EDITORIAL: DIAGRAMMATIC OPERATIONS

By Christoph Ernst & Daniel Irrgang

"I believe I may venture to affirm that an intelligible relation, that is, a relation of thought, is created only by the act of representing it. [...] As Diagram, it excites curiosity as to the effect of a transformation of it."
– Charles S. Peirce (1906)

The fields diagrammatics and interface studies have long been seen as related.[2] Given the fact that diagrammatics is the study of the epistemic properties of materially inscribed externalized signs, which are well known for – but *not* limited to – their use in information visualization,[3] the connection between the two fields is easy to understand. Take for example the well-known class of graphical user interfaces (GUI). A GUI relies on semiotic elements that are spatially distributed according to interrelations they signify. Such elements constitute as visual interfaces an "operational space" ("Operationsraum")[4] in a medium (e.g., a touchscreen). According to this notion, the interactive visual space of a GUI can be treated as a diagrammatic configuration. As such it is part of a certain "form of relation" between users and computers that has been considered typical for an interface. As Branden Hookway states, "the interface is treated here as a *form of re-*

lation. This is to say that what is most essential to a description of the interface lies not in the qualities of an entity or in lineages of devices or technologies, but rather in the qualities of relation between entities."[5]

Given this notion of the interface, a GUI or website organizes information and possible actions in a specific way, a 'two-dimensional space' of interrelations which can be regarded as 'diagrammatic' and thus analyzed by using concepts from diagrammatics. Such a connection between semiotic forms of information visualization (in the broadest sense), its multiple forms and historical roots, and the various practices of designing the use of digital media technology is doubtlessly one of the prime examples for a dialogue between interface studies and diagrammatics.[6] However, following Hookway's definition, other types of connection between diagrammatics and interface studies are plausible as well. A visual interface discussed in Hookway's work would be for example the Kinalog Display System, dating back to the 1950s. This artificial horizon in airplane cockpits was structurally coupled with the bodily feedback of the pilot, establishing a "pilot-plane system"[7] that made use of rather simple diagrammatic signs dynamically indicating the position of the plane in relation to the horizon. Fol-

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Quote title page: Charles S. Peirce, PAP [1906], in: Peirce, *The New Elements of Mathematics*, vol. IV: *Mathematical Philosophy*, ed. Carolyn Eisele (The Hague 1976), pp. 313–330, here 316/17.

2 Cf. Johanna Drucker, Graphesis. *Visual Forms of Knowledge Production* (Cambridge, MA and London 2014).

3 Cf. Johanna Drucker, *Visualization and Interpretation. Humanistic Approaches to Display* (Cambridge, MA 2020); Thomas Lischeid, *Diagrammatik und Mediensymbolik. Multimodale Darstellungsformen am Beispiel der Infografik* (Duisburg 2012); Isabel Meirelles, *Design for Information* (Beverly, MA 2013); Sandra Rendgen, Julius Wiedemann and Nigel Holmes, *Information Graphics* (Cologne 2012); Sandra Rendgen, *History of Information Graphics* (Cologne 2019).

4 Sybille Krämer, 'Operationsraum Schrift': Über einen Perspektivenwechsel in der Betrachtung der Schrift, in: *Schrift. Kulturtechnik zwischen Auge, Hand und Maschine*, ed. Gernot Grube, Werner Kogge and Sybille Krämer (Munich 2005), pp. 23–57.

5 Branden Hookway, *Interface* (Cambridge, MA and London 2014), p. 4.

6 Drucker, *Graphesis*, pp. 138–179.

7 Hookway, *Interface*, pp. 141–148, here 145.

lowing the evolution of interface technologies, today especially the relation between three-dimensional gestural interfaces, diagrammatics, and complex man-machine-relations comes to mind.

