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*Critical Review - The Architecture of Error: Matter, Measure and the
Misadventures of Precision, 2014*

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Abstract & Lay Summary: *The Architecture of Error: Matter, Measure and the Misadventures of Precision*

This PhD submission comprises two parts, the above book published in 2014 and its critical review. The latter, rather than transplant the book into the present, looks back to it, across the extraordinary contextual changes of the interval, to its making and reception, from the positions of both the present and 2014. Given the book employs diverse theoretical frameworks relevant to the material it interrogates, the review itself is framework-agnostic and instead is structured via a series of questions and recursive conceits or mirrors. Both the review's (re)contextualisation and framework-agnosticism are elaborated in a foreword that acts as a guide. The review also comprises a summary of the book in question, the abstract of which is below:

Last century witnessed a quantum increase in both effective and surplus precision in all material processes. As architects started to draw bricks to several decimal places, 'precision', an already promiscuous term, no longer simply attended to the control of error, nor even to its longstanding contract with truthfulness. This book asks: What does 'precision' *mean* when it is redundant? What is the price we pay for our use of generative or explanatory models that are made more reductive in order to be (apparently) more precise? What might we learn from an elaboration of error as a productive category?

To address these questions the analysis sets out a latent subtext in the body of architecture's twentieth century discourse: the accelerated unravelling of the relations between precision and error. This takes the form of a critique of the role of precision – itself a complexly imprecise term – in architectural culture, and a claim that behind the architect's now acute fetishisation of redundant precision lies a special fear of physical error. It posits that each of the seminal turns that govern our historiographies of modernity can be understood to have been silently orchestrated by a fear of error. In each, error does not go away but necessarily reconfigures, and in so doing, also reconfigures the architect's ever-precarious relations to material life. Focusing on the key moments of intensification in the material ecologies of architecture's twentieth century, the book examines how the cultivation of surplus precision laid the ground-work for the removal of ornament, the rejection of organic materials, the arrival of 'science' onto the building site, the rhetorical obstacles that blighted early cybernetics, the subsequent 'death' of concept and the digitised operations in which an algorithm arbitrates new form.

The arc of the argument is organized not by the subject's chronology but by its notional topography: we enter and exit at the surface with the drawing's interrogation of precision in chapter 1 and with the substitution of ornament by redundant precision in the closing chapter. Following a second chapter that briefly sets out Aristotle's conflation of error with matter (and not form), the middle chapters take us through the interior of error and precision relations via two key internal systems and their historic ruptures. The first, on materiality (in chapters 3 and 4) is defined technologically; the second, on reproduction (in chapters 5, 6, and 7), culturally. Although segregated, the analysis, if nothing else, demonstrates the inseparability of the technological from the cultural when it comes to error.

At the time of writing many of the questions raised had been neglected in architectural research, however they had been keenly addressed by key voices in adjacent fields: visual art, the histories and philosophies of science, STS, feminist and Gender Studies. Thus the critiques of techno-determinism emerging in STS, Nancy Cartwright's critique of inference and Evelyn Fox Keller's of metaphoric epistemologies are brought to bear on the effect of instrumentalism, inference and metaphoric trading on precision in architecture. Equally, close analysis of the material techniques of several visual artists that maintain alternative economies of error in their practice – Vija Celmins, Barbara Hepworth, Gordon Matta Clark, Rachel Whiteread – illustrates the potential of error as an active, critical category in architectural production. Gordon Matta-Clark understood that precision in architecture is a political question first; surplus precision does serve a purpose, it is just undeclared. At the same time, any endeavour to produce a comprehensive or even coherent theory of error would by definition be a fallacy: error will always evade containment and mutate to escape. What I proposed in this book is an active elaboration of error as a category that acts critically on our relations to redundant or false precision, short-circuits its material interference, undercuts its hold on our practice and imagination, interrogates the mechanisms that install and protect it, and understands it for what it is: an architecture of fear whose politics we must question.

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I am most grateful to ESALA for embarking on their first PhD by Publication with me and to my supervisors for their guidance in its preparation, in particular Prof Mark Dorrian for his ever nuanced, scholarly and patient advice.

Dedication

This thesis is dedicated to the memory of its examiner, Anthony Vidler, posthumously, and with eternal gratitude for all the light that he has shone on architectural education.

