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Out of sight but not out of mind: A diagrammatic conversation on relational drawing

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Abstract

The authors reflect on their ongoing dialogue about connections between drawing in the practice of art and the practice of mathematics. They show how visualising relational connections in mathematical diagrams can be used to contextualise aspects of Heath's drawings. Our account provides a sequence of loops, reflecting on drawings where relational marks coexist with those that are not. Diagrams are the vehicle for this dialogue across the disciplines of art and science, acting as boundary objects, supported by a common visual vocabulary of loops, connections, change over time, negative space and a shared interest in exploring ideas through the physicality of practice.

Loops

A loop can be a journey, traced out in space, that returns to its starting point. Sometimes this 'coming full circle' does not leave the traveller in exactly the same place that they started. Even if the place is the same, time has moved on, and in coming back to a starting point it is neither exactly the same person that left nor exactly the same place they return to. Returning is not in itself a thing that can be pointed at, held, or felt directly through physical sense of touch. This does not diminish the fact of returning, although it does raise the question of how to represent being 'part of' something, having 'the same' thing, 'looking like'.

In conventional life drawing attending to and recording impressions of negative space (the spaces between things), admits relational observations about scale, proportion, size and position into the drawing process [1]. This paper reflects on how one contemporary drawing practitioner experiments with ways of representing relational properties in addition to negative space, allowing these cohabit with properties that are inherently visual and spatial. This paper examines a dialogue informing this, between an artist and mathematician over a period of some 15 years. Here, diagrams acted as boundary objects between two disciplines [2] negotiating the boundaries of the dialogue [3] and drawing out what becomes a common language [4]. Casting Heath as artist and Stell as mathematician is not meant in an exclusive way: during our dialogue Stell studied for a BA in Fine Art (2004—2010), and Heath pursued PhD study in Cognitive Science (2009—2014). Our account provides a sequence of five Loops for the reader to follow the development of the conversation.

Loop 1: Diagramming Granularity, Change, and Connection

We start with Figure 1, where the main image came from thinking about change over time, as developed in [5, 6]. A series of qualitative changes occur and are tracked in the diagram over a series of frames: ring-like darker patches appear; they coalesce into a single patch with two open areas; these two areas merge and enlarge to such an extent that the dark area remains only as a thin ring. Below, we zoom out and small features disappear; open areas are

invisible; only a single blob is visible; and when the dark area becomes a thin ring around a large hole, the ring itself is no-longer seen.

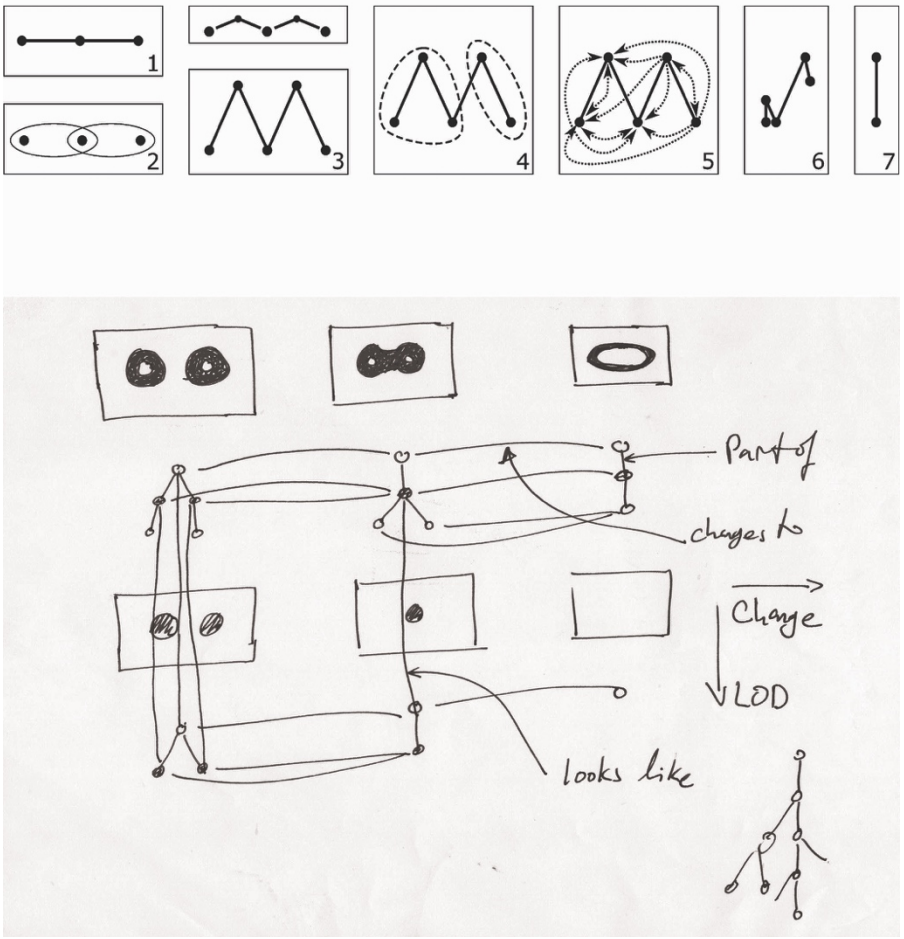

Figure 1: John Stell. Main image (bottom): *Diagram*, hand-drawn by Stell during visit by Heath to Leeds, circa 2007. Here, change over level of detail and over time is explored. Top image (1–7): these show types of diagrammatic grouping, linking, and changing level of detail (please see discussion in text). Copyright the artist.

