

Stretched Between Servers and Services

Artistic and Institutional Strategies Dealing with Evolving Internet Infrastructures

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Introduction

We all experience software updates on a weekly – if not daily – basis. And so do online artworks: all of them. I aim to examine this particular socio-techno-ecological environment. If we understand the internet as a multi-layered fabric of protocols, platforms, regulations, policies, software services, technologies, communities, and private commitments, it is not surprising that this complex constellation is constantly changing. In this dynamic field, new standards are regularly created, security holes are closed, and programs are updated. Internet artworks ‘dwell’ amid this volatile infrastructure. For most art historians, these settings and constellations are unknown. If we want to grasp how online art pieces work in this very real technological environment in which they are placed – why and how they change in reaction to their surroundings – we need to open the black box. Doing so not only deepens our understanding of a work’s production logic, but it also helps appreciate the programming artists’ craftsmanship and inventiveness. We also learn what keeps them busy. Oftentimes, it is the support layer. Their works all rely on a fabric of software, hardware, and socio-political factors. Depending on how they are integrated into these coded fabrics – whether plugged-in or added-on – artworks exhibit varying degrees of sensitivity to even the slightest changes. We may be tempted to see art that connects to services as mere ‘add-ons,’ sitting on top of ‘found footage.’ However, this type of ‘found footage’ is either itself equally infrastructure-dependent or part of the infrastructure itself, and therefore paradoxically less stable than in times when this was coined a cinematic technique. It may pursue the ideal of being stable enough, but not unchanging. Developers want to minimize what they term the “ossification risk” (Nottingham 2021). In their view, ‘add-ons’ by artists or privacy advocates (Claburn 2017) might be seen as an indication of a cluttered structure in need of rejuvenation.

Real-world Dependency and Field-specificity

The relatedness to live real-world factors in the information age makes the internet artworks prone to failure. Not only information changes – this might be embraced and is the whole point of fetching data live online – but also how information is formatted, placed, framed, and accessed. Depending on the architecture of a coupling, each tiny change could be fatal. Whenever parts of the web are sourced for information as integral components of an artwork, a certain dependency happens as artists dock onto existing services such as search engines or social media platforms. They can use them in pragmatic terms for whatever theme or intentionally target these services with their action, making them the subject of their work. The services that artists dock to often prove to be more unstable partners than artists can reasonably handle. When a service updates, the artwork may have to adapt as well – and it is usually the artist who must ensure it remains functional. In this contribution, I analyze the solutions artists employ to maintain service-based artworks and explore what these failures reveal about the nature of the internet. I conceive of programmed online artworks as dispersed entities – distributed across servers and services that they must reliably connect to. These artworks scrape information from external sources, feeding it into their system to generate artistic expression. My perspective emphasizes the structural disposition of artworks that enables them to ‘function.’ As performative or generative entities, they can migrate only in limited and assisted ways. This contrasts sharply with their output or derivatives, which can pop up on screens worldwide and be shared as images, sounds, or videos. While these derivatives travel freely, the productive core remains embedded within a framework of functionalities and rules—the infrastructure. This does not mean that the artwork cannot be stored on multiple servers simultaneously. In fact, this is one of the current models used to make artworks more robust.¹

However, this flexibility of where its code is stored will not free it from the need to conserve all its connections, from which it sources the ingredients for its output. It has this ‘conservative’ trait to keep its functionality. The concept of site-specificity, developed in the 1970s, traditionally refers to an artist taking the location of the artwork into account when producing it. To what degree are digital artworks ‘site-specific,’ tailored for this concrete location on the internet? It might be necessary to acknowledge a second term: field. A field is where several parties perform different parts of the calculation, thus embodying a distributed agency. Network computing, for example, interlaces

¹ Cf. For instance The Data Trust is a peer-to-peer, decentralized artist-owned archive for long-term sustainability, <https://transfergallery.com/>. Accessed 12 January 2025.

processes on different computers (cf. Antic/Fuller 2011). As Josephine Berry states: “when one attempts to pin down the nature of site on the Net, it dissolves into a set of processes occurring simultaneously at different points in virtual and geographical space” (Berry 2001, 15). If this constellation turns out to be a relevant factor, ‘site-specificity’ should be further developed into ‘field-specificity.’ This, in turn, would imply that modernist ideas of isolatable (transportable, nomadic) works represent the opposite pole of field-specific works. At the same time, that opposite pole seems to be one of the few paths available for conserving such works. To enable their migration, it may be necessary to sever their ties. However, that is another discussion.

The more spread out the socio-technical infrastructure, the more elements an artwork connects to within the ‘field,’ the more vulnerable it becomes. Being networked is not an inherently stabilizing factor unless redundancy measures are in place. Otherwise, when a work relies on multiple interconnected actors functioning in concert, the loss of each connection is palpable. What can provide some reliability and reassurance is the concept of the network-as-multiplication and network-as-distribution (The Data Trust), as this was the motivation for creating the internet in the first place. However, the network-as-functional-infrastructure, as outlined here, paints another picture. Here, we deal with what the internet infrastructure affords to artists and what stances and strategies they develop for their artworks.

Surprise and High-frequency Repairing

On his website, the British artist Wayne Clements explains his link list of original works (fig. 1), which is split into WORKING in green and SEMI-AND-PERMANENTLY RETIRED in red.