A Critical Review of *The Architecture of Error: Mode d'emploi*

Two Contexts:

This critical review by definition engages with two contexts – the years leading up to the publication of *The Architecture of Error: Matter Measure and the Misadventures of Precision* in 2014 and now, 2023. Today we find ourselves in the wake of Fake news, Post-truth and the concomitant rise of populist regimes with their sustained attacks on institutions of democracy; after Black Lives Matter and Occupy and newly alert to the continuing project of whiteness in all its violences; and also after a global pandemic and the not unconnected and long-forecast arrival of a climate that is already changed. To provide an exhaustive list of the profound transformations of this interval, as reflected in architecture's own internal discourses, is impossible here, but I emphasise the following:

- the move from the valorisation of the sole author or 'Starchitect' that prescribes for the user, to that of collective authorship that listens to and works with the user, echoing Donna Haraway's recent call for sympoiesis to replace autopoiesis.¹
- the related refusal of the lingering modernist fetishisation of autonomy and a recognition of its fallacy (a repeated motif in *Error*). This best articulated in new theories of Care (Puig de la Bellacasa) in a politics of interdependence of humans, non-humans, ecologies and their materials that expands and redefines previously instrumentalised and anthropocentric understandings of what is 'sustainable' or 'resilient'. New practices of radical care and repair are effectively countering the smart city, and the precepts of platform and cognitive capitalism (Halpern), while folding in older 'ethical' projects such as Peggy Deamer's work on labour or Mabel Wilson's on 'Who Builds Your Architecture'.²
- the shift from Post-colonial theory (Said, Spivak, Bhabha and Mbembe) to Necropolitics (Mbembe), decolonisation and its inseparability from decarbonisation in extractive capitalism (Vergès, Latour, Iturbe).³

¹ See: Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene*, 2016. A shift signalled in the UK by Assemble's Turner Prize award in 2015 and cemented by Sumayya Vally's incorporation of various migrant communities, their voices and architectural motifs, into her Serpentine pavilion, with its satellite interventions across London, in 2021.

² See: Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More than Human Worlds*, 2017; Orit Halpern & Robert Mitchell, *The Smartness Mandate*, 2022; Peggy Deamer, *Architecture and Labour*, 2020; Mabel Wilson's coalition Who Builds Your Architecture, <http://whobuilds.org/about/>. Both *Error*'s critique of both false constructions of autonomy and its focus on material feedback, requiring longer and slower forms of attention, resonate with and find new articulations in theories of Care.

³ See Edward Said, *Orientalism*, 1978; Gayatri Chakravorty Spivak, 'Can the Subaltern Speak?', 1988; Homi K. Bhabha, *The Location of Culture*, 2004; Achille Mbembe, *On the Postcolony*, 2001; Mbembe, *Necropolitics*, 2019; Françoise Vergès, *Une Féminisme Décolonial*, 2019; Bruno Latour, *Down to Earth: Politics in the new Climatic Regime*, 2018, Elisa Iturbe, 'Architecture and the Death of Carbon Modernity', 2019. A shift exemplified by this year's Venice Biennale, *Laboratory of the Future*, which, while frequently citing of the writings of Audre Lorde and bell hooks, in the works selected manifested an evident awareness of the Whiteness of precision and techno-optimism, not least in Andres Jacques'/Office for Political Innovation's exhibit: *Xholobeni Yards, Titanium and the Planetary Making of Shinness/Dustiness*.

- a move from understanding the category of gender as stable and binary to the ‘dysphoric’ (Preciado) possibilities of post-gender, the non-binary and other forms of the non-confirming body, in addition to the augmented critical prowess of queer theory in all aspects of culture (Preciado, Butler, Halberstam, Ahmed).⁴
- the passage from a Feminism that was, being between waves, stealthy if not near dormant and certainly nostalgic for the fertile bodies of French Feminism (Cixous, Kristeva and Irigaray) and its relations to Deconstruction and Post-Structuralism to one that is a multivalent mantle, enfolding myriad questions of human and non-human social justice, combining the theorists of the three points above (Care, Decolonisation, Gender instability) with the works of Federici, Grosz, Braidotti, Povinelli, Bennett, Laboria Cuboniks and many others.⁵
- from the unchecked ascendancy of techno-rationalist solutionism and optimisation (Schumacher), Big Data and the AI-fed Smart to the newly critical embracing of the sub-optimal, with the arrival of the Imperfect Turn (Halberstam) and Glitch theory (Kelly, Ngai), and the more systemically argued critiques of the fallacies of singular and/or digital solutionism (Easterling, Morozov), and, more concretely practiced, the flourishing developments of adaptive reuse and zero-new-construction (exemplified by Rotor Architects).⁶
- in terms of our instruments and their silent formatting of cognition, from the orthographic consciousness of the architect’s drawing, with its legacy of gesture-mechanised, to the ‘statistical seeing’ of the constantly refreshing real-time electronic image, whose ‘grammatisation/signalisation’ is more akin to a spreadsheet than orthographic drawing (Kittler, Stiegler, May), as the discipline’s prime media have merged with the platforms of cognitive capitalism in which the architect is rendered yet another ‘compulsive consumer’ (Stiegler, Graeber) of machine learning’s predictive analytics – *Revit, BIM, Blox* (Halpern & Mitchell).⁷

