of the work in producing the final images is done long after the photographic information has been captured (increasingly so — watch the green-screen takes for *Gravity*). Deborah Levitt suggests that CGI is a continuation of a relation between humans and images that is much older and deeper than photographic cinema — an "animatic apparatus." Similar to Manovich, she draws a continuum from CGI to painting and other pre-photographic forms of image production that form the history of human storytelling and imagining. They move beyond indexing and representing reality to creating it.[15]

Consequently, though a film like *Minority Report* borrows codes and tropes of photographic cinema, something we are aesthetically predisposed to as consumers of film and television, it also leverages the hyper-realistic and imaginative potential of CGI. In doing so, it convinces us of new and more plastic ideas of technology, such as the gestural interface.

Science-fiction is one example of how future images are produced and mass-disseminated to enormous audiences. Part of that process is the construction of these images as

[15] Deborah Levitt, *The Animatic Apparatus: Animation, Vitality, and The Futures of the Image* (Winchester, UK: Zero Books, 2017).

computer-generated images: animated and post-produced aesthetics rendered inside a computer with enormous precision and control. Since the 1990s, science-fiction has entered the mainstream, particularly through cinema and video games. As a result, it has become a prime source for future images, and, consequently, it continues to shape our imaginable futures. These Hollywood science-fiction images are contingent on and enabled by advances in CGI technology that have made it cheaper and more efficient to create convincing versions of previously unimaginable futures. Real advances in technologies, such as chroma-keying, motion tracking, and other post-production advances, enabled the believability of Underkoffler's design work on *Minority Report*.

However, these new technologies pre-dispose certain aesthetic decisions and approaches, as we shall explore next. Joel McKim borrows from philosopher Bernard Stiegler in describing this as a process of "aesthetic conditioning," where "we adopt aesthetic formats and content expectations encouraged by the platforms themselves."[16] The tools used to shape computer-generated images also shape the

[16] Joel Mckim, "Speculative Animation: Digital Projections of Urban Past and Future. Animation: An Interdisciplinary Journal" *Animation*, Vol 12, Issue 3 (November 2017): 287-305. https://doi.org/10.1177/1746847717729581

aesthetics and content of those images, which, thereby, shape our imagination. Pressingly, these tools are increasingly becoming standardized. As we explored previously with the "Shazam Effect" and the work of James C. Scott, standardization goes hand-in-hand with homogeneity. As Manovich agrees: "With electronic and digital media, art making similarly entails choosing from ready-made elements: textures and icons supplied by a paint program; 3D models which come with a 3D modeling program; melodies and rhythms built into a music program."[17]

McKim, in his discussion of aesthetic conditioning, also references Stiegler's notion of the "industrialization of memory" when "symbols, images and sounds available to us are increasingly provided by commercialized culture industries." In his view, the industrialization and standardization of visual memory then "has implications for our formation and preservation of cultural memory and our ability to effectively imagine the future."[18]

[17] Manovich, "What is Digital Cinema?."
[18] McKim, 289.

Software and Standardization in the Production of Future Images

The significant consequence of the "Shazam Effect" was the homogenization of Billboard charting pop music. Data demonstrates that everything, from song length to tempo, timbre, and tone, has become increasingly and coherently altered over time. In Thompson's article, he cites the fidelity and volume of data on listening habits, made available to record companies, as being responsible for the feedback loop that created this homogenization. Yet, we must also acknowledge the platforms and tools used to create digital content and how they reinforce aesthetic conditioning.

To stick with the metaphorical vehicle of music (remember what happens to musicians happens to everybody), the advent of digital music production hardware and software since the 1970s has also helped to shape the way it sounds. In 1980, the launch of the Roland TR-808 drum machine had a significant impact on the development of electronic music. Artists' use of the machine is

easily recognizable, even today with the sound of contemporary snare drums samples made to sound like the 808. In the mid-2000s, Apple computers started coming with Garageband free and pre-installed. Garageband was aimed specifically at 'bedroom musicians.' Consequently, many of the more complex elements of recording, such as post-production and backing, were standardized. The software came with plug-ins for everything, from reverb to compression, which took the responsibility of dealing with these technical complexities out of the hands of musicians. Yet, in doing so, these effects standardized the sound of the musicians' performances. Coinciding with the growth of platforms, such as MySpace and Garageband, a generation of pop and indie musicians became familiar with the sounds and loops that came pre-configured in the software.[19] In some instances the presets, templates, and range of use of these platforms shaped the sound and creative abilities of the artists using them, which contributed to a homogeneity of sound.