The links in ‘SEMI-AND-PERMANENTLY RETIRED’ will take you to the home-pages. There is info and documentation. But the programs either are not running, may produce an error message, or run in a reduced version. None of this will harm your computer. The reason for the programs developing problems is software entropy. My paper originally published by ‘CHArt’ explains this: Art and Software Entropy. (The CHArt website has, since 2015, itself given in to entropy.) WORKING software can also develop problems sometime in the future. (Clements 2009)

While this timeframe may seem manageable, artists often encounter difficulties after different periods of time – rarely decades, but more commonly years, months, or even weeks.

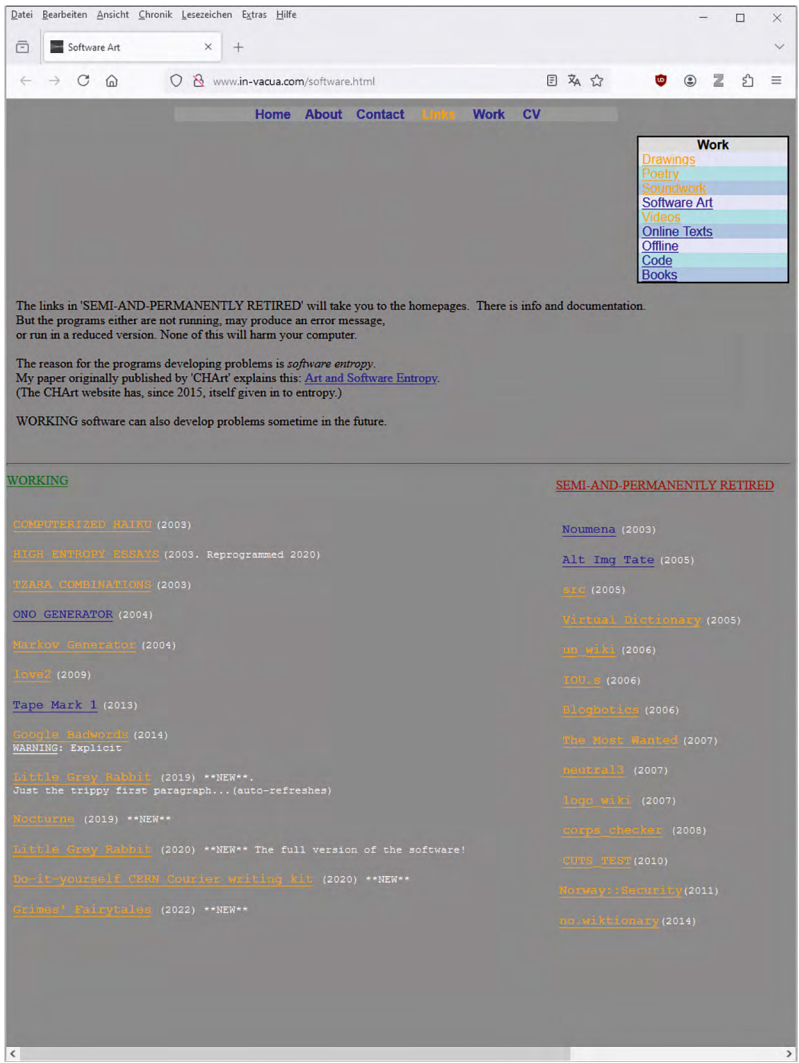


Fig. 1 Wayne Clements, Website <http://www.in-vacua.com/software.htm>. Accessed 11 January 2025 (screenshot: Inge Hinterwaldner, 2025).

The Swiss artist Marc Lee created *OAMOS* (2007–2013) and *Breaking the News – Be A News Jockey* (2007) by scraping news from the web. He faced dysfunction soon after making the works. Lee comments, “My projects always evolve and change; and if something changes constantly, it has to be monitored constantly. And I never imagined that, without doing so, they might not be working anymore after three or four or five years” (Lee 2022). Even so, this life expectancy seems rather long compared to other works.

With their Firefox plug-in *The Real Costs* (2007), the artist Michael Mandiberg created a user service providing the exact amount of CO₂ emissions for any chosen flight on air travel websites such as Orbitz.com, United.com, and Delta.com. To automatically gather, calculate, and deliver this information,

the work needed to be connected to airplane data, but the new value also had to be added to the websites. Mandiberg stated that they have

encountered archival problems quicker than most technology projects, as it is dependent on the airplane websites it runs on, over which I have no control. These sites will inevitably change their HTML/CSS so that the plug-in can no longer decipher which site it is running on and how to calculate the distances and thus the carbon footprint. (Mandiberg n.d.)

The project was tailored to work with a defined set of air travel websites. Such websites are redesigned frequently, and with developers implementing a substantial change every few months, which were likely the moments in which *The Real Costs* broke for that particular website. To insert graphics and text without disrupting the website layout, it is necessary to identify the suitable 'anchor' to insert the bit of code. To do the math, the program needed to find the indication for the mileage between the two airports to put this scraped information into the equation. This means, the artist needed to find the <div> class and id in the HTML code, both to get the information on one spot and to safely insert the new information next to the price tag. Some real-life changes could have ripple effects on the online representation. "Or worse, these sites will cease to exist as companies absorb each other" (ibid.). Having included 10 to 15 websites, Mandiberg continued updating their work for about a year and a half before ultimately abandoning it, as the intensity of the labor showed no prospect of ending and proved unsustainable (Mandiberg 2024). The issues tend to add up on several levels: with establishing HTML5 standard in 2014, the use of <div> started to be recommended only as a hack for exceptions: "Authors are strongly encouraged to view the div element as an element of last resort, for when no other element is suitable" (WHATWG community 2024). If Mandiberg's project could have been maintained longer, it very likely would have witnessed the gradual disappearance of these HTML commands on which the functional architecture of *The Real Costs* relied.

