Electronic Imagery in Experimental Film: The Affordances of the Oscilloscope

Stefanie Bräuer

Abstract

This article focuses on electronic imagery in experimental film, and specifically examines the usage of the oscilloscope. The images generated by this electronic testing and measuring device reflect the techno-material setting in which they were produced. Their implementation in experimental filmmaking demarcates a site where electronics and cinematography meet. In order to better understand this arrangement and to identify certain practices afforded by this social and material environment, this article follows a specific understanding of the concept of affordance. Depending on the field, affordance has been framed in a multitude of ways, amongst others as a prescriptive design tool. However, outlining the concept as descriptive, instead of prescriptive, and focusing on its material and relational dimension is better suited to an analysis of how the oscilloscope has been used in filmmaking. By highlighting the material, functional, relational features of the concept, this article focuses on how this socio-technical arrangement enables specific uses. The aim is to determine affordances for a set of oscilloscopic and filmic practices: What does the electronic oscilloscope, understood as bound in a socio-technical environment, afford experimental filmmakers? First, I will lay out the term affordance with a focus on the ways in which electronic imagery can be produced by means of an electronic oscilloscope in order to specify the afforded practices in a second part. In the third and last section, I will present a specific example of an experimental film that incorporates oscilloscopic imagery, *Around Is Around* directed by Norman McLaren in 1951, tying it back to the concept of affordance developed earlier.

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Affordance

The psychologist James J. Gibson introduced the term *affordances* in derivation from the verb to *afford.* He explicated it in a chapter titled 'Theory of Affordances' as part of a book on the ecology of perception, where the term concerns the interaction between animals or humans and their environment.[1] Gibson has been involved in researching visual perception since the 1920s and refers to the work of Gestalt psychologist Kurt Lewin who developed associated terms within the framework of field theory: "The concept of affordance is somewhat related to these concepts of valence, invitation, and demand but with a crucial difference. The affordance of something does not change as the need of the observer changes."[2] Here, Gibson locates Lewin's notion with the observer while positioning his own concept between observer and environment: "An affordance cuts across the dichotomy of subjective-objective"[3]. Hence, he conceives affordance as relational in order to overcome the dualism of the observer and the observed, assuming an environment shared by both.

Donald Norman adopted the term for practical product design, putting aside the relational aspect. He defined affordances as product properties triggering specific uses which should be addressed already during the design process, bearing in mind the product's later usability: "*affordance* refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used…. When affordances are taken advantage of, the user knows what to do just by looking"[4]. This shift in the term's usage towards product design and, since the 1990s, software and interaction design shaped the understanding of affordance as a prescriptive design tool rather than as a descriptive category, as initially suggested by Gibson. Norman later acknowledged that he should have restricted his own usage of the notion specifically *to perceived affordance*.[5] Nevertheless his take on affordance became prevalent within Human-Computer Interaction.[6]

In media studies, both readings gained traction, often without clarifying whether the descriptive or the prescriptive dimension was relevant. For example, in a text on actor-media theory, Tristan Thielmann and Jens Schröter refer to Madeleine Akrich's script approach. In the context of actor-network theory, script refers to instructions on the use of a technical object. Thielmann and Schröter mention *affordance* to be an alternative term to *script*,[7] and thereby implicitly derive *affordance* from Donald Norman's prescriptive approach. In media ecology, however, authors prefer to reference James J. Gibson's descriptive take on the term, both implicitly, such as Jussi Parikka, and explicitly, e.g. Matthew Fuller. In

2011, Parikka suggested the possibility of "media history as a history of affordances".[8] This would presume media technology as an active entity within the circulation of matter, energy and meaning.[9] Parikka cites Matthew Fuller's 2005 book *Media Ecologies*. For Fuller, Gibson's work on the ecology of perception is an important point of reference, especially in regard to the relational and anti-essentialist dimension of the term *affordance.* "The advantage of his [Gibson's, A/N] work is that it takes up the possibility of detailed exploration of the material qualities of things-in-arrangement, rather than of their essence."[10] Even though there is research on non-material imagined affordances,[11] media ecology's focus on materiality and relationality allows to consider concrete practices involving technical imagery.

