2013

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ABSTRACT

In 1735, Leonard Euler presented a solution to the practical problem of whether a route could be plotted to cross each of seven bridges in Königsberg once. His negative solution used the simplest of mark-making strategies to resolve a conceptual problem. Euler did not actually cross the town's bridges, but used them to resolve questions of connectivity, after which diagrammatic representations can be seen as the restructuring of logical problems to allow for inductive reasoning, for fruitful application beyond theory. But what if such a working graphic has as its target something that is simply incomprehensible? What are the upper limits of the denotational logic of such diagrams? This paper presents a drawing-research project that tests the cognitive advantages of technical graphics by directly engaging with things that cannot be made easier to understand through their use.

Introduction

In describing this portfolio of drawings, and grounding the questions raised by their implementations, I will start by citing the cognitive psychologist William Ittelson, who usefully characterized a mark made as an artefact of human intention as "decoupled" from its real-world source [1]. Ittelson crucially reminds us in the same paper that the "perception of markings is a pragmatic affair enmeshed in a complex of individual, social, and cultural processes, applied to the interpretation of forms that always underdetermine meanings" [2]. The drawing research project discussed here shows the scholar's decoupling to be deeply and perversely problematic when mark and surface are impossible to feel, so to speak, in the hand, and when the thing or relationship being delineated is out of this world. In this paper, I describe a portfolio of three drawings, inscribed onto the sort of troubling contexts where technical graphics are widely used to regulate the under-determination of our readings, to attenuate the oscillations, so to speak, of our lived experience.

I begin by simply describing the conditions of the making of these drawings, each of which adapts the conventions of some well-understood technical drawing system, to interrogate the capacities of these systems for representing ideas that are otherwise extremely difficult (never say impossible) to grasp, in the sense of our normal "2 metres/100 kilos" expectations. I then provide some context in which the reader can consider disciplinary uses of drawing as a practice of thinking, beginning from the abundance of the sketch, which straddles disciplines of art and design in particular, moving to Euler's parsimonious nodes and edges, to anthropological studies at opposite ends of our recorded history, where notations are used to get a working handle on murky or incomplete information. Finally, I address technical and epistemological problems posed by the drawings, all of which belie the smallness of the project's graphical beginnings (Figure 1): a set of humble thumbnails that set this author/artist on the course of a kind of time-space drawing practice with rhetorical dimensions. They are vitally invisible drawings, with referents that are likely impossible to fully recognize, in spite of their illumination by proposed networks of lines of light, inscribed on spaces we can know only in conjecture.

Drawing into space

The first of the three drawings is a topological diagram consisting of a one-second-long laser burst, aimed at the centre of our Milky Way Galaxy. This single line has approximately 300,000 kilometres of length, resulting from a series of questions related to orientation, distance, and other physical matters, in support of an event that will take one second to begin, and something on the order of 25,000 years to complete, assuming a definition for the word "complete" that allows room for the provisional.