It's also important to acknowledge that, in these examples and many more, cheap – if not free – access to quick and easy-to-use digital production

[19] Andrew Wang, "Inside Garageband, the Little App Ruling the Sound of Modern Music." *Rolling Stone*. 2019. Online: https://www.rollingstone.com/pro/features/apple-garageband-modern-music-784257/

platforms had an enormously emancipatory effect on who could produce and distribute music. Genres from hip-hop to nu-metal owe their popularity to platforms, such as drum machines, Garageband and MySpace, and many innovative and original artists emerged from acquiring ease and facility with these platforms. However, we can see the same, if not more severe, homogenization in the production of computer-generated imagery and the range of practices that emerge from such software.

Advances in the technology of music production made it easier to create a broader range of users. This advancement was accompanied by elements of standardization that broadened the appeal of the software and increased its usability. In many ways, these are the core tenets of the industrialization of any technology. From the car to digital music production to, as we shall see, computer-generated imagery: technology requires standardization to find usability and popular appeal.

Within computer-generated imagery, we are seeing the same popularization and standardization. As of 2014, 75% of the IKEA Catalogue is CGI.[20] By now, it is presumably more. For IKEA, this is an obvious cost-saving measure, granting them faster

[20] Kirsty Parkin, "Building 3D with Ikea." CGSociety. 2014. Online: http://www.cgsociety.org/index.php/CGSFeatures/CGSFeatureSpecial/building_3d_with_ikea

and more versatile control over how they present their products. This goes for most companies. So, the vast majority of visual media that people interact with is the result of some level of computation. In the same way that the technologies of digital music production liberated artists to be more prolific, so too does the standardization and cheapening of computer-generated imagery software. It's much easier to try out different colors, lighting, camera setups, and arrangements on a desktop rendering application than it is in an expensive photo studio, thereby opening the door for more practitioners.

The artist and researcher Alan Warburton has explored the development of CGI hardware and software in his video essays, describing, in particular, the enormous boom of CGI into consumer technology since the 1990s. Early CGI was expensive and complicated, requiring advanced knowledge of computer science and access to incredibly expensive hardware, which is now available on everybody's laptop. For example, Pixar, one of the world's most well-known CGI studios, has its origins in a group of computer scientists from the New York Institute of Technology who experimented in building their own hardware in 1974. They had the ambition of producing the first fully computer-animated film, which they eventually achieved with *Toy Story* (1995). Along the way, these

scientists pioneered the standards for much of CGI. From alpha transparency to particle effects, they authored the principles of how to calculate and simulate physical phenomena, which is now standardized across almost all commercially available software.

Over the decades, with advances led by organizations like Pixar straddling research and commercial development, standards were developed around certain scientific principles. Render engines were built that could work across operating systems; principles of physics and simulation were developed, compiled, and packaged, able to work interoperably across different applications and systems. In short, the literal coding of generating images in a computer became standardized, as part of the progress towards the industrialization of computer-generated imagery.

Analyzing this history in *Goodbye Uncanny Valley* (2017), Warburton describes how:

> Computer scientists incrementally created a library of simulated phenomena [and] software companies packaged these tools together into multi-purpose 3D animation programs. These creative suites naturally prioritize certain

> tasks and outputs. They ship with presets for lights, objects, motions, bodies and materials.[21]

Just like the journey from the legendary recording studios and producers of the 1960s and 70s to Garageband of the early 2000s, the science developed by Pixar and others became desktop software. As a result of this industrialization of CGI science, desktop software programs now come with standardized assumptions about the creative intentions of their users, necessarily limiting their use-cases and delimiting the possible aesthetics that are approachable for everyday users.

