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The fractal canvas: complexity and constraint in webcomics

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Abstract

The Web browser has offered a development of the comic beyond the page into expansive spaces of the infinite canvas, removing the limits of the printed page. Simultaneously, hypermedia has provided opportunities to generate ever more complex links to supplement or even remove the limits of a linear narrative. However, the borders of conventional comics persist, and some of the most successful webcomics have thrived within the self-imposed constraints of limited panels, limited images or limited resolution. This article will ask how these different forms of experimentation interact and propagate in webcomics, across their content and context, their narrative structures, and the medium as a whole. Considering the experimental modes of creating and reading in the infinite canvas, hypermedia or other forms of webcomics, the article will outline a fractal dimensionality to webcomics.

Full text (PDF file)

This article will explore the imposition of limits on webcomics as a tool to explore the negotiation of content, narrative and medium. Against the transcendence of visual borders in the infinite canvas and dimensional borders in hypermedia, a further trend of expansive webcomic aesthetics will be interrogated. The article will thereby propose a fractal dimensionality to webcomics. Whether they employ vast hypermedia experiences or a single panel, the scalable constraints and interactions of webcomics create self-similar mediations that can define new relations to narrative and readership. Fractals offer a useful framework for

analysing complexity and constraint, and webcomics as a digital and literary mode of creativity often lie at the interplay of this relationship. Webcomics often use creative simplicity, either of available technologies or of traditional formal comic style, with complexity emerging instead from the interaction between these two strands of creativity. This article will outline how a fractal dimension emerges whereby the canvas is greater than its area or the sum of its parts, enabling a rabbit-hole of cultural practice at the intersection of art, literature and technology. The direct confrontation with the medium generates new modes of writing, new approaches to reading and in turn new cultures and settings to represent. Examining works from *Argon Zark!* to *Failing Sky*, *Netboy* to *The Oatmeal*, *Dinosaur Comics* to *Les Autres Gens*, and *Nawlz* to *Seeing Thru Walls*, the argument will draw out the reappropriations and cultural representations that feed into loops of cultural and intermedial causality. The article will thereby suggest a new mode of viewing the interconnected experiences of a medium that has the potential for many forms of infinite expansion in the convergence of digital media technologies and literary practices.

Webcomics

Across the full spectrum of experimental to humorous aims and practices, webcomics from their inception have engaged with a critical and satirical reflexive interaction with the cultures of both technology and comics, as well as related media and genres. Yet webcomics remain a contested mode of artistic expression, in terms of their merit, their aesthetic potential and even their definition. Indeed, the Eisner Awards separated the Digital Comic/Webcomic category into two separate awards in 2017, while the Harvey Awards attempts a broader label when awarding the prize for Best Online Comics Work. However, while Dittmar argues for the differentiation between webcomics and digital comics, on the grounds that webcomics are a subcategory of digital comics[1], this separation has become somewhat outdated. Across all media, the majority of content today is delivered over the internet; with the limitations of bandwidth, device capability and compatibility having been largely solved, all media have become to some extent web-based. We are now at a stage where ubiquity of devices and connectivity is at least sufficient for content producers to rely on them as the dominant distribution platform. The need for explicit categorisation of webcomics perhaps stems from a persisting debate over the definition of comics in general. Even McCloud, idealistic proponent of digital comics, maintains a closed definition of comics as "juxtaposed pictorial and other images in deliberate sequence," styled as a "still life."[2] Such a definition precludes the more radical opportunities offered by cybertexts, neurofiction or algorithmic art, yet McCloud emphasises the increasing importance of conceptual distinctions. Goodbrey, by contrast, opts for a series of characteristic tendencies rather than a strict definition of comics, combining and building on Eisner, McCloud and Groensteen to include: space as time; juxtaposition of images; closure between images; spatial networks; reader control of pacing; tablodic images; and word and image blending.[3]

While these characteristics carry over to webcomics, there is necessarily a type conversion that occurs with the change of medium. Indeed, Kirchoff has warned of digital comics becoming a "retro" technology as the medium tends towards emulating or enhancing print media. Instead, he suggests that digital comics should be considered different, and identifies the need to "shift attention from immediacy to hypermediacy...to allow for more complex, choice-driven interactions between readers and texts."[4] Yet the most influential aesthetic shift in webcomics has been a simple manipulation of space: McCloud's "infinite canvas."[5] Against the constraints of the physical page, the infinite canvas allows for full artistic freedom in expressing narrative time. The ability to scroll the page beyond the borders of the monitor