⁴ See: Paul B. Preciado, *Dysphoria Mundi*, 2022 and *Can the Monster Speak?*, 2021; Judith Butler, *Gender Trouble*, 1990; J. Halberstam, *In a Queer Time and Place*, 2005 and *The Queer art of Failure*, 2011; Sarah Ahmed, *Queer Phenomenology: Orientations, Objects and Others*, 2006.

⁵ For a further description of contemporary feminism see page 48 and see the ARCH + ‘Contemporary Feminist Spatial Practice’ map ‘ in the Appendix, *Impact Study*, e.iii. For a draft of a less Eurocentric map of feminist spatial practice, an ongoing project led by Bryony Roberts, Abriannah Aiken et al, see here:

<https://www.e-flux.com/architecture/chronograms/506357/feminist-spatial-practices-part-1/>

Both maps mark a clear intent to both prevent future occurrence of the ‘amnesia’ the post-critical period saw and to consolidate and connect feminist productions across space and time. See also the diverse positions of: Silvia Federici, *Caliban and the Witch: Women, the Body and primitive Accumulation*, 2004; Rosi Braidotti, *The Posthuman*, 2013; Elizabeth Povinelli, *Geontologies: A Requiem to Late Liberalism*, 2016; Jane Bennett *Vibrant Matter: a Political Ecology of Things*, 2010; Laboria Cuboniks, *The Xenofeminist Manifesto: a Politics for Alienation*, 2018.

⁶ See: Patrik Schumacher, *The Autopoiesis of Architecture*, Vols 1 & 2, 2011; Jack Halberstam, *The Queer Art of Failure*, 2011; Caleb Kelly, *Cracked Media: The Sound of Malfunction*, 2009; Sianne Ngai: *Ugly Feelings*, 2007; Keller Easterling, *Medium Design: Knowing how to Work the World*, 2021; Evgeny Morozov, *To Save Everything Click Here*, 2014. The repurposing of the ‘negative’ in Glitch theory clearly resonates with the arguments in *Error* and with parallel strategies in Queer theory, such as Sianne Ngai’s *Zany, Cute, Interesting* 2012, and Lauren Berlant’s *Cruel Optimism*, 2011.

⁷ John May, *Architecture. Signal. Image*, 2019; Bernard Stiegler, *Technics and Time 1 & 2, The Age of Disruption: Technology and Madness in Computational Capitalism*, 2019; ‘Relational Ecology and the Digital Pharmakon’, 2012; See also Stiegler’s work with *Ars Industrialis*: <https://arsindustrialis.org/disaffecting-individual-process-psychic-and-collective-disindividuation>; David Graeber, *Bullshit Jobs: A Theory*, 2018; Friedrich A. Kittler, *The Truth of The Technological World: Essays on the Genealogy of Presence*, 2013; Orit Halpern and Robert Mitchell, *The Smartness Mandate*, 2022.

The list is subjective and therefore incomplete, but consciously so in a way that leans towards the optimistic – a far darker one could be written. Suffice to say that the non-discrete nature of all of the above territories means that from their diverse corners, Bernard Stiegler’s madness and disenchantment with loss of individuation and Haraway’s call to enmesh ourselves with our myriad kin in sympoiesis unsurprisingly generates what Preciado describes in *Dysphoria Mundi: Le son du monde qui s’écroule*, as a whole set of organisational categories that are now (and here he invokes Hamlet’s untranslatable) “*out of joint*”: the narrator; time; the body; code; the border; sexual difference; home; the modern subject; breath; the truth; the ground; labour; society; citizenship; reproduction; history. For Preciado this is a source for optimism, a sentiment I share, as “la révolution comme transition épistémique.”⁸ Today, for better or for worse, and unlike 2014, all is newly indistinct in its, at times precarious but hopeful, interdependence and cross-contamination.