Many aspects of the online world are constantly changing. In 2005, the curator Steve Dietz highlighted this phenomenon. Under the headline "Innovation on Internet Time," he provided a humorous hypothetical description of changes on the internet.

If an artist is going to play in the cutting edge [sic] tech field, the pace is brutal. Not only has Bill Gates's wealth increased $\times$ percent in y minutes, but there is now an updated version of Macromedia Director; two new releases of Real-player; three enhanced versions of Microsoft Internet Explorer; Microsoft has

broken up into four companies: Microsoft Classic, Diet Microsoft, Microsoft Lite, and Internet Microsoft; there are five new video codecs; six American Online (AOL) virus messages in your email; seven competing music formats and matching players; each Microsoft has issued new patches for Windows comprising a total of eight; nine new iMac colors have been introduced; ten new dot coms have announced Initial Public Offerings (IPOs); 11 new memes have circulated, and 12 new artist websites have been announced on Rhizome. (Dietz 2005)

A significant portion of the changes enumerated by Dietz would impact users not because of their news value (wealth, memes, homepages), but because they form part of the online infrastructure (programming languages, players, web browsers, compression codecs, data formats, software patches). He seems to be addressing the sense that these elements are updated almost as frequently as user content is created. Without all the layers of the specific field of the artwork functioning, errors creep in.

Physical and Cultural Entropy

Infrastructures become tangible due to frequent failures. Instead of stating ‘normally the internet infrastructure works well,’ I would suspect it is more adequate to say, normally it is kept ‘in good repair.’ Without enormous multi-lateral caretaking, the default would be an incessant spiraling of disrepair. I adopted this way of thinking from Fernando Domínguez Rubio’s book *Still Life: Ecologies of the Modern Imagination at the Art Museum*. He suggests viewing artworks as temporal configurations that are constantly deteriorating, which requires continuous attention to stabilize the object as much as possible. They are falling apart by the “blind relentlessness of things” (Domínguez Rubio 2020, 17), meaning: physical entropy – but also by neglect or re-evaluation, dynamics he terms “cultural entropy.”² I would like to specify the latter in one direction by introducing the term “regulatory entropy.” This term is not specific to online situations. Laws change, thereby opening and closing windows of opportunity for all – also for artworks. In the 1970s, when Anthony McCall developed his *Line Describing a Cone* (1973), dust and cigarette smoke made the projected light rays visible in the dark room, creating a penetrable

² This notion goes back to the sociologist Terry McDonnell (2016), not to be confounded by the notion ‘Cultural Entropy Score’ which denotes the measure of frustration and dysfunctionality in a company; cf. Bokler 2022.

sculpture. Later, insalubrious air was ruled out for public exhibition venues (cf. Williams 2008, 380). With clean spaces and smoking prohibited, McCall's work lost its taken-for-granted ecosystem and became dysfunctional. This caught the artist by surprise, with the audience already waiting. He vividly narrates how he got ordered out of the room by a museum guard while frantically trying to save the situation and generate smoke with three cigarettes in his mouth (cf. McCall in: McCall/Godfrey 2007). Basically, the same happens to artworks, but in their case, no one is there to say with authority: 'This is the artist' or 'This is art' and 'Let him/it re-join the opening.' A series of changes may get underway to settle the new legal circumstances. As a declared valuable ersatz, fog machines, and hazers were eventually offered and used in McCall's case. However, they came with inevitable sound, odor, a different feel of the fumes, the need to dose the smoke. This introduced rhythm, and sometimes interference issues with the light projector. Comparable challenges appear when one software is supposed to stand in for another one that got retired. Artists often see themselves in a situation where they need to find solutions for the unintended follow-up issues arising from the change in the system.

Artistic Strategies

In most cases, the use of an online service is granted only under certain terms of condition. When these terms change, the service per se is not gone, but some artworks may suddenly find themselves outside of the new ruling. Mechanisms judge all works and handpick those that get banned, removed, or have their access denied. When inspecting this regulatory version of 'cultural entropy,' which agents have a say in judging other entities? It is firewalls, websites, and all services offering an Application Programming Interface (API). API is the software intermediary that "connects computers or pieces of software to each other" (Wikipedia 2024, API) and performs security measures. APIs have specifications defining how to use and implement them. These 'gates' can be redesigned or introduce policy-based limits and quotas on API requests. They may alter the number of queries allowed per hour or day. For instance, Google limits the permitted contingent to 20 queries per second per IP address (20QPS). This is aimed at those who can act more quickly, namely bots. Bots are programs that operate autonomously and play a central role in artworks with a real-time component. Sometimes, they transgress the limits set by an API and are targeted as 'suspicious activity.' APIs experience the artworks based on their requests and they are then judged according to this performance or pattern of action. These artworks become

the subject of surveillance on a machine level. Since exceptions are difficult to negotiate,³ this circumstance is reflected in the artworks by way of various workarounds.