In what follows, I'll refer to the affordances of the material oscilloscope-user-arrangement in terms of Fuller's and Gibson's take on it, in conjunction with Ian Hutchby's sociology of science approach. In *Technologies, Texts and Affordances,* Hutchby mediates between the seemingly mutually exclusive alternatives of social constructivism and technological determinism. According to Hutchby, affordances are functional and relational aspects of a technical artifact that frame, rather than determine, the possibilities for interacting with it. For Hutchby, functionality points to enabling certain operations and limiting others, while relationality focuses on the interdependency between the technical object and the user, including the notion that some possible operations might be relevant to some users and irrelevant to others.[12] The emphasis on the relationality of affordance benefits the description of the production processes that led to the early 1950s experimental films in question as embedded in a specific social and techno-material environment.

The Oscilloscope's Electronic Imagery

The oscilloscope, understood as embedded in a socio-material arrangement, affords a set of practices: (1) rapid visual display and analysis of dynamic phenomena, (2) modification of parameters in real-time, (3) generation of specific regular shapes – so called Lissajous curves – and (4) the storage of these volatile electronic images through opto-chemical means, i.e. photography and film.

The oscilloscope has its origins in the context of gas discharge and cathode ray research of the 19th century as well as in tool making for self-recording instruments. In 1897, the physicist Ferdinand Braun employed a specially prepared evacuated glass tube for the visualization of alternating current.[13] This specific cathode ray tube (CRT) was to become the oscilloscope's main component and, in a more involved setup, the picture tube of later television sets. The purpose of Braun's initial self-registering apparatus was to record otherwise invisible electrical current. The working principle is the cathode ray beam's control through deflection coils connected to the current which is to be visualized. The beam originates from a cathode and is composed of negatively charged electrons that are pulled towards a positively charged anode. A pinhole mask focuses the beam before it hits the phosphorescent screen, creating a spot of light. The beam may be deflected electrostatically or electromagnetically, moving the light spot accordingly. With the advent of radio in the 1920s, alternatives to Braun's electronic setup, such as mechanical oscillographs, proved to be too slow for adequately displaying oscillations in the megahertz range.[14]

Figure 1: Heathkit oscilloscope model O-12 with 5-inch tube, ca. 1958.
Photo by the author. Licensed under CC BY-NC-SA 4.0.

The oscilloscope's (1) rapid visual display allowed for the analysis of high frequencies without any time lag or self-oscillations of the measuring device (fig. 1). The electronic oscilloscope was, and still is widely used for measuring, testing and maintenance in electrical engineering, as well as for demonstration purposes in class room settings. Aside from high oscillations, low frequencies can also be displayed, such as those derived from sound, after its transformation into electrical current by means of a microphone. As oscilloscopic sound visualization happens in real time, the audible and its visible counterpart appear to be closely related and point towards their integration within the audiovisuality of electronic media.

The oscilloscope not only lends itself to the visualization and analysis of dynamic phenomena, such as sound, but also to the (2) adjustment of parameters on the fly. In addition to switching between external signal sources as well as their alteration through gain controls, the modification of the horizontal sweep and of the beam's position, intensity and focus, effect the display very quickly. As the oscillatory images are free of inertia and respond rapidly to changes of a given setting, the interaction with them happens in real-time. Reactivity and real-time interactivity result in a feedback loop that both the user and the device engage in during the generation of visuals.[15]