Quantitative spatial descriptions model spatial phenomena using coordinate locations; qualitative descriptions talk about ‘next to’, ‘alongside’, ‘overlapping’, etc. This still allows computation, as explained by Cohn and Renz [7], and is beginning to be used in the humanities [8]. The qualitative content of the hand-drawn lower image in Figure 1 consists of the linear network linking nodes across the six frames. Three kinds of relational connection are shown: ‘part of’, ‘changes to’, and ‘looks like’. The dark regions would be ‘visual

objects' in the terminology of Anderson et al [9]: 'They may not have material form, but nevertheless they can be visualised' [10]. In contrast, 'nonvisual objects' include: 'the visualisation of statistical data or the visual representation of processes and of relationships between concepts.' Our focus is on the latter, nonvisual mathematical objects, generally relationships between objects. The participating objects may well be visual, such as the dark regions in Figure 1, but our dialogue has concerned the relational.

Stell's mathematical investigations started by playing with language: "Given there are rough sets [11], what should a rough graph be?" and "What does it mean to zoom out from a graph or hypergraph [12]?". Diagrams we shared were not illustrating a theory that had already been formulated, but were a way of thinking about what the theory might be. Drawing diagrams prompted challenges to find rigorous mathematical meaning behind them. The multiplicity of ways of visualising mathematical structures prompted occasional slippages, disruptive connections and mis-readings in this search for meaning and resonance. In the case of looping, there is slippage between i). lines that are travelled along, and ii). lines that lasso and collect things, and such lines alternate between describing visual and nonvisual objects.

Within Figure 1 the sub-diagrams at the top (numbered 1—7) show visualisations of key relational structures. In 1—3, the same three nodes and two edges are drawn in different ways. Sub-diagram 4, from [13], has loops denoting clustering; as shown in 5 by bidirectional arrows, and in 6 by closeness. In [14] Sarah Casey and Gerry Davies discuss diagrams by Stell in the context of drawing in contemporary art.

Loop 2: Split-Views of Plants

At a residency in 2001 at the Centre for Drawing, Wimbledon School of Art in London, Heath collected a variety of plants to draw, followed by an exhibition in the residency studio space [15]. There, Heath experimented with spatial arrangements of drawing surfaces, in one case with two panels set in an L-shape, a potted plant set within the elbow of this shape. He reached over and around the panels to draw out of sight (Figure 2). Moving around to draw from different perspectives, Heath used the size and orientation of the panels to delimit space and marks. Sometimes using two hands to draw simultaneously, at other times passing the drawing tool from one hand to the other as he moved from one board to the next –

interconnecting lightweight lines of different colours indicate where the parts of the subject are seen from different points of view.