Turning Invisible – Disguising Bot Behavior

Artists venture into all sorts of directions disguising their bots. The FAQ section of a project is often where artists and programmers explain certain unexpected features or errors. The artist Adriana Knouf, for instance, released the following message regarding her *MAICgregator* (2009), which is a browser extension augmenting the news sections of US American universities with information about their sponsors. The user can select different degrees of information, and some include presenting portrait photos of the universities' trustees. One frequently asked question is: "Why are there no trustee images?" Knouf provides three reasons: as it is a research project with an open outcome, they might not have found any trustees from that particular university (yet) or any photos of them (yet). The third reason is infrastructural. Even if theoretically, the search could be accomplished more quickly, the search process might be artificially curbed, resulting in prolonged procedures. This strategy is adopted in cases when the search engines used would ban the bot because it easily exceeds the established request limitations. In Knouf's case, found trustee images are stored one by one, with considerable time passing between two such downloads (cf. Knouf n.d.).

These artificial delays and pacing strategies result in rhythms performed out of necessity, rather than by concept. Such arrhythmic calls are not necessary for a bot to function. Thus, they primarily serve as cover moves so that the bot is not blocked from the requested service. We could think of this behavioral pretending as a time-based key for an API gate. If using an API is vital, this slow-motion dance is a survival strategy. In that sense, certain aspects of how an artwork functions are directed solely toward the infrastructure. A human recipient may be unaware of the internet's largely invisible technical ecosystem and the additional maneuvers artworks must perform to accommodate it. Networked artworks are Janus-faced: one face is oriented towards the user (UI), the other towards another machine or algorithm (API). On both ends, there are expectations to be met and as can be seen from *MAICgregator*, often they are incongruent and the artist steps in to mediate.

³ It is not impossible to negotiate exceptional allowances. Christa Sommerer and Laurent Mignonneau met Google personnel at SIGGRAPH conference and could get a deal for their image-heavy work *RidingTheNet* (2000), cf. Sommerer/Mignonneau 2022.

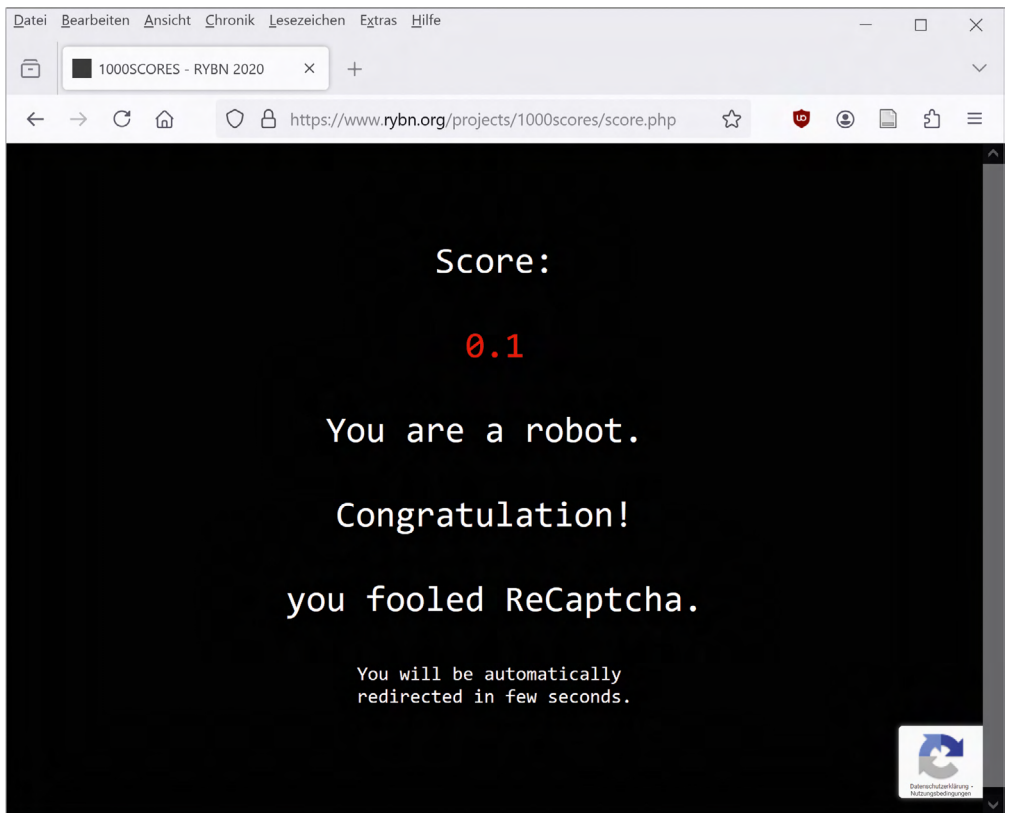


Fig. 2 RYBN, *Double Negative Captchas*, 2020, software. Website with which users can test their browser's user profile online, www.rybn.org/projects/1000scores/score.php. Accessed 16 December 2024 (screen-shot: Inge Hinterwaldner, 2024).