For example, Blender, a free and open source but commercially standard 3D rendering platform, is used for a huge range of types of work, mostly in animation and image production, from cinema to architectural renderings. The platform ships with a preset for producing and simulating ocean surfaces. On the part of the development team, this is a sensible decision that significantly reduces the workload of the user for what, otherwise, might have been a long and difficult process to achieve a surface that looks convincingly like the ocean. Similar to Garageband, this platform takes an advanced task and makes it accessible to the

[21] Alan Warburton "Goodbye Uncanny Valley." 2017. Online: https://vimeo.com/237568588

beginner. However, the preset only works at a certain scale of about 5-50 meters. If you were to use the imagery in a larger scene, such as a cinematic aerial shot, the repetitive tiling, which is used to save memory, would become noticeable. Think of how old video games used to tile small textures to save memory, which became very apparent as you moved through a map; Blender graphics act in a similar way. At smaller scales, the preset is not capable of capturing and representing the micro and macro details of close-up water. So, this preset, which — in a few clicks — makes convincing-looking water, prescribes certain use-cases to the artist or designer using it. They have to make a choice about their scale and scene based on this preset. A lot of CGI is about tricking the eye to work around software limitations, and it's perfectly possible to do so. However, the decision by the Blender development team, in choosing this particular set of algorithms and giving users these particular settings, reveals assumptions they made about users and the type of uses they believe users want.

In another example, Nicole Sansone Ruiz explored how software developers who render natural phenomena make decisions for computational expediency that shape the aesthetics of the model. Importantly, these "aesthetics become

both a tool and a standard of knowledge."[22] In other words, the software decisions shape aesthetics, which, in turn, shape the knowledge of the users. In one example, Ruiz explores the contradiction between realism and expediency in how light is represented digitally. The RGB colors of computer monitors is technically unable to accurately visualize and simulate the interactions of natural sunlight. Thus, developers avoid asking "whether a computer graphics system is properly displaying what is being modeled but instead [ask] if the appearances *look right for the effect that is to be conveyed?*" *– does it make the game, or advertisement, or logo more or less attractive?*."[23]

Similarly, Lara Chapman has explored how Google Earth's technical choices produce an aesthetically idealized version of Earth. Google uses a bespoke piece of software called 'Universal Texture' to ensure a smooth continuity of images across the enormous troves of satellite data. Universal Texture stitches images together, matches saturation, white balances, contrasts, and other qualities to not only create a continuous experience but to make an aesthetically pleasing one. Google Earth is an Earth of perpetual green foliage and

[22] Nicole Sansone Ruiz, "Arguing Against Graphic Ambivalence: What Earth Modelling Reveals about Visualization in Scientific Computing." *Information and Culture*. 55(3). p 210.
[23] Ibid., 215.

spring lighting that commodifies the planet.[24] In doing so, it creates false expectations of a 'smooth' world, devoid of climate disaster, mass migration, and exploitation.

In another example, Ted Kim has done extensive, important work tracing the racist history of physical rendering engines, in particular that of skin and hair. He describes how the standard algorithm for simulating hair in CGI was "custom-designed to capture the subtle glints that appear when light interacts with the microstructures in flat, straight hair. No equivalent micro-structural model has ever been developed for kinky, Afro-textured hair."[25] In the case of skin, the focus in scientific research has been on subsurface scattering – the way that young, white skin has semi-translucent properties similar to marble or milk. This process results in "a stomach-churning tour of whiteness" in the technical literature, where scientists often celebrate an "image of a computer-generated white person as empirical proof that [their] algorithm can depict *humans*."[26]

[24] Laura Chapman, "Springtime Everywhere." *Real Life*. October 5, 2020. Online: https://reallifemag.com/springtime-everywhere/
[25] Theodore Kim, "The Racist Legacy of Computer-Generated Humans." *Scientific American*. August 18, 2020. Online: https://www.scientificamerican.com/article/the-racist-legacy-of-computer-generated-humans
[26] Kim, "The Racist Legacy of Computer-Generated Humans."

This aesthetic conditioning, at the behest of the software, extends in many dimensions. Researcher Matthew Plummer-Fernandez suggests that "So much of the aesthetics [of a building] is inherited from the software without you realizing it…You can almost spot what sort of software applications have been used for a particular building."[27] Most desktop software even used by professional companies comes with presets for materials, environments, shapes, and surfaces that are used and reused for thousands of images. Even someone working with as few presets as possible would be constrained and conditioned aesthetically by the engine underlying the software; the way it traces light interactions and simulates volumes are easily discernible to the trained eye.