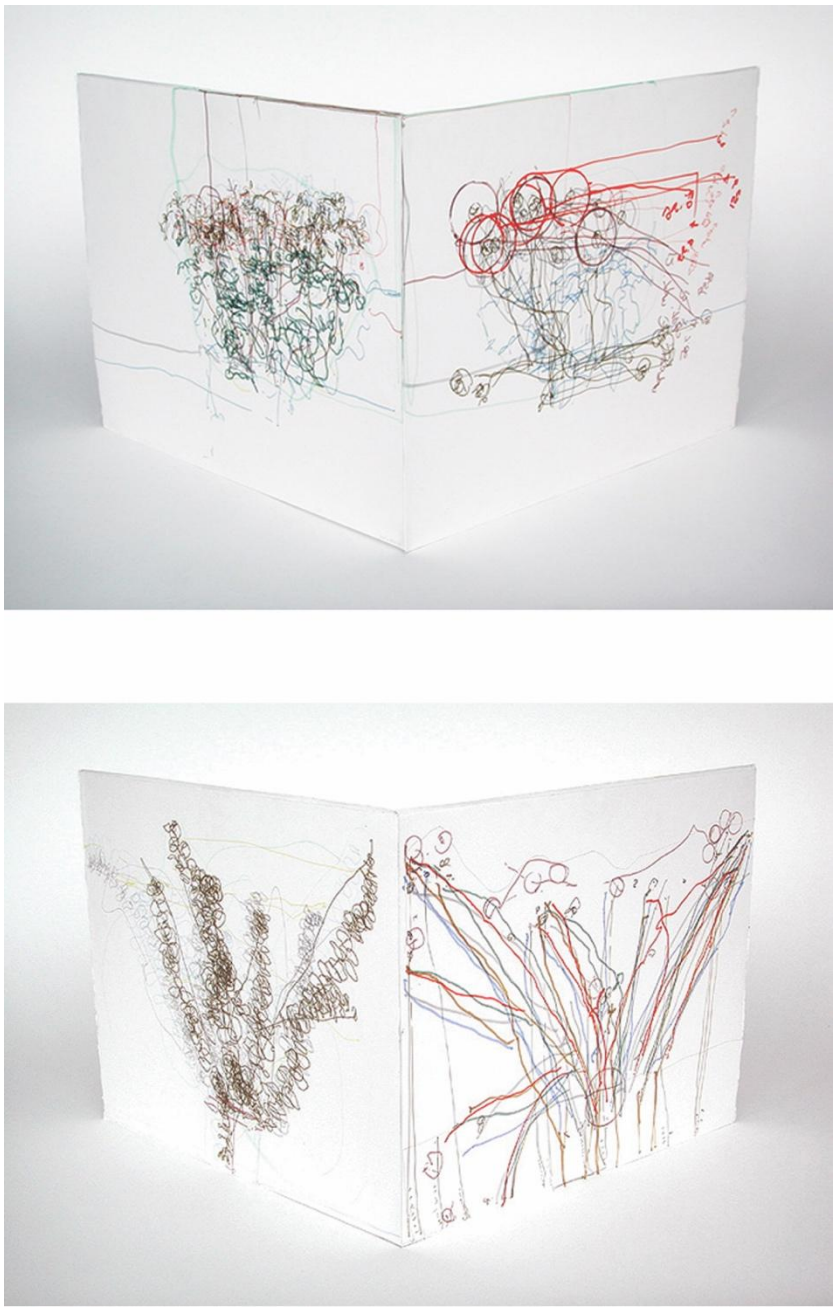

Figure 2: Claude Heath. Top: *Pepper Plant*, 2001. Acrylic ink on paper, mounted on board, on aluminium, two panels, each 45.8 x 56 cms. Bottom: *Eucalyptus*, 2001. Acrylic ink on paper, mounted on board, on aluminium, two panels, each 45.8 x 56 cms. Copyright, the artist.

As with Stell's 'frames' in Figure 1, here each panel is concerned with a different level of detail. The left side drawing focusses on individual stems and leaves, shape and texture. The right side drawing notates patterns of growth and clustering - colour-coded lines and circles indicating relational properties rather than material structure. Together, the two panels build a concept of the subject, carrying both fine and coarse levels of detail. This suggests the possibility of our moving between different levels, all within the single frame of one artwork with two halves, allowing cross-readings to be made. Looking back at Loop 1, we can say that these drawings of plants contain looping marks that group by enclosing, lines that connect, and display a change in level of detail. The plant drawings as seen in Loop 2 predate our dialogue, and understanding these correlations has been one of the outcomes of our conversations.

Loop 3: Stereoscopic Landscapes

During another residency, as the Kettle's Yard Artist Fellow at Cambridge University in 2002—3, Heath worked with material from the Library of Aerial Photography: analogue pairs of photographs taken over landscapes of the UK [16]. One drawing shows Ben Nevis, the tallest mountain in Scotland, a section of peak and valley, partly obscured by cloud (Figure 3). The mirrors of the library stereoscope visually united the two overlapping aerial views, so they appear as a single richly detailed three-dimensional scene. Heath drew again on L-shaped surfaces, this time as he looked through the stereoscope. In the top half, the elevation of the mountain is seen, while the bottom half shows the bird's eye view.

Figure 3: Claude Heath, *Ben Nevis*, 2003. Acrylic inks on triacetate film, 42 x 59.4 cms. Private collection. Drawn in a L-shape arrangement, the folded sheet is mounted flat here. Copyright, the artist.

Between the two halves, two thin roughly parallel vertical lines connect and align the points where the summit and the lowest point on the valley are placed. Broad yellow lines loop around the mountain and up and down the valley, like flight-path markings. In the drawing's lower half, the yellow line forms a complete loop around the summit, one of several

movements activating the empty (negative) spaces around the mountain and in the valley. Each path occurs in both halves but appears differently.