Methodology:

Framework:

Given this is the first PhD by publication candidacy at ESALA – itself an honour – there were no precedents to inform the approach. It was important upon commencing to imagine what a critical review could be of a work itself already deemed sufficiently theoretically robust in terms of its own critical framework and scholarship to be accepted for this opportunity. From the outset it was essential for me to remain true to the original work. So rather than apply any external critical framework to revisit a work that itself references several frameworks in order to unpack the interpretive challenges presented by the material in question, and to do so across years that involve such paradigm shifts, I chose instead to consider what it means to write a critical review that does not attempt to transplant the book into the present but rather looks back, over the shoulder as it were, to it, to its making, and to its reception. Part of this thinking was that the review should speak in a different way *to/from/than* the book. Whereas in the latter the tone is authoritative, in the review I explored the freedom to be candid, not assertive, and to articulate the state of doubt that marks our contemporary environmental ‘out of joint-ness’.⁹ That is, by speaking directly to the full messiness of the material, the passage of years and the lived experience they brought.

Thus, rather than employ any particular framework, the review is driven and structured via a series of key questions: What influence has *Error* had? How have the arguments been taken up, or overlooked? What have been the misadventures of this book in its life after publication? How has it directed and inflected my own research and work in education since? Where within the complex and distributed mappings of contemporary feminism is it now situated, if at all?

Certain questions required careful historicising: What was the environment that produced the book? How did I come to write it in the way that I did? What were the external provocations and what were the internal desires or longings regarding the context of my professional life at the time that critically drove its making? Did the book contribute to the dethroning of parametric optimisation and the emergence of the imperfect turn and if so, how? Why was its uptake in feminist theory so minimal at the time – where was feminism in architecture at the time of publication? Whether this was, in part, an unintended consequence of the book’s stealth feminism to enlist better uptake in other areas of architecture, namely computation, or not, was this strategy worth it? And in what quarter of our lives and of my work as an educator now is redundant precision most pernicious, most destructive?

⁸ Preciado, Paul B., *Dysphoria Mundi*, 51

⁹ “I heel to the impressive and authoritative voice that sets the structure”, MIT Press commissioned anonymous review 01 of manuscript. See Appendix *b*, *MIT Press Review*-01,1.

This choice of questions – and there could have been others – was to advance three aims:

- firstly, to uncover and assert the feminist project in *Error*, which had been perhaps overlooked by contemporary readers due to its stealthy and sublimated nature.
- secondly, in so doing, to articulate the feminist project that has continued in all my work since, including that within the realm of computational architecture and history, for the current generation of post-optimisation computational design and digital fabrication researchers.
- and thirdly, to argue that redundant precision now manifest in education systems as the subjecting of everything to measure is impeding the a project to genuinely decarbonise and decolonise the processes of learning: if redundant precision is part of the project of Whiteness, then architectural education, to again ‘transgress’ (hooks), needs to shed itself of its own redundant precisions.¹⁰

Research methods:

Too close and too far

Upon commencement of the writing of this critical review I faced an immediate paradox: I was at once too close to and too far from *The Architecture of Error*. Too close in that how was I to garner critical distance from a text of whose making I was so intimately entangled with? Too far in that in the intervening years the form and content of architecture’s discourses had radically transformed.

To overcome my proximity I sought immediate external views from ‘hard’ and ‘soft’ sources of evidence. ‘Hard’, from a citation search (via engines such as Google Scholar) providing ‘objective’ data, laced with all the arbitrariness that is the signature of such systems: the uncontextualized adjacency of good scholarship to poor, most evident in the repetition of key soundbites from the book (see Appendix, *Impact Study, e.i. – Citations 1-15*). ‘Soft’ evidence took the form of written responses elicited from respected colleagues, invited on the basis that I knew they had – importantly – read the book at the time of its publication and that each commanded expertise in different realms of architectural production (see 40-41 and Appendix, *Impact Study, e.v.- Respondee’s Answers*). Much as I tried to solicit unbiased responses, I knew the ‘subjective’ evidence would vary in kind – the respondees’ replies would differ in approach and not all would be equally engaged. Both (‘hard’ and ‘soft’) complete sets are in the appendix and are footnoted when and where they inform the review. Both sets opened as many questions as they answered, and both are, in their own ways, partial. But together they did, upon reading their combined and very varied reactions, help impart to me the distance needed to separate from the book and be able to reconsider it from my contemporary standpoint.

The review – in order to open up and explore the temporal space of change that it spans – attempts to recreate the vertiginous effect of this too-close-and-yet-too-far by constantly oscillating between the theoretical frameworks and lenses of 2014 and the myriad ones of today. Thus the summary and the review itself employ different temporal structures: while the summary separates the then from the now via the discrete structure of main text and footnotes, the review indiscreetly oscillates between the two eras, as if without friction.