1. Jakob Dittmar, "Digital Comics," *Scandinavian Journal of Comic Art*, vol. 1, no. 2, 2012, p. 85.
2. Scott McCloud, *Reinventing Comics,* New York, Harper Collins, 2000, p. 200, 229.
3. Daniel Merlin Goodbrey, "Game Comics: an Analysis of an Emergent Hybrid Form," *Journal of Graphic Novels and Comics*, vol. 6, no. 1, 2015, p. 5 *sqq*.
4. Jeffrey Kirchoff, "It's Just Not the Same as Print (and it Shouldn't Be): Rethinking the Possibilities of Digital Comics," *Technoculture*, vol. 3, no. 1, 2013, p. 2.
5. Scott McCloud, *Reinventing Comics*, New York, Harper Collins, 2000, p. 222.

can enable variable lengths and shapes of "page" to better suit the structure of the content and narrative, but this potential for an infinite page is not without practical constraints. While McCloud himself acknowledges that there will always be limits, he misguidedly locates these in the medium: resolution, download speed, storage. However, I argue that technologies such as hypertext (the expansion of potential beyond the immediate frame) and procedural generation (the folding of narrative worlds into a smaller functional description) can transcend obvious visual technological boundaries. Rather, the limitations are themselves conceptual. The difference between scrolling and turning/clicking on the next page are not sufficient to afford the infinite canvas the revolutionary quality that McCloud intends. There remains the need for reader interaction to reveal more content, to see beyond the frame of the medium, whether printed page or computer screen. The window and infinite canvas simply displaces this constraint into a variable form, depending on precise relations of resolution, rather than integrating the limit into the narrative structure through the shaping of the page (physical or digital). The infinite canvas can be conceived as merely a scalable and less absolutely quantised series of pages. Thus, not only are digital comics "no closer to realizing McCloud's infinite canvas,"[6] but it is in other areas of technical, visual and conceptual development that the potential for digital comics lies. As Steiling acknowledges, this may require a substantial departure from conventional definitions, but immersive media can still embody the practices and tradition of comics.[7] What is needed is an alternative framework within which to view webcomics and the visual, narrative and interactive potential of the digital medium.

The fractal canvas

What lies beyond the infinite canvas? For an answer, we can look to McCloud's own webcomics. In both *Porphyria's Lover* and *Zot! Online*, McCloud attempted to demonstrate the infinite canvas. In *Porphyria's Lover*, a setting of a Robert Browning poem by the same name, the rhyme scheme of the original text is embodied in the placement of the frames, the A-B, A-B-B pattern creating an uneven zigzag that repeats in each stanza extending vertically down the page. This runs counter to more literal expressions of the infinite canvas, as shown in comics such as *Hive* which started the stylistic trend on the Korean Webtoons platform, which simply consist of equal width frames arranged in a linear vertical alignment. In *Zot! Online,* a more freeform approach is taken, driven by the narrative, that includes irregular and nonlinear lines and placement of frames, text outside of frames for background, reflection, or speech bubbles. Other frames remain unbordered, are styled with geometric and fragmented borders, or lie within retrofuturistic screen interfaces. The narrative across parts 10 to 12 is even split into two parallel strands, each with its own line extending down the infinite canvas. The nonlinearity and expansion of these aesthetic choices extends beyond the simple infinite line of the canvas. Even a two-dimensional linear structure enacts a folding of space, occupying more of the canvas than a linear depiction and thereby extending beyond the one-dimensional topological space of the narrative time to which McCloud attempts to cling.

With such an increased dimensionality, fractals offer one way of conceptualising such space. Indeed, in his description of the mathematical understanding of chaos, Gleick states that "in the mind's eye, a fractal is a way of seeing infinity."[8] McCloud's infinite canvas leads naturally then into fractal thinking, and fractals allow for further consideration of the expanded dimensions of webcomics through all manner of spatial, hypertextual and multimedial practices that are made possible for comics in with digital technology. McCloud himself describes the computer as a single environment containing a vast and ever expanding array of tools and possibilities, and even highlights fractals in terms of their imagery, as a digitally-enabled aesthetic, and their scaling, with detail at arbitrary scales made visible only through the appropriate level of zoom.[9] Both fractals and webcomics rely on a technologically

6. Jeffrey Kirchoff, "It's Just Not the Same as Print (and it Shouldn't Be): Rethinking the Possibilities of Digital Comics," *Technoculture*, vol. 3, no. 1, 2013, p. 2.
7. David Steiling, "Reading from Within the Panel," *ImageTexT: Interdisciplinary Comics Studies*, vol. 6, no. 2, 2012. [Online] http://www.english.ufl.edu/imagetext/archives/v6_2/steiling/index.shtml [accessed 16 March 2018].
8. James Gleick, *Chaos* [1987], London, Vintage, 1998, p. 98.
9.   Scott McCloud, *Reinventing Comics*, New York, Harper Collins, 2000, p. 148, 224 *sq*.

mediated relation with their informational objecthood in order to be read or viewed, always constrained by a limit of perceptual detail between different parts and scales.