The way that developers make decisions about what to include is based on what they believe their users want easy access to, either through feature requests or analyzing use-cases. This is why they ship software with presets for open water, bodies, silk, cotton, leather, rubber, fire, and smoke but not, say, liquid mercury, light scattering at high altitude, underwater volumetrics, or the way sunlight looks on the surface of Mars. More prosaically,

[27] Matthew Plummer-Fernandez with Benedict Hobson, "You can "spot what software has been used" to Design a Building." *Dezeen*. October 17, 2014. Online: https://www.dezeen.com/2014/10/17/movie-matthew-plummer-fernandez-you-can-spot-software-design-building/

software specific for architects generally has pre-made materials for common surfaces, such as concrete glass and steel, in the same way that word processors come with the Times New Roman font as the default option. These presets, templates, and predilections structure the aesthetic decisions made by users, resulting in a standardization that approaches aesthetic homogeneity. Freeware developers, such as Blender, are notable for having open development processes that elicit feedback directly from their users on what to develop. In many ways, this method leads to genuine innovation; Blender consists of a small team supported by donations, so they must find ways to compete with enormously wealthy competitors that are cheaper and quicker.

Bedroom Musicians and Blackbirds

It's worth briefly tracing the edges of this kind of software's use-cases. At one end, we might find the equivalent of the bedroom musicians, as enabled by Garageband; experimentation and play developed reflexively with the software. On the other hand, the other result might be the hyper-specific, high-end

development of cutting-edge, goal-oriented technology.

Image 142: Still from DS031

The emancipatory potential of Garageband, in broadening access to music production for a new generation of musicians, is also replicated in the cheap, if not free, access to computer generated imagery software. Decades after Pixar's computer science beginnings, apps and software now allow the creation of compellingly photorealistic and rich scenes, with relatively little understanding of computer science required for its users. Just as Garageband was successful due to elements of standardization that made it easy to use, thus leading to a degree of homogeneity of music produced by it, we see the same process with various kinds of CGI software.

Instagram is replete with 'dreamy renderings' — soft palettes of pastel blues and pinks with contrasting textures and dramatic shadows.[28] These images are found on the edges of the possible, hovering on the cusp of photorealism, while giving

[28] Natasha Levy, ""The desire for escapism is at an all-time high" say visualisers creating fantasy renderings." *Dezeen*. July 10, 2020. Online: https://www.dezeen.com/2020/07/10/dreamy-renderings-design-3d-artists/

hints to their simulative nature in surfaces that are just slightly too clean, as in light that interacts just slightly too… scientifically. It would be reductive to suggest that the homogeneity of these images is solely related to the preferences of the software used. A milieu of the demands of Instagram algorithms, such as creative zeitgeist and technical constraints, are all at play here. With that being said, the decisions made in the design of the software, available to these designers, affects the aesthetics that are both produced and producible with this technology.

Image 143: The Blackbird

Let's take the opposite example that returns us full-circle to cars – the cornerstone technology of the 20th century. The Blackbird is a remarkable thing that exists on the boundaries of the computer generated and physical reality. It is a fully adjustable chassis for post-producing CGI cars. The 'rig' of the car has adjustable length and width and an arsenal of online sensors and cameras to capture its position, speed, direction, and even the light sources around it. It makes incredibly detailed captures of physical reality from a car's perspective that can then be brought into the rendering platform of your choice, with a 'real car' able to be added in over the

top of it in CGI. (Spoiler alert: Almost every single car advert is entirely composited in CGI anyway.) The problem that Blackbird addresses is realism in the physics of cars. Rendering engines are incredibly good at getting realistic materials for paint, rubber, metal, and glass, but physical movement can still be a giveaway. For example, metal flexes, bends, distorts, and leans in ways that are almost impossible to animate convincingly. However, the Blackbird does this job for you.[29]

Yet again, this incredibly useful tool for doing something that would otherwise be laborious and complex – the micro and macro physical interactions of a car moving at speed – predisposes certain uses. Most obviously, it assumes a certain form, size, and shape of the car. Secondly, it assumes certain needs for its users. The marketing material and visualization reinforce the romanticized and generally masculine aesthetics of car advertising since their inception: speed, power, escape, and independence. The Blackbird excludes the progression of the aesthetics of cars beyond these notions. It's hard to imagine other use-cases or ways of designing the car with the Blackbird. This

[29] Stuart Miller, "The Blackbird Can Be Any Car it Wants to Be." *Newsweek*. February 7, 2017. Online: https://www.newsweek.com/2017/02/17/blackbird-can-be-any-car-it-wants-be-553295.html

dynamic limits our social imagination of what cars are and what they could be.

