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Abigail Reynolds, *Mount Fear East London*, sculptural installation of police crime statistics, 2003. (© Abigail Reynolds) See General Article by Tom Corby.

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ABSTRACT

Discussing his recent artworks alongside those by Abigail Reynolds, Lucy Kimbell and Christian Nold, the author examines emerging phenomena in the digital and wider fine arts whereby information visualization practices are approached as creative media. By laying bare points of convergence and divergence between artistic and scientific approaches, the article develops a number of arguments that show how the pictures produced by information visualization may be reframed within wider aesthetic and critical frameworks. Thus the author explores how models of image production derived from processes of scientific inquiry expand possibilities for the visual arts to develop new types of hybrid images that consist of data grounded both in material realities and in symbolic and aesthetic elements.

This article identifies experimental practices in information visualization (IV) that are situated in the digital and fine arts and occur outside of normative science contexts. By referring to my art practice, my curatorial projects and my ideas from the sciences, art history and theory, I set out a number of arguments toward an appreciation of visualization as a form of image-making able to function and be applied to a wider range of topics than is currently the case. I explore how scientific and visual arts domains may inform and learn from each other. This leads toward new understandings of the role and value of images produced using IV by showing how its processes can extend contemporary understandings of the image in the visual arts. The discussion shows that images are a vehicle capable of enabling comprehension of material realities. Equally, by referring to specific artworks, I demonstrate that the analytical function of IV can be overridden to produce types of images capable of producing critical, aesthetic and affective experience [1].

Article Frontispiece. Lucy Kimbell and Andrew Barry, *Pindices* **project, website component, 2005. (© Lucy Kimbell and Andrew Barry) The front page of the website provided an "at a glance" view of the types and frequency of activities that individual participants were engaged in.**

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Fig. 1. Gavin Baily and Tom Corby, *Cyclone.soc,* **2006. (© Tom Corby and Gavin Baily. Photo © John Marshall.) Immersive installation visualizing newsgroup postings as weather formations.**
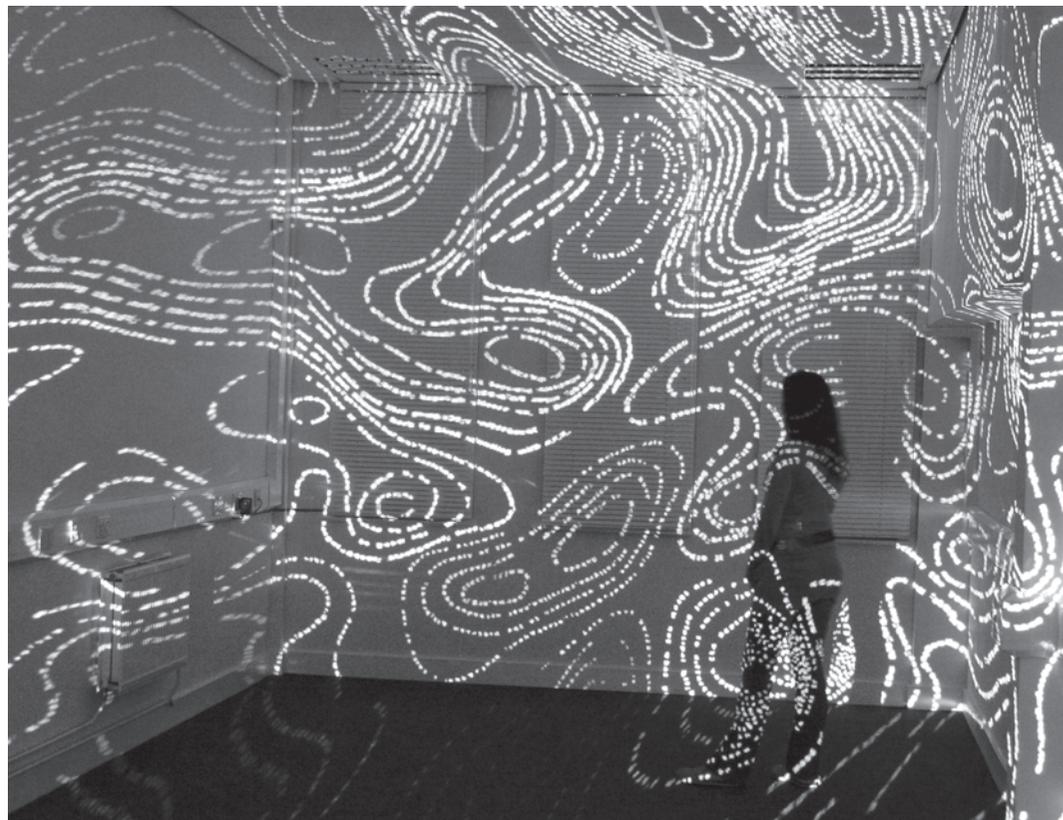
BACKGROUND: VISUALIZATION AND CULTURAL PRODUCTION