Like webcomics, fractals tend to exist "entirely inside a computer's memory,"[10] and are identified by a series of characteristic tendencies rather than a specific definition, including some or all of: detail on arbitrary scales; irregular beyond description by conventional geometry; self-similarity (exact or approximate); a fractal dimension larger than its topological dimension; a simple definition or recursion.[11] As described by Benoit Mandelbrot, originator of the term fractal as a bringing together of a long history of chaotic and unpredictable structures in mathematics, "differences in fractal dimension express differences in a nontopological aspect of form, which I propose to call fractal form. Most problems of real interest combine fractal and topological features in increasingly subtle fashion."[12] Just as fractal analysis is applicable to conventional topology (it just tends not to add anything of value unless there is a complex dimensionality to be explored and contrasted to the expected topologies), fractal conceptions of the canvas in webcomics can be applied to conventional or even infinite canvas. This is particularly the case with webcomics that expand into interactive or critical relations with the digital medium, as the fractal canvas extends beyond the topological through the folding of non-visual dimensions into the visual field of the comic. In the ongoing webcomic *Failing Sky*, we wee a full fractal implementation of the infinite canvas, with irregular frames sprawling across each page with scrolling in all directions but not according to any discernible pattern. Discovering the visual path(s) is part of uncovering the narrative, but each page remains clearly defined just not instantly accessible to reader. Beyond the obvious visuals, the links to the next pages or chapters are often not at the end of the previous one. Instead there are overlapping storylines and timelines that mirror their spatial arrangement. There is a complex dimensionality at work that embodies the supernatural elements of the equally fragmented narrative. The temporality of the work also demonstrates a fractal expression in that pages still in progress can be viewed ahead of release, the early sketched images preceding their full visual form.

Perhaps the first embodiment of the fractal canvas was also the first created exclusively for the internet, *Argon Zark*! The difference of the Web to preceding modes of organising, distributing and interacting with information is carried throughout this webcomic, foreshadowing humorously or in passing many facets that would come to define the medium and its critical power in later works. The themes of the webcomic, based on the science fictional premise that one could teleport through the internet into digital spaces, are firmly rooted in the cultural tropes of science fiction and the early internet. There are abundant cultural references, such as the robotic companion quoting *Lost in Space* and *2001: A Space Odyssey*, or the fact that in-world teleport links are represented by objects with a blue glow—echoing the html custom for identifying hyperlinks. Sometimes the characters travel into spaces displayed as actual webpages, including one where all the links have been "corrupted" and lead to a page resembling a faux virus scan or hacked site that gives options such as "delete your hard drive, melt your computer, burn your house and nuke your car." This cultural recursion follows through into the narrative structure, where nonlinear interactive dimensions echo the content and themes of the story. There is a fractal dimension to information that spreads in both structural and cultural ways, including "turning on" a search engine to progress to the frame, or the many images that link to additional information. This bonus content includes backgrounds, additional art, computer-generated images, and even an explanation of the fractal visualisation that was used to create clouds in one frame. There is even a side narrative spread across multiple hidden frames, under the guise of an internal email chain between the evil corporation's technical R&D department and "Bill" in management. There are links back to earlier panels, as well as to now deprecated search engines (such as yahoo or lycos, for *Argon Zark*! predates the dominance of Google), providing recursive loops and open-ended exploration respectively. The deprecation problem persists to limit further structural

10. Benoit Mandelbrot, *A Fractal Geometry of Nature*, New York, W.H. Freeman and Co., 1983, p. 10.
11. Kenneth Falconer, *Fractal Geometry. Mathematical Foundations and Applications,* 3rd Edition, Chichester, John Wiley & Sons, 2014, p. xxviii.
12. Benoit Mandelbrot, *A Fractal Geometry of Nature*, New York, W.H. Freeman and Co., 1983, p. 17.

opportunities, such as a panel filled with CGI coloured balls that should lead to a variety of different sites but whose links are now mostly broken. This highlights the limits of the medium itself, a debate with which *Argon Zark*! actively engages throughout. There is a mix of conventional comic images with animated GIFs and 3-d computer-generated images, to visually display the exploration of the potential for digital tools, and the embodiment of the fractal canvas, that flows into all aspects of the webcomic. The present discussion will now explore three separate manifestations and implications of the fractal canvas: content (and, relatedly, context), narrative, and the medium itself.