Battery Rendering and the Mass Production of the Future

The construction of software as a tool — its functions, presets, and templates, as foregrounded by developers — shapes the way this software is used, which subsequently shapes the images produced by such a tool. There is another aspect to the mass industrialization of future images: the rapid mass-production of images on a massive scale by rendering companies, what we might call "battery rendering."

As opposed to the solo designer or artist working with CGI software to craft something in the line of their own practice, battery rendering is the outsourcing of image production, usually to enormous companies that produce digital images and visualization renderings quickly, cheaply, and on a massive scale. Companies like Crystal CG, with 3000 employees in 17 offices, produce renderings for development companies all over the world on

enormous hoardings and evocative advertisements. These companies operate by being able to quickly turn around visualizations and installations that evoke a feeling of futurity and technological optimism. Just as with any mass-production operation, this involves even higher levels of standardization. Certain ways of showing steel and glass, the amount of greenery required, the way that light frames the silhouette of the sculptural elements of the building: all of these stylistic techniques can be dragged-and-dropped from one project to the next, guaranteeing speed and cheapness but also total aesthetic homogeneity. Crystal CG, and the other companies like them, dominate the aesthetic of the future found in architecture through their rapid deployment of off-the-shelf visualizations, developed over hundreds of projects.

As in countless industries before, these "battery renderers" begin to dominate the market, absorbing smaller and more experimental outfits or putting them out of business by being able to offer a cheaper, faster product with a known track record of success. Quickly, the software developers begin to respond to their needs and uses.

Browse Crystal CG's website, and you will find hundreds of images that could be from anywhere. They appear devoid of context, just a set series of angles, lighting conditions, and dramatic

skies. One begins to notice commonalities in the styles of materials like concrete and glass. The aesthetics are recycled into a conditioned audience that expects and demands the same as before, just like the record companies that keep reproducing the same pop songs.

Conclusion

It's more than theoretical to spend several thousand words critically tracing one of the many connections between kinds of software and "future imaginaries." Designers and architects will extol the values and uses of tools, while often uncritically engaging in the infrastructures used to produce and maintain them. While all work is now digital, these infrastructures are the murky, non-corporeal swamps we pay subscriptions for to swim in.

Occasionally, things bubble to the surface, such as a weak link in the chain that exposes it. In 2019, Adobe's Creative Cloud was deactivated in Venezuela because of a political embargo. One "future imaginary" (a jingoistic U.S. foreign policy) runs up against another (a pan-global subscription model based on the nebulous idea of the 'cloud'). In 2020, a group of leading architects wrote an open letter to Autodesk, criticizing the lack of

