

From Animation to Augmentation: *Dennō Coil* and the Composited Self

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Abstract

When cities are covered over with layers of augmented reality, what shadows are cast by this new ability to see? The Japanese anime series *Dennō Coil* explores exactly this question, following a group of children living in a near-future society where augmented reality glasses have become as essential to daily life as smartphones have today. Comparing debates over ‘seamful’ design in ubiquitous computing with the role of the alpha channel in digital image compositing, the author argues for understanding the sensory environments of augmented reality as part of a longer history of bringing the animated image out into the spaces of everyday life. This article explores the new physical and psychological demands placed on individuals as they seek to navigate the protocols of this newly augmented world, while cultivating and conditioning what the author calls the ‘composited self’.

Keywords

alpha channel, animation, anime, augmented reality, childhood, *Dennō Coil*, image compositing, Iso Mitsuo, ubiquitous computing

The history of animation is crucial for understanding an augmented reality future. Both fields are expressly concerned with how to composite together different types of visual material. Debates over the aesthetics and ethics of image compositing in cel animation offer a prelude to similar debates occurring in the world of ubiquitous computing and augmented reality. Ubiquitous computing, also known as pervasive computing or ambient intelligence, describes the spread of computer technologies anywhere and everywhere throughout the lived environment. The overlapping field of augmented reality (AR) seeks to make this ubiquitous computational data more readily available within everyday sensory space, creating ‘mixed reality’ environments compositing existing objects, buildings, and landscapes with synthetic audiovisual overlays.

Animation can be understood as an important predecessor of these mixed reality experiments, given its long tradition of blending different visual materials with varying degrees of physical

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plasticity into the same perceptual field. As Suzanne Buchan's (2013) edited volume on 'pervasive animation' hints, ubiquitous and pervasive computing environments can be understood as one site where animation exceeds the frame of the screen, moving out into the spaces and interactions of everyday life. Niantic's recent smartphone augmented reality game *Pokémon Go* (2016–) represents only one of the more obvious examples of how to layer animation aesthetics onto existing space. Animators have long explored what subjectivity might look like given a more plastic world; how an animated character might navigate a more malleable corporeality. Augmented reality brings this plasticity more directly into the realm of everyday lived experience, asking users to navigate a plastic world of semi-transparent images, and to understand themselves as one layer within this composited world.

The first part of this article examines the congruity of animation with augmentation, and the opportunity this presents for rethinking compositing as a mode of perceptual and subjective experience. The latter half then turns to explore what I call the *composited self*: a new form of self-understanding emerging as individuals learn to live with and through augmented space. My focus throughout is on the 2007 Japanese anime series *Dennō Coil*, which uses a mixture of hand-drawn and digital animation to explore life in a more fully augmented city of the near future. I first examine how the show experiments with animation to envision a more fully augmented future city before shifting to trace out the subjective and sensory boundaries of the composited self as explored in the show's narrative.

Ubiquitous computing and the quest for seamlessness

The resonance between animation and augmentation is evident in the discourse surrounding the emergence of ubiquitous computing. When Mark Weiser first set out to define ubiquitous computing as manager of the Xerox PARC lab in the 1990s, his colleagues' focus (and the popular imagination) was largely focused on creating self-contained virtual reality (VR) spaces cut off from everyday life. By placing users in an alternate reality housed entirely within a computer, VR often sought to leave ordinary space behind. In contrast, what Dourish and Bell (2011: 13) call Weiser's 'animating vision' describes spreading simple computational technologies throughout already existing environments. Weiser rejected the VR push for immersion, preferring instead to bring computing out 'where the action is', to borrow a phrase from Paul Dourish (2001).¹

While rejecting the immersion of the VR headset, Weiser still imagined ubiquitous computing interfaces as largely invisible, smoothly integrated into existing environments. As Weiser (1994: 7) writes in one of the first essays setting out his vision of ubiquitous computing, 'a good tool is an invisible tool.' Yet Weiser was quick to caution against trying to make these computational interfaces completely seamless, eliminating the boundary between user and technology or between device and device. Instead, Weiser advocated *seamful* interfaces with 'beautiful seams' (Chalmers and MacColl, 2003: np). Later ubiquitous computing interface designers have echoed this concern, noting that when the various layers in a mixed reality environment don't quite come together, this in itself can afford a more active form of engagement. Dourish and Bell (2011: 110) argue for leaving the seams visible so that ubiquitous computing can become a way 'not to replace the social and cultural negotiation of boundaries but rather to enable it'. Adam Greenfield (2013: np) similarly notes how

every technological intervention that is made with the intention of smoothing out urban experience also deprives us of an opportunity to encounter something external to our own will, and so doing robs us of a moment in which we might reflect on the contingency of our own values, choices and beliefs.

This debate over seamless and seamful design in ubiquitous computing clearly echoes similar concerns about the sensory affordances of full and limited cel animation, particularly as it played out in the Japanese context (Lamarre, 2009: 184–206). To simplify a complex history for our purposes here, what came to be known as full animation emphasized not just smooth and seamless character movement but richly-detailed, immersive, self-contained environments. In contrast, limited animation made use of less detailed drawings and fewer of them per second of animation, leading to more stuttering and disjointed movement. The worlds presented in limited animation are likewise less immersive and self-contained, more seamful and open to the outside.

Both Thomas Lamarre and Marc Steinberg's recent discussions of limited animation resonate with the push for seamful interfaces described above. For Lamarre (2009: 201), the more open compositing of limited animation draws attention to its own layered construction and doesn't do as much to immerse anime viewers in an alternate reality; it is thus 'less prone to disavow the force of technologies' involved in its creation. In a complementary argument, Steinberg (2012: 44) shows how limited animation becomes a catalyst for the Japanese anime industry's turn towards a multi-platform media mix: audiences would be spurred on by the 'dynamic immobility' of limited animation to seek out toys, games, and other merchandise to continue elaborating the animated world by other means. Here animation moves beyond the screen into a process of 'environmental diffusion', taking the form of imaginative and interactive objects like stickers, toys, and figurines.