Loop 4: Multidimensional Drawing

At the point where dialogue began, Heath's previous experience with digital multidimensional drawing had been with a 'haptic' digital sculpting system at Edinburgh College of Art from 2004 [17]. Haptics relates to the sense of touch and manipulation of objects, and in this case, devices that provide physical feedback to the user. On our meeting in 2005, the idea of creating a digital non-haptic 3d drawing system was floated – and later realised at Leeds University's School of Computing. On several visits to Leeds between 2005–6 Heath made works on two iterations of the 3D drawing system (Figure 4). Version 1 had a working area of approximately 8 square metres, employing a tethered hand-trigger linked to magnetic sensors to record movements as input to the system. With this Heath drew 'GL8' ('Gold Leaf Primula' eighth iteration) seen here in an overhead view (Figure 4, top). As with Loop 2 (Figure 2), the subject here is a small plant. Relational marks abound in these 3d studies. For example, a number of blue ribboning marks describe the negative spaces around the plant; at the base a large loop circles the drawing, grouping the massed collections of filigree marks above.

Version 2 of the system had a smaller working area of less than one square metre and used a tall hinged haptic arm as input and feedback device, like an Anglepoise lamp. With this version of the system and the smaller working space, Heath created a series of 'logic diagrams', based on Stell's published and unpublished diagrams (Figure 4, Bottom). In a joint effort to use the drawing system to devise relational notations for 3d space, we pursued a common interest in mapping changing levels of detail and changes over time. With both system versions, Heath chose to work closely from source materials while maintaining the physicality of the drawing process, without visual feedback available via a screen.

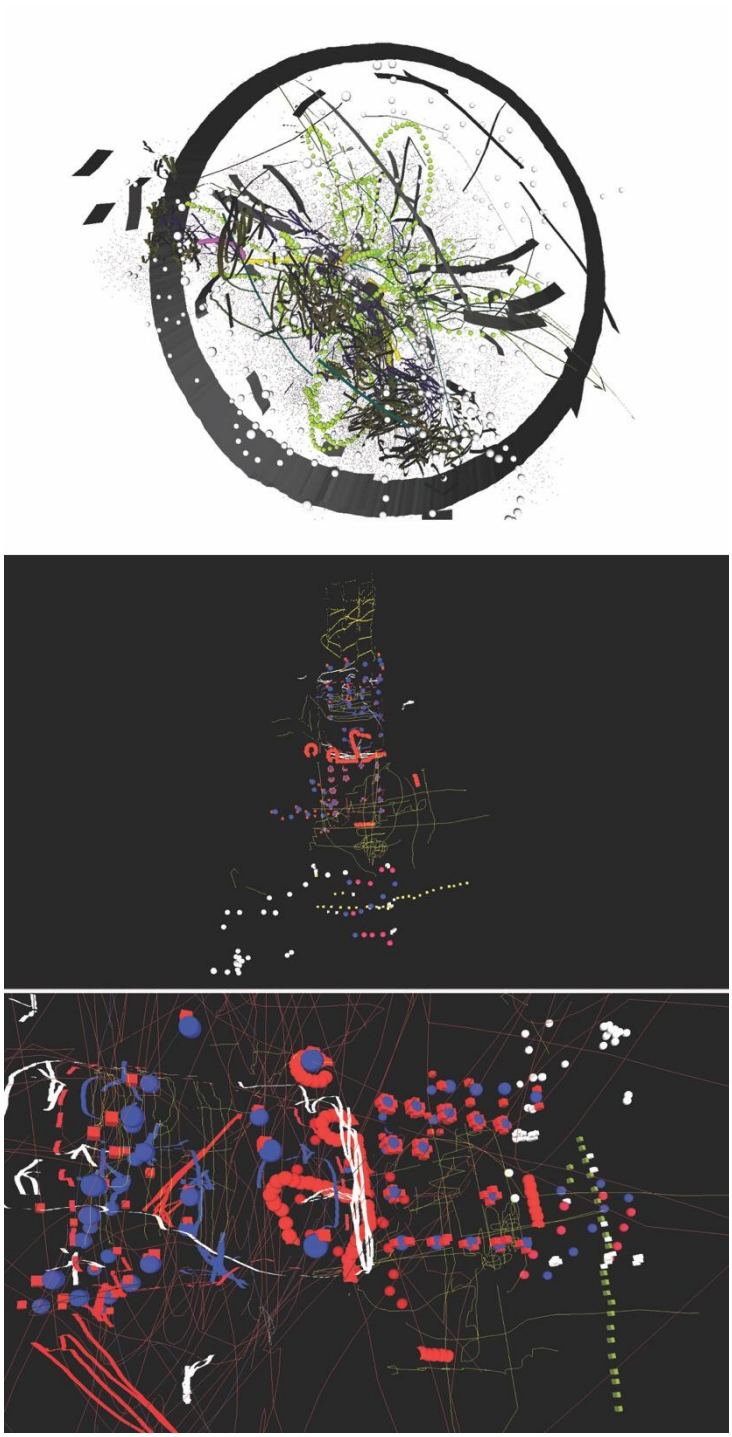

Figure 4: Claude Heath, 3d digital drawings. Top: *GL8 (Gold Leaf Primula, version 8)*, 2005– 6. Bottom: *Logic Diagrams*, 2005–6. Screenshots of 3d drawings made on the Leeds 3d drawing system. Copyright, the artist.