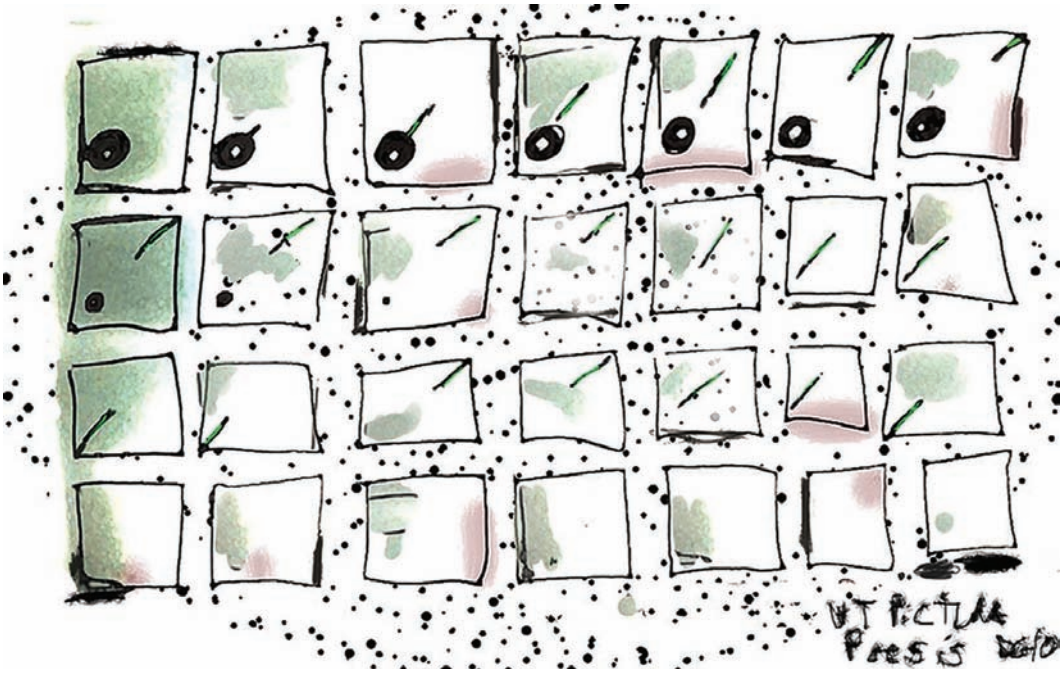

Figure 1. Preparatory sketches for Ut Pictura Poesis. In each of these tiny drawings, LASER is proposed as a kind of pure marking instrument, to draw on the surface of space itself as a support. These thumbnail sketches represent the germination of an idea for a series of drawings that, contrary to the expectations of graphic practices, are essentially invisible. They also epitomize, while obscuring, the capacity for diagrammatic drawing to help us express things that are quite inexpressible by mere thought. Ink on paper, approximately, 3x3 inches each; from the sketchbook of the artist. © 2012 D. Griffin.

The second and much smaller (briefer?) drawing inscribes a network between our small planet, our mote of dust, and the other planetary bodies in our local physical space—a metaphor, really, allowing us to extend our grasp to scales that are otherwise incomprehensible in the scales to which we are accustomed. This quasi-semantic diagram will actually connect us to those seven mythically charged bodies, for a period of time computed from the relative distances between us and them, beginning with the farthest and ending with the closest. This network will ultimately have the absurd property of around 10 billion linear kilometres of length, tied ineluctably to about four hours of active drawing.

The third drawing in the portfolio builds from the professional principles of multi-view orthographic projection, which is an analytical design-drawing method that constrains to sets of parallel views of a proposed object's sides. The multi-plane system, in its normal usage in industrial design, presents its users with a kind of totalized truncation: pictorial, in the sense of showing sets of true shapes and measured spatial relationships, but flattening and denuding them of visual detail, while mounting the inscription on an infinite parallel (indeed, impossible) orthogonal substructure. Reading from such a drawing, a fabricator can make the required

object in accord with the compound needs of designer and client. As written, this rough description also identifies temporal and spatial dimensions, encoded through conventional adaptations: the drawings are spatialized images of distribution, in a time-factored multi-view format. In this final colossal drawing, three bisecting lines drawn through polar points on the planetary scale will form 12 wedges, flaring outward, amounting to another set of absurdities, delivered in the soft fiction of metaphor.

The proposed graphics will have an existence that is actually dubious, qua Drawing, at least from the point of view of consumers of art production. But they will not be any less marks on surfaces than the object of connoisseurship under glass, in a frame, in exhibition on the walls of an art gallery. Further defining our terms, the art theorist John Willats has described a pictorial representation as mapping spaces "out there" to the page, while a diagram maps logical relations [3], but these peculiar drawings—mapping space and time in conjunction—operate somewhere between these two classic categories. They will physically span the dimensions they map in diagrammatic form, at once tracing and creasing, oddly re-coupling Ittelson's mark and surface.

Drawing speculations

I am a visual artist, so the small sketches in Figure 1 provided a sufficiently potent creative spark for the general parameters of this work to emerge. But the history that allows an understanding of the theoretical implications of those little marks began in 1735, when the mathematician Leonard Euler presented a solution to the problem of whether a route could be plotted to cross each of the town of Königsberg's seven bridges only once. Reviewing the town plan in schematic terms, Euler's negative solution showed how the scope of a conceptual problem can be investigated using only points and lines, the simplest of mark-making strategies. The mathematician's method, which manages both largeness and smallness of scales, led to a metonymically driven insight: Euler did not actually cross the bridges, but used them as characters in a denotational scheme, to resolve questions of connectivity, after which diagrammatic representations can be taken as a re-structuring of logical problems to allow for inductive reasoning, for fruitful application beyond the merely theoretical.