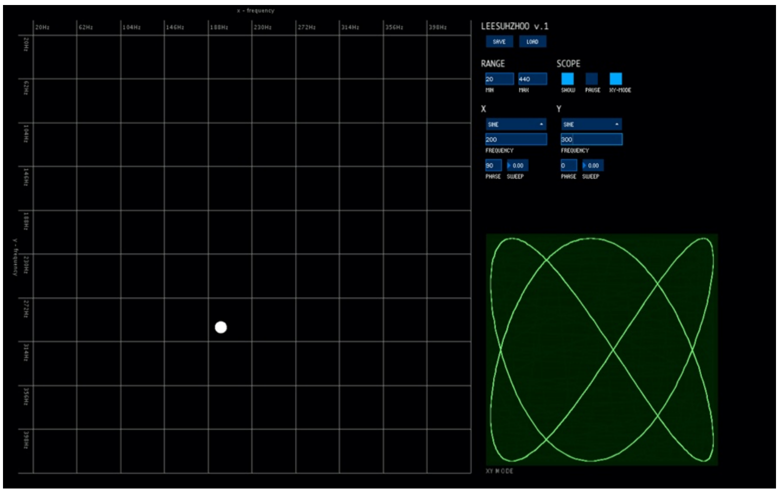

Figure 2: Ted Davis, Leesuhzhoo, 2015/2020, screenshot of application, Lissajous curve at frequency ratio of 3:2. "Leesuhzhoo," Github, accessed January 8, 2021, https://github.com/ffd8/leesuhzhoo. Licensed under CC BY-NC-SA 4.0.

These electronically realized visuals are two-dimensional function graphs.[16] The oscilloscope allows both the depiction of a signal plotted against a linear time base, generated through a built-in sawtooth oscillator causing a horizontal sweep, as well as plotting a signal against a second variable signal. If their mathematical relation is harmonic, (3) regular closed curves, so called Lissajous curves, may be generated. In engineering, oscilloscopic Lissajous patterns proved to be valuable for frequency determination,[17] as they visually facilitate the identification of an unknown frequency in comparison to a known one. The variety and regularity of these patterns has prompted their study from contexts outside of an applied usage. *Leesuhzhoo* is a tool built in Processing by media artist and designer Ted Davis that allows for the exploration of these geometric dual-frequency plots.[18] The tool enables the user to move a two-dimensional slider within a coordinate system to adjust frequencies. It offers a preview, emulating an oscilloscope screen and generates audio output that may be fed to the two input channels of an analog oscilloscope set to XY-mode. A set of controls alter wave shapes and frequency ratios, such as the Lissajous curve in figure 2 which is based on two sine waves at the frequency ratio of 3:2.

The oscilloscopic real-time imagery is volatile and therefore (4) requires storage through opto-chemical means, such as photography or film. Pointing a camera at the CRT-screen and recording the patterns was common in engineering. Camera-screen-compounds branched out into various special equipment, such as Stromberg-Carlson's S-C 4020 microfilm plotter, investigated by Zabet Patterson in relation to 1960s and early 1970s computer art.[19] In the case of electronic oscillography and its filmic records, in the early 1950s three experimental filmmakers – Mary Ellen Bute, Norman McLaren and Hy Hirsh – tinkered with the engineering practice of documenting the oscilloscope screen and combined it with their own approach of setting abstract animated patterns to music. Of the resulting colorful *Visual Music-films, Around Is Around* shall serve as a case for closer examination in the last section.

Oscillograms for the Experimental Film Around Is Around

Around Is Around[20] is an experimental animation incorporating electronic imagery photographed from the oscilloscope. It was directed in 1951 by Norman McLaren who, at the onset of World War II, emigrated from London to New York and in 1941 moved to Ottawa, where he worked at the National Film Board of Canada (NFB) until shortly before he passed away in 1987. He received assistance in the production of Around Is Around by Evelyn Lambart, who worked as letterer, animator and director at the NFB from 1942 until 1974, and by Chester Beachell, who had a radio engineering background and worked at the NFB's technical research division from 1949 until 1980. The Lissajous curves integrated into the film are devoid of a narrative structure and behave as autonomous figures moving in accordance to music by Louis Applebaum, set in front of hand-drawn backgrounds.[21] The synchronization between the musical and visual movement is on point. The oscilloscopic curves are presented as spinning around their own axis, which is due to a deliberate phase shift between the frequencies. Rotation lends itself to stereo-optics: *Around Is Around* is a 3D-film. The occasion for its production was the 1951 *Festival of Britain* in London. The festival was meant to attain national self-assurance after the dismantling of the British Empire. It involved contributions by Canada, as a member of the Commonwealth, including films by the National Film Board of Canada. *Around Is Around* employs polarization stereoscopics and was screened as part of the *3D program* at the Telecinema, a London theater built especially for the Festival that featured a stereoscopic projection system, and a multi-channel sound system.[22] These specific parameters required consultation by the technical research department, NFB's research and development unit.