Loop 5: Human Interaction and Negative Space

From 2010— 2014 Heath pursued PhD study in Cognitive Science at Queen Mary, University of London. He analysed video of collaborative design meetings at an architectural practice, in order to understand how space is used as a resource to develop shared understandings. The research proposed a visual methodology for rich visual inscription of 'fields' of shared space, as a response to the 'sparse' character of conventional scientific drawings [18].

Using pens, and gestures onto and above the table-top design plans, paper sheets, and various inscriptions, the architects were seen to enact a series of fleeting gestural models representing their proposed design changes [19]. Heath drew these 'topic spaces' as outlined fields, superposed on the scene (Figure 5, Middle and Bottom). The shape of these fields is determined by a combination of evidence: speech-turns of the architects, use of artefacts, surfaces, sketching, resting hands, posture, gaze, and other qualitative 'boundary phenomena'. This results in a picture of the internal structure of qualitative spaces. In an exploratory but reproducible way, the visual method highlights how the architects displace, extend, and flip 'non-metric' qualitative spaces during design meetings.

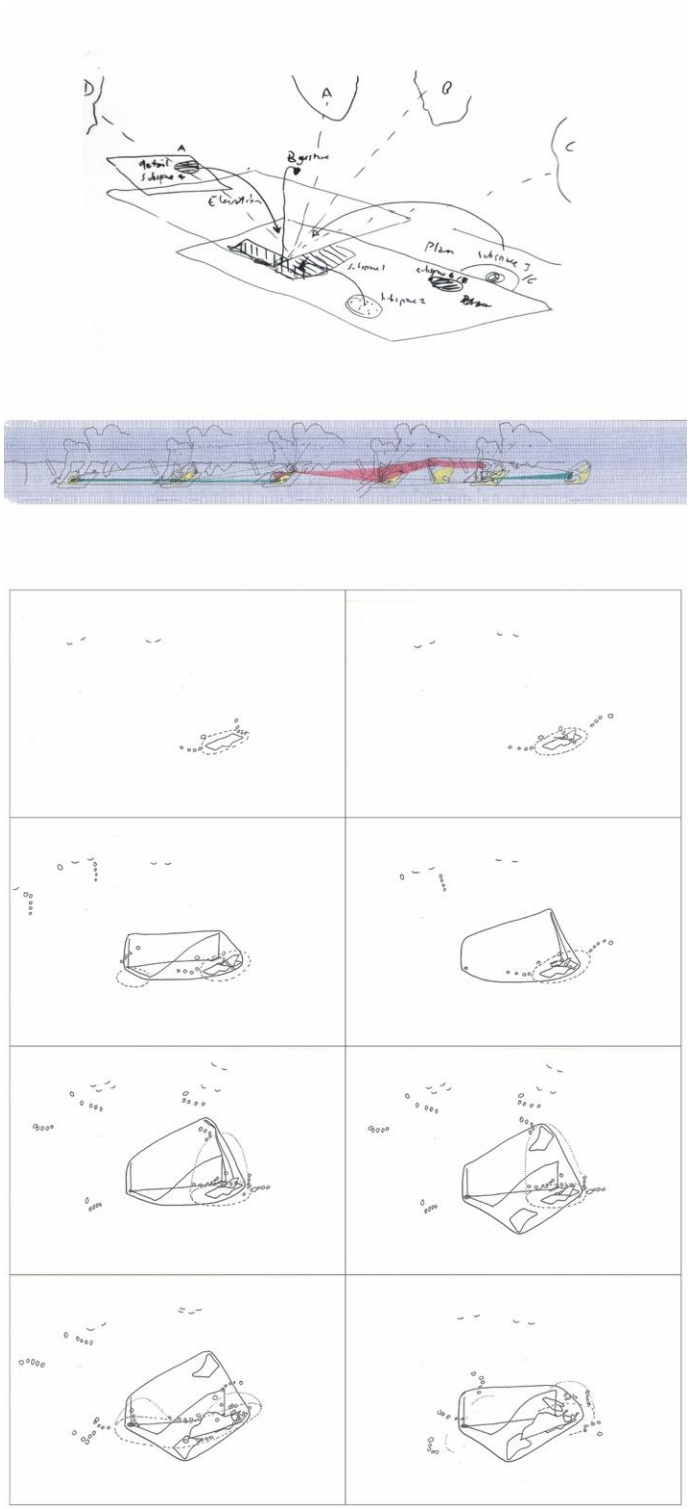

Figure 5: Claude Heath, the evolution of the field inscription method. Top: a first attempt at describing the spaces and sub-spaces in the architects' interaction in video *Clip 1*. Middle: A portion of Clip 1 represented on a strip of graph paper, showing continuities and discontinuities as new fields are referenced in speech and action and then cease to be referred

to. Bottom: a sequence of field inscriptions develops the internal structure of shared space. Copyright, the artist.