Indirectly, this double-sidedness is made a topic and rendered experienceable by some artworks. They support users in not being detected as humans, as in the browser extension *Refuse to be Human* × (2020–2021). !Medien-gruppe Bitnik suggests testing the effectiveness of the camouflage – that always needs to be performed anew with each user setup – with RYBN's *Double Negative Captchas* (2020, fig. 2). When passing the test with the help of the extension, they can experience the 'grey' web that is presented to search engine bots only. They are passing gates other users are denied. In a fully automated world, this can have both advantages and disadvantages at the same time, as was aptly illustrated by Tomo Kihara and Daniel Coppen in their interactive installation *How (not) to get hit by a self-driving car* (2022). Kihara and Coppen simulate a pedestrian crossing and allow artificial intelligence to analyze what happens on this spot. The audience is encouraged to traverse these meters in a way the AI does not identify them as persons – an understandable human desire and a real-world scenario in times of ubiquitous surveillance. Those who fooled the system triumph after their non-standard movement,



Fig. 3 Tomo Kihara and Daniel Coppen, *How (not) to get hit by a self-driving car*, 2022. A boy performs successfully at Ars Electronica, Linz 2024 (video stills: Inge Hinterwaldner, 2024).

only to learn that they would have been hit by a self-driving car (fig. 3). Being judged one way or the other potentially leads to different consequences. In the best scenario, it lets one explore the web differently, the standard situation is more likely that one encounters an obstacle.

Turning Narrative – Adding the Story of the Struggle

Everything a Google crawler algorithm labels as ‘unsafe’ will be added to Google’s blacklist. This has affected about 10,000 websites every day since 2003. As a consequence, Google, other search engines, and anti-virus companies flag the website as not secure to visit. This blacklisting results in a protective veil put in front of the work – here not protecting the work, but the user. It definitively changes the perception of that website for most of the rest

of the world. There are several reasons why people would think that their site is on a Google blacklist or URL blacklist. “When users see these stark warnings, most will understandably steer clear of your site, immediately and severely impacting your traffic and visibility in Google Search” (Sild 2024).

Some of Constant Dullaart’s Google-based work met that destiny. Dullaart put together a documentation website where he laid out the struggle to get along with Google regarding his series of works animating the search page. His documentation and narration are kept to a minimum and the site is little more than an untitled list of events with chronological entries from 2008 to 2019. It informs viewers why a particular project was blacklisted, the responses this triggered in him or fellow artists, and which of the projects had already gone offline or defunct. We learn that his <http://thedisagreeinginternet.com> (2008) was blocked in 2008 and again in 2018 and according to the artist, even emails mentioning the websites got blocked. As of January 2025, it appears to be whitelisted (Dullaart n.d.). The measures and countermeasures provide the basis for enhancing the artwork with a diary of this fight. By producing a (hi)story, the status of being offline is just one mode of existence into which this work is forced temporarily. With that narrative enters also the additional semantic layer of honoring both the Sisyphus and David versus Goliath myths.

Turning Performative – Showing the Caring

While one might imagine infrastructure as a stable pillar – something one should be able to rely on in the long run – online infrastructure, by contrast, seems to be cooked by the minute. The US-American artist Ben Grosser who constantly fights the updates of the interface (API) to Facebook gives a visceral report. His *Facebook Demetricator* (2012–present) is a browser extension that hides all metrics on Facebook. As soon as these numbers vanish, a lot of competitiveness built into this attention economy service gets undermined. Thus, this work changes one’s attitude and diminishes the urge to check for likes. It provides some calm, but it operates in unsteady waters. “NOTE on January 1, 2021: I am currently rewriting Demetricator for the new Facebook design and will release it ASAP. Check back for updates – or if you already have it installed, you’ll get the update automatically” (Grosser n.d.). Later that year, he transformed this misery into a strategy and an art performance: “NOTE on 28 July, 2021: I will be rewriting Facebook Demetricator during a series of live coding events as part of my upcoming exhibition *Software for Less* at arebyte Gallery, London. The show opens on 20 August, so check back for links to watch and/or get the new version shortly thereafter” (ibid.). The artist connects and stays in contact with his audience. In four weekly ses-

sions, Grosser live-streams his coding on the gallery's YouTube channel. Before the audience can see his debugging techniques, he explains the situation. Due to time running out for the opening of the show, the artist and arebyte Gallery's curator decided to make the recoding of the work part of the exhibition's events program (Grosser 2021). Grosser lays open the routines of detecting problems in the interplay between Facebook's new settings and his source code, finding solutions and typing alterations in his code. Normally, this happens behind closed doors. By publicly performing this maintenance work, he draws attention to its problems, situating himself as a 'maintenance artist' in the tradition of artist Mierle Laderman Ukeles by showing how long the repairs take, educating others about how to do it, and framing this activity as something that is, in principle, remunerable. Here we see a strategy that we can characterize as the evolution from an autonomously performing art piece to a service-providing artistic performance.

Turning Fossilized – Replacing Action with Recordings

Ted Davis's work *youtube.pawgorithm* (2016) was hit by a new regulation in the middle of an exhibition, when the API for YouTube suddenly went from unlimited credits to a few searches per day (Davis 2021). The work depended on sending frequent consecutive requests to the YouTube Search module to function. As a consequence, under the new rule, it was blocked after only a few minutes. Being on show, the artist did not have much leeway. So, Davis recorded several sessions for as long as he could and pieced these recorded snippets together. Although an average visitor might not have noticed the difference phenomenologically, for the artist this emergency solution felt like a bitter compromise. It altered his work's character. An originally interactive live work had turned into a video documentation or demo version of itself. It is dissatisfying to end up with a format that might have been reached much more easily with other methods. In Davis's case, it was particularly disruptive because it catapulted the artist into an emergency that required reacting swiftly. Unpredictability creates distress. Time pressure can turn into a quick temporary fix while another, better solution could have been feasible with more time.