Content and context

One aspect of fractals that webcomics embody is the fact that they are often simply defined and display a recursive quality to the issues and topics they describe. The roots of webcomics in smaller online communities of those involved in technology and/or research was linked to the emergence of many webcomics out of college or small newspapers. These formats, aimed at special interest groups developed "a dominant model for webcomics"…"similar in format (if not in content) to that of the daily newspaper comic strip."[13] Where the reduced audience for webcomics takes on a recursive quality is this shift in content, towards a trend for cultural self-reference relating to computers (for example, *The PC Weenies*, *General Protection Fault*, *Ctrl+Alt+Del*, *User Friendly*, *Angst Technology* or *Netboy*) and associated cultures such as videogames or role-playing games (including *8-bit Theater*, *PvP*, *Penny Arcade* or, later, *d20monkey*). From their earliest days, webcomics have tended towards depictions of "nerd" culture, which itself revels in associations with mathematical concepts such as fractals and recursion. *Netboy* was labelled "comics for the hardcore geek" when listed as one of *Wired*'s "cool webpages" during the rise of graphical browser Mosaic.[14] The technological content of *Netboy* is echoed in its visual style and relation to the medium. It makes use of GIFs for limited animation, and is constructed of a very simple aesthetic composed of line drawings, responding to the constraints of low bandwidth on visual complexity. This technocultural self-reference is often displayed at higher scales of recursion, such as in *PvP*. While also based on geek culture, this early and long-running webcomic is set not at a technology company but a video game magazine company. Rather than being about the games themselves, it is already one step removed, positioned at a cultural scale and thereby propagating the self-similar impact of gaming throughout society. Digital culture as a whole envelops digital technologies, both following and preceding the technical developments,[15] creating a feedback loop of the ideas that construct "the digital" as a fully socio-technical medium. Similarly, webcomics have instigated a feedback of digital culture that has come to define the medium.

As Hobby points out, the episodic comic strip format of webcomics reflects the faster reading speeds of Web browsing,[16] to which we can add the now familiar reverse chronological presentation characteristic of social media news feeds, as opposed to the conventional ordering of volume-based print media. This fusion of format and content is linked to the technological specificity of webcomics and their audiences, such as *The Penny Arcade* which is not only about computer gaming but therefore "draws a specialized audience already literate with computers."[17] The potential for and limitations of webcomics aimed at niche audiences has been discussed by Fentry *et al.*,[18] who explore webcomics in a functional

13. Daniel Merlin Goodbrey, "Game Comics: an Analysis of an Emergent Hybrid Form," *Journal of Graphic Novels and Comics*, vol. 6, no. 1, 2015, p. 293 *sq*.
14. Gary Wolfe, "The (Second Phase of the) Revolution has Begun," *Wired*, 1 October 1994. [Online] https://www.wired.com/1994/10/mosaic/ [accessed 19 March 2018].
15. Charlie Gere, *Digital Culture*, 2nd Edition, London, Reaktion, 2008, p. 17 *sq*.
16. Mark Hobby, "From Still Scene to Static Screen: Australian Comics in the Digital Age," *Metro Magazine*, vol. 169, 2011, p. 92 *sq*.
17. Mark Bell, "The Salvation of Comics: Digital Prophets and Iconoclasts," *The Review of Communication*, vol. 6, no 1-2, 2006, p. 139.
18. Sean Fentry, Trena Houp and Laurie Taylor, "Webcomics: The Influence and Continuation of the Comix Revolution," *IMageTexT: Interdisciplinary Comics Studies*, vol. 1, no. 2, 2004. [Online] http://www.english.ufl.edu/imagetext/archives/v1_2/group/index.shtml [accessed 16 March 2018].

relation to underground comics. The position outside of mainstream media places webcomics in a self-reinforcing feedback loop, whereby small readerships become less of a problem than print underground comics due to the broader reach of online distribution. Webcomics are therefore read by a much larger percentage of their niche demographic, often leading to highly devoted fan bases.

The scalability of online media emphasises the iterative and self-similar nature of fractals in that the shared interests and opinions of their audiences can be expressed and shared in communities regardless of the limits of geographical topologies. The hosting of webcomics on websites allows also for greater interaction with and between readers in, for example, comments sections and discussion of the creative process. Thus alienation of audiences is less of a concern for webcomics, enabling them to deal with non-normalised topics and themes, often including profanity, sec, violence and other taboo issues. Fentry et al. emphasise here the need to look beyond geek culture as a potentially homogenising classification of webcomics, for the same functional processes can be applied to other subject matter, and webcomics offer a natural mode of creation and distribution for broader underground and non-mainstream traditions. The feedback loops are therefore not exactly but functionally and approximately self-similar, acting as strange attractors for creative behaviours and attitudes, as well as offering critical reflections on the tropes of given cultures and their audiences. One area Fentry *et al*. identify here is the treatment of women in technology, which is persistently parodied in webcomics by those seeking to address the limitations of closed and self-reinforcing communities. Fractal content in webcomics is concerned not only with the more affirmative processes of iteration and recursion, but also with a self-referential critique of the cultural constraints of feedback loops.