¹⁰ bell hooks, *Teaching to Transgress*, 1994. See also Hughes, Francesca, ‘A School Willing to Take Risks’, joint interview with Lesley Lokko in ‘Where Do We Go From Here?’, *The Architectural Review*, issue 1486 (November 2021) 32-36.

Analysis of Application and Contribution:

Given the non-prescriptive approach of *Error*, and the range of sources or case studies it references and engages with, areas of potential contribution and application are wide ranging, including:

- architecture's instruments and apparatuses and the theorisation of practice processes and methodologies;
- 'error' and 'precision' as theoretical categories in architectural criticism, e.g. in relation to exactitude or the normal;
- 'error' and 'precision' (and 'exactitude') as theoretical categories in archaeology and built heritage conservation;
- 'error' and 'precision' as theoretical categories in art criticism;
- 'error' and 'precision' as theoretical categories in social sciences;
- 'error' and 'precision' as theoretical categories in architectural representation and modelling;
- general theories of failure, glitch theory and the imperfect turn;
- theories of art/architecture relations;
- architectural feminism;
- general architectural criticism in the form of surveys or as applied to single architects e.g. see application to the works of Eladio Dieste, Felix Candela, Sverre Fehn in appendix;
- computational architecture, notably digital fabrication, and questions concerning precision bottlenecks and redundancy and designing with and for uncertainty;
- theories of architecture and history of science/histories of technology;
- precision as a project of Whiteness in decolonisation theories.

From my findings, thus far all but the last have documented direct applications using *Error*. The general nature of these applications is addressed in the review under 'Doubt: Impact as Doubt' on pages 34-38, with evidence in Appendix, *Impact Study, e.i. Citations, 1-15*. Application and contribution in terms of impact as invitations that ultimately pulled my thinking into new areas is addressed throughout the review and evidenced in appendix, *Impact Study, e.ii. Invitations*. In addition, more detailed analysis of contributions to computational architecture is elaborated in the section entitled 'Right Wing Mirror' chapter, pages 42-45. Equivalent detailed analysis to attempt to understand the absence of application in architectural feminism is elaborated in the section entitled 'Left Wing Mirror' chapter, pages 46-51.

The Architecture of Error – A Critical Review

Preface:

In preparing this critical review for consideration for PhD by Research Publications I am acutely aware that here, unlike in a normal Doctoral Thesis, rather than staking a claim to future impact or effect the task is forensic. However, my objective in preparing this review has been to find a way in which to use this essentially reflective endeavour to project. What follows is my attempt to analyse and better understand how the arguments and research contained in *The Architecture of Error*, and their impact, reception and changing relevance to the field have influenced my writing and educating since, and how they continue to define and test my future research. Otherwise put, forgive me for hijacking this critical reflection for my own purposes: to figure out where *The Architecture of Error* came from and where it is going – my own inductive looping across three decades of practice as an architectural educator and theorist.

Introduction:

All error is relational. Being, by definition, that which we did not intend or desire, it is also a cunning antonymous portrait of all our plans and hopes, and their thwarting. As with failure, if we set out to err, we likely won't; error too will only confound our ambitions. It undoes instrumentality; it will not be harnessed, let alone optimised. It does not need to be big to disrupt proceedings; it is the thorn in the side of success. This book concerned itself with material error only, as it attends to the making of architecture, and the lessons that might be drawn from its peripheral disciplines. Although error has different consequences in different disciplinary contexts, all error is networked. And error, like sin, is cumulative. Therefore the threat that material error poses to architecture's many systems – of thought, fabrication, analysis, representation and origination – always far exceeds its humble physical presence; this without necessarily taking on any catastrophic scale. Catastrophe is thus excised from this project; it is a sublime distraction. Although returning to *The Architecture of Error* now, in our era of daily catastrophes, it is hard to hold epic material error at bay as we face the consequences of our more-than-epic mistakes. But, true to the forensic nature of this exercise, I want to return instead to the context of the writing of this book: that of an anti-theory backlash, and the not-unconnected arrival of optimisation's redemptive logics and procedures first to the architecture studio, and then to just about everywhere and everything else. In this alarmingly reductive new paradigm, error was, it seemed to me, our best and possibly only defence.