Before proceeding, I should perhaps clarify what I mean by information visualization and review how it is presented to and interfaces with wider public and visual cultures. Conventionally, the term refers to the application of computer graphics to data derived from external objects in order to generate visually understandable pictures of phenomena. It is generally considered to have originated in the mid to late 1980s [2] as an attempt to manage contemporary increases in the quantity and complexity of information. This practice, as Edward Tufte has pointed out elsewhere [3], is but the latest manifestation of the "cognitive arts," which historically have included maps, scientific diagrams, MRI scans, mathematical projections, charts and schematics, among many other visual expressions of data. Computer-based IV is differentiated from these historical precedents by its ability to represent data interactively in multidimensional, navigable form, thus making it a particularly effective tool for handling large data sets and modeling differing views and perceptions of the phenomena studied.

By translating data into pictures, with IV we aim to capitalize on humans' natural ability to spot patterns and relationships in visual fields (cognition). This enables an intuitive identification of structures, which would not be available if presented in purely numeric form. In its role as part of the scientific discovery process, IV is routinely employed as an aid to inspire hypotheses and a mechanism to devise further questions and forms of data. Other prefixes such as "scientific" and "data" are also employed to refer specifically to the representation of naturally occurring objects and processes, such as the climate and the human body, and in the visualization of data, i.e. non-physically occurring abstract phenomena, such as stock market behavior and Internet traffic. For the sake of consistency, I will continue to use the term IV as a convenient catch-all label capable of encompassing all these approaches [4].

Outside of their immediate investigative function, visualizations play an important public role as a communication medium and are regularly used by architects [5], employed in documentary and weather broadcasts, and utilized in venues that promote scientific ideas as spectacle, such as IMAX cinemas. Visualization then has been established as a broad cultural form that acts as an explanatory interface between science and the public, media and policy makers [6].

Despite this cultural penetration, until recently the fine arts have rarely used IV as a vehicle for creative activity. There are some notable exceptions to this rule, including Ad Reinhardt's satirical pictures of the American art scene [7] and Mark Lombardi's complex drawings of political and financial interdependencies [8]; but the visual representation of data in the visual arts has traditionally been a prerogative of graphic artists, who in the contemporary context work in what Donna Cox has characterized as "renaissance teams"—that is, cross-disciplinary groupings of artists and scientists who jointly contribute their expertise in order to solve the problems of picturing and communicating specific bodies of scientific knowledge [9]. This work, while important, is not the remit of this article, as it generally adheres to an institutional focus that is predominantly, if not exclusively, framed by scientific rather than broader critical and aesthetic discourses.

Recently, however, the creative landscape has changed: an increasing number of independent artists have begun to explore the aesthetic and critical potentials of IV, as evidenced by the growing numbers of projects and online initiatives [10]. Despite this, little has been written that seeks either to understand how this emerging work relates to scientific visualization or to develop a broader cultural analysis of what is being produced by these practices.