Placing these limited animation and ubiquitous computing discourses side-by-side, it becomes clear the tension between seamless and seamful environments constitutes a deep fault line running through the history of composited space. The less immersive, more open composite of limited animation parallels the affordances offered by a seamful ubiquitous computing interface. The diffusion of animated characters from the screen into the surrounding world as toys and stickers can similarly be understood as an important precedent for the environmental ubiquity aspired to by augmented reality technologies. Contrasted with Niantic's earlier and in many ways quite similar AR game *Ingress* (2013–), the more limited animation style of *Pokémon Go* clearly demonstrates the popular appeal of diffusing familiar animated worlds into the familiar environments of everyday life.

Glasses

While *Pokémon Go* makes do with currently available smartphones, developers aiming for a more fully augmented interface have mainly focused on semi-transparent screens placed directly in front of the eyes. The augmented reality glasses under development by Google, Microsoft, and numerous other companies make a particularly interesting site for exploring the convergence of animation and augmentation, as this lens and camera-based approach to augmenting the visual field directly links augmented reality back to earlier technologies of lens-based image compositing in film and animation. But there is no need to stop there: the glasses interface also links contemporary AR back to an even longer tradition of human augmentation: the practice of filtering the world through a pair of lenses in front of the eyes. Eyeglasses situate a transparent screen right in front of the face, covering most of the visual field, and they are designed for long-term daily use. In Weiser's early writings on ubiquitous computing, they serve as his central example of the invisibility of what he calls a 'good tool': 'Eyeglasses are a good tool – you look at the world, not the eyeglasses' (Weiser, 1994: 7). And yet, even with eyeglasses this invisibility is not automatic or guaranteed, as anyone who has ever had to get used to a new pair of glasses knows well.

Google very quickly discovered just how 'seamful' eyeglasses can be after their limited release of the Google Glass in 2014. A widely publicized fight broke out in Molotov's, a San Francisco bar,

after patrons grew anxious wondering whether a newly arrived Glass wearer was or was not secretly recording them. Some other San Francisco establishments banned Glass wearers from their premises in response to the event (Alexander, 2014). This kind of anxious response has often greeted new technologies, including ones we now take for granted. Seams can deepen or fade as social norms and personal habits shift over time. As Weiser (1994: 7) notes later in the same essay, ‘With enough practice we can make many apparently difficult things disappear.’ This emphasis on embodied habituation is crucial: whether a technology draws attention to itself or not is not just the result of interface design, but above all is the result of *practice*.

Following this insight, I propose that rather than positing a binary choice between seamful and seamless design principles in animation and ubiquitous computing, it is more productive to understand the way compositing makes practicable a continuous movement *between* these poles of visibility and invisibility. Like animation, augmented reality asks participants to navigate a world made up of multiple layers, each with varying degrees of transparency. On a technical level, this remains a problem of image compositing: how to blend both the virtual (the image overlay) and the actual (the existing world before the eyes) into a coherent and navigable visual field. As I argue in this article, however, we should also understand this as leading to new techniques of the self (Foucault, 1990: 10–11). What new behaviors become necessary to create and maintain a coherent subjectivity while navigating the more variable and plastic layers of an augmented world?

Dennō Coil

Animation provides some clues here: not only because it has long grappled with the technical side of image compositing, but because animators have already begun to explore what a more thoroughly augmented future might look like, once the initial shock of the new has faded and augmented reality glasses have become tools for everyday use. Nowhere is this more fully explored than in the anime series *Dennō Coil* (*Dennō koiru*), produced by the Madhouse animation studio in Nakano, Tokyo. The show follows a group of sixth grade elementary school children living in a near-future Japanese city where AR glasses have become as essential to daily life as smartphones have today. Set in 2026, the show envisions an augmented society where the imaginary landscapes of childhood are intimately entwined with public data space and the software protocols of massive IT conglomerates. The Japanese term *dennō*, written with the Chinese characters for electronic brain (電腦), serves here as a variation on the English prefix *cyber-*, and like that term marks out objects and phenomenon with their origins in computational augmentation.² This gives rise to neologisms like *dennō kūkan* (*dennō* space), and *dennō petto* (*dennō* pet).

The program’s 26 episodes aired in Japan at 6:30 on Saturday evenings from May–December 2007, on NHK-E, the national broadcaster’s channel devoted to educational content. It won an Excellence Prize at the 2007 Japan Media Arts Festival, and the Seiun award for Best Dramatic Presentation at the annual Japan Science Fiction Convention. Audience response was enthusiastic and sustained, and the show has already become a cultural touchstone for research and debate surrounding emerging AR technologies (Murakami, 2014; Rekimoto, 2012: 1048). The show’s term for AR glasses, *dennō megane* (*dennō* glasses) has already become an accepted term in Japan for augmented reality glasses generally. This includes the Japanese engineers now racing Google and numerous other companies to be the first to create a viable prototype for everyday consumer use (Sakamoto, 2012).

At first glance, the ‘educational’ objective of the show might be cynically understood to be cultivating an audience of young, would-be users of future AR technologies. NHK has a history of developing advanced video technologies and promoting them through in-house content, as with their 4k and now 8k ultra-high-definition televisions. And yet *Dennō Coil* doesn’t back away from

exploring the potential challenges and dangers of a more fully augmented life, exploring for example how AR glasses might allow for the intensification of corporate control over public space, and pose physical and psychological risks to children growing up inside mixed reality spaces.