Turning Communicative – Putting Up Intermediate Remedies

As net art is always on view, the real-time effect often does not allow artists time to repair it before a potential visitor detects the ruin. Something not working always looks abandoned in this realm. They become thin, like skele-

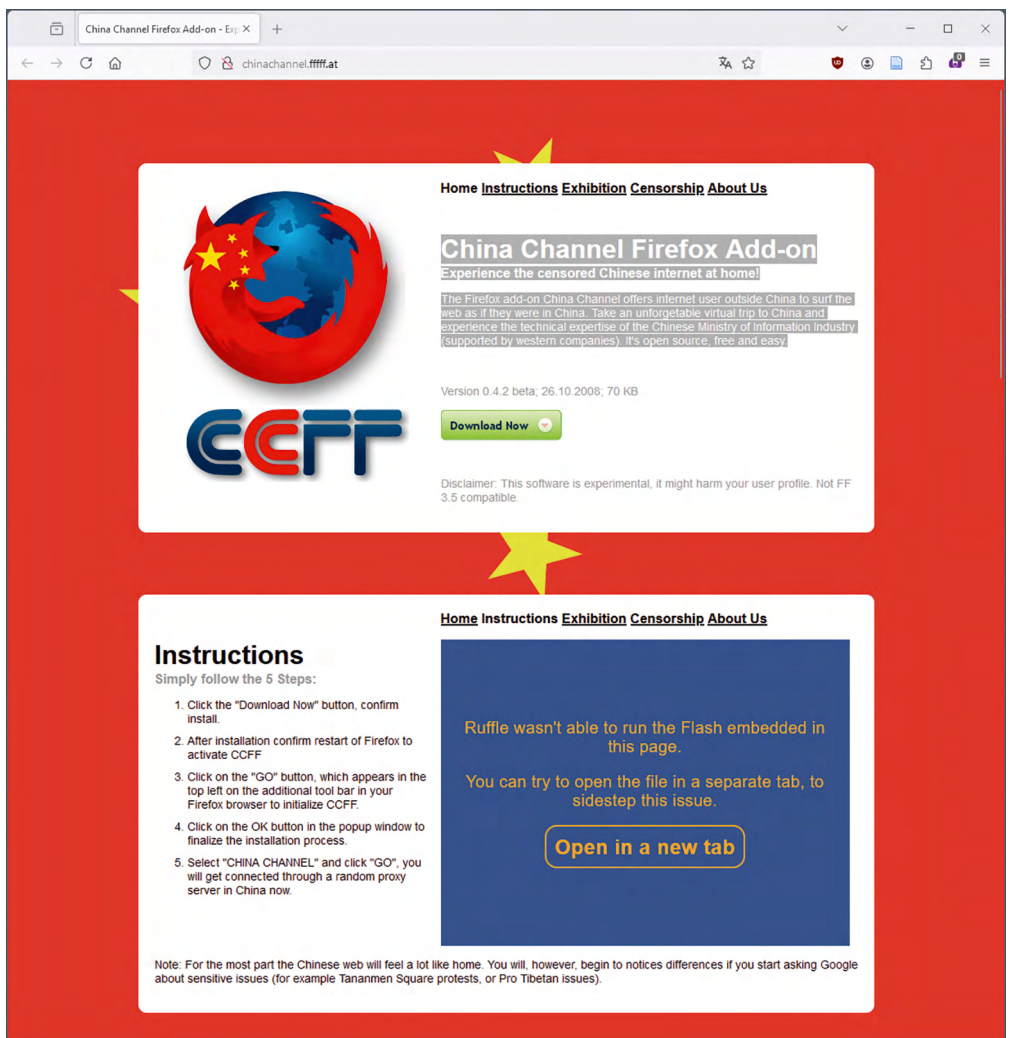


Fig. 4 Tobias Leingruber, Aram Bartholl, Evan Roth, *China Channel Browser*, 2008, <http://chinachannel.fffff.at/> (screenshot: Inge Hinterwaldner, 2025).

tons of broken links and past functionalities, with no flesh and surely no full aesthetic experience. The various messages of brokenness, of unsupportedness, of dead ends are the new face of digital ruins (fig. 4). They remain as written reminders of what once was, of which varying degrees of decay and existence can be perceived. Upon seeing such signs, the user knows that it is not worth devoting further attention, it is often a hopeless case. Sometimes the work is still partially functional, which can be mistaken for the full artistic intention.

The remedy for the change of the infrastructural base is handed down to the artists. When roaming the homepages of internet artists and focusing on hints of dysfunctionality, we find several strategies (fig. 5). They might first

Archival Video

This 2005 work was created to run in browsers using the now-obsolete Flash plug-in. It is archived here as a video.

Got It

temporarily down due to upgraded PHP on webhost...
stay tuned.

Kathack-Extension

Chrome extension that revives [Kathack](#). Originally created by Alex Leone, David Nufer, and David Truong, the original bookmarklet no longer works because web browsers have become picky.

Unfortunately, Google now requires a valid Google Maps API Key in all HTML maps, and Google doesn't seem to think that this map's key is valid. Check your browser's JavaScript console for more details.