Less technologically-focused recursion in webcomic content can be seen in the relation to other specific audiences and their use of the medium. For example, the 404 error page of *Existential Comics* claims that "the server looked inside itself for your file, but found only an all consuming *emptiness*,"[19] crossing the tone, content and style of the comic itself with a comment on the medium and infrastructure upon which it relies. Webcomics take on a meme-like quality in their self-referential and recursive propagation. This is sometimes literal, as in the "trollface" meme that originated as a "oneshot" six-panel comic Trolls on deviantart. What started here as a reflection on internet trolls has come to signify the negative behaviour as a whole.

Other proliferations of content in webcomics include multilingual distribution such as *Maliki* (in French and English) or *Bludzee* (in 19 languages). In a different approach, *Les Autres Gens* takes a common small team of writers to develop the thematic content and narrative, but distributes the visual content across a large group of artists. Each adjacent episode has a different artist, creating a common thread and context without a singular or canonical visual style. The fact that it is published every weekday furthers this variation through the speed of its iteration. The emphasis on functional context even with variety of content is seen in the reverse operation in *The Oatmeal*. With a common visual style by a single artist, embodying the cultural persistence of simple line drawings as the dominant webcomic aesthetic, *The Oatmeal* uses a quasi-infinite canvas that adapts its scroll length depending on the needs of its content. There is no overarching narrative, but a series of variable-length one-off pages that include a variety of topics and links to other media. The webcomic includes different media, including further projects developed by the artist (such as the card game *Exploding Kittens*), links to external fact-checks for its claims, and quizzes (such as "how many hungry weasels could your body feed?"), among others. The irreverent style, the succession of niche cultural topics, and the embedding of the content within the visual style and the hypertextual possibilities, display the recursion and self-similarity of webcomics in their recursive embodiment of the medium within its own content. This setting provides the culture and context in which the narrative possibilities of webcomics can be explored.

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19. Corey Mohler, "404 Error," *Existential Comics*. [Online] http://existentialcomics.com/404 [accessed 19 March 2018].

Narrative

McCloud's vision for digital tools in the creation of comics was less about visual effects and more about their use for narrative effects.[20] This can be extended to the fractal canvas and the relation between complexity and constraint in giving webcomics focus and a distinct creative identity. Nowhere is this relation seen more clearly than in *Dinosaur Comics*. This long-running webcomic takes on the ultimate iterative, self-similar visual constraint: every single comic consists solely of exactly the same images, six panels that define the comic. It is the different text that creates the narrative throughout this practice, accompanied by alternative hover text to add a further dimension. The consistent and small visual space is unfolded through time in an evolutionary self-similarity. The artist initially "worried that the structure would be too restricting because you have these dinosaurs and there's a narrative implied in their motions,"[21] but through the manipulation of time (for example "three weeks later"), space ("in an alternative universe where…") and implied extension or visual disruption of the panels (with non-visible characters such as voices from previous panels or god), the fixed structure generates endless variation even within its repetition. The apparent constraints reveal fractal narrative space-time, dimensions beyond the obvious structures of the page. A similar function can be seen in the collaborative work *Whispered Apologies*, in which anyone can submit artwork and then others write for it. The anonymous interaction establishes a fixing of the image to which text must then be applied to expand the visual space into a new narrative. As Dittmar writes, "new and established media trigger the development of specific narrative forms that cater to their particularities."[22] It is precisely from the constraints that narrative complexity draws its specificity.

Despite the constraints imposed by certain artists or writers, and by the prevailing style of comic strips on the web, digital media allows for a much freer range of narrative structures. Goodbrey describes this as a "hypercomic nature, offering the reader a multicursal maze of narrative to explore and interrogate,"[23] and McCloud had identified the "interactive matrix of narrative choices"[24] that are offered by hypertexts. Counter to McCloud's focus on the infinite canvas as the supposed salvation of comics using digital tools, Goodbrey takes a wider view that encompasses the hypertextuality of the medium, the expansion of narrative into complex dimensions of possibility. More recent examples, such as *The Empty Kingdom*, *Icarus Needs*, and *A Duck has an Adventure* take this interactivity far enough to be hosted on the flash game platform Kongregate, embodying his exploration of the intersection between games and comics. The latter game has sixteen different endings, a complex Web of narrative paths guided by the reader's decisions. Here the constraints are constructed by the artist and imposed upon the reader, for the multicursal maze is still a system of control, still embodying self-similar modes of interaction, and still just as tightly defined by the comic's creator at the metanarrative level.

