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Extending Beyond the Ultimate Display in *Image Objects: An Archaeology of Computer Graphics*

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ABSTRACT

This essay reviews the book *Image Objects: An Archaeology of Computer Graphics* by Jacob Gaboury (Cambridge, MA: The MIT Press, 2021). In this book, Gaboury explores the materiality of computer graphics by deconstructing rendered images and tracing the history of their development and impact on contemporary computing.

In 1965, the computer scientist Ivan Sutherland called members of the International Federation for Information Processing to picture "the ultimate display" as a "room within which the computer can control the existence of matter."[1] Such power to manipulate the material world, however, now extends far beyond Sutherland's imagined "kinesthetic display," and Jacob Gaboury's *Image Objects: An Archaeology of Computer Graphics* investigates just how computer graphics transformed and continue to shape physical and digital objects.[2] Throughout *Image Objects*, Gaboury argues that the world is now filled with "image objects," things that cannot be understood solely by their final renderings; they have been materially shaped by the computational objects that enabled their construction, such as microprocessors, software suites, and algorithms. As Gaboury explains, with the rise of computer graphics and the development of "systems for graphical human-machine communication," the computer transformed from a machine for procedural calculation into a "technical medium" that "better [reflects] our understanding of the sensible world" by prioritizing vision and interactivity.[3]

Rather than begin his exploration with the rise of the graphics processing unit (GPU) in the 1990s, Gaboury focuses on the three decades preceding this moment. In his words, he views "this book as an archaeology because it looks to a neglected prehistory that has been assumed or obscured by popular discourses of graphical realism."[4] Following the work of the media theorist Vivian Sobchack, Gaboury takes on a materialist methodology that deprioritizes representation by "[excavating] dead media objects" to "[bring] them to bear on the present through a descriptive contextualization."[5] While media theory has worked to move past visual bias over the last twenty years, Gaboury argues that the materiality of the screen image has been ignored as a result. Thus, his book aims to make visible the materiality of computer graphics by deconstructing rendered images.

Each chapter of *Image Objects* presents a different technical object that is key to the construction of computer graphics, questions how these objects developed, and traces their influence on contemporary computing. Gaboury's case studies progress chronologically through the early history of computer graphics. Together, they demonstrate how the objects developed to tackle the problems of the field materially structured digital images. Simultaneously, the case studies explain how computer graphics subjected material objects to the "logic of the digital image."[6]

Chapter one explores various efforts undertaken between 1962 and 1978 to solve the hidden surface problem, or the need for computers to calculate which surfaces to display and which to hide when rendering images. While a student at the University of Utah, Edwin Catmull developed a lasting solution for this problem by creating a hardware object called the z-buffer. By storing the depth values of objects, the z-buffer allowed for quick calculations and contributed to the rise of interactive graphics. Emphasizing the difference between computer graphics and other media forms that precede it, such as photography, Gaboury describes how computer graphics construct rather than capture visuality while utilizing and shaping computer memory. Focusing on the period between 1946 and 1975, chapter two presents the history of the screen interface and the accompanying move away from calligraphic and towards raster graphics. Gaboury details how the frame buffer emerged at this time to handle graphical data processing with the help of random-access memory, which allowed for increasingly diverse ways of manipulating individual points of light on screens. Such manipulation enabled computer graphics to expand beyond merely capturing and displaying images and towards interactivity.

Moving away from the "unique function of computer graphics as both visual representation and object simulation," chapter three details the standardization of graphical objects in the mid-1970s.[7] At this point, researchers began digitizing physical objects and worked to standardize their methods of simulation. Primarily focusing on the Utah teapot, the most common object standard used for the application of processes and testing of algorithms, Gaboury illustrates how the objects of computer graphics became functionally interchangeable through this process. As a result, new objects no longer required fully unique renderings from the start, as individuals could instead alter "master objects" as needed. Chapter four builds upon this concept of interchangeability by highlighting the programming paradigm of object orientation. Transitioning from a visual focus to language, this chapter demonstrates how the logics of computer graphics spread beyond images on screens through Alan Kay's development of this programming paradigm in the late 1960s at the University of Utah. While early programming methods operated like flow charts or diagrams, object-oriented programming introduced a structure based on modular and reusable objects, and thus moved conceptions of computation towards the spatial and away from the linear.