Dennō Coil was not alone in seeking to understand the implications of this rapidly approaching augmented future. When the show was first broadcast in 2007, ubiquitous computing and augmented reality were already experiencing a boom in Japanese popular discourse. From 2004 to 2007, the Japanese Government's Ministry of Internal Affairs and Communications pursued the U-Japan (Ubiquitous Japan) campaign, launched to help Japan 'realize the ubiquitous network society by 2010 as the world's most advanced ICT nation'.³ *Mogii*, a locative GPS game where players across the country traversed actual space to hunt for virtual treasures, was offered as a free service on KDDI's mobile phone network from 2003–2008. It was one of the first locative mobile games to develop a significant player base, making use of Japan's early introduction of GPS and internet-enabled mobile phones (Licoppe and Inada, 2010). And in Spring 2007, shortly before the show was broadcast, the Tokyo city government's Tokyo Ubiquitous Technology Project undertook a public experiment placing one thousand RFID tags around the busy shopping neighborhood of Ginza 4-chōme. Passersby received small devices to read the tags and see affiliated AR imagery and information as they moved through the streets and subways (Fitzpatrick, 2007).⁴ A range of industry and academic conferences at the time also focused on predicting how ubiquitous technologies would transform the media environment.⁵

Old space

At the height of all this activity, *Dennō Coil* drew on the visual affordances of animation to envision what a more augmented society might look like, and what it might be like to grow up in one. The show is set in Daikokushi, a fictional city located somewhere near Kanazawa on the west side of central Honshū, the main island of Japan. In the show, inhabitants describe the city as 'the second example of a partially privatized government in Japan', and at this point 'basically a subcompany of Megamass', the massive IT conglomerate that has a monopoly over the AR glasses market in the world of the show. Megamass manages the virtual space throughout the city, working with the *dennō* division (the *dennō-kyoku*) of the city government to keep AR data space secure and updated to the latest version. The *dennō* division's large AR robots, called *Searchmatons*, roam the city formatting old space and deleting viruses. Seen through the glasses, a Searchmaton appears to float above the ground and tower over the children (Figure 1), but this threatening appearance is softened by its bulbous torso, oversize hands, bright colors, smiling emoji-style face, and childlike voice. The kids in the show jadedly note how the Searchmatons, with their cute design and official nickname ('Sacchi'), are just another example of the government trying to use cute characters to disguise their own power and authority.

Unlike the adults, who mainly use the glasses as a practical tool, Daikokushi's children are more interested in how the AR technology works, how to hack it, and what happens when it breaks down. They are drawn to what they call 'old space' (*furui kūkan*): parts of the city where the latest version of AR software has not yet been installed. As a result, when seen through the *dennō* glasses, these spaces appear to be suffused with a glitchy fog. Much of the first half of the series follows the children as they investigate the puzzles and mysteries lying buried in this old space.

These are sites the city has literally forgotten about, such as an old abandoned factory and a lot full of decaying city buses no longer in use.⁶ The bus graveyard in Figure 2a appears as a digital swamp of outdated transportation technologies, surrounded by the lush green of an untouched forest and a distant mountain in the shape of Mt Fuji. Construction sites are another area where the virtual space is often unstable and in flux, full of bugs left over from partially formatted earlier



Figure 1. A Searchmaton roaming the city in search of viruses and glitchy space. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

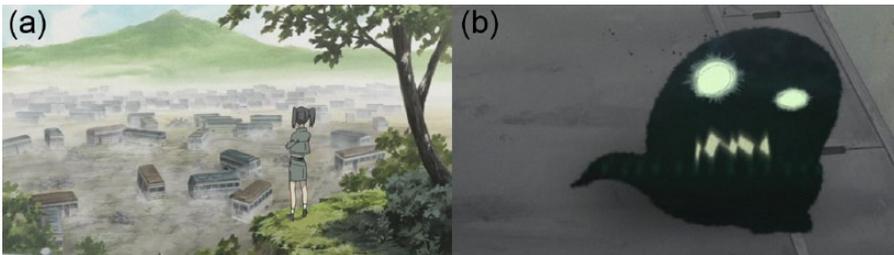


Figure 2. (a) Fog suffuses the ‘old space’ of Daikokushi’s bus graveyard; (b) One of the first illegals encountered in the show. DVD screen grabs from *Dennō Coil* (Iso Mitsuo, 2007).

protocols. These less stable spaces are home to a range of viruses that become visible in the AR as shadowy, blurry, seemingly animate creatures the children call *illegals* (*iriigaru*). The dark round shadows of the illegals resemble animals, dinosaurs, or even humans, but this dark matter (as seen in Figure 2b)⁷ appears to fragment and slough off when seen through the glasses. The illegals’ programming starts to dissolve if they spend too long in new AR space, and they are constantly being hunted down and formatted by the Sacchi. The children clearly empathize with the way the illegals are refugees at the fringes of the adult world, and several of the most moving episodes focus on them trying to help illegals find their way across the city to the shrinking number of old spaces they can safely inhabit. As the children’s glasses are also full of hacks and off-protocol code, they too are in constant battle with the Searchmatons, whose laser beam-like formatting attacks threaten to erase their data and destroy their devices. The children use a number of these same hacks to momentarily freeze the Sacchi in their tracks while they make their escape. Through these playful battles over urban space the show maps out a city overlaid with AR infrastructure, but in ways highly uneven, full of holes and bugs and glitches. As the next section explores, this seamfulness intersects in important ways with the show’s unique admixture of hand-drawn animation and computer graphics.

Image compositing and the alpha channel

Dennō Coil’s creator, writer, and director, Iso Mitsuo, is well known as an aesthetic innovator in the Japanese anime industry. Working as a key animator earlier in his career, he became known for

what he called *full limited* animation, a unique hybrid of full and limited animation techniques. Working only with keyframes and no in-betweeners, Iso would intuitively shift between a full style with one drawing every two frames – known as animating on twos – and a more limited style with new drawings only every third or fourth frame. Moving between these rhythms results in somewhat jerky but highly detailed motions, and Iso's style was lauded for giving an enhanced sense of weight and expressivity to the actions depicted (Ettinger, 2005). His well-known creations as a key animator includes Kusanagi's battle with the spider-tank at the end of *Ghost in the Shell*, a particularly beautiful Eva fight sequence in episode 19 of *Neon Genesis Evangelion*, and the outer space hallucinations of Morimoto Kōji's stunning 'Magnetic Rose' episode from *Memories* (all 1995).