Similarly, the process of working with diagrammatic signs and their various forms like diagrams (in the sense of "diagrams proper"[8]), maps, sketches, and infographics has been described as a practice of performing "diagrammatic operations" ("diagrammatische Operationen").[9] These operations are 'diagrammatic' because of their association with the spatial distribution of – mainly but not exclusively – geometric primitives like lines and circles. Diagrammatic operations represent a specific, interrelated way of using spatial configurations as a media for creating information and means of manipulation and operation. This implies an 'interface relation' in the sense of the diagram as an externalized medium for epistemic operations, relating a specific semiotic configuration to the significant embodied experience of and orientation in space.[10] Hence, to 'think' and 'reason' with diagrams consists of practices of – literally – 'drawing' hypotheses and conclusions[11] by means of embodied practices of "reconfiguring"[12] such types of externalized signs. For typically 'epistemic' practices such as abstraction or explication, this process is crucial.[13]

Various forms of practices of 'thinking with diagrams' have been well researched over the last years, using different theoretical frameworks. Widely influential has been the pragmatist approach of Charles S. Peirce's semiotics, one of the most important figures in the history of diagrammatics.[14] In addition, there exists a large body of work made up by studies with different philosophical backgrounds that discuss, e.g., the properties of visual systems of logic.[15] Almost all of these positions presuppose that diagrammatic thinking (or

8   Michael May and Frederik Stjernfelt, Measurement, Diagram, Art. Reflections on the Role of the Icon in Science and Aesthetics, in: *Magnet. Thorbjørn Lausten's Visual System*, ed. Morten Søndergaard and Peter Weibel (Heidelberg 2008), pp. 53–73, here 67.

9   E.g., Sybille Krämer, Operative Bildlichkeit. Von der 'Grammatologie' zu einer 'Diagrammatologie'? Reflexionen über erkennendes 'Sehen', in: *Logik des Bildlichen. Zur Kritik der ikonischen Vernunft*, ed. Martina Heßler and Dieter Mersch (Bielefeld 2009), pp. 94–117; Matthias Bauer and Christoph Ernst. *Diagrammatik. Einführung in ein Kultur- und medienwissenschaftliches Forschungsfeld* (Bielefeld 2010); Birgit Schneider, Operationalität und Optimieren. Einleitung, in: *Diagrammatik-Reader. Grundlegende Texte aus Theorie und Geschichte*, ed. Birgit Schneider, Christoph Ernst and Jan Wöpking (Berlin 2016), pp. 182–187.

10   "There is a temptation to draw diagrams of the relevant schemata as a way of suggesting intuitively how they operate perceptually", stated Mark Johnson in his pioneering cognitive semiotics study *The Body in the Mind. The Bodily Basis of Meaning, Imagination, and Reason* while describing the embodied or spatial schemata that he identifies at work in metaphoric abstraction and reasoning (Chicago and London 1987, p. 22).

11   Nikolaus Gansterer (ed.), *Drawing a Hypothesis. Figures of Thought* (Vienna and New York, NY 2011).

12   Bauer and Ernst, *Diagrammatik*, pp. 9–82.

13   Cf. Christoph Ernst, *Diagramme zwischen Metapher und Explikation. Studien zur Medien- und Filmästhetik der Diagrammatik* (Bielefeld 2021)

14   Frederik Stjernfelt, *Diagrammatology. An Investigation on the Borderlines of Phenomenology, Ontology and Semiotics* (Dordrecht 2007).

15   Amirouche Moktefi and Sun-Joo Shin (eds.), *Visual Reasoning with Diagrams* (Dordrecht 2013).

'reasoning') is linked to various forms of 'doing.' As a consequence, diagrammatic thinking has been considered a "thinking in action"[16] which is not, in a cognitivistic sense, a solely 'mental' operation but for which, among other factors, embodiment and especially gestures play a crucial role.[17]

To highlight this 'practical' and (as a practice) 'embodied' foundation of diagrammatics is important for a rather simple reason: A goal of diagrammatics has always been to provide insight into what Johanna Drucker calls the "*visual forms* of knowledge production,"[18] e.g., by illustrating to what extent the spatialization of logic symbols creates epistemic differences in contrast to other notational systems (algebraic, etc.).[19] According to this notion, analyzing the *visual* properties of a specific diagram (or related forms such as maps, etc.) is

crucial to delineate the creation of new knowledge associated with diagrams in a given context.