Tarot Arcana and Suits

Urban Dictionary

BananaSlug uses the [Google APIs](#), and as such, it's limited to 1000 queries a day (which is happening quickly now!) If we're past the limit, we send you to Google with your search term and seed word.

One more thing... if plain old Google doesn't return many results for your search, BananaSlug's seeded subset won't either.

<http://www.easylife.org/>

(Ignore warning, website exists!)

The site was made in 2002. A lot has changed with browsers and javascript since. The site currently (2021) seems to work as intended in most browsers, but that might change at any time.

This website is being changed to a "secure" website, using the https protocol instead of http. Currently the "secure" version is not working. To see the non-secure site please copy and paste this link into your browser:

<http://jevbratt.com>

Fig. 5 Collage of messages artists put on the websites of temporary defunct artworks. From top downward: William Poundstone, Ted Davis, Constant Dullaart, Nasa203, Aneel Nazareth, Steve Nelson, Alexei Shulglin, and Lisa Jevbratt (screenshots: Inge Hinterwaldner, 2021–2025).

tag their ruins as ‘temporarily out of order’ to say ‘this is not it’ as a measure to minimize damage to their reputation.⁴ Some messages show that they felt the need for social repair. Artists have to revisit their works regularly. The US-American artist Don Relyea decided to explain his updates to his *Real Time Contextual Art Generator* to his audience in 2007, on his website:

Due to some changes with the google images service I needed to fix my data scrape and release a new version immediately to fix a but with the images not showing up. So I have released a slightly less buggy new alpha version with the ability to pull in local files after an initial query has been made. (Relyea 2007a)

In other words, after the difficulties persisted, he produced a variant with an offline mode. We can therefore assume that functionality was attributed a slightly higher priority than the fact that the images need to come from the internet. The second quote reads: “Due to a security update in shockwave the online preview version does not work anymore. Please use the exe. Thanks!” (Relyea 2007b). Relyea explains that the origin of the problem was brought to his piece from outside, and nonetheless, he is not hesitant to actively rewrite his code. Why is the rewriting of the code so virulent in the first place? Because infrastructures such as hardware, software, and policyware fail and change. All this (need for) readiness to change one major defining site of a programmed artwork is rooted in the need to compensate for changes in the supporting structures that do not lay in the artists’ hands.

Who Cares? Mending One’s Own Oeuvre – Not New, Still Unpleasant

The conservator Hanna Hölling wrote that traditionally, “[f]rom the perspective of an artist, doing the job of mending other master’s crumbling sculptures was neither considered artistic nor even as honourable work” (Hölling 2017a, 89–90). However, now – especially in the digital domain – artists are increasingly required to mend their works. To be sure of this, we can also find examples in the past. These situations mainly arise from the use of cheap production materials since the 20th century or with improper use. An early known example for the latter is the copying practice that Federico Barocci’s altar piece *Entombment of Christ* (c. 1579–1582) was submitted to. The commissioners had secured themselves the permission for professionals to copy

⁴ Dragan Espenschied draws a more optimistic picture and is convinced that younger scholars learnt to appreciate the ruins.

the painting. This resulted in other artists placing a thin paper directly onto the painting and tracing its contours. With its popularity rising, this happened so often that the painting soon got in a precarious state. In 1588, an annoyed Barocci agreed to restore his own work, however, that was pricy for the commissioners (cf. Lorch 2013, 13). This example shows how artists in the past also carried out preservation measures to protect their own works that had become worn down without the artists' fault.

In cases where the artworks succumb to software obsolescence, the journey may sometimes be over. Given the entropic tendencies of software-based art, Clements pleads for open-sourcing the code so that the structure of the artwork becomes accessible and interested parties can engage in versioning (Clements 2009, footnote 5). But sometimes somebody cares about the remnants and arranges pathways forward. Elliot Woods from the artist duo Kimchi and Chips wrote in an Instagram post: "10 years ago I got heavily into creative coding with C++. Since then, more than 0.5% of my life is spent getting my own old code to work again with updated libraries. I love openFrameworks, but I can see why other platforms are more attractive to a new generation of artists" (Woods 2021). Artists can quantify how much of their productive time goes into repair, mostly as unpaid labor. If substantial financial support exists, it is likely only for the conservation or revival of an old artwork for a specific purpose, such as an exhibition. What is necessary is a vision for how to carry a work forward, along with the idealism to make it happen. Sustaining a piece of software in any form involves not only a physical transfer but also a conceptual translocation.

Institutional Care

For works fortunate enough to enter a collection, the chances of institutionalized care are better. Then, the developed strategies are thoroughly evaluated by specialist teams, eventually executed, and possibly also published. I will briefly touch on three such case studies.

Cutting the Code – Redrawing the Boundaries

The net art piece *Brandon* (1998–1999) by the artist Shu Lea Cheang was commissioned by the Solomon R. Guggenheim Museum and was also in Rhizome's ArtBase.⁵ This double affiliation ensured that it was subject to at least

⁵ Rhizome's ArtBase was established in 1999. It is an archive of born-digital artworks with a focus on net art. The earliest contribution dates back to 1983. In addition to collecting art-

two major reconstructions, in 2006 and 2016–2017. The first collaborative effort was conducted with the support of the artist and led by Francis Hwang, the technical director of Rhizome as well as Caitlin Jones from the Guggenheim Museum. They updated the work from a then seven-years-old PHP 3, however, the complex parts written in Java posed a major problem. Additionally, they could not establish contact with the original programmer. Both led to the decision to “clos[e] off those areas of the site so they wouldn’t be part of the artwork” (Francis Hwang, in: Martin c. 2006).