These and other issues were used as a platform for the exhibition The Information, which I co-curated with Michael Maziere at the University of Westminster's art gallery in November 2005. Taking the form of screen projection, sculpture, installation and workshops, the exhibition sought to map how artists were assimilating insights and processes from the sciences in relation to aesthetic, critical and conceptual knowledge in the visual arts. It developed three overlapping arguments:

- IV is capable of functioning as a sensual and critical art medium able to handle complex affective and emotive subject matter
- The visual arts can learn from scientific IV insofar as it offers them an effective means of producing new types of images that are hybrids of data grounded in material realities and symbolic and aesthetic elements
- Forms of IV that are possible (and perhaps necessary) are directly embedded in the wider communities of users and creators than is the norm in science.

FEELING DATA

The process of visualization involves translation of data into visual, symbolic form or pictures. The oft-quoted phrase, "The purpose of visualization is insight, not pictures" [11], suggests that, as an instrumental practice, it is possible to separate the results of visualization from the pictorial artifacts that produce them: i.e. visualizations are valued according to their ability to efficiently enable access to literal concentrates of data with minimal interference from aesthetic "noise" that might cloud interpretation. However, encounters with images of any kind involve interpretive and subjective responses on behalf of the viewer. These are influenced by personal experience, education, knowledge of the subject in hand, wider histories and social and cultural contexts [12]. If an image is worth a thousand words, the meaning within an image is necessarily fluid and resists assimilation to singular interpretation—which is as true for IV as for other disciplines. Epistemological issues of objectivity—the truthfulness of the image and its interpretation—have long been debated in IV; its veridical function as a clear window onto the phenomena studied is compromised by the layers of mediation through which it travels. While Jack van Wijk [13] argued that the value of IV as a practice within scientific process is not questioned, data is not an asocial phenomenon untouched by human hands, but is processed according to specific data parameters, hardware, chosen algorithms as well as the final visual output or pictorial metaphor employed to represent it—producing what Donna Cox has argued is a "culturally contingent" form grounded in wider visual cultures and histories of interpretation [14]. James Elkins has persuasively argued that scientific processes produce pictorial forms with both "propositional" and "nonpropositonal" content. What he means by this is that they contain informational components that clearly describe data and can be analyzed to propose or illuminate theories in a cognitive sense and also aesthetic constituents more akin to pictures in the fine arts that produce different effects. These aesthetic elements, he suggests, have the potential to be more prominent, enabling images concerned with data analysis to "mean more freely," i.e. to produce more expressively nuanced images that override

the propositional function of the scientific image [15].

The first two artworks I discuss in this article, *Cyclone.soc* (2005–2006) (which I produced in collaboration with Gavin Baily) and *Mount Fear East London* (2003) by Abigail Reynolds, take this potential as a starting point to explore how IV has the potential to generate sensual and affective experiences for audiences through the use of intricate formal assemblages of information, space, material and image [16].

Intense conviction is the subject matter of *Cyclone.soc* (Fig. 1), an immersive interactive environment that combines Internet debates between extremist religious and political groups with severe weather conditions. Streamed live, different newsgroup postings are fitted to the atmospheric topologies of a number of cyclonic weather fronts of differing strengths, giving the overall effect of a conversational churn and eddy of argument and counter-argument. Postings can then be read by either walking around the space or using controls to maneuver to specific formations and conversations.

Cyclone.soc uses an edited concentrate of data from different storms derived from publicly available satellite forecasting for the eastern coast of the United States during the autumn of 2005. This information was then re-worked as vector animations traced from the original isobar projections using Adobe Illustrator and given depth, dimension and interactivity by being re-programmed using the open GL platform. In this way, the work "shadows" scientific practice, because it does not image a specific event, but rather constructs a fictive space that is an amalgam of different data. Thus, a mutant or hybrid image is produced that threads information derived from social interactions into a pre-existing meteorological topology. In resituating newsgroup postings as weather phenomena, the project frees pictorial elements to act as metonyms for different types of cultural and ideological tension enabled and produced through technological domains. It also develops a suggestive link between extreme belief systems and their potential wider impacts on the material world.