Field inscriptions are comparable to manufactured ('fiat') boundaries of human interaction [20, 21], and were stimulated by Stan Allen's notion of 'field condition': 'any formal or spatial matrix capable of unifying diverse elements while respecting the identity of each' [22]. Heath's drawings minimally loop together key phenomena: eyes, fingertips, gestural movement, and the parts of table-top papers being referenced by the architects. With the use of closed loops to group phenomena, and representing different levels of detail and change over time, Heath's human interaction drawings were informed by previous dialogue with Stell. The technique of looping as a means of grouping, as seen in Loops 2, 3, and 4 was built upon in Loop 5 by formalising an interest in notating negative space.

Conclusion

There is a profound requirement to handle complexity and qualitative space in the social sciences and digital humanities. The 'field inscription' approach described in the previous section has shown that it can be adapted to the analysis and representation of participatory research data (Figure 6) [23], and has the potential to support critical approaches [24]. It can also help develop visual analysis tools in ethnomethodology [25].

Collectively, the Loops discussed in this paper make a case for diagramming to be considered part of the physical practice of mathematics, often thought to be incidental to the core of mathematics [26]. To illustrate this point, Figure 7 (Top) juxtaposes Stell's drawing, one of a series created through the physical act of walking, with his diagram analysing a process of qualitative change to boundaries of spatial regions (Figure 7, Bottom). While the line diagram draws relational connections explicitly, this is informed by the experience of discovering connections during the making the walking drawing.

If mathematics can be seen as a partly physical practice, this can account for the shared production of meaning in conceptually 'endowed gesture spaces' [27]. School students speak of feeling physically imbued into the graphs of mathematical functions, advancing their understanding of them as a result, reporting that "you kind of feel like part of the graph,

going up and down", and conceptualise this as 'being the graph' rather than 'seeing the graph' [28]. This sense of embodiment and involvement in a physical process may be compared to a blindfold drawing process, explored by Heath at the outset of his practice as an artist (Figure 8) [29]. Lines loop out and sometimes back to their starting points, with the subject kept out of sight, but not out of reach, and certainly not out of mind.