This approach to graphical thinking has since become a critical tool in many fields, yielding methods for representing complex processes in the simplified, embodied-metaphorical terms of sequence and proximity. We now recognize that the structural simplicity of such diagrams exploits certain capabilities of the human visual system, displacing difficult logical, memory, and search requirements with a perceptually grounded context for making judgments [4], permitting views of relationships that are otherwise quite difficult to grasp, becoming therefore a kind of interface between intuition and interpretation; the diagram becomes both analysis and argument. More broadly, beyond the system and sequence analysis of nodes and edges, drawing has long been a core component practice for multiple disciplines, each of which benefits from the blended space of seeing, thinking, and making that happens on the page.

A brief review of the capacities of drawing as speculative thinking practice is in order, and the sketch will be our key example. Sketching is a robust research method in creative disciplines, where the user plays with the very tics, hesitations, and flourishes of the act of drawing itself, in a search for salience. The sketch provides a haptic search space useful for conjecture, for testing against experiential knowledge [5, 6], and for provisional re-construction of what researcher Nigel Cross has called design's "ill-defined" problems [7].

But evidence of the speculative spirit of the sketch lingers even in those drawing methods that seek to communicate more explicitly. Two examples of this articulate, speculative use of drawing

intriguingly share a disciplinary motivation (that is, to understand incomplete human stories), even as they bridge extreme ends of our recorded history as a species. First, in the anthropological research of Alexander Marshack [8], the scholar applied the terms "time-factored" and "time-factoring" to describe paleolithic marked artefacts, specifically the figures the researcher traced on bits of bone and stone, seeking their significance as early examples of notation. Marshack's study suggests that the early scribe-scientists who made them were not idly notching or decorating the bone bits, but were in fact drawing temporal sequences, placing marks over time, and in time, and reading relationships within them. Marshack sought to demonstrate that these mark-makers were in fact tracking the moon across the sky [9], using a simple marking system of tilted lines and notches as a proxy for knowledge of a passing thing that could not otherwise be grasped by its witnesses. And at the other end of our recorded history, in the profoundly collaborative practice of stratigraphy [10], archaeologists draw through their dig sites in order to arrive at plausible narratives which could account for those sites, relative to the current state of knowledge, creating spatial/temporal cross-sections directed at the telling of some fragment of larger stories. Wickstead notes that while a collection of photographs might provide more comprehensive documentation, those at work in the field attest to the superiority of drawing for their purpose. Wickstead writes: "We draw contexts" [11], description and interpretation coming together in the laying on of hands, and pencils.

From a review of all of its instrumental uses, it becomes clear to those who study drawing that a primary motivation of the practice is measurement; this insight connects the haptic, emotionally loaded figure-drawing experience, with its loose gesturing between shoulder and paper, to more analytical systems such as projective orthography, or node-link diagrams, or the common music notation, with its oddly spatialized interval-scaling timeline and vertical pitch space. Across the range of my own mongrel artistic practices, I have identified this metric value in acts of representation of relationships between entities and forces, or a purely felt scaling of body to body. Of course, the measurement motivation has its most explicit application in geometrical drawing, suitably defined by the mathematician Felix Klein as working in "a space together with a set of transformations of that space" [12]. Geometric drawing is a visual-mathematical enquiry developed to take a measure of the field of sensible reality as a kind of wireframe accounting of dimension and incidence. The drawing itself enacts the principles it theorizes: "the acts of construction literally can be said to have taken place" [13]. Thus drawing allows inductive responses into the logic of a mathematical problem. Through work performed over external representations, then, our culture has moved from exploring natural principles in terms of location and change, as in Marshack's scribes, to the inscribed networks of computational visualizations, which allow sensate experience of a different kind of system, which is to say, information.

Impractical drawings

So if we take the generalized view of drawing as a vital (because simplest) cognitive assist, then what if a graphic, such as those that have been derived from Euler's ad hoc construction of nodes and edges, has as its target a thing that is simply incomprehensible in terms of the handfuls and footfalls to which we are naturally bound? What if we place node-link graphics in a space where their pragmatism is met by senselessness? The mark-making instrument used in these drawings will be the coherent light of LASER, here used for its linear values (that is, as lines of energy applied to the "geometry" of space itself as support, in a marking-up of unobtainable proportions). Such drawings must have multi-disciplinary entailments: in conversation with cosmological enquiries, they will become graphs writ large, equally measurable (from our earth-bound point of view) in temporal and spatial terms.