Earlier experiments such as the *HAPPYfrictions* project focused on the core functionality of the hyper nature of comics, not based on the existence of animation or sound but rather on the simple addition of reader choice in the narrative. Within this series, *Higherfunctions* creates a recursive net of looping quasi-narratives. There are 26 frames, each composed of a black and white pixelated or blurred image plus a fragment of narrative text. This text contains two or more words acting as links. Each frame therefore takes the place of a word (such as "human," "tonight" or "shit"). Words consistently link to the same image, and appear on multiple frames. The nonlinear narrative is constructed not only by the interactive choices of the reader but by their interpretation of the fragmented structure. As with fractals, the extra dimension afforded by hypertextuality is never simply whole. We are not moving from 2D to 3D, as one might identify in the progress of gaming graphics. Rather it is the creation of fractional experiences, dimensions measured in decimal places.

20. Scott McCloud, *Reinventing Comics,* New York, Harper Collins, 2000, p. 146.
21. Ryan North quoted in Karen Whaley, "Tall Poppy Interview: Ryan North of Dinosaur Comics," *Torontoist*, 17th May 2006. [Online] https://torontoist.com/2006/05/tall_poppy_inte_31/ [accessed 19 March 2018].
22. Jakob Dittmar, "Digital Comics," *Scandinavian Journal of Comic Art*, vol. 1, no. 2, 2012, p. 89.
23. Daniel Merlin Goodbrey, "From Comic to Hypercomic," in Jonathan Evans and Thomas Giddens (dir.), *Cultural Excavation and Formal Expression in the Graphic Novel*, Witney, Interdisciplinary Press, 2013, p. 293.
24. Scott McCloud, *Reinventing Comics*, New York, Harper Collins, 2000, p. 214.

Another *HAPPYfrictions* taking this theme to a more abstract level is *Hipaffliction*. Here we are presented with five equal panels of black and white lines. In some sense we can take in the whole content at once, until we start to interact. Hovering the mouse over a panel causes the lines to shift into a ripple or swirl, and clicking causes the whole window to shake before either changing the distortion applied to the lines or revealing a random part of the hidden images. These images themselves are fractional, composed of partial views of a person and/ or gun. There is ostensibly no narrative at all here, other than the path of interaction created by the reader and the tension built up through the successive shots of the characters and their deadly arms. We create the scene of a Mexican standoff, not only within the frame but also between reader and medium as the narrative emerges through the recursive build-up of tension without true narrative and without release.

The fractal hypercomic thus offers an opportunity to overcome the limits of the narrative imperative presented to us by artists such as McCloud, while maintaining the possibility for complexity and a fractional quasi-narrative experience. Yet the criticisms levelled at digital comics persist in their accusations of the abandonment of the comic ideal and a particular conception of narrative. Dittmar,[25] for example, appear to take great offense at the idea of including sound in digital comics, lest the audio component becomes a sound-track in the filmic sense and thereby removes control of the reading speed and narrative pace from the reader. He also objects to the removal of cliff-hangers and the loss of the page turn in the infinite canvas, insisting that traditional comic conventions will always persist as part of a broader culture of narrative. In practice, however, audio used in webcomics tends more towards a series of continual soundscapes rather than timed soundtracks (as we shall see in examples below), while webcomics such as *Failing Sky* demonstrate how the tradition of the printed page can be transposed onto the webpage while still allowing for a more engaged experience through the need for interaction and a disruption to visual conventions. Narrative in the fractal canvas is drawn inherently and explicitly into its mediation.

Medium

One of the defining features of digital comics is self-determination, the fact that they "can define their own format."[26] Whether single-pane webcomics or expansive interactive experiences, digital comics can use their relation to the open possibilities of the medium to let content and narrative drive the overall nature of the individual work. Although, as with any digital media, the plethora of devices, operating systems, screen resolutions, browsers, required software, bandwidth and other components of the "medium" must be taken into account to overcome issues of device specificity, usability and compatibility. Further, the use of the digital medium generates a relation to information literacy and education, and webcomics become "surrounded by and implicated in other multimodal texts that, taken together, form a Web of interlinked information that provides opportunities and challenges that were never faced by preceding generations."[27] Even *xkcd*, which mirrors the short-form newspaper comic strip, uses hover text to add an extra layer of meaning and self-narrative beyond the capabilities of print, but this requires either a certain level of familiarity with the comic itself or a general informational literacy to look for it. Indeed, such use of hover text has become a stock technique in short-form webcomics, expanding the title and caption to include an often self-descriptive, humourous or alternative take on the idea presented. A further example of this literacy from *xkcd* is "1110: Click and Drag."[28] After three conventional panels forming an introduction of sorts, depicting a stick figure floating along holding a balloon, a panel is presented with the text "I didn't expect it to be so big." While this panel is itself proportionately larger, the reader can "click and drag" to discover an even greater world within the frame. Behind the short-form webcomic is an infinite canvas with which the reader must interact to explore, requiring a simple but necessary level of technical literacy for the