The context of production:

My writing has always been reactive. The writing of *The Architecture of Error* took place over a period of more than ten years and emerged in response to two contexts. One that preceded it: it is a lament for the abandoning of some of the more fertile seams that had emerged in the 1990s in architectural theory that were thrown out with the anti-theory backlash of the ensuing and very long post-critical decade; in particular the articulations concerning relations to matter by Jennifer Bloomer (prescient figurations of the Feminist and New Materialism to come) but also the embracing of subtler thought that had been long sustained by Catherine Ingraham, Mark Wigley,

K. Michael Hays, Alicia Kennedy, Stan Allen, Sarah Whiting and many others, best encapsulated by *Assemblage*.¹¹ The second context was the present in which I found myself teaching at the Architectural Association (2003-2017), which witnessed the acute rise of techno-determinism in its discourses, manifest most keenly as the parametric optimisation (with its attendant redemptive logics), taking place in the graduate school – DRL, Em.Tech and Landscape Urbanism – but also in several of the diploma studios –not to mention in schools further afield, notably GSAPP, Columbia.¹² Embraced in the design methodologies they employed, no doubt as part of the previously mentioned backlash against what was perceived as the excesses of semiotic inefficiencies, was a form of optimising techno-determinism, now instituted in almost all quarters of life in the form of digital solutionism.¹³ This context forged not only the agenda of my own studio teaching at the time, in Dip 15 with its counter-focus of indeterminacy, a-functionality, and what we termed ‘hypercontexts’ (complex, qualitative readings of the physical and non-physical context that defied being reduced to a few quantitative-only parameters), but also my teaching in the diploma school History and Theory seminars, then run by the late Mark Cousins.¹⁴ The content of *The Architecture of Error*, its various drafts and their argumentation and research, were developed and refined in discussion with the Masters’ History and Theory students in the form of seminars given in three iterations: 2003, 2006, and 2010. Like every teacher that brings their research to the classroom, I owe these students more than they know. Their questions, confusions, reformulations and insights fed the project with each iteration, pushing it to the next step. Equally, though we only discussed its content once or twice, Cousins’ serial invitation to teach *Error*’s next and hopefully sharper draft effectively honed the project. It implicitly had his scrutiny and blessing and I am in his eternal debt for this and for being my intellectual compass over the decades. During *Error*’s long writing I was reassured by a dear colleague that if a book does not take at least ten years to write, it likely will not outlive the shelf life of its own long production, rendering it likely not worth writing in the first place. This book was *slow*; for numerous reasons, not least two children and hundreds of students. During its very long shelf-life-of-becoming it mutated, as real research does, as it tried to figure out what its central motif really needed to be – Matter or Measure? Ultimately Aristotle’s *Metaphysics* provided the Nabokov-like knight’s move to error – as an agent of matter, which unlike matter, we can see, can represent, can measure. In betraying matter’s presence, only error allows us to make vicarious contact with matter, itself, by definition, outside of representation and thus ‘unreachable.’¹⁵

Subtended Authors/Subtended Books:

“In the process of writing I found that I could best discover my insights about the logic of civilised man by going underneath logic, that is by writing associatively, and thus enlisting my intuition, or uncivilised self.”

Susan Griffin, *Woman and Nature: The Roaring Inside Her*, 1978

¹¹ *Assemblage: a Critical Journal of Architecture and Design Culture*, 1986-2000, published by MIT Press.

¹² Key proponents in the school at the time were: in the graduate school – Brett Steele, Patrick Schumacher, Theo Spyropoulos, Michael Wienstock, Michael Hensel, Ciro Najle and Eva Castro; and in the Diploma school – Dip 1 Charles Tashima & Mirco Becker, Dip 4 Achim Menges and Michael Hensel, Dip 6 Sam Jacoby and Chris Lee, Dip 11 Eva Castro (again) and Holger Kehne, and Dip 14 Ciro Najle and Hanif Kara.

¹³ Digital solutionism is big data deployed as the quick fix that eternally postpones addressing the root causes of a problem while systematically rejecting political alternatives.

¹⁴ See Francesca Hughes, *Drawings That Count* (London: AA Publications, 2013). Diploma unit 15 was taught with Rita Lambert 2004-2006 and with Noam Andrews 2007-2010.

¹⁵ I say ‘only’, but of course gravity also betrays matter’s presence. Hence Jennifer Bloomer’s work on the gravid. See Left-wing Mirror section below.