As Frederik Stjernfelt and Michael H. G. Hoffmann have shown with great authority,[20] the notion of an "operational definition"[21] of iconic signs in Peirce's work must first and foremost be read as an epistemological and pragmatist issue of expanding and developing knowledge, or: of solving problems. In a Peircean view, 'operating' a diagram means to operate a subtype of iconic signs. The form of representation typical for iconic signs is similarity, and in the case of diagrams' *structural similarity*.[22] From this premise it follows that, while structural similarity is best represented in visual forms and their various media, diagrammatic operations are by no means bound to 'thinking with' two- or three-dimensional visual objects. At this point, however, an epistemological as well as a media-theoretical problem arises. To 'decouple' diagrammatic operations (as a form of reasoning) from the practices of interaction with external materialities – hence *media* –, be they visual or of any other form, 'mentalizes' the notion of diagrammatic operations up to the point that (as in Peirce's work) elementary forms of in-

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16   Barbara Tversky and Angela Kessel, Thinking in Action. *Pragmatics & Cognition* 22/2 (2014): 206–223.

17   Cf. Barbara Tversky, *Mind in Motion. How Action Shapes Thought* (New York, NY 2019), in a broader context Sybille Krämer, *Figuration, Anschauung, Erkenntnis. Grundlinien einer Diagrammatologie* (Berlin 2016). With a focus on Cognitive Metaphor Theory (CMT), as it was developed by George Lakoff, Mark Johnson and others, see, e.g., Stjernfelt, *Diagrammatology*, pp. 133–135, 257–261; Schneider, Ernst and Wöpking, *Diagrammatik-Reader*, pp. 87–92, 104–108; Ernst, *Diagramme zwischen Metapher und Explikation*, pp. 253–344; Daniel Irrgang, Topological Surfaces: On Diagrams and Graphical User Interfaces, in: *Interface Critique*, ed. Florian Hadler and Joachim Haupt (Berlin 2016), pp. 49–73; Daniel Irrgang, *Erweiterte Kognition. Zum diagrammatischen Zeichen als verkörpertes Denkding* (Berlin 2022), pp. 161–189.

18   Drucker, *Graphesis* (emphasis added).

19   Cf. Sun-Joo Shin, *The Logical Status of Diagrams* (Cambridge, MA and London 1994); Sun-Joo Shin, *The Iconic Logic of Peirce's Graphs* (Cambridge, MA and London 2002); Jan Wöpking, *Raum und Wissen. Elemente einer Theorie epistemischen Diagrammgebrauchs* (Berlin 2016).

20   Cf. Stjernfelt, *Diagrammatology*, pp. 90–92; on the issue of expanding knowledge and the problem of new knowledge in Peircean diagrammatics see Michael H. G. Hoffmann, *Erkenntnisentwicklung. Ein semiotisch-pragmatischer Ansatz* (Frankfurt/M. 2005).

21   Stjernfelt, *Diagrammatology*, p. 99.

22   Charles S. Peirce, *The Essential Peirce. Selected Philosophical Writings*, vol. 2: *1893–1913* (Bloomington, IN & Indianapolis 1998), pp. 272–288.

ference such as abduction *as such* imply a 'diagrammatic operation.' While this might be consistent within the confines of Peircean semiotics, it leads to an overgeneralization of any notion of 'diagrammatic operation.' In other words: every mental operation becomes diagrammatic. This implies some sort of 'pansemiotism,' which is problematic given the material situatedness of cognitive processes as they are expressed in the famous "4E"-paradim in cognitive science and philosophy of mind.[23] A strictly semiotic definition of diagrammatic operations tends to lose focus here.