25.   Jakob Dittmar, "Digital Comics," *Scandinavian Journal of Comic Art*, vol. 1, no. 2, 2012, p. 87, 89.
26.   Jakob Dittmar, "Digital Comics," *Scandinavian Journal of Comic Art*, vol. 1, no. 2, 2012, p. 87.
27.   Dale Jacobs, "Webcomics, Multimodality, and Information Literacy," *ImageTexT: Interdisciplinary Comics Studies*, vol. 7, no. 3, 2014. [Online] http://www.english.ufl.edu/imagetext/archives/v7_3/jacobs/index.shtml [accessed 19 March 2018].
28.   Randall Munroe, "1110: Click and Drag," *xkcd.* [Online] https://xkcd.com/1110/ [accessed 19 March 2018].

comic to work. The hidden aspect of the perceptual limit requires knowledge of the titular phrase in order to uncover its true visual dimension. The narrative therefore expands openly within the expansive medium, allowing for myriad paths built on the iterative act of clicking and dragging. A similar function is achieved in "1608: Hoverboard."[29] Here a simple-looking game is presented with a hoverboard controlled by the arrow keys. The required literacy for this comic is stylistic and cultural—moving beyond the bounds of the game itself to reveal another expansive world filled with "Easter Egg" style content. Embodying the principle of game comics, the narrative exploration is based entirely on the reader's desire to explore and the knowledge that there is a greater dimension to the comic than the initial presentation. In such works, the content is revealed always in partial form, and the narrative is defined by the reader's own pace and direction as well as the limited distance of any single drag. The medium itself enables and constrains the potential of the webcomic.

One of the most well-known and radical examples of digital comics that fully embrace an active relation with the medium and its possibilities is Sutu's *Nawlz*.[30] This comic, using the full range of multimedia and hypermedia techniques, began in Flash before being later released for iPad. This shift embraces the dilemma of deprecated formats that Sutu has explored elsewhere, for Adobe itself has announced (in conjunction with Apple, Facebook, Google, Microsoft and Mozilla) the end of support for Flash by 2020. Unless Nawlz is ported to a fully html compatible format, it risks becoming readable only in legacy browsers or in the newer iPad app format. The thematic content of *Nawlz* embodies the complexities of digital culture, drawing on a strong cyberpunk aesthetic to depict a world of augmented realities, mind-altering drugs and the gaps in reality that these tropes create. This is carried into the layout of the comic, with layers of images and backgrounds with words flexibly embedded and interlaced. The images themselves are malleable and shift with reader interaction, echoed in the series of soundscapes that shift and unfold with each successive interaction. The visual and audio components are never fixed, but constantly evolve in self-similar ways to create a constant and well-defined aesthetic experience even as it depicts the complexities of the main character's fractured mental state.

The interactivity itself is also erratic, full of sidetracks and possible hallucinations to draw the reader into the world and mind of the protagonist. The constant side scroll of frames that appear as the reader finds the links to click through is disrupted by blurred, irregular and overlapping edges of frames, while interaction with one frame can change the images of previous ones that remain visible to one side or even track backwards from a tangential line of thinking. We are thrust into a stream of consciousness where the hypertextual interaction is expansive but not without constraint. There are a succession of fractional narrative strands, retreating from dead ends with evolving landscapes, as well as much hidden supplementary content for the reader to find. This level of interaction has been described as the closest yet to "non-trivial interaction" on multiple levels,[31] embodying the possibility of intentional interactive choices and the choice between scroll (in the style of the infinite canvas) or point and click (which allows for additional content to be found). Yet the immersive experience is also one of constraint. Not only would scrolling keep the reader on the linear narrative path, but there are also some transitions that are timed, taking the role of animation as a series of temporary images that cannot be paused or slowed down. Here the interactivity is used to fully support rather than replace the narrative, imposing strict limits on the reader and the visuals when required for narrative effect. Yet the animation element often remains adaptive, responding to positions mouse as images follow the reader's movements, further blurring the line between hypermedia and infinite canvas. The complex interaction not only between the reader and the comic but also between the stylistic and medial components creates an increasingly multidimensional pace to *Nawlz,* asserting the cyberpunk style and the full potential of the medium. Against the simple strip aesthetic of many webcomics that creates a recursive loop of the historical limitations of bandwidth and resolution, *Nawlz*