A similar approach is evident in Abigail Reynolds's project, *Mount Fear East London* (Color Plate E); however, unlike *Cyclone.soc*, Reynold's project does not rework an existing visualization, but instead creates one from scratch using police statistics of violent crimes that have occurred over a year-long period in east London. The statistics were initially plotted in a 3D modeling program that extruded the data and then mapped it to the specific geographical location pertaining to the event. From this, Reynolds developed a sculpture made up of layers of cardboard whose resultant form dramatizes the data by transforming it into a landscape of sheer mountains and plunging gorges, with peaks and valleys signifying high and low levels of violent incident.

Mount Fear could feasibly be used as an analytical tool to determine where more police resources or social programs are needed in London, but its material presence suggests a more nuanced range of cultural meanings. The sculpture is large (5.4 × 4.25 m, with a height of 1.47 m), which allows the audience to walk around and peer into its undulating features. Developing an experience of

Fig 2. Abigail Reynolds, acrylic and wax pencil study on card, 600 × 840 mm, 2002. (© Abigail Reynolds)
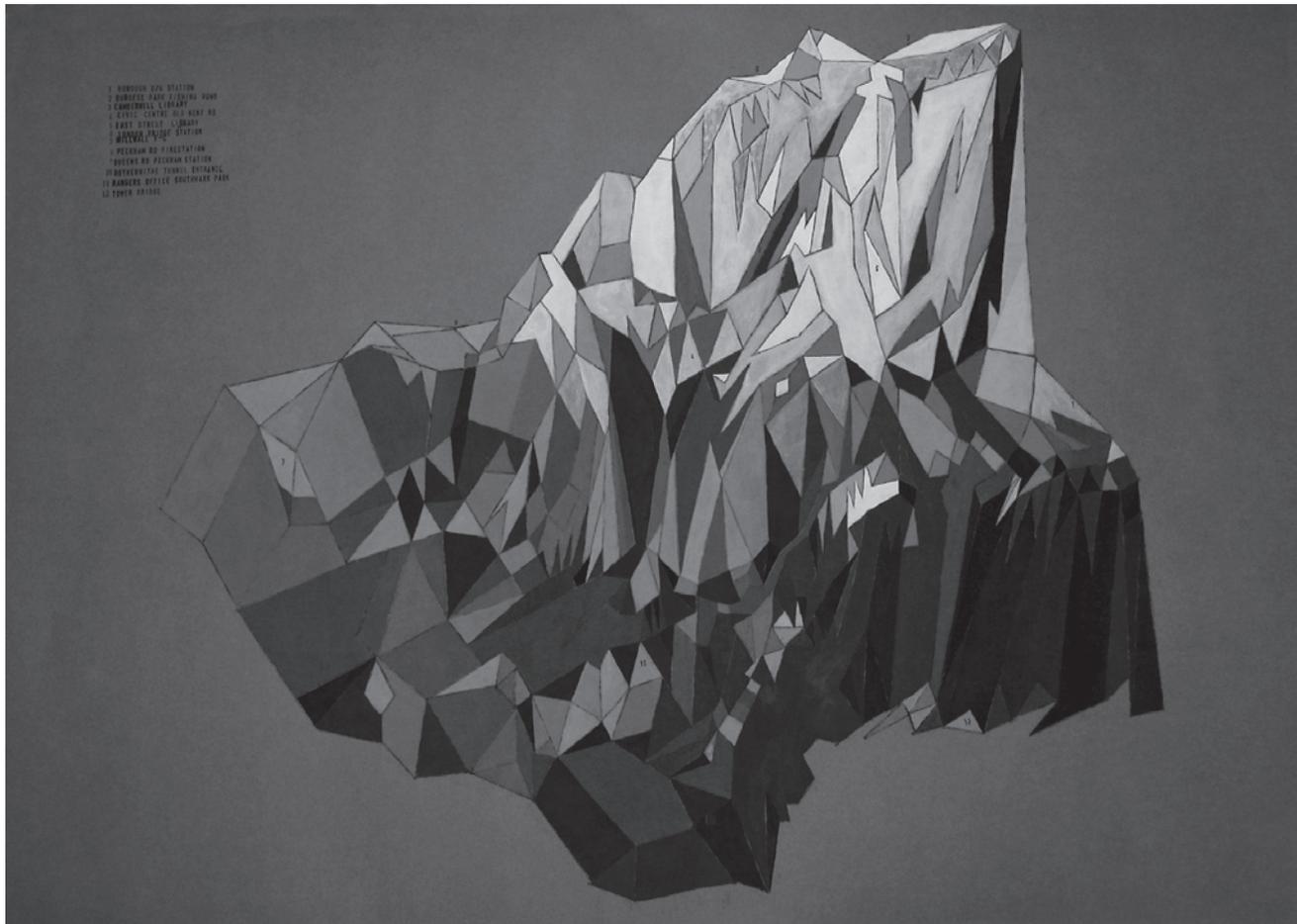
Fig. 3. Christian Nold, *Bio Mapping* project, 2004. (© Christian Nold) Participants wearing the response measuring units.