This leads back to the notion of *interface*, which in turn can be regarded as much more than just the 'user interface' in computer science. In fact, an interface can come in a multitude of shapes, forms, and operations. For Brendan Hookway, as a "form of relation" the interface must be "an active relation"
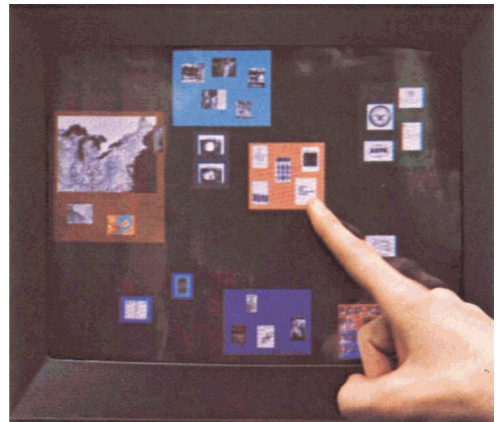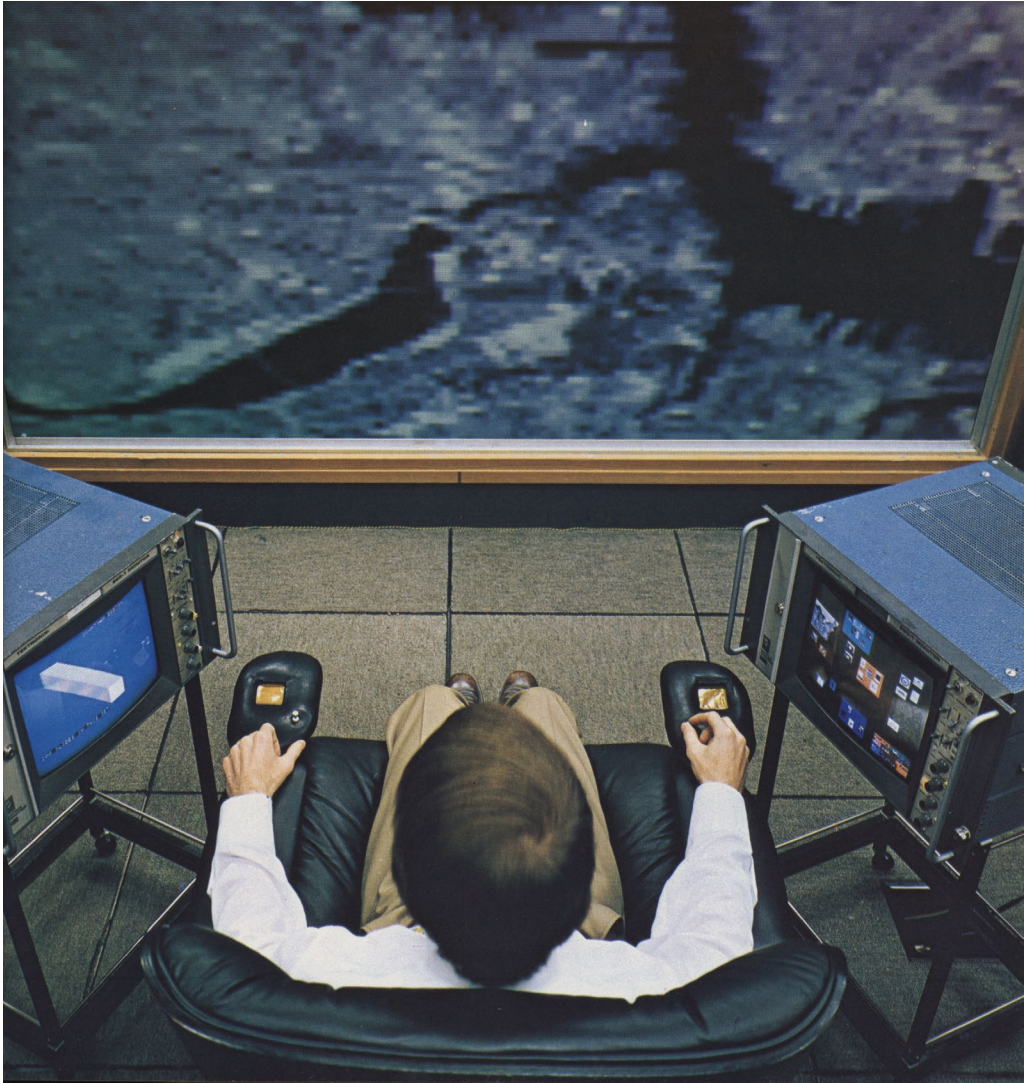
which actively maintains, polices, and draws on the separation that renders these entities as distinct at the same time as it selectively allows a transmission or communication of force or information from one entity to the other. And in such a way that its overall activity brings about the production of a unified condition or system that is mutually defined through the regulated and specified interrelations of these distinct entities.[24]
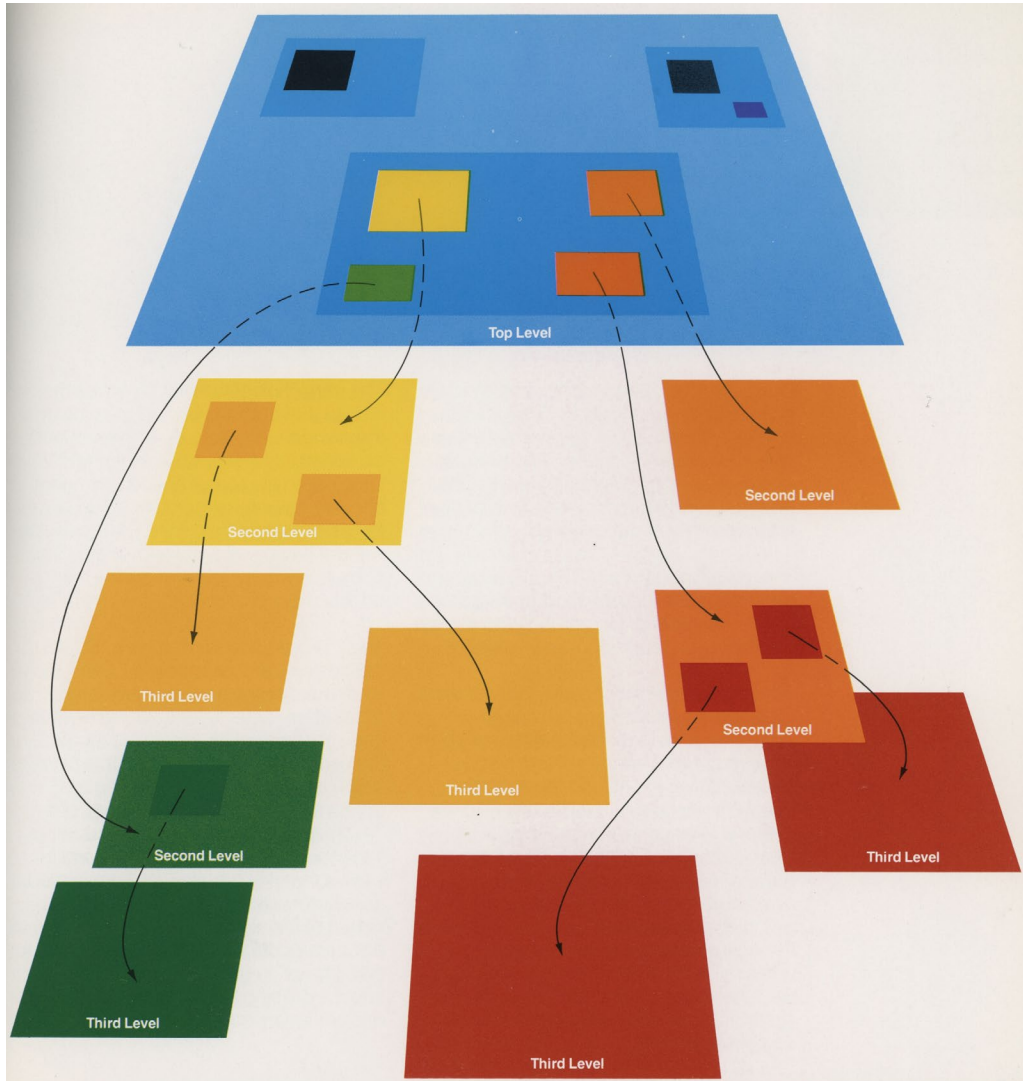
Not only implies this a much broader concept of interface than 'just' the user interface. It is now also possible to define the specific 'doings' implied in diagrammatic operations as specific forms of 'interfacing.' The conclusion is that diagrammatic operations are – *as practices of interfacing* – always already specific types of 'interface operations.' In consequence, the interface is not subject to analytic explication via diagrammatics, but *is always implied in diagrammatic operations as spatialized practices*. This allows to account for the broad heterogeneity of media specific settings in which diagrammatic operations are externalized – be it the sandbox in which the geometric and astronomical diagrams of antiquity were drawn, or be it the manifold forms of computer-based diagrammatic operations and interactions.