29. Randall Munroe, "1608: Hoverboard," *xkcd.* [Online] https://xkcd.com/1608/ [accessed 19 March 2018].

30. Sutu, *Nawlz*, 2008. [Online] http://www.nawlz.com [accessed 20 March 2018].

31. Jeffrey Kirchoff, "It's Just Not the Same as Print (and it Shouldn't Be): Rethinking the Possibilities of Digital Comics," *Technoculture*, vol. 3, no. 1, 2013, p. 14, 17.

explores the broader history of digital culture by making use of technological advances to achieve a much grittier style that is still equally abstracted in its own way. The aim here is to represent the flow of information as directly as possible, seen also in the way the interface intrudes on, or perhaps adds to, the narrative. An example of this is season 1 issue 4, which is preceded by a note in the style of the content of the comic, purportedly from an in-world "Nawlz administrator," warning of a fullscreen bug that will limit interactivity on a specific platform/browser (Safari on Mac). The medium is ever present in *Nawlz*, and that is precisely the point, for the full fractal canvas displays first and foremost itself, iterated across specific media in the self-similar, self-referential culture that is digital comics.

Conclusion. The fractal time of comics

Throughout the fractal narrative effects of digital comics, one tension within the medium persists: temporality. Despite the best efforts of many artists towards both the simple regular streams of iterative short-form strips and the elaborate potential of hypermedia experiences, there will always be the ultimate limit of the reader's own linear reading experience. As temporal creatures, humans cannot escape the arrow of time in reading and (re)constructing narratives, and the fractal dimension will always remain to some extent implied, excessive and hidden. An intentional or forced interactive choice is always a closing off of possibilities. As Gardner writes in relation to archiving in new media comics, "the excess data—the remains of the everyday—is always left behind (even as the narrative progresses forward in time), a visual archive for the reader's necessary work of rereading, resorting, and reframing."[32] The expansion of the fractal beyond the topological will always generate a lost excess of information.

This is embodied in two final examples. The first, Sutu's *There Memories Won't Last*, concerns the artist's grandfather and his loss of memory. On entering the webcomic, the screen states that it is "loading memories," and the infinite canvas uses linear scroll in both directions as the panels and narration converge through opposite movements, as if simultaneously going forward in time and remembering the past. Yet there is more than linearity here, for certain "memory" panels use a sideways scroll to display a separate remembered timeline, and scrolling backwards causes clouds to fill the screen. We can never truly remember here, only move forward in our own narrative time, with the game remembering our place even if we cannot. With the lack of conclusion to the story, only an implied downwards spiral into the loop of forgetting, the comic comments on the temporality of the medium. This is a common theme for Sutu, indeed the comic itself had to be redesigned halfway through the creative process with the release of new features and incompatibilities in html5. He focuses on using the new possibilities and limits of interactivity to convey a feeling for the particular narrative, and it is not only our memories that fail but also those of digital technologies with the perpetual entropy of obsolescence.

To conclude, the fractal canvas is a framework for viewing the unfolding potential and fractional limitations of digital comics. Bringing together the new possibilities of the infinite canvas and hypermediality as well as the constraints of specific technologies and the artistic process, the fractal canvas embodies the complexities of partial dimensions that can never be fully apprehended by the reader's own linear narrative path. The future potential of webcomics is open-ended, constantly propagating the cultural and aesthetic tendencies of traditional and digital comics into new areas. As a closing remark, it is worth mentioning the potential for radical experiments such as *Seeing Thru Walls*. This GPS-based comic uses location as the mode of interaction, with the reader living the story through their geographical movements. The reader is displayed in real-time on a map alongside locations and characters to visit or avoid, and even combines the multisensory input of the physical world with the digitally presented comic (such as a frame about the smell of chlorine that appears when arriving at a swimming pool). Bringing artistic experimentation together with technical

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32. Jared Gardner, "Archives, Collectors, and the New Media Work of Comics," *Modern Fiction Studies*, vol. 52, no. 4, 2006, p. 802.

research, this work seeks to enable "a set of new meaning making opportunities."[33] This is value of understanding digital comics in terms of a fractal canvas, and embodies the aim and potential for webcomics as a medium: creating new possibilities for artists, individual readers and communities of audiences to share new experiences and approaches to comics as a form.

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33. Ozge Samanci and Anuj Tewari, "Expanding the Comics Canvas: GPS Comics," *Fun and Games 2012*, Toulouse, France, September 4-6, p. 27-34.