data in this manner is not arbitrary, an aesthetic act for its own sake. Rather, as the project visualizes the consequences of hidden social behavior in subtle, critical ways, it goes beyond mere decoration. Experiencing the data tangibly gives what Reynolds has described as a "psychological dimension" to a work that images a hidden experience of urban life, one that is both shocking in its physicality and fascinating as a discharge of memory. In occupying the same space as the audience, the work produces a physical equivalence for abstract facts, which enables the audience to reconnect to the situated acts they measure.

Cyclone.soc and *Mount Fear* show that, when unshackled from analytics, visualizations can convey complex subjective experiences in novel aesthetic forms. While they share an interest with scientific IV in the production of pictorial surrogates for invisible objects and forces, these experimental arts-based visualizations are not strictly concerned with cognition. Rather, these are productions of a more ambiguous kind of embodied

knowledge. It is an aesthetically situated knowledge that arises when audiences encounter and negotiate complex interchanges of data, feeling and sensation.

Both artworks also make historical connections to older art traditions and therefore locate IV techniques in other frameworks of history and meaning. In particular, the intense visual and immersive landscapes produced by these works are reminiscent of 19th-century landscape painting and its fascination with the un-representable, that is, the sublime. In addition, each also evokes early and mid-period modernist abstraction. For example, the looping spiraling texts of *Cyclone.soc* contain a cultural memory of the visual organization of Concrete Poetry, and the drawings that Reynolds produces in her sculptural practice share art-historical "DNA" with late or synthetic cubism and the formal experiments of Russian constructivism (Fig. 2). As has been suggested by Lev Manovich [17], the ability of visualization to pictorially render invisible phenomena equates to early modernism's efforts to produce

forms of visual epistemology capable of reducing complex social relations to tangible structures. Thus we might argue that (even inadvertently and unconsciously) the scientific image is subject to historical forms of pictorial production rooted in experiments in wider visual and fine art cultures, while, as evidenced by the work discussed here, IV is simultaneously cycling back into visual culture the new pictorial forms produced by emerging technologies.

VISUALIZATIONS FOR THE PEOPLE

Visualizations are used to inform governmental policy in areas as diverse as national defense, climate change, economic performance, education, industry and law [18] and thus impinge on our lives at the level of social, economic and environmental planning. Access to tools that generate information privileges its users ("information is power"), retrenches systems of fixed privilege and builds divides between information "haves" and "have

nots." Christian Nold and Lucy Kimbell's artworks in The Information exhibition ask what might happen if, rather than be subject to these top-down processes, people were able to develop their own customized information tools in order to aid social and personal empowerment [19].

Christian Nold's *Bio Mapping* (2004–ongoing) allows the generation of data visualizations that link a user's emotional response to location. The work consists of two elements: a wearable mechanism consisting of a lie detector and global positioning satellite (GPS) technology, which detects a user's galvanic skin response (GSR) and position, and visualization software that maps this change to specific locales (Fig. 3).