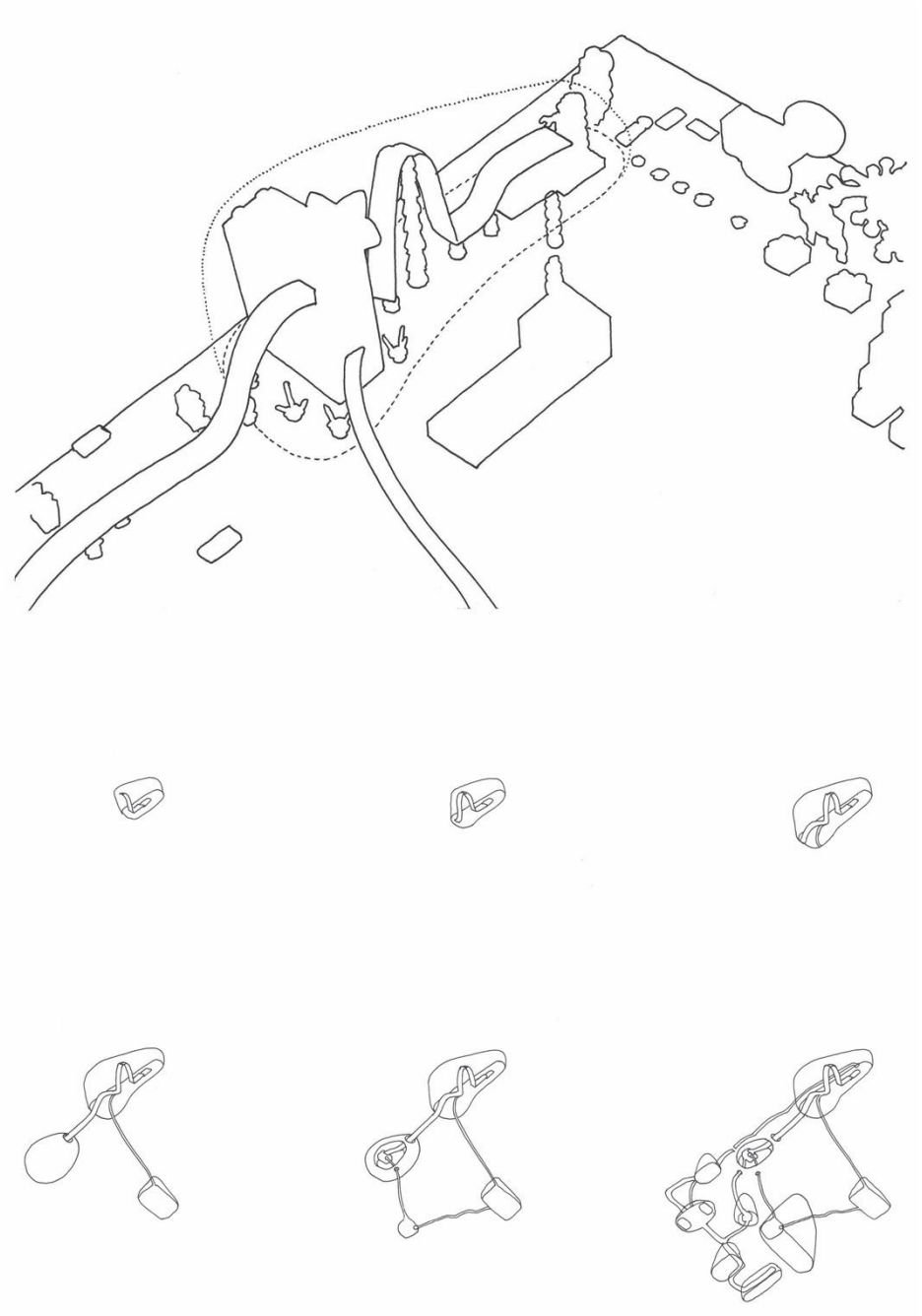

Figure 6: Claude Heath, *IPTV, field inscriptions*. 2014. Top: during workshops Heath and Coles-Kemp provided Lego kits to help participants reframe everyday challenges. This

drawing uses field inscriptions to analyse shared spaces that participants described in the Lego model. Bottom: A sequence of drawings depicting how the model evolved. Copyright, the artist.

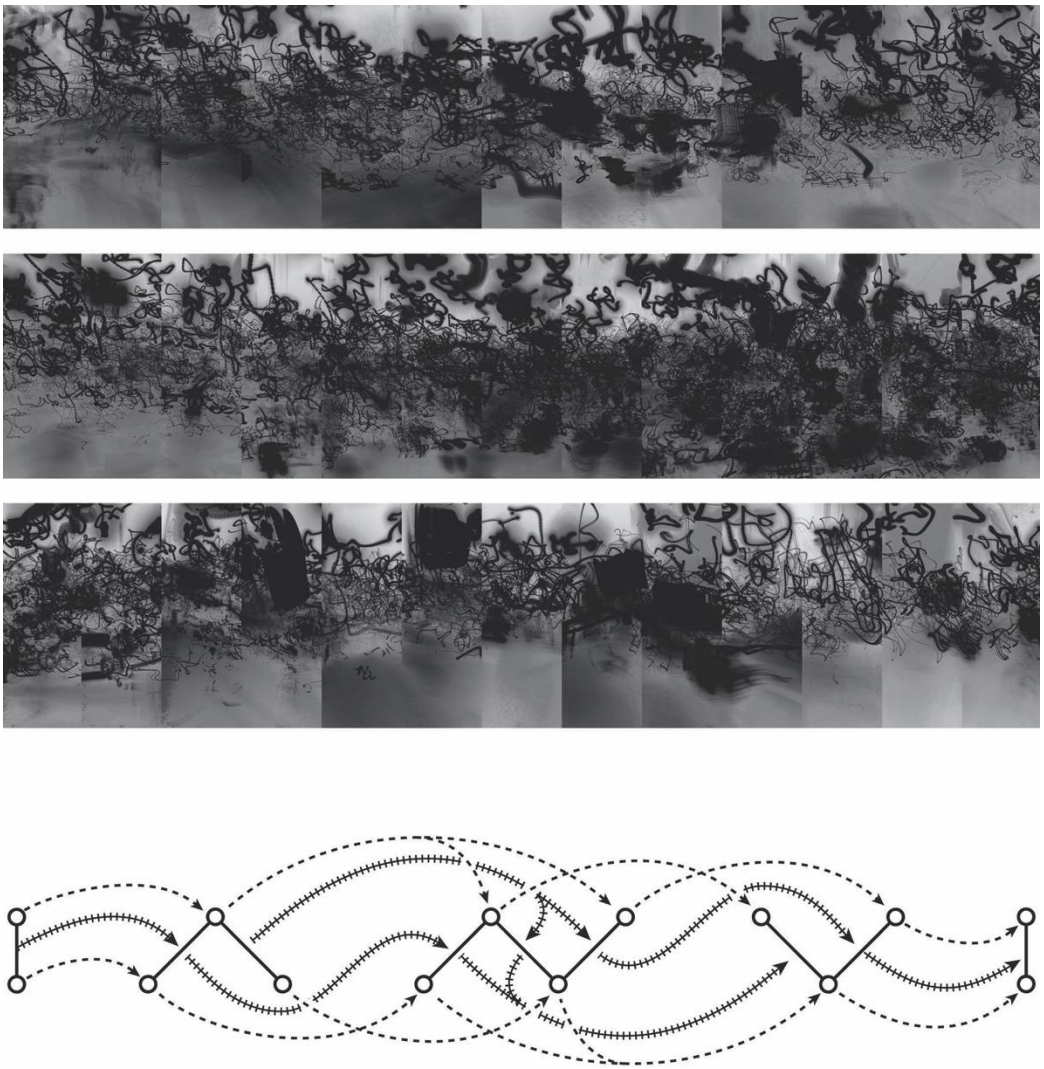

Figure 7: John Stell. Top: *Places 1-39, Bingley, Right hand series*, digital image, 2005. The first half of a drawing produced by repeating the same walk 10 times at dusk and superposing marks collected in approximately the same places on different days. Bottom: A diagram showing sequential change to regions and boundaries [30]. Copyright, the artist.