In more recent years, Iso's attention has turned to devising new ways of merging digital image compositing with more traditional 2D anime production. Echoing the cost-cutting motives driving limited animation innovation in the 1960s, Iso was interested in leveraging digital imaging software in part as a way to bypass the division of labor usually found in anime production, allowing a smaller team to achieve both increased productivity and more creative control. Iso put these principles to work in the 15th episode of *RahXephon* (2002), for which he took on the duties of director, writer, storyboarder, key animator, in-betweeners, and digital effects, all the while completing the episode on time and under budget (Ettinger, 2006). The episode's innovative mixture of digital and traditional 2D animation and the low production costs raised a lot of eyebrows in the industry, and led to Iso being tapped to direct his first entire series, *Dennō Coil*.

All techniques of image compositing are basically structured the same: image layers are stacked on top of one another, and all but the deepest image in the stack has some kind of mask determining which areas are opaque and which are transparent, allowing the layer below to be visible. In film this would traditionally mean literally stacking up surfaces, with painted glass or animation cels in front of the camera or using optical printing techniques on layered celluloid in postproduction. Analog video further developed various methods of chroma keying, drawing on a single color to determine areas of transparency within a video image. As computer-based compositing began to become more common starting in the late 1970s and especially from the 1990s, software engineers developed a way to integrate the image mask information *into* the image file itself: the alpha channel.⁸

To simplify things as much as possible, every pixel in a digital image usually has three values attached, one each for red, green, and blue (RGB). The combination of these three values determines which color is displayed onscreen. The alpha channel adds a fourth variable explicitly for use in compositing (RGBA). This value determines the degree of opacity the pixel will have, including separate values for the red, green, and blue color channels. In other words, the alpha channel determines how much each color will let you see through it to the layer below.

If we look at any of the digital compositing in *Dennō Coil*, it quickly becomes evident how central the alpha channel is in delineating the border between different types of AR space in the show. 'Old space' in Daikokushi is where the alpha channel is most active: the layers of digital fog appear semi-transparent and drifting precisely due to these fluctuating transparency levels. Two-dimensional surfaces made of older and unstable AR similarly appear to glasses wearers (and the show's viewers) as glitchy and pixellated 2D textures overlaid with digital noise and distortion. As in Figure 3, the variously-sized squares of these fragmented surfaces flicker rapidly between transparency and opacity. The silhouettes of the illegals likewise appear blurry and indeterminate precisely because of the rapidly fluctuating transparency levels of the pixels at their edges, setting them off against the solidity of the background. In the context of Daikokushi's AR network, then, the alpha channel is most active whenever the integrity of older versions of augmented space begins to break down.

In contrast, when depicting AR space of the latest version, the animation's alpha settings are stable, with AR objects seamlessly composited into existing environments. Thanks to the way the

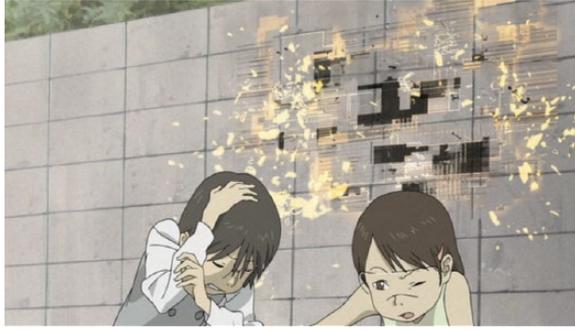


Figure 3. Flickering textures in glitchy old space. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

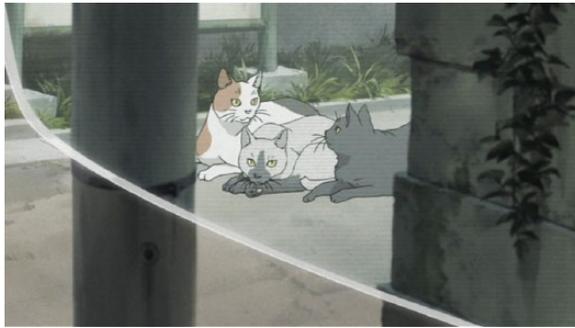


Figure 4. A newest-version *dennō* cat (middle) drawn to look much like the non-AR cats on either side. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

show's animation allocates drawn and computer generated imagery, up-to-protocol AR items like the middle cat in Figure 4 – a *dennō* pet – appear in the same hand-drawn style as the non-AR characters and objects in the city, with clearly delineated lines and coherent fields of color and shading. This shot is one of only a handful of moments in the entire series where characters take off their glasses while the image is in first-person perspective. The lower edge of one of the lenses cuts across the frame as the glasses come off, allowing viewers to distinguish between what is and is not AR by what disappears from view when the glasses are removed. When it comes to this latest-version AR protocol, the fluctuating alpha channel transparency of old space is replaced by a simple binary logic: objects are either visible or invisible, present or absent.

To summarize, in *Dennō Coil* the alpha channel fluctuations of the show's own *animated* compositing serve to mark out the seams of the more open *augmented* compositing within 'old space' in the world of the show. The main characters often go in search of exactly these traces. In emphasizing these seams, the show shifts the focus away from the functionally seamless and perfectly composited visuality of new AR space, and towards the intrigue (and fun) to be had exploring the obsolete and virus-ridden spaces of older AR protocols. The more stable composite of Megamass's newest AR update is functionally invisible, with the past and its older software formatted and written over. In contrast, the more glitchy, pliable, and technically 'illegal' seams of outdated AR space present the children of Daikokushi with openings to play with and hack the augmented infrastructure.