The unit works according to the theory that it is possible to capture and define measurable parameters of a person's internal emotional "state" through the levels of sweat users secrete through their hands. As part of the University of Westminster exhibition, self-selecting student volunteers were introduced to the project in a workshop situation. Each was fitted with a device and sent out on an hour-long walk of the university and its immediate environs, which includes a hospital and a densely built-up urban environment. While this was happening each student's changing location and level of arousal were sampled every 4 seconds by the device and the data downloaded to a memory chip. This information was then fed into Google Earth and visualized as three-dimensional forms to produce, what Nold calls, an "emotion map" of the area (Fig. 4).

After the students returned from the walk, another phase of the project was instigated whereby students were debriefed and asked to notate and analyze the subsequent visualization of their journeys, e.g. by commenting on how they felt at specific times and locations. This allowed a customization of the function of the work, in which some students tagged the map with subjective commentary while others preferred prosaic descriptions. The "emotion map" was then projected within the gallery space as an aggregate of the tagged walks enabling further group discussion of results to be developed.

These conversations allowed a number of interesting outputs to accrue. For example, consensual interpretive processes allow participants a deeper purchase on ownership of their data. By taking analysis and information-gathering out of the hands of experts, persons normally considered as "subjects" of study are enabled to construct understanding of results

Fig. 4. Christian Nold, *Bio Mapping* project, 2004. (© Christian Nold) Screen shot showing aggregate of routes taken by student participants; peaks of greater height indicate strong physiological arousal.

in any way they see fit. Thus, the work provides an alternative to institutionally directed visualization practices that is rooted in what Nold has described as social or "bottom-up" data gathering [20].

Including the user as an interpretive agent in the work means that its results are ambiguous and deny fixed meanings. The GSR mechanism itself is unable to distinguish between stress and excitement, implying that there is no "result" or "truth" to be discovered; rather *Bio Mapping* engenders an open-ended discursive event whereby meanings emerge from the shared subjective responses of groups of users.

Lucy Kimbell's project *Pindices* (2005) shares some similarities with Nold's project because it actively encourages user participation and is a "socially engaged" work. However, unlike *Bio Mapping*, it is less directly concerned with technological computer visualization, but rather brings together an assemblage of processes in order to measure and make tangible political activity, toward developing wider cultural conceptions of democratic processes.

Existing tools, such as opinion polls, function effectively to show aggregates of public opinion, but are less useful as tools for the representation of individual conduct or belief. The *Pindices* project sought to develop a way in which these normally hidden activities could be tracked, with the aim of developing an expanded conception of what political activity is and how it might be made

visible. Working with sociologist Andrew Barry [21], Kimbell decided not to formulate a prescriptive framework of what it meant to be political, but rather to develop a context within which it would be possible for participants to express what *they* considered it to be, by enabling them to associate specific activities with various forms of public visual display.

Pindices consisted of a number of components: the interdisciplinary research carried out with Andrew Barry described above, a website, a gallery installation and the active input of self-selecting participants. A humble button badge was chosen to operate as both a unit of measurement and a visible demonstration of political preference and was employed in both website and installation versions of the work. The website [22] invited each user to participate in the project by creating and nurturing a "personal political index" (pindex) published as an activity graph that measured his or her political endeavors over a set period. Each pindex could be annotated and was accessible and usable by others, therefore providing a public accounting that encouraged an awareness of the role and prevalence of political acts in participants' lives (Article Frontispiece).