Chester Beachell assisted McLaren and Lambart during the production, initially for the stereoscopics that were based, not on three-dimensional objects, but on flat artwork.[23] Beachell's work was later reflected in a publication on the development of a stereo camera system.[24] Another outcome of the collaboration was stereoscopic oscillography, as prominently employed in *Around Is Around*. An article by McLaren and Beachell, published in a technical journal shortly after the film's premiere, helps in retracing the appropriated use of the electronic oscilloscope for experimental filmmaking.[25] Among other aspects, the authors go into the production of the electronic oscillograms. They mention the oscilloscope's tube, as it featured the relatively long afterglow of green phosphor[26] and therefore was nearly unsuitable for filming: "Due to the low actinity of the phosphor used – the oscillograph tube was a 5LP1 – it was necessary to shoot at varying frame rates depending on the complexity of the pattern. This was also an advantage as it permitted *greater manual control* of the figure during shooting."[27] Considering Ian Hutchby's understanding of functionality as a main aspect of affordance, the tube limited rapid camera speeds due to its actinity and enabled other operations, in this case a detailed control of the images materializing on the tube's screen and their careful filming through lower frame rates.

These conditions of filming the screen present a specific case of affording (4) storage of volatile electronic imagery, while the emphasis on adjustability points to the abovementioned affordance (2) of on-the-fly modifications. The authors write: "The growth and change of the patterns were controlled by manually operating the control knobs on the oscillographic setup."[28] They specify these controls comprising vertical and horizontal gain, as well as mixing, phase-shift and rotation controls,[29] that were applied to vary the fundamental sinusoidal, square and saw-tooth wave shapes generated by oscillators.[30] The resulting Lissajous patterns were put into horizontal rotation by shifting the frequencies' phase, which allowed for stereoscopy: "The movement of the patterns was kept predominantly horizontal, so that the monocular dynamic parallax would produce binocular parallax, when two identical prints were staggered as a stereo pair."[31] Parallax in this case refers to the difference of location between a left-eye print and the respective film images of the right-eye print. As the two film prints were identical and merely presented slightly off-set, McLaren's and Beachell's use of Lissajous curves proved to be a low-budget procedure for creating a 3D-effect. As stereo-optics is not usually part of oscilloscopic imagery and obtained relevance only in this particular setting of preparing a stereoscopic film for the *Festival of Britain's* 3D program, this appropriation of an electronic measuring device for alternative purposes points to Ian Hutchby's notion of relationality as a major aspect of affordance. As mentioned above, operations might be relevant or irrelevant, depending on a technical object's user which underscores the mutual interdependency. The fact that the oscilloscope affords (3) the generation of rotating Lissajous curves, resulted in in the stereoscopic film *Around Is Around*, engendered through this specific production context.

Conclusion

In analyzing the oscilloscope-user-arrangement as a social and material environment while following the descriptive understanding of affordance, I highlighted the material, functional, and relational features of the concept. Functionality and relationality are main aspects of affordance, as laid out by Ian Hutchby. Regarding relationality, the oscilloscope-user-arrangement affords a set of practices that present themselves with varying degrees of relevance to different users. The afforded practices include (1) displaying and analyzing dynamic values rapidly, (2) real-time interactivity, (3) generating Lissajous curves, and (4) storing these volatile images on film. The relationality becomes apparent in that the (1) analysis of dynamic phenomena is important to engineers, while it is secondary from a filmmaking perspective. Furthermore, whereas the (4) documentation of electronic images on film most likely poses itself as a mere necessity in an engineering context, it is appreciated as a ground for further exploration by experimental filmmakers. In the case of Norman McLaren's, Evelyn Lambart's, and Chester Beachell's work on *Around Is Around*, (3) the creation of regular geometric shapes set in rotation lends itself to a new method for obtaining an inexpensive stereoscopic effect. Therefore, this animation presents itself as a telling case of an experimental film integrating the oscilloscope's electronic imagery, and thereby the affordances of a specific socio-technical and material setting in the course of its production process.