The contributions to *Interface Critique 4: Diagrammatic Operations* are devoted to this heterogeneity – to the interplay between diagrammatic forms of interface relations and the interface implied in diagrammatic operations. As interdisciplinary as the various studies on diagrammatics published in recent years, the contributions approach their subjects from the angles of media studies, history of technology, philosophy, art history, science and technology studies, as well as art and design research.

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23   4E stands for "embodied," "embedded," "extended," "enactive," as elementary features of cognitive processes, cf. Albert Newen, Leon De Bruin and Shaun Gallagher (eds.), *The Oxford Handbook of 4E Cognition* (Oxford and New York, NY 2018).

24   Hookway, *Interface*, p. 4.

Left: The visual devices setup of the 'Spatial Data-Management System' (1976), a HCI prototype for efficient data retrieval developed by the MIT Architecture Machine Group: A large screen for the navigation mode and two touch sensitive monitors to the user's left and right for grasping details (left) and gaining overview (right). A joystick for navigation in 'Dataland' (the telling title of the spatially organized GUI) is mounted on each armrest of the control chair. Image source: Richard A. Bolt, *Spatial Data-Management* (Cambridge, MA: MIT, 1979), pp. 43, 10, 17.

Above: With joystick and zoom feature the user could navigate "through" several layers of navigational levels of Dataland. Richard A. Bolt, author of the study, notes as a premise: "It is surprising how pervasive the underlying notion of spatiality is, even in symbolic modes of thought." He concludes later on: "What we should learn are lessons concerning people's ability to create mental spaces and then to search them." (Bolt, *Spatial Data-Management*, image: p. 51, quotes: p. 7., 57) The symbolic and spatial principles − essentially diagrammatic modes of operation − of the Spatial Data-Management System did not only influence the pioneering GUI research at Xerox PARC but also the related development of the Apple Lisa GUI (Roderick Perkins, Dan Smith Keller and Frank Ludolph, Inventing the Lisa User Interface. *Interactions* 1 (1997): 40−53).

The contributions that associate directly with this issue's thematic focus of diagrammatic operations are complemented by yet a new 'special section' with papers by members of the working group 'Interface' of the German Society for Media Science (GfM), continuing a tradition that has started with the second issue of this journal. This section focusses on "Interfaces as Experimental Arrangements". We are grateful for the working group's continuous commitment to the interface critique cause. We are also grateful to Maria and Lena Knilli for entrusting us with a very personal obituary to the legacy of their father, Friedrich Knilli (1930–2022). To be able to provide the *Interface Critique* project as a platform to remember this pioneer in both audio drama research and German media studies in general[25] is a privilege.

We are indebted to everyone who contributed to this issue – either directly by submitting a contribution or by supporting us otherwise with feedback, infrastructure, or intellectual encouragement. Without the growing network of contributors and supporters, this project would not be possible. A special thanks goes out to our publisher, arthistoricum.net, and the Heidelberg University Press, especially Bettina Müller, Frank Krabbes and Anja Konopka.

The next journal issue is in preparation, and so is a prospective new title in our book series. Stay tuned for more things to come!

– Mainz & Berlin, December 2022

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25 Cf. "Das Medium altert, nicht das Thema" – Friedrich Knilli in conversation with Siegfried Zielinski, in: *Zur Genealogie des MedienDenkens*, ed. Daniel Irrgang and Florian Hadler (Berlin 2017), pp. 15–33.

References

Bauer, Matthias and Christoph Ernst, *Diagrammatik. Einführung in ein Kultur- und medienwissenschaftliches Forschungsfeld* (Bielefeld: Transcript, 2010).

Bolt, Richard A., *Spatial Data-Management* (Cambridge, MA: MIT, 1979)

Drucker, Johanna, *Graphesis. Visual Forms of Knowledge Production* (Cambridge, MA and London: Harvard University Press, 2014).

Drucker, J., *Visualization and Interpretation. Humanistic Approaches to Display* (Cambridge, MA: The MIT Press, 2020).

Ernst, Christoph, *Diagramme zwischen Metapher und Explikation. Studien zur Medien- und Filmästhetik der Diagrammatik* (Bielefeld: Transcript, 2021).

Gansterer, Nikolaus (ed.), *Drawing a Hypothesis. Figures of Thought* (Vienna and New York, NY: Springer, 2011).

Hoffmann, Michael H. G., *Erkenntnisentwicklung. Ein semiotisch-pragmatischer Ansatz* (Frankfurt/M.: Vittorio Klostermann, 2005).

Hookway, Branden, *Interface* (Cambridge, MA and London: The MIT Press, 2014).

Irrgang, Daniel, *Erweiterte Kognition. Zum diagrammatischen Zeichen als verkörpertes Denkding* (Berlin: Kulturverlag Kadmos, 2022).

Irrgang, D., Topological Surfaces: On Diagrams and Graphical User Interfaces, in: *Interface Critique*, ed. Florian Hadler and Joachim Haupt (Berlin: Kulturverlag Kadmos, 2016), pp. 49–73.