The gallery installation offered a similar way for audiences to identify with political acts, albeit in a different public context and manner (Fig. 5). This part of *Pindices* consisted of 12 clear vinyl tubes, each initially full of different colored badges printed with slogans

derived from the list of activities identified in the initial research phase: "I kept myself informed," "I raised issues," "I signed a petition," amongst others; that is, each tube represented a political act. A dispensing mechanism at the bottom of each allowed visitors to select the badge they felt most empathy with, thus reducing the level of buttons in any particular tube. Simultaneously a visualization and a method for creating data directly, the visible effect of this process was the generation of a dynamic bar chart that made public the personal preferences of its users. However, for Kimbell, "hard results," i.e. the level of badges in specific tubes and their final destination, were of less importance than the effectiveness of the project to generate discourse around what its users considered politically important. Thus framed, the work is explicitly concerned with consciousness-raising, in finding ways and means of threading together technological methods with social processes, in order to enable people to reflect upon the political dimensions of their lives and their capacities to act on individual and collective levels [23].

In his writing since 1980, Frederic Jameson has argued that contemporary Western culture consists of fractured economic and social spheres that result from advanced, technologically driven, capitalist, political and media hegemonies. As a result, these forces produce an illegible, discontinuous reality, its scrambled relations functioning to confuse socioeconomic structures and disperse effective alternative political and cultural developments. In response, Jameson has called for the visual arts to produce pictorial forms, or "cognitive maps," which would both enable the comprehension and orientation of these abstract structures and prototype alternative modes of being and acting in the world [24].

Both *Bio Mapping* and *Pindices* may therefore read as forms of "cognitive map" as envisaged by Jameson, as they make visible hidden social, environmental and political realities by transferring them into comprehensible material forms. They also produce a visualization practice that models a role for the artist/visualizer as an enabling agent, rather than a top-down interlocutor insofar as contexts for participation in information visualization processes are designed that provide ordinary members of the public with ways of grasping, accounting for and investing in their lives.

CLOSING REMARKS

The works discussed in this article highlight some of the ways artists have found to bind scientific visualization processes to cultural activity. It is not my purpose to set these experimental artist-led approaches against scientific visualization, but rather to lay bare useful correspondences and points of interest in order to build upon and extend current understandings of the subject area.

The relationship of these artist-based visualizations to scientific practice (and vice versa) is complex, as the works discussed are cross-disciplinary but do not involve direct collaboration between scientists and artists. While the two disciplines converge in terms of attempting to image invisible phenomena through data visualization, they diverge in terms of the types of knowledge and experiences they seek to create and their attitude toward the image as a locus of meaning. Production processes are also novel and generally bear little resemblance to approaches in the sciences. The featured artists treat visualization processes as a form of creative media capable of functioning in broader aesthetic, critical and historical contexts. They work with an un-

derstanding of the image as a producer of meanings that are often ambiguous or multi-leveled and that produce embodied, affective, sensory experiences that elude rational description and measurement. This approach offers a contrast to scientific visualization, which first and foremost strives for clarity of interpretation in order to service analysis of specific phenomena.

The tension between these different conceptions of the image provokes interesting questions for both subject domains about the limits of representation. If, for the sake of debate, we can broadly characterize understandings of the contemporary image in the arts as being dominated by post-modern debates as imagined by Baudrillard, i.e. a hobbled form (simulacra) incapable of functioning as an enabling agency for comprehension of the real, then what the sciences teach visual artists is that ways of producing images that are anchored to material realities are possible and that data visualization offers a route that enables a reconnection to it [25]. The models of visualization practice produced by these artworks develop a new type of image that consists of objective and subjective, informational and aesthetic components. It operates at the limits of what the image is understood to be in the visual arts. In doing so, these images also expand our understanding of what IV is and what it might be. They show that visual arts can usefully contribute to the ongoing debates in science concerning epistemological issues of objectivity of the image in IV, through the production of models of practice that actively highlight and foreground the role of the general public in data gathering and interpretation of results. In other words, what is normally seen as problematic in scientific IV—i.e. the ability of images produced to contain multi-level meanings—is productively turned to show that images grounded in objective data can be aligned with a more generalized and discursive function in the visual arts as a system that produces affective experience and alternative narratives or perceptions of the world. In such terms

these works set out arguments for a possible wider role for IV as a vehicle for cultural production that shifts its practices to wider areas of attention and is inclusive of different constituencies of users and publics.