In revisiting the book's making, a strange auto-archaeology of sorts, I am reminded of how it is suspended between what I had written before and what I have written since, and, more importantly, what I had read before and what I have read since. I had read *Woman and Nature* in 1989. Some ten years before I started to think about what was to become *Error* with the birth of my daughter, Griffin had sent me down the track of matter. Labour surfaced my uncivilised self which I promptly put to use. By the time I had time to really start writing the book, I was, to paraphrase Claire-Louise Bennet in *Checkout 19*, subtended between the books I had read before and the books I was yet to read: I had read Ann Bergren and Milton and Jennifer Bloomer (her every written word, repeatedly) but was yet to read Jane Bennett and Paul B. Preciado and Sara Ahmed, and also, lesser known writers I came across while more recently running an architecture school in Australia.¹⁶ Notably Kim Mahood's critique of the Western construction of autonomy and subject superimposed on indigenous ways of knowing that echoes with *Error*'s closing call for intimate distance. Mahood quotes Anne Carson:

“The senses are open to the environment, absorbing the messages it carries from the human and non-human world. In oral cultures, the human self is not differentiated from the environment, or from other humans in the way that literate cultures have evolved. ‘To close off the senses would be counterproductive to life and thought,’ she [Carson] writes. In the Western world, somewhere between the emergence of the alphabet, the development of agriculture, and the invention of lyric poetry, writing harnessed the seduction of story, broke it down into words constructed from vowels and consonants, and organised the words into lines of text. And somewhere in this process, humans also developed edges. The ‘I’ stepped out from the cluster of sounds, capitalised itself, and spoke back to the mind that wrote it. Thus began the conversation with the self, and with it the process of increasing individuation, introspection, and self-awareness. As the solitary act of writing replaced the shared experience of memorising as a means of passing on knowledge, the concept of loneliness entered the human vocabulary.”¹⁷

Closing off the senses is precisely what the machine of thought did. The matter we inherited and the configuration of lonely relations that now organise our encounters with it is a logical extension of the paradoxical blindness of the Enlightenment legacy:

“The corollary of this calculable natural world was not, as one might have expected, a determinism that renders human agency an illusion but a sense of mastery bequeathed to the thinking subject: the cogito (I think) that Descartes identified as ontologically other than matter. In distinction from the passivity of matter, modern philosophy has variously portrayed humans as rational, self-aware, free, and self-moving agents. Such subjects are not only deemed capable of making sense of nature by measuring and classifying it from a distance but are also aided in such a quest by theories whose application enables them to manipulate and reconfigure matter on an unprecedented scale. The Cartesian – Newtonian understanding of matter thereby yields a conceptual and practical domination of nature as well as a specifically modern attitude or ethos of subjectivist potency.”¹⁸

¹⁶ Claire-Louise Bennett, *Checkout 19* (London: Jonathan Cape, 2021).

¹⁷ Kim Mahood, *Wandering with Intent* (Melbourne: Scribe, 2022), 5-6.

¹⁸ Diana Coole & Samantha Frost eds., *New Materialisms: Ontology, Agency and Politics* (Durham, Duke University Press, 2010), 8.

Continuing the chain of before-and-afters, the arguments in this book are similarly subtended between those addressed in an earlier book, *The Architect: Reconstructing her Practice*, 1996, and those in the later *Architectures of Prediction*, 2019, itself a rehearsal for my current book, *The Architect's Computer: Indiscrete Histories of Architecture's Universal Discrete Machine*.¹⁹ Throughout, there is a feminist critique of the harm of reductive abstraction, of the violence that underpins its claim to autonomy, of the *loneliness* it installs in our actions. This takes various forms: a critique of the division of the theory from practice, and the personal from the professional, in *The Architect: Reconstructing her Practice*; of the reductive superficiality in architecture's use of computation (notably the combination of parametric optimisation with the hyperreal render) in *Drawings that Count* (AA Publications, 2013); of the fear and fetishisation that organise architecture's relations to material error and redundant precision, respectively, in *The Architecture of Error: Matter, Measure and the Misadventures of Precision* (MIT Press, 2014); and of the colonising of architecture's futures by systems of prediction in *Architectures of Prediction* (ARQ docs, 2019). Each project is a response to an absence in the previous. In *The Architect: Reconstructing her Practice* I realised only upon becoming a mother myself that not one of the all-female contributors had mentioned (felt able to mention?) their own corporeal reproductions. This despite many of them being mothers. Despite also the currency in theory circles at the time of the work of the late Ann Bergren on the shape-shifting fertility of Metis and how the troping of the feminine in architectural culture makes a "paralysing quagmire" for any woman that makes objects, buildings or babies.²⁰ This absence, once noted, could not be ignored, triggering my ensuing crisis regarding form and matter and the measure of volume set out in *Error's* preface.²¹ An equivalent absence drives my current project: in focusing on error I felt myself continuously pushing away its foil: architecture's entanglement in the longer history of the ultimate project of correction – computation.