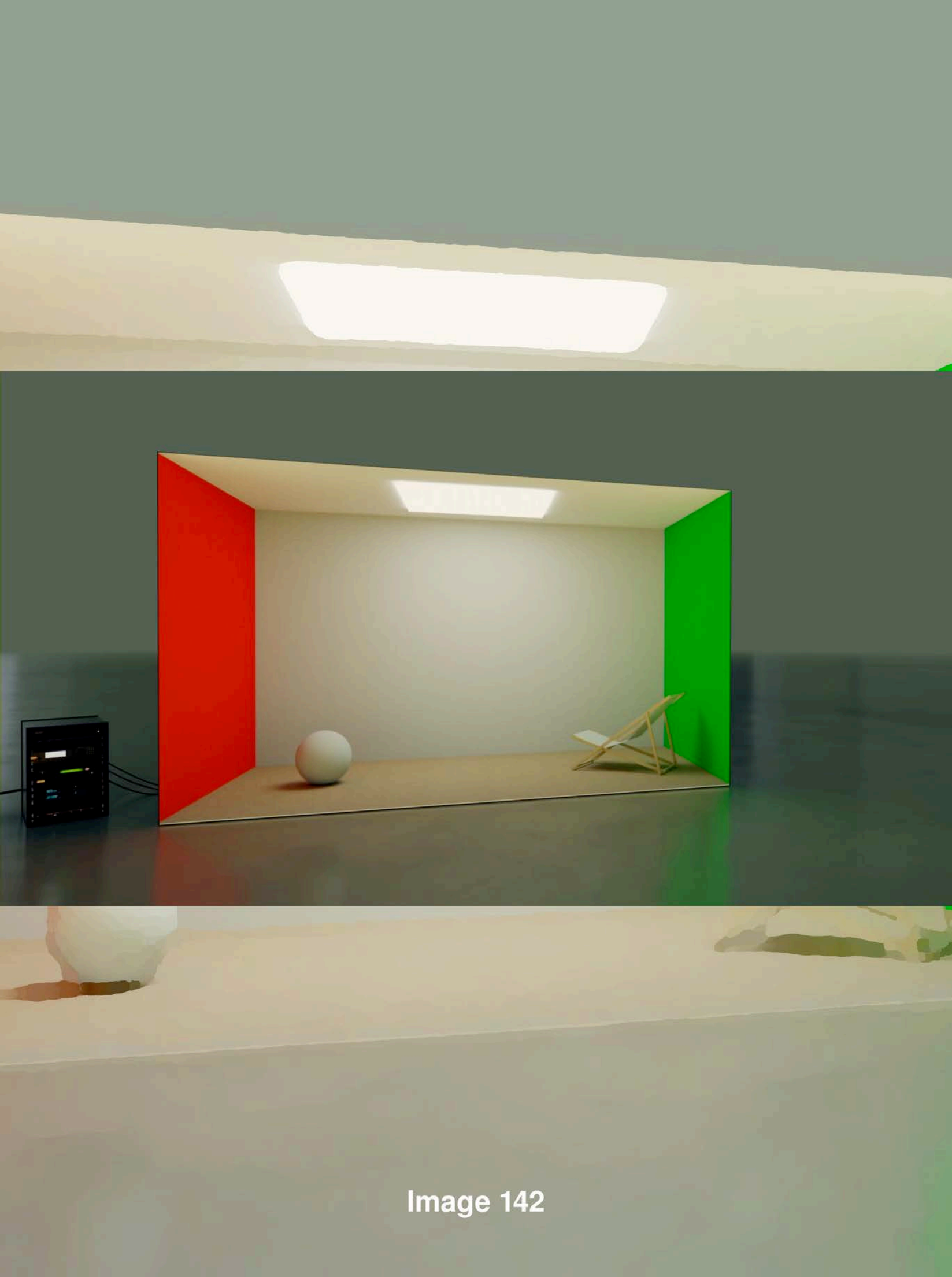

Image 142

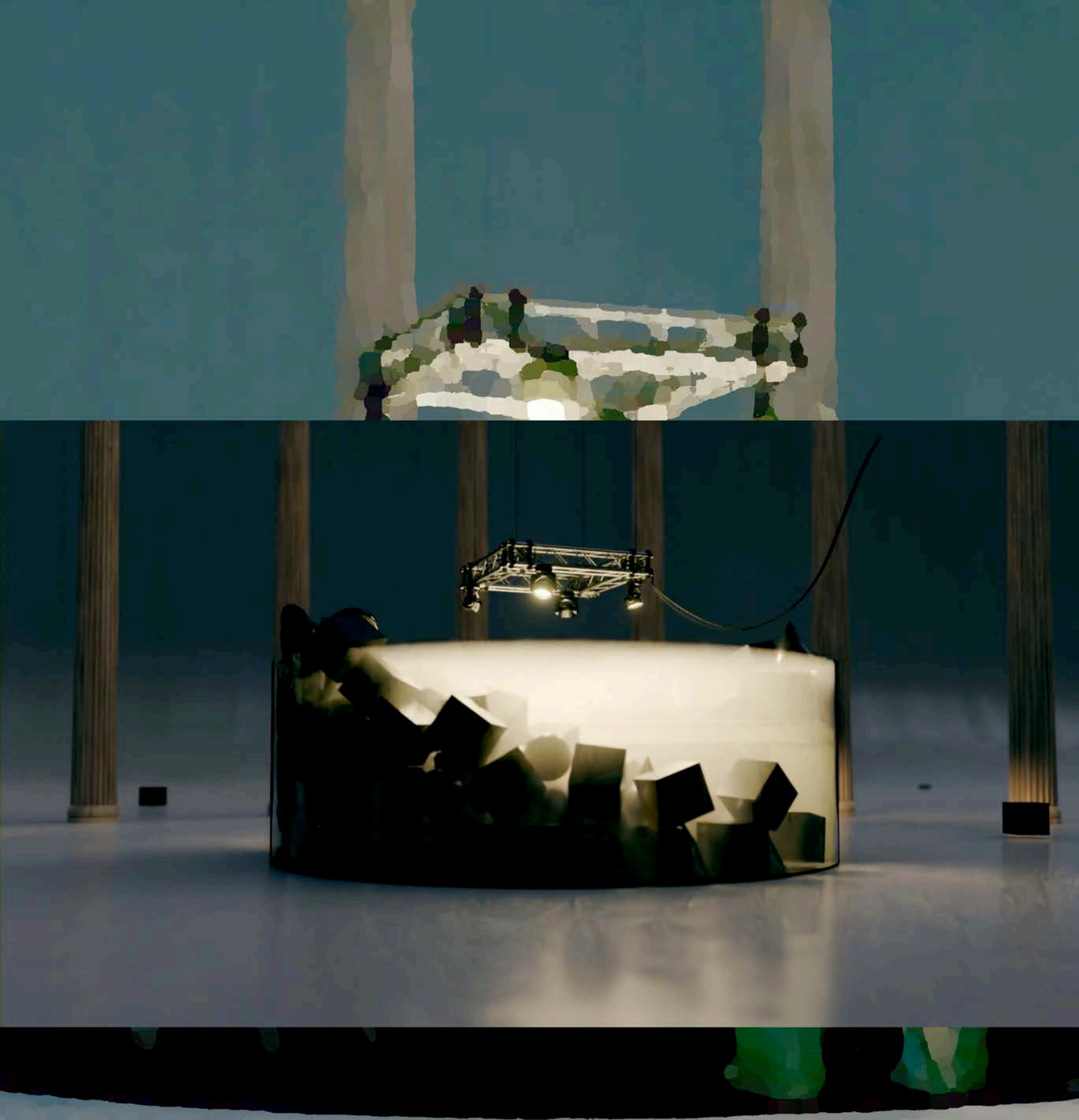

Image 143

development and unsuitability of Revit, a piece of software that has monopolized the building information management sector.[30] This event briefly drew attention to the interdependencies of software infrastructures in realizing and visualizing futures.

These specific examples could be further drawn out exploring the macro-politics of software, which is as real as wood, stone, and concrete. We could also go further in exploring the use of critical practice (where I work) in exposing the cracks and construction of software, reflexively asking who made it that way and why? What does turning science and technology on its head do for our understanding?

Myself and Natalie Kane have been curating collections of work and workshopping these ideas in our ongoing project *What if Our World is Their Heaven?*.[31] We hope to develop a corpus of work and series of theories that relate CGI aesthetics to "future imaginaries." Other practitioners, such as Alan Warburton, call for a celebration of the grotesque, as a way of breaking free of standardization of software and aesthetics by exploring the very limits of that software's capabilities. His research and essays collect work by

[30] Letters to Autodesk, 2020, Online: https://letters-to-autodesk.com/

[31] Tobias Revell and Natalie Kane, "What if Our World is Their Heaven?," 2020. Online: https://tobiasrevell.com/What-If-Our-World-Is-Their-Heaven-UAL-London-UK-02-2020

artists attempting to break software and develop uncomfortable aesthetics, as a kind of deconditioning of the platforms in order to stimulate imagination.

For now, describing, recognizing, and noticing these relationships will allow practitioners to more reflexively understand how the tools they use shape their own work, how that work shapes "future imaginaries," and how those "future imaginaries" shape the tools they use.