In turning its attention to obsolete software, the show is much in tune with contemporaneous developments in post-alpha channel digital aesthetics. As Carolyn Kane (2014: 178) describes, the

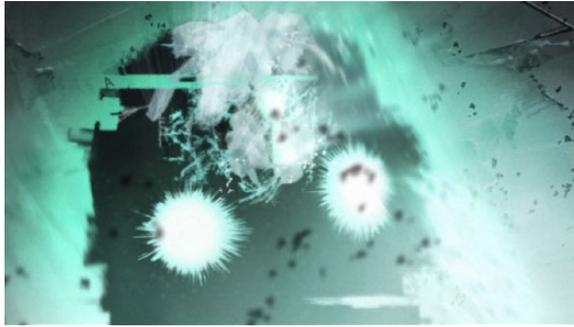


Figure 5. The open compositing of ‘dirt style’ augmentation: an illegal fragments into shards of data. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

rapid spread of the alpha channel in digital compositing since the turn of the century has generally led to a cleaner, more seamless, and more corporate-looking ‘Web 2.0’ graphic interface. However, media artists also created what she calls *dirt style* in response: an aesthetic foregrounding more open, more messy, and more glitchy composites. Dirt style artists often infuse their work with nostalgia for earlier moments in the history of software interfaces, when corporate control had not yet permeated computing so thoroughly. The digital dirt and grime in Daikokushi’s ‘old space’ appeals to the children in the show for much the same reason, with the older versions of AR providing a space to mess around in and explore. In Figure 5, the messy, fluctuating textures and digital distortion of old space and illegals produce a strangely compelling openness in the play of rapidly shifting semi-transparent surfaces, more approachable and radically at odds with the hard lines and seamless composite of the Megamass’s newer protocol.

By presenting *new* AR space to viewers in the form of clean, more traditional hand-drawn animation, and *old* AR through the relatively novel affordances of the alpha channel, the show provocatively shuffles the technological teleology of animation history that usually positions digital effects as something inherently more contemporary and up-to-date. While the show’s animators render the *dennō* glasses’ heads-up displays using vector-based computer graphics, most of the new AR in *Dennō Coil* is hand-drawn. More recognizably digital textures, in contrast, come into view only by looking *back* to older spaces and obsolete software formats.

This temporal reversal – the emergence of a seamful digital *past* – marks an important turning point in the history of image compositing. As expressed in the name of the most prominent image compositing software, Adobe’s *After Effects*, digital compositing has long been assumed to be temporally subsequent to the main event. The live-action shoot or the act of drawing always comes first; the ‘special effects’ of the digital is what happens later, in postproduction. This temporal structure gives ontological priority to the world assumed to lie beyond or before the software; the virtual realm of digital image manipulation is but a supplement to the actual content hiding underneath. What *Dennō Coil* presents, on the contrary, is a world where *compositing comes first*. Layers of older software build up and shape what can emerge thereafter, including the city and its inhabitants. To stick with Adobe’s phrasing, *Dennō Coil* positions the digital as a realm of *before effects*. This has serious implications for an augmented ontology: while after effects always arrive late to the game, touching up people and objects that pre-existed the software, with before effects the software itself becomes the ontological ground of individuation, shaping the actuality – the composited world – that emerges through it. We will now move deeper into the world of the show to work through the implications of this reversal for growing up in an augmented world.



Figure 6. Augmented athleticism: one of many scenes where children run through the streets to escape formatting by the Searchmaton patrols. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

Syncing actual and virtual bodies

Navigating these mixed spaces presents a considerable challenge to children growing up with and through their AR glasses: how to understand their own identity, how to trust their own experience, when it has become distributed not just across actual and virtual space but across an historical palimpsest of augmented layers. This kind of individuation, emerging through the navigation of layered space, is what I am calling the *composited self*. The composited self emerges in Japan in tandem with the rise of the *eizō sakka*, or ‘moving image creator’, a term referring to someone who operates simultaneously in a range of media contexts like video art, motion graphics, and commercial video – though not usually traditional animation – and is fluent (like Iso) in a range of image compositing styles and software. The term first appears in the 1970s as a way to describe artists active in both film and video, like Matsumoto Toshio and Kawanaka Nobuhiro. But the late 1990s and the rise of digital image compositing is when the term really takes off. There really isn’t anything similar in English, and the term captures something important: the increasing hybridity and environmental diffusion of the digital image, matched with the intensifying fluidity of the labor market. Image creators themselves can now practice their work in many spaces and with many different digital tools, but on the flipside this becomes a pressure to successfully stitch together a life across this layered media landscape.

This situation necessitates new kinds of subjects able to situate themselves within and among shifting layers of augmentation. On the level of practice, it demands a kind of *athleticism* in regards to self-compositing; not to reject or disavow the importance of virtual tools (the stance of many of the adults presented in *Dennō Coil*), but rather to actively investigate how these different layers come together, giving form to new practices of individuation and new relationships with lived space.⁹ For the kids in *Dennō Coil*, this athleticism is often quite explicit: the children spend much of the show’s running time literally *running* back and forth through the streets, homes, and abandoned lots of Daikokushi. This is usually to chase after illegals or to attempt to outmaneuver the Searchmaton patrols, as in the race against a Sacchi seen in Figure 6. The virtual overlay also causes the kids to move through the city in very specific ways: unlocking secret passages by tracing certain trajectories through the city, for example.