Author Biography

Stefanie Bräuer is an art historian who works at the intersection of art history, media studies, film history and the history of science. Stefanie received her master's degree in art history in 2013 from the Berlin Humboldt University. Currently, she pursues a doctoral thesis at the Institute for Media Studies, University of Basel. Her dissertation explores the implementation of oscilloscopic imagery in early 1950s experimental film. After contributing as a research assistant to a project on ultrashort audiovisual forms funded by the Swiss National Science Foundation (2014-2017), she was associated with the German Center for Art History in Paris as a guest researcher (2017-2018). Parallel to her research, Stefanie taught courses on the history of audiovisuality as well as on the theory and culture of digital media at universities in Switzerland and Germany. Email: s.braeuer@unibas.ch

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Notes

[1] James J. Gibson, *The Ecological Approach to Visual Perception*, rev. ed. (New York: Taylor & Francis, [1979] 1986). The following quotes are referring to a preprint of this chapter as part of an edited volume published in 1977: James J. Gibson, "The Theory of Affordances," in *Perceiving, Acting, and Knowing. Toward an Ecological Psychology*, ed. Robert E. Shaw and John Bransford (Hillsdale: Lawrence Erlbaum, 1977), 67–82.

[2] Gibson, "The Theory of Affordances," 78.

[3] Gibson, "The Theory of Affordances," 70.

[4] Donald A. Norman, *The Design of Everyday Things*, rev. ed. (New York: Currency Doubleday, [1988] 1990), 9.

[5] Donald A. Norman, "Affordance, Conventions, and Design," *Interactions* 6, no. 3 (May 1999): 38–43, 39, https://doi.org/10.1145/301153.301168. Norman refers to Gibson's approach in a footnote where he also indicates his unwillingness to follow Gibson's idea of relationality. Norman, "The Design of Everyday Things," 219, footnote 3.

[6] Regarding the importance of Norman's approach for HCI, a 1991 article on technology affordances may be cited exemplarily: "The role of a good interface is to guide attention via well-designed groups of sequential and nested affordances." William W. Gaver, "Technology Affordances," *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1991, 82.

[7] Tristan Thielmann and Jens Schröter, "Akteur-Medien-Theorie," in *Handbuch Medienwissenschaft*, ed. Jens Schröter (Stuttgart: Metzler, 2014), 148–158, 150.

[8] Jussi Parikka, "Media Ecologies and Imaginary Media: Transversal Expansions, Contractions, and Foldings," *Fibreculture Journal. Issue on Unnatural Ecologies*, no. 17 (2011): 34–50, 43.

[9] "[H]ow can matter circulate energy and meaning? Does this suggest the idea of media history as a history of affordances? Could we look at media technologies as active furnishings of 'what-ever-can-be-done' in terms of seeing, hearing, moving and relating, for example?" Parikka, "Media Ecologies and Imaginary Media," 43.

[10] Matthew Fuller, *Media Ecologies. Materialist Energies in Art and Technoculture* (Cambridge, MA: MIT Press, 2005), 45.

[11] Nagy, Peter, and Gina Neff, "Imagined Affordance: Reconstructing a Keyword for Communication Theory," *Social Media + Society* (2015): 1–9.

[12] Ian Hutchby, "Technologies, Texts and Affordances," *Sociology* 35, no. 2 (May 2001): 441–456, 444, https://doi.org/10.1177/S0038038501000219.

[13] Ferdinand Braun, "Ueber ein Verfahren zur Demonstration und zum Studium des zeitlichen Verlaufes variabler Ströme," *Annalen der Physik und Chemie* 60 (1897): 552–59.

[14] Jacob H. Ruiter Jr., *Modern Oscilloscopes and Their Uses* (New York: Murray Hill Books, 1949), 12.

[15] Regarding games, Inge Hinterwaldner suggested to identify the act of playing – the linkage between player and game – as a cybernetic system, as opposed to the program-based rules structuring the game. Inge Hinterwaldner, "Programmierte Operativität und operative Bildlichkeit," in *Die Kunst der Systemik. Systemische Ansätze der Literatur- und Kunstforschung in Mitteleuropa*, ed. Roman Mikuláš, Sibylle Moser, and Karin S. Wozonig (Wien: LIT, 2013), 63–94, 67.