Johnson, Mark, *The Body in the Mind. The Bodily Basis of Meaning, Imagination, and Reason* (Chicago and London: The University of Chicago Press, 1987).

Knilli, Friedrich, in conversation with Siegfried Zielinski, "Das Medium altert, nicht das Thema" – Friedrich Knilli, in: *Zur Genealogie des MedienDenkens*, ed. Daniel Irrgang and Florian Hadler (Berlin: Kulturverlag Kadmos, 2017), pp. 15–33.

Krämer, Sybille, *Figuration, Anschauung, Erkenntnis. Grundlinien einer Diagrammatologie* (Berlin: Suhrkamp, 2016).

Krämer, S., 'Operationsraum Schrift': Über einen Perspektivenwechsel in der Betrachtung der Schrift, in: *Schrift. Kulturtechnik zwischen Auge, Hand und Maschine*, ed. Gernot Grube, Werner Kogge and Sybille Krämer (Munich: Wilhelm Fink, 2005), pp. 23–57.

Krämer, S., Operative Bildlichkeit. Von der 'Grammatologie' zu einer 'Diagrammatologie'? Reflexionen über erkennendes 'Sehen', in: *Logik des Bildlichen. Zur Kritik der ikonischen Vernunft*, ed. Martina Heßler and Dieter Mersch (Bielefeld: Transcript, 2009), pp. 94–117.

Lischeid, Thomas, *Diagrammatik und Mediensymbolik. Multimodale Darstellungsformen am Beispiel der Infografik* (Duisburg: Universitätsverlag Rhein-Ruhr, 2012).

May, Michael and Frederik Stjernfelt, Measurement, Diagram, Art. Reflections on the Role of the Icon in Science

and Aesthetics, in: *Magnet. Thorbjørn Lausten's Visual System*, ed. Morten Søndergaard and Peter Weibel (Heidelberg: Kehrer, 2008), pp. 53–73.

Meirelles, Isabel, *Design for Information* (Beverly, MA: Rockport, 2013).

Moktefi, Amirouche and Sun-Joo Shin (eds.), *Visual Reasoning with Diagrams* (Dordrecht: Springer, 2013).

Newen, Albert, Leon De Bruin and Shaun Gallagher (eds.), *The Oxford Handbook of 4E Cognition* (Oxford and New York, NY: Oxford University Press, 2018).

Peirce, Charles S., PAP [1906], in: Peirce, *The New Elements of Mathematics, vol. IV: Mathematical Philosophy*, ed. Carolyn Eisele (The Hague: Mouton, 1976), pp. 313–330.

Peirce, C. S., *The Essential Peirce. Selected Philosophical Writings*, vol. 2: *1893–1913* (Bloomington, IN & Indianapolis: Indiana University Press 1998).

Perkins, Roderick, Dan Smith Keller and Frank Ludolph, Inventing the Lisa User Interface. *Interactions* 1 (1997): 40–53.

Rendgen, Sandra, *History of Information Graphics* (Cologne: Taschen, 2019).

Rendgen, S., Julius Wiedemann and Nigel Holmes, *Information Graphics* (Cologne: Taschen, 2012).

Schneider, Birgit, Operationalität und Optimieren. Einleitung, in: *Diagrammatik-Reader. Grundlegende Texte aus Theorie und Geschichte*, ed. Birgit Schneider, Christoph Ernst and Jan Wöpking (Berlin: De Gruyter, 2016), pp. 182–183.

Shin, Sun-Joo, *The Logical Status of Diagrams* (Cambridge, MA and London: The MIT Press 1994).

Shin, S.-J., *The Iconic Logic of Peirce's Graphs* (Cambridge, MA and London: The MIT Press, 2002).

Stjernfelt, Frederik, *Diagrammatology. An Investigation on the Borderlines of Phenomenology, Ontology and Semiotics* (Dordrecht: Springer, 2007).

Tversky, Barbara and Angela Kessel, Thinking in Action. *Pragmatics & Cognition* 22/2 (2014): 206–223.

Tversky, B., *Mind in Motion. How Action Shapes Thought* (New York, NY: Basic Books, 2019).

Wöpking, Jan, *Raum und Wissen. Elemente einer Theorie epistemischen Diagrammgebrauchs* (Berlin: De Gruyter, 2016).