References and Notes

Unedited references as provided by author.

1. The term "affect" is complex and is often used in place of "emotion" or "feeling"; when used here it refers to a sensation of embodied intensity generated through an encounter between affecting agencies, i.e. an artwork and audience. Or, as Brian Massumi puts it in his introduction to Deleuze and Guattari's *A Thousand Plateaus,* rather than a personal emotion, affect is "a prepersonal intensity corresponding to the passage from one experiential state of the body to another"—an embodied condition that exists outside of consciousness. See: G. Deleuze and F. Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, London: The Athlone Press, 1996, p. xvi.

2. B.H. McCormick, T.A. DeFanti, and M.D. Brown (eds.) "Visualization in Scientific Computing: Report of the NSF Advisory Panel on Graphics, Image Processing and Workstations," Computer Graphics, 21, No. 6, Nov., 1987.

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6. I. Kallick-Wakker, "Science Icons: The Visualization of Scientific Truths," *Leonardo*, 27, No. 4, 1994, 309–315.

7. Examples of this form of Reinhardt's work are featured on the Silverstein gallery website: "Ad Reinhardt—Art Comics and Satire 1949–1954," <http://www.silversteingallery.com/Pop_Ad.html>.

8. Lombardi's work can be found at the Pierogi gallery website, <http://www.pierogi2000.com/flatfile/lombardi.html>.

9. D. Cox, "What Can an Artist Do for Science: 'Cosmic Voyage' IMAX Film," *Art @ Science*, C. Sommerer and L. Mignonneau (eds.) Springer-Verlag: New York.

10. See for example Vande Moere's blog: "Info Aesthetics," <http://infosthetics.com>.

11. Card et al [4], p. 6.

12. M. Kemp, "From science in art to the art of science," *Nature*, 434, Issue 7031, 2005, 308–309.

13. J.J. van Wijk, "The Value of Visualisation," C. Silva, E. Groeller, & H. Rushmeier (eds.) Proceedings of IEEE Visualization 2005, 2005, 79–86.

14. D. Cox. "Metaphorical Mapping: The Art of Visualisation," *Aesthetic Computing*, P.A. Fishwick (ed), Cambridge, Mass: The MIT Press, 2006, 89–114.

15. J. Elkins, "Art History and Images That Are Not Art," *The Art Bulletin*, 77, No. 4, 1995, p. 553.

16. More information about Corby and Baily's work can be found at <http://www.reconnoitre.net>; documentation of Abigail Reynolds's work can be found at <http://www.abigailreynolds.com>. The version of *Cyclone.soc* exhibited in The Information was a prototype, one of a series of versions of a project that was developed throughout 2006.

17. L. Manovich, *The Anti-Sublime Ideal in Data Art*, August 2002, Manovich, <www.manovich.net/DOCS/data_art.doc> (accessed 16 November 2006).

18. Kallick-Wakker, p.309.

19. Further information about Christian Nold and Lucy Kimbell's work can be found respectively at <http://www.Biomapping.net> and <http://www.lucykimbell.com>.

20. C. Nold, "Christian Nold Ittaca project," Bio Mapping, January 2004, <http://www.Biomapping.net/leaflet.pdf> (accessed 12 March 2006).

21. Dr. Andrew Barry is a member of the School of Geography at the Oxford University Centre for the Environment.

22. The version of *Pindices* shown in The Information did not include the website component of the project. The *Pindices* website no longer exists but documentation may be found at <http://www.lucykimbell.com/pindices/prototype/index.htm>.

23. See Lucy Kimbell's discussion of *Pindices* in "If Networked Art is the Answer: What Is the Question?" in *Network Art: Practices and Positions*, T. Corby (ed) London Routledge, 2005, 154–172.

24. F. Jameson, "Cognitive Mapping," *Marxism and the Interpretation of Culture*, C. Nelson & L Grossberg (eds.) Urbana and Chicago: University of Illinois Press, 347–357.

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Acknowledgments

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