Marschack pithily reminds us that "the sky is a calendar" [14], graphically capturing how we have come to use its apparent features for a kind of temporal-spatial codex. Of course the sky is really only a calendar when its features are drawn together by the mind's eye and, moreover, when it is then shown to us by the workings of graphite on some surface. And when those remote features become marks on a surface, they then enter into the call and response of symbolic exchange. We read them as metaphor, recognized in inchoate projections, and they become characters in a scheme. Despite these proposed drawings' essential invisibility, through application onto the tangle of distortions and misunderstandings between what I know and what I do not, or cannot, know, witnesses to their making, in performance, will have an opportunity to examine intuition as a rational response to unreasonable quantities.

At the very least, this portfolio provides experimental frameworks for discourse, but how are we to judge their success or failure as drawings? What is the relationship between such a drawing and its putative object? Entering into more flows of metaphor, where are these drawings? Where exactly is "the centre" of a galactic mass, here and now, and so long from the moment of the line's inscription? How long must each line be in order to form a continuous connection between us and any of our neighbors (a question with at least two correct answers)? What is the significance of an external representation we cannot interact with, not because it is hidden away, but because it is beyond us? Among other things, the very idea of scale and scaling in this portfolio is muddied, possibly beyond measure, and yet we might still seek refuge in a cascade of diagrammatic, numerical, and literary views, at least to make them legible for a mixed audience of artists and scientists.

Finally, leaving aside any earth-bound obstructions (which are considerable, and which must be accounted for in their executions as drawings) we must answer questions about diffusion, or what might interfere with line formation and coherence in those spaces lying between the nodes of their enormous edges. Furthermore, what are the odds of such an occurrence? When and where is there a window of opportunity through which we might connect ourselves to all the planetary bodies on the same evening, for example, opening up the possibility of another conclusion devoutly to be wished: a multi-national, coordinated drawing activity?

Ultimately, this peculiar recoupling of mark and surface may not find resolutions to the problems of their implementation, because if we can know anything in this particular problem space, we know that our bodily measures actually prohibit direct mappings of our experience onto structures at either end of cosmic scales [15]. We are prisoners of this incomprehension, so it is problematic even to apply metaphorical terms to the situation. Yet we also know that drawing practices play key roles in formal systems for recording and understanding relationships, from particle interactions to planetary orbits, to the elbows and hips of the life-drawing studio. Well after Euler's elegance, quantum theories in the physical sciences have presented us with infamously strange questions to be addressed. Crossing bridges, as that mathematician did without doing, is the least of our difficulties in this problem space. Key drawing practices have developed in response to those questions. In the visual modeling of quantum-physical knowledge, for example, Niels Bohr's graphical models posited projective diagrams of atomic motion in an orbital mode [16], while Richard Feynman's diagrams [17], seeking to map probabilities to the page, have proven themselves useful beyond the work in which they had their flush of first successes.

The drawings in this portfolio interrogate the understood cognitive advantages of diagrams [18], inscribing what are surely the largest lines ever made in spaces about which we almost certainly know less than we think, asking after the upper limits of their denotational values. In drawing

them, and seeing them drawn, we are forced to ask if connectivity is always a knowable state, even in the parsimony of diagrammatic reasoning. Seeking more questions, perhaps, than answers, this project offers collaborations between the abundance of artistic drawing and the deductive aims of the geometer. Finally, there is the sweet likelihood that, like the supernatural, otherworldly depictions of Renaissance painters, or even the indexical markings of modernist painting, our current state of knowledge is simply inadequate, which will reveal the project as a mere phantasm of a worldview.

As a fine artist's drawing-research project, reaching around the rhetoric of Euler's graphic insights or the pragmatic productions of design-drawing, seeking knowledge which may not be possible to know, the drawings are marks on surfaces which are equally temporal and spatial. There will need to be a range of consultations undertaken, and, moreover, there must be a pragmatic recognition of impossibility built into this work. This futility I think reflects some measure of the general condition of representation, at least from the perspective of the painter or the poet (I am unable to speak for the cosmologist). Certain of my colleagues have suggested that they are rhetorical drawings, in the bad sense (is there such a sense?). While possibly true, this characterization nevertheless represents vexing questions with intriguingly unstable answers—a condition to which any productive 21st-century art practice aspires. After all, they are not merely rhetorical. They will be drawn in fact, further confounding the meaning of that expression. As external representations with which we can only interact in the plan, they are free of aesthetics insofar as they cannot be directly apprehended, or at least not for long, and they are also free of use: they are not representative, cannot be exchanged, cannot exemplify or denote anything but some view of our own limitations. And, of course, they may be utterly wrong. The project will rely on technical and social interactions and communication, in support of gestures whose existence is equally a matter of time and space, and, moreover, of fantasy as a function.

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