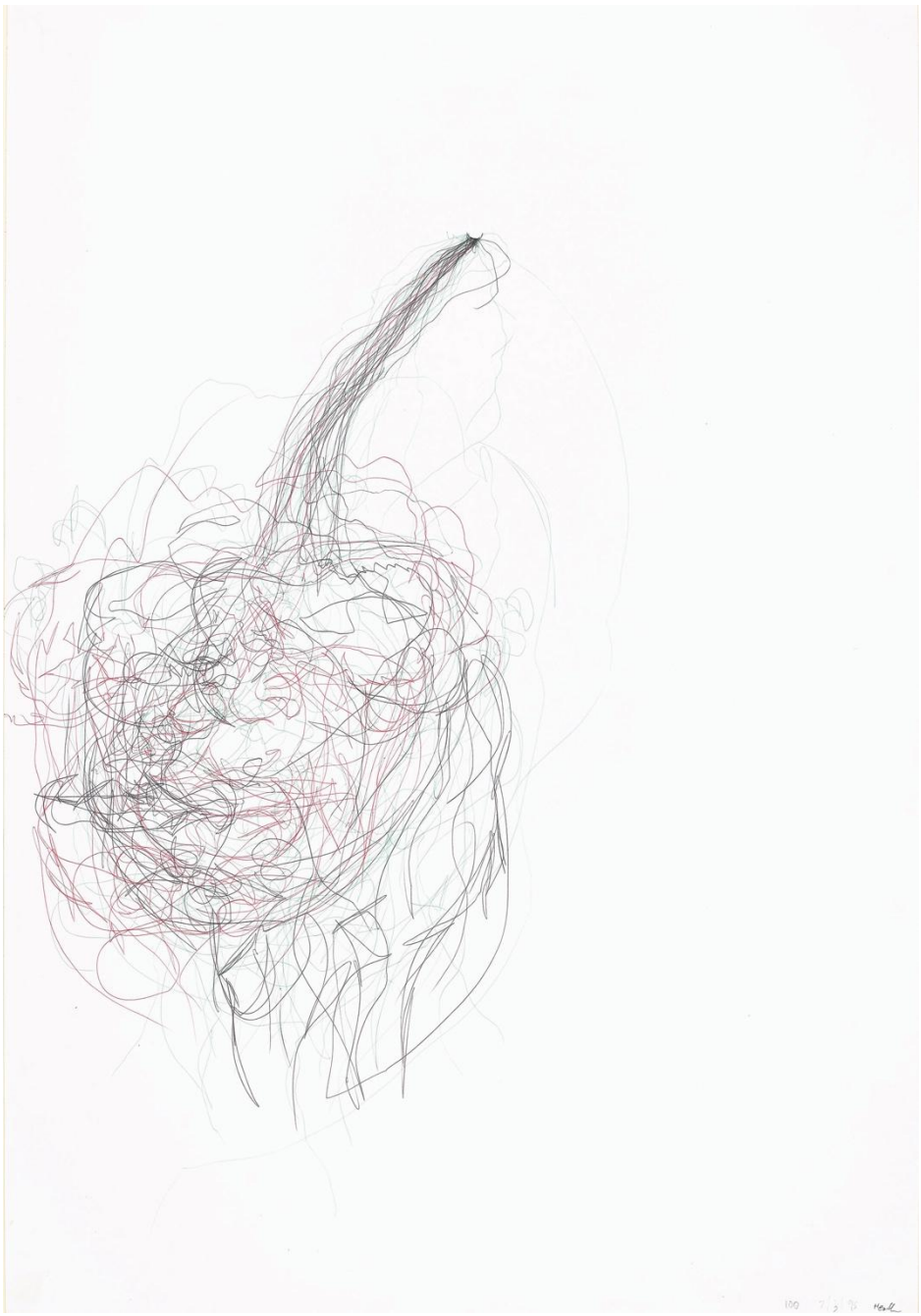

Figure 8: Claude Heath, *Drawing 100*, 1996. Ink on paper, 70 x 100 cms. Part of a series of drawings made over a period of years, where Heath drew objects by touch while blindfolded, using one hand to feel and the other to record his sensations. British Museum. Copyright, the artist.

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Bios

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