[16] Bernhard Siegert, *Passage des Digitalen. Zeichenpraktiken der neuzeitlichen Wissenschaften 1500–1900* (Berlin: Brinkmann & Bose, 2003), 390; Wolfgang Ernst, *Chronopoetik. Zeitweisen und Zeitgaben technischer Medien* (Berlin: Kadmos, 2012), 150–51.

[17] For a visual reference chart, please see the respective section on frequency determination in Merwyn Bly, *A Guide to Cathode Ray Patterns* (New York: John Wiley & Sons, 1943), 6–13.

[18] Ted Davis: *Leesuhzhoo*, 2015/18. "Leesuhzhoo," Github, accessed January 8, 2021, https://github.com/ffd8/leesuhzhoo. Leesuhzhoo is open source and may be developed upon.

[19] Zabet Patterson, *Peripheral Vision. Bell Labs, the S-C 4020, and the Origins of Computer Art*, (Cambridge, MA: MIT Press, 2015).

[20] The film is property of the National Film Board and has been licensed for distribution on the Blu-Ray *3-D Rarities* by the 3-D Film Archive in 2015. "3-D Rarities," 3-D Film Archive, accessed January 8, 2021, http://www.3dfilmarchive.com/3-d-rarities.

[21] Norman McLaren and Evelyn Lambart, *Around Is Around*, 1951, color, sound, 3D, 35mm, 10', oscillograms by Chester E. Beachell. A film still on the website of the National Film Board of Canada shows a Lissajous pattern at the ratio of 3:2, the basis for the recreation in *Leesuhzhoo* (fig. 2), "Around Is Around," National Film Board of Canada, accessed January 8, 2021, https://www.nfb.ca/film/around_is_around.

[22] A second *Festival of Britain*-contribution by Norman McLaren and Evelyn Lambart served as a prompt to the audiences to put on polarized glasses at the start of the 3D-program: *Now is the Time (to Put on Your Glasses)*, 1951, color, sound, 3D, 35mm, 3'. Raymond Spottiswoode, "Progress in Three-Dimensional Films at the Festival of Britain," *Journal of the Society of Motion Picture and Television Engineers* 58, no. 4 (April 1952): 291–303, https://doi.org/10.5594/J01197.

[23] In a chronology of his work, the scriptwriters of an unrealized documentary about Beachell list the following for the year 1951: "The 3-camera 35mm multiple camera control system. Assisted Norman McLaren in his 3-D productions 'Now Is the Time' and 'Around Is Around'." Martin Defalco and Douglas Cameron, "Story Outline for 'Ches Beachell – Portrait of an Inventor,'" box 12425, folder *Biographic File Chester E. Beachell*, Archives of the National Film Board of Canada (October 1980): 1–5, 2.

[24] Chester E. Beachell, "A 35mm Stereo Cine Camera," *Journal of the Society of Motion Picture and Television Engineers* 61, no. 5 (November 1953): 634–41, https://doi.org/10.5594/J00969.

[25] Norman McLaren and Chester E. Beachell, "Stereographic Animation. The Synthesis of Stereoscopic Depth From Flat Drawings and Art Work," *Journal of the Society of Motion Picture and Television Engineers* 57, no. 6 (December 1951): 513–20.

[26] "Either Type 5LP1 having medium-persistence green screen, or Type 5LP5 with short-persistence blue screen for film recording may be supplied." Allen B. Du Mont Laboratories Inc., *Du Mont Type 208 Cathode-Ray Oscillograph*, Product info sheet (after 1941), 4.

[27] McLaren and Beachell, "Stereographic Animation," 520 (emphasis added).

[28] McLaren and Beachell, "Stereographic Animation," 518.

[29] McLaren and Beachell, "Stereographic Animation," 520.

[30] McLaren and Beachell, "Stereographic Animation," 519.

[31] McLaren and Beachell, "Stereographic Animation," 518.