Chapter five, the final chapter, turns to the hardware platform of the graphics processing unit (GPU), developed in the early 1980s by James Clark, another graduate of the Utah program. The GPU—designed to calculate graphical data and operating, in a sense, as a separate computer—moved computation further away from universal architectures by demonstrating the power of parallel computation. Here, Gaboury argues for an understanding of the GPU as a "metaobject" in which "each of the objects of the previous chapters [was] miniaturized and embedded," allowing for increased accessibility to computer graphics outside of exclusive research sites.[8]

In focusing on the computational research program at the University of Utah, *Image Objects* positions Salt Lake City as the geographical center for the development of computer graphics. Founded in 1965 by the computer scientist David C. Evans and principally funded by the

Department of Defense, the Utah program prioritized strengthening human-machine communication by experimenting with enhanced computer graphics. Through his object case studies, Gaboury demonstrates how this research program generated a theory "in which the world is understood as a relational system of objects capable of discrete forms of interaction."[9] Though this theory of objects helped align computing with sensory human experiences, the transmission of its logic throughout the field also reshaped physical experiences and environments to comply with the demands of object orientation. By moving away from focus on Utah, chapters four and five trace the afterlives of its program and the dissemination of its theories, as individuals involved in its early research efforts migrated throughout the industry to other sites like Xerox PARC, Silicon Graphics, Inc., and Pixar Animation Studios. Although Gaboury details some humorous and entertaining traces of the program, such as the inclusion of the Utah teapot in Pixar's *Toy Story* and the enablement of 3D graphics for the Nintendo 64 console, he emphasizes its entanglements with the Department of Defense and the construction of simulation technologies, such as an interactive model of the New York Harbor, for military training purposes.

Shifting the historical narrative from individuals to materiality by investigating how the rendered images of computer graphics physically came into being, Gaboury draws attention to neglected accounts of everyday research tasks. Examining his archival findings, he questions the lack of women in this history. To surface these "traces," Gaboury points to records of wives driving their cars to be measured by students and offering their teapots and faces as models. Furthermore, he describes how the photographic collection of Evans & Sutherland (E&S), full of images of women assembling hardware, demonstrates hidden forms of labor. In her essay "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," Lisa Nakamura calls for "attending to software's procedural codes, its hardware, its infrastructures, its histories, and its racial and gender formations" when studying visual representations and their constructions, a call that Gaboury attends to throughout *Image Objects*.[10] He does not, however, differentiate between women who contributed supporting labor and those who invented new systems, such as computer scientists Joan Miller, Adele Goldberg, and Lynn Conway, whose contributions the book also details extensively. For instance, while researchers like Lynn Conway worked to design very-large-scale integration (VLSI) chips, many other, mostly anonymous women repeatedly strained their eyes, hands, and backs to build them. When Gaboury leaves such differences unexamined, he renders the women's labor as functionally equivalent and interchangeable, signaling a generic hiddenness that does not account for varying levels of access to the spaces of research and development where image objects emerged. This lack of specificity also risks overlooking histories in which such images of women laboring were made hypervisible, as seen in Nakamura's account of Navajo women working for Fairchild Semiconductor's Shiprock plant, which opened in 1965, only three years before E&S.

In the coda of *Image Objects*, Ivan Sutherland's "ultimate display" returns, as Gaboury illustrates the proliferation of image objects through examples involving the marketing of the Volkswagen Beetle, the creation of the IKEA catalogue, and the unveiling of the Apple Watch. By revealing how computer graphics simultaneously exist everywhere yet evade attention, *Image Objects* encourages readers to consider how the future of computing will be shaped by logics and objects like the GPU that emerged from the history of computer graphics. Crucially, Gaboury calls for consideration of the potential consequences of reimagining "the world as a massive computational task that can be solved through parallel processing."[11] Perhaps most importantly, Gaboury's essential and timely *Image Objects* provides an understanding of both image objects and the

contemporary world they occupy as at once material and immaterial, natural and designed, physical and digital, while simultaneously exceeding these categories altogether.[12]

ENDNOTES

[1] Ivan Sutherland, "The Ultimate Display," in *Information Processing 1965: Proceedings of IFIP Congress 65*, ed. Wayne A. Kalenich (London: Macmillan and Co., 1965), 507.
[2] Ibid., 506.
[3] Jacob Gaboury, *Image Objects: An Archaeology of Computer Graphics* (Cambridge, MA: The MIT Press, 2021), 200.
[4] Ibid., 6.
[5] Ibid., 5.
[6] Ibid., 7.
[7] Ibid., 24.
[8] Ibid., 25.
[9] Ibid., 12.
[10] Lisa Nakamura, "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," *American Quarterly* 66, no. 4 (2014): 937.
[11] Gaboury, *Image Objects*, 189.
[12] Ibid., 25.

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