Meanwhile, the illegals, which remember are computer viruses found in old AR space, also represent a potential threat to the integrity of the composited self. Upon contact with them, the virtual AR body (the *dennō* body or *dennōtai*) and the actual body no longer line up properly; the two layers fall out of sync. This is, literally, a compositing problem, but it also registers to the children as a kind of phantom pain: they wince and flee, even though AR objects themselves are



Figure 7. The *dennō* body falls out of sync on coming into contact with an illegal, causing a kind of phantom pain. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

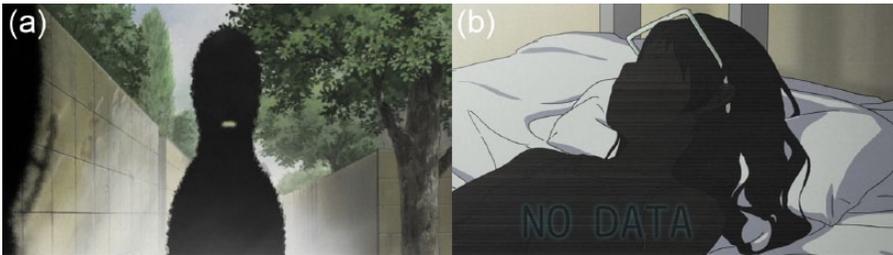


Figure 8. (a) A null carrier emerges from a portal to the coil domain; (b) As a result of the coil phenomenon, the physical body appears through *dennō* glasses as a shadow labeled NO DATA. DVD screen grabs from *Dennō Coil* (Iso Mitsuo, 2007).

weightless and cannot directly injure the physical body. The girl in Figure 7 grimaces as she comes into contact with an illegal and the code written across her *dennō* body begins to fragment (as, simultaneously, the layers of the animation itself appear to fall out of alignment). Rather than respond by taking off their glasses, children in this situation rush to try to re-sync these different layers of self by applying additional strings of protective code to their *dennō* bodies.

In the last half of the series, however, the plot thickens. It turns out old space is not just glitchy but also serves as a portal to the ‘coil domain’, a shadowy and desolate virtual space that mirrors the actual city and is populated by an older form of human-shaped illegal known as the *null carrier* (Figure 8a shows one just after emerging from a portal to the coil domain visible to the left). Like other illegals, null carriers appear as shadows with blurred and fluctuating borders, but float instead of walk in the manner of a traditional Japanese ghost. If a person is touched by a null carrier, their conscious mind travels with their virtual body into this other world, leaving the actual body behind. This is known as the *coil phenomenon* (*koiru genshō*). When this happens, as seen in Figure 8b, the actual body loses consciousness and remains visible within the AR field only as a dark diaphanous patch labeled NO DATA, with what look like television scan lines flickering across the surface of the unstable silhouette. As the virtual body wanders in a sleepwalking haze across the coil domain, the actual body left behind becomes increasingly transparent. The greater the physical distance between the virtual body and actual body, the greater the level of transparency. The animator’s alpha channel settings here become a measure for how far the different layers of the composited self have fallen out of sync for characters in the show. The tension running through much of the last

episodes of the series surrounds whether the children caught in the coil phenomenon will be able to successfully recomposite the different layers of their selves.

Augmented therapy

The stakes here can be high. One 11-year-old glasses user is killed crossing an intersection while out of sync: her virtual body registers to the Daikokushi AR network as several meters to one side of her actual body. As a result, an oncoming car's automatic navigation system adjusts itself to avoid hitting her virtual body, driving over her actual body instead. The show makes it clear how in a context of ubiquitous machine vision, the actual body is often the one more at risk of becoming invisible, and this can be very dangerous. Later we learn about the main character's grandfather, a doctor who died while trying to save a child whose consciousness had become trapped inside the coil domain. He separates his virtual body from his actual body to go to the 'other side' and try to retrieve the child, but the split puts too much strain on his elderly frame, and he dies before his virtual consciousness can reunite with his physical form.

Recalling this traumatic event later triggers a process of emotional consolidation for his granddaughter, who witnessed his death as a young child from inside the coil domain and had for many years locked the memory away in her unconscious. The show contains a number of episodes like this, where recompositing the self becomes both a task of literal *re-membering*, of compositing the body back together limb-by-limb (Farman, 2012: 116), and of remembering in the more usual sense: finding lost memories and working through personal traumas by digging into the historical unconscious of old-version augmented space.

Here the show presents a 21st-century spin on Tsutsui Yasutaka's classic Japanese science fiction novel *Paprika* (1993), where a team of experimental psychologists use machines to enter into patients' dreams, only to inadvertently open up a portal between the dream world and waking life. Something similar happens in *Dennō Coil*: we learn the glasses technology had been developed in the past for use in experimental therapy sessions, including a mechanism for manifesting augmented environments directly from the thoughts and desires of the patient. This project was abandoned once it became clear the boundary separating this virtual therapy space – the aforementioned coil domain – and the city itself could not be kept secure. The virtual remnants of these experiments, null carriers infused with the intense emotions of past patients, now roam the old spaces of the city, feeding on children's fears. Megamass had tried unsuccessfully to format them out of existence, and is now intent on keeping them a secret from the general public.

As with the scientists in *Paprika*, the doctors in *Dennō Coil* are attracted to virtual space as a potentially powerful tool for healing trauma through embodied affect and the vivid recreation of past events – what the show hints has become a whole industry of glasses-based *dennō* medicine (*dennō iryō*).¹⁰ But as the AR becomes tuned to the children's memories and unconscious desires, the composited self confronts even more complex challenges to its spatial integrity.

In these ways, *Dennō Coil* comes down firmly on the side of recognizing the virtual as fully and entirely *real*, precisely because it is so deeply entwined in the children's physical, imaginative, and emotional lives. A remarkable sequence in episode 24 sees most parents in Daikokushi decide to take away their children's AR glasses, spooked after two kids end up in the hospital in a glasses-related incident. The main character's mother sits her down for a lecture about what she says is the difference between the glasses world and the real world: what is real is 'warm' and 'you can touch it with your own hands.' She pleads with her daughter to give up playing with the glasses and come back to the 'world of the living' (*ikiteiru sekai*).¹¹ Lying awake in bed that night, the girl tries to talk herself out of the grief she feels for her recently deceased *dennō* pet. Following her mother's logic, she can't see or touch her sadness, so it must not be real. But then she realizes

her mother's definition of reality cannot account for the truth of her feelings. The *dennō* pet may have been nothing but data, but her love and attachment were real, and so is her grief. Rejecting the simple binary put forth by her mother, the girl decides to believe reality resides not in what you can touch, or even in what you can see, but in what you can *feel*. The show here puts forth emotion, not visibility or even touch, as the most stable measure of reality in augmented environments like these. By taking emotion as their guide – literally embracing the pain of childhood – the children untangle the coil phenomenon and are able to come to terms with past traumas and reintegrate the various layers of their selves. They achieve this without rejecting the shadows of the past or denying the augmented foundations of their reality. The show emphatically insists the virtual does not have to be a site of illusions in tension with the real (as the children's parents worry), nor simply an enhanced mechanism for controlling existing environments (Megamass's objective), but can also be a creative space and a personally generative one.