The strategy to render the piece presentable was to conduct amputations. They excluded from the work all elements deemed to irrecoverable to be restored. Ten years later, the conservator Emma Dickson restored it for the Guggenheim Museum (Guggenheim Museum 2017).

Enveloping and Commenting the Code – ‘Code Resituation’

The mathematician Deena Engel and the senior conservator at the Guggenheim Museum Joanna Phillips propose an alternative to the so-called ‘code migration,’ which is the current practice by computer programmers and

includes the deletion and replacement of non-functional original code. Intended behaviors and discernible output of an artwork would be recreated by means of contemporary programming languages, aiming for the most elegant and efficient programming solutions currently available. (Engel/Phillips 2017–2018)

However, with this radically invasive intervention, several features related to the aesthetics of production (an artist’s way of programming, choice of programming language, and all artistic and expressive idiosyncrasies) are in danger of vanishing for the benefit of ‘behavioral’ surface performance aspects. And with artworks, one looming danger is always the possibility of misinterpreting the intended creative malfunctional and aesthetic behaviors of a programmed piece. The authors call their alternative ‘code resituation,’ which is based on the conservation principle of minimal intervention and transferred to the software-based art (like the Guggenheim initiative ‘Conserving Computer-based Art’). It seeks to keep the original code and add an exoskeleton of a new code to restore functionality, it seems to be more an addition than a replacement. The code and its execution are often dependent on a

works and data about art, they provide an emulation service and operate an own webrecorder platform. Website: https://artbase.rhizome.org/wiki/Main_Page. Accessed 16 March 2025.

specific hardware and software environment. As soon as these environments fail because of technological obsolescence, breakdown, or retirement, the artwork “may require conservation intervention on its code level” (Engel/Phillips 2017–2018).

One concrete example is that some Java applets are no longer supported in a 20-year-old artwork nor is the `<blink>` tag that was once used to make a text flash – a frequent feature of early websites. The solution here could be to keep the command in the original code and to write a Javascript function *outside* of the artist’s code, surrounding it and pointing into it. This commenting, performative second layer of code indicates that the program should retrieve a specific sequence of code and then execute its intended function. It helps navigate and interpret the original code. It is like an exoskeleton.

Rewriting the Code – ‘Generative Preservation’

Martine Neddham created the artistic web project *mouchette.org* (ongoing since 1996). She argues that if something has to be redone – and choices must be made – it should be done in a way that stays truer to the spirit of the work than to its material components, such as code or hardware (Neddham in: Hendricks 2020). Neddham coined the concept of “generative” preservation or conservation, in which the notion of an ‘original’ is set aside in favor of the idea of an ‘origin.’ The former implies a fixed object, whereas the latter serves more a starting point for a process. In this view, “the focus becomes the relation of this point to a multi versioning path” (Black 2020).

As constant evolution and versioning seem to be a feature of the internet infrastructure and culture, this conceptual model makes the artwork fitter. It does not stick to an established status quo but goes with the flow. *Mouchette* has already lived through several software versions and programming updates. Neddham leaves the traces of previous versions, for instance by inserting a small message that says the section ‘Lullaby for a Dead Fly’ of her *mouchette.org* project has moved from Flash to HTML5 (cf. Hendricks 2020). Hölling reports that early conservation theories pursued an object-based approach and took the artist’s intention as the main guideline. In 1963, Cesare Brandi published his book on the theory of restoration (Brandi 1963), which is remarkable due to its anti-positivist stance and its foregrounding of artistic, historical, and aesthetic criteria for restoration. For him, the unity of an artwork was central, and while the look (*aspetto*) needed to be preserved, the structure (*struttura*) could be altered if necessary (cf. Hölling 2017a, 91). When trying to align Brandi’s considerations with the situation of software-based art, it is likely the source code that would figure as ‘structure’ and that ‘can be subject to resto-

ration' (which seems to be the opposite of 'being preserved unaltered'). The freeze-frame paradigm (artwork becoming frozen at the moment of museum purchase) hardly holds true for net art. Referring to Henri Bergson's concept of *durée*, the conservator Hölling proposes a temporal logic for conservation theory that recognizes an artwork's life and that its present state conserves also something of its past states (cf. Hölling 2017b, 5).

This seems to resonate with Martine Neddham's stance in her long-term project *Mouchette*. Hölling promotes the idea that custody can be seen as a stewardship that accompanies the life of an artwork, not clinging to a certain status at a specific point in time. If a changeable work is said to conserve something of its former states, it thus accumulates history without losing its lifeline to the past versions.

Confronting this idea with the harsh reality of many online pieces, it remains to ask where we would position the broken state of an artwork. What does a broken piece of software transmit regarding its earlier versions? Or would only functioning states of the works enter their CV? I believe that the broken states of artworks also have something valuable to tell us. The failed connections to servers, services, and software updates are certainly witnesses to a change in the infrastructural field. They can help us date and log (culture-relevant) events that have taken place in the infrastructure. They will have closed – and opened – windows of opportunity.

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Infrastructures of Art Producing, Transporting, and Logistics from a Transnational Perspective

Burcu Dogramaci, Ursula Ströbele (Eds.)

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