To put this in more general philosophical terms, the show rejects both a Platonic distrust of mediation *and* a transcendental idealism that would seek to judge what should and should not be 'legal' in virtual space. Instead, *Dennō Coil* presents the self as an open composite developing with and through the surrounding environment, including its historical layers of augmentation. Emotion, as it traverses virtual and actual space, becomes an important part of what ties all these layers together.

Historical memory also plays an important role. Iso has stated that he designed the show so that it would feel nostalgic to viewers no matter what generation they are from (*Yomiuri shimbun*, 2 May 2007). For example, the children purchase *dennō* 'metatags' (small sheets of printed code used for hacking) from what looks like an old-fashioned neighborhood candy shop. The metatags themselves resemble the paper fortunes long available at Shinto shrines and Buddhist temples in Japan. Rather than imagining augmented reality as something radically new (or radically foreign) and only as good as its latest software update, *Dennō Coil* positions AR as a technology with a deep cultural past – a past that will sometimes come back to haunt you.

Conclusion: Growing up augmented

Through excavating these older layers of affect, memory, and software, the children at the center of the narrative learn to confront their fears, work through painful emotions, and discover an inner fortitude. This is the educational challenge the show lays out for those who would be successful athletes of the composited self: learn how to practice this technology without getting out of sync, either physically or emotionally. Interestingly, the same Weiser text I quoted at the start of this article ends by addressing the subject of childhood, linking interface design with the experience of growing up:

Invisible technology needs a metaphor that reminds us of the value of invisibility, but does not make it visible. I propose childhood: playful, a building of foundations, constant learning, a bit mysterious and quickly forgotten by adults. Our computers should be like our childhood: an invisible foundation that is quickly forgotten but always with us, and effortlessly used throughout our lives. (Weiser, 1994: 7–8)

While sharing this rather Romantic idea of childhood, *Dennō Coil* moves beyond metaphor to make a direct connection between seamless technologies and the mysteries of growing up. The show presents childhood as a critical period for learning to navigate the interface between the composited self and the augmented environment.

To do this, the children pursue quite literal methods of media archeology, like the boy in Figure 9 who uses an augmented shovel to dig into the old space under a bus (in the bus



Figure 9. A child digs into old space in the Daikokushi bus graveyard, in search of metatags. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

graveyard from Figure 2a), uncovering fragments of obsolete data. Other kids research the history of illegals for their summer vacation homework assignments. Contrary to Weiser's dream of an intuitive and effortless interface, however, the show emphasizes all the work – physical, intellectual, and emotional – that goes into successfully navigating the volatile layers of an augmented world.

This kind of augmented labor may often be playful, but it isn't exactly voluntary: the show presents AR athleticism as the *only* option for a successful childhood. This of course ties in with the show's implicit advertising message: you are going to want these glasses. Those without access to the necessary physical mobility and technological capital, and who thus cannot participate fully in AR society, are nowhere represented in the show. With no presence in AR space, they too are functionally invisible. Even for those who can play along, access is far from evenly distributed. As several of *Dennō Coil*'s voice actors point out in a video interview included with the DVD releases, the show presents glasses play as a largely gender-inclusive activity. At the same time, when it comes to issues like cyber-bullying or the divide between 'new' and 'old' space, the show accurately predicts that AR, like other computer networks, will work to translate existing power differentials into a new digital realm. Indeed, so far one of the most interesting aspects of AR games like *Mogii*, *Ingress*, and *Pokémon Go* from a sociological perspective has been how they can make visible the seams of public (data) space, showing how the seemingly 'ubiquitous' space of digital augmentation is always accessible to some more than others, and from some places more than others.¹²

Meanwhile, the composited self brings with it whole new demands for learning and self-care, such as negotiating various layers of electronic tracking and data security. The children approach surveillance not as an abstract threat but as an everyday occurrence they simply need to manage as part of their virtual hygiene. They continually spy on each other using their *dennō* pets' video recording capabilities, and there is a running joke about several kids' claim to be doing *kansatsu* (scientific observation) when really what they are up to is *tōsatsu* (spying with a hidden camera; literally 'stealing pictures'). Megamass's bureaucracy and their periodic software updates also play an intimate role in their daily lives. The Sacchi cannot enter schools, religious sites, or private homes, as these spaces fall outside the *dennō* department's jurisdiction. The children use this to their advantage in avoiding the patrols. However, the more aggressive Searchmaton 2.0 introduced later in the show (Figure 10) not only drops the Sacchi's cute design for the look of a hard, square, metal-plated military technology, but also can gain near-immediate access to search warrants for entering private data space.

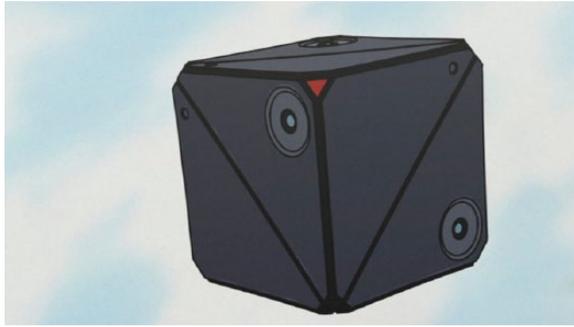


Figure 10. The more aggressive and invasive Searchmaton 2.0. DVD screen grab from *Dennō Coil* (Iso Mitsuo, 2007).

As Dourish (2001: 130–131) points out, ubiquitous computing protocols can be understood as ‘designing the ontology’ for the relationships that subsequently emerge. These augmented worlds need not be static or unidirectional; rather, they emerge through play and negotiation with the technologies at hand. Like the variable transparency of the alpha channel, the noticeability of the AR interface might shift back and forth: ‘At any given moment, my action may be directed toward one of any number of elements in the world and in the computer. I act *upon* some; I act *through* others’ (p. 141, emphases in original). The question posed by augmentation is never simply a binary choice between seamfulness or seamlessness, but what *kinds* of compositing an interface makes practicable. And, in turn, what kinds of composited self.

As Dourish and Bell (2011: 27) emphasize in *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*, we might do best to reject the fantasy of a seamless ubiquitous computing infrastructure lying just over the horizon, and instead realize we already live in a highly augmented world. From smartphone GPS to self-driving cars, ubiquitous computing will always be unevenly distributed, dirty, glitchy and partial. And, in fact, if we look back at the longer history of compositing in animation, we realize we have already been learning to navigate this mess for a quite a while. As the kids of *Dennō Coil* can attest, in order to more effectively navigate an augmented present, we might do best not to flock to the latest technology, seeking ever greater degrees of augmented immediacy, but rather dig deep into the flickering layers of our composited past. Tracing out these seams may in fact be the best way to situate ourselves in the world.

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Notes

1. Computing architecture innovator Sakamura Ken, long the foremost proponent of ubiquitous computing in Japan, similarly rejected this dominant view when he began his TRON project in the 1980s. Many at the time saw the future of computers only in more and more powerful mainframes (Callon, 1995: 26).

2. Sakamura Ken makes use of the term starting in the 1980s, calling himself a *dennō kenchikuka* (*dennō* architect) and ruminating on the *dennō toshi* (*dennō* city) of the future (Noda, 1986; Sakamura, 1985). For both Sakamura and the creators of *Dennō Coil*, the term works to position the ‘cyber’ within an explicitly East Asian technological lineage, one reaching back historically to both Japanese and Chinese sources. At the same time, the reference to an ‘electronic brain’ imagines ubiquitous computing as intimately related to cognition, a connection we will explore below in relation to *Dennō Coil*.
3. This campaign closely parallels a project launched by the South Korean minister of information and communication in 2004, which the Korean press had similarly dubbed ‘U-Korea’ (Dourish and Bell, 2011: 38–39). An official flash animation introducing the U-Japan project can be found at http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/intro.html. The 2007–2008 global financial crisis appears to have quickly put the brakes on both governments’ lofty visions for an ubiquitous future, though research and development continues.
4. Sakamura Ken led the project, whose stated goal was to have the chips ‘operate in a concerted manner, processing, exchanging information with each other within the ubiquitous computing architecture. Making available location-specific information anytime, anywhere, to anyone’ (Fitzpatrick, 2007). That same year, Sakamura published *Yubikitasu to wa nani ka* (What Is Ubiquitous?), a mass-market paperback seeking to introduce ubiquitous computing to a general audience (Sakamura, 2007).
5. On 10 April 2006, the Japanese broadcasting industry gathered for the ‘Age of Ubiquitous TV’ symposium at the Chiyoda Broadcasting Center in Tokyo. And, from 13–16 July 2007, while *Dennō Coil* was on the air, Tokyo University held a major conference on ‘Ubiquitous Media’ led by Yoshimi Shunya, Mike Featherstone, and Ishida Hidetaka. Papers from this conference were later published in two special issues of *Theory, Culture & Society* 26(2) and 26(3), March and May 2009, respectively.
6. Here the show taps into a long-running popular interest in post-high growth Japan in abandoned factories and other ruins (or *haikyo*), including their complex relationship to historical time.
7. The political overtones this term carries in English do not necessarily come through in the original Japanese, but this is an interesting word choice to say the least, considering the illegals’ fraught relation to Megamass’s own spatial controls.
8. The concept was first introduced in the early 1970s by Ed Catmul and Alva Ray Smith, who would both go on to be key players at Pixar. It was later further developed by Thomas Porter and Tom Duff at Lucasfilm. For more on the history of image compositing and the alpha channel, see Kane (2014: 174–209).
9. I am drawing the term *athleticism* from Gilles Deleuze’s book on the painter Francis Bacon, where Deleuze emphasizes how the material demands of a medium reshapes the physical discipline of those living and feeling through it:

What makes deformation a destiny is that the body has a necessary relationship with the material structure: not only does the material structure curl around it, but the body must return to the material structure and dissipate into it, thereby passing through or into these prosthesis instruments, which constitute passages and states that are real, physical, and effective, and which are sensations and not imaginings. (Deleuze, 2006: 18)

See below for more on the role of sensation and affect as part of this augmented athleticism.

10. For a contemporary parallel, consider the PTSD symptoms reported by some drone pilots for the American military, whose job asks them to drop bombs on people thousands of miles away while sitting comfortably in a secure control room (Väliaho, 2014). This kind of situation can be understood as a ‘coil phenomenon’ not unlike the one in the show, where the actual and virtual selves, and the emotions that accompany these different layers, are in danger of falling out of sync. At the same time, virtual reality simulators are being deployed to *treat* military PTSD through exposure therapy by modeling past traumatic events, much like the AR therapy described in the show.
11. The coil domain is here and elsewhere associated with the ‘other side’, the world of the dead, or the afterlife. Old AR serves here as an example of what Eugene Thacker (2014: 129) calls ‘dark media’, his term for obsolete technologies that come to mediate far more than was originally intended, including (as often happens in Japanese horror films) the world of the dead.

12. See, for example, Licoppe and Inada's (2006) work on the 'perceptual asymmetries' of *Mogii* players based on age, gender, and location. Similarly, while theoretically anyone can play Niantic's *Ingress* and *Pokémon Go*, the dynamics of the game clearly favor those in major urban centers with ample access to 'portals' and 'gyms', which are themselves often (though not inevitably) mapped onto existing sites of cultural and economic capital.

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