Lastly, I am also reminded, of another remark by the same dear slow-book friend, that like him, I too am always writing the same book: different titles, different topics even, but ever the same preoccupations. However much each book can be cast as a reaction to a deemed lack in the previous, it is clear that I am always writing the same critique of abstraction and its abuses, sometimes more explicitly feminist, sometimes less, it powers the work; it remains.

Constellations: Related Texts

Like all books, *Error*, externally, sits in a growing and shape-shifting configuration of texts with which it shares affinities, road-maps and allegiances. Outside of the texts upon which the

¹⁹ See Francesca Hughes ed. *The Architect: Reconstructing her Practice*, (Cambridge: MIT Press, 1996) and Francesca Hughes, *Architectures of Prediction* (Santiago: ARQ Docs, 2019).

²⁰ Bloomer's term. See Jennifer Bloomer, 'Architecture and the Feminine: Mop-Up Work', *ANY* 4 (January/February 1994), guest edited by Bloomer, 8-11, 11; and Anne Bergren, 'Dear Jennifer', 12-15.

²¹ "Something about being pregnant crucially disrupted my faith in precision, in the stability of relations it assumes between the measured and the measurer, between matter and form. My doubt centred itself around the question of material error in the production of architecture. The finer pen was a crutch, it could no more shelter me from the lumpiness of those walls than can the enormous computational capacity we now bring to bear on material... So what of the architect who happens to one day become building material, a mother-to-be? A crudely literal point, yes. But the leverage of the literal, tasteless as it can be, is not to be underestimated. Such an architect may (or may not) face a crisis in her material relations: she who is accustomed to taking control of form-making that is remote, outside of her own material self (her body), finds suddenly that form is being made outside of her control and inside of her body; and, worse still, that she is the material. That this realization disrupted my relations not to my own body (nor to the institution of motherhood) but to the institutions of architecture is telling." Francesca Hughes, *The Architecture of Error*, ix-x.

book leans heavily and frequently cites – the writings of Evelyn Fox Keller and Nancy Cartwright for instance – the project of *Error* has several important fellow travellers (see full list as item *a.* in the appendix). Each plays a different role, of greater and lesser significance, in my ongoing thinking. Amongst them, some act as formal models: revisionist histories that address other obsessions of modernism, such as Mark Wigley’s *White Walls: Designer Dresses (1995)* and Francisco Diaz’ *Patologías Contemporáneas: ensayos de arquitectura tras la crisis de 2008 (2019)*. Both of which rehearse arguments that reveal how such obsessions are always networked via what they commonly suppress – the desire for whiteness is related to precision’s ornamental role and the phenomena of OCD, addressed by Diaz, is clearly a consequence of the fetishisation of precision. Other texts have oblique relations to *Error* via shared sensibilities to matter and its agency: most obviously *Vibrant Matter: A Political Ecology of Things*, Jane Bennett (2010) and *New Materialisms*, D. Coole & S. Frost eds. (2010) and, disparate as it may seem, *Emergence*, Steven Johnson (2001). The relations to Jennifer Bloomer’s scholarship, expanded at length in ‘Left-wing Mirror’ below, fuses this sympathy with a shared feminist project for architecture. Then there are the many texts that deal with the idea of accuracy, both from inside the discipline and from STS and history of science: M. Norton Wise ed.’s foundational *The Values of Precision*, (1995); *Standards and Their Stories*, M. Lampland & S. Star (2009); and a more recent flurry of publications – *Exactly*, Simon Winchester (2018); *Certainty, Ambiguity and Deviation*, Mhairi McVicar (2019) and *Exactitude: Precision in Architecture*, P. Riahi & L. Davis eds.(2022 and to which I contributed a chapter). Lastly, *Error* features in a recent survey of the history of *techne* in architecture (*l’art de bien bastir, fabrica e ratio, Baukunst*) which ties its analysis to the long history of the theorisation of making – Franca Trubiano’s *Building Theories: Architecture as the Art of Building (2023)*.

In another category are texts that similarly approach architecture’s lacunae: *Industries of Architecture*, Lloyd-Thomas et al. (2015); the recent interest in architecture’s own technical methodologies, best exemplified by *Design Technics: Archaeologies of Architectural Practice*, Z.Ç. Alexander & J. May eds. (2020); and *Maintenance Architecture*, Hilary Sample (2016), this latter from a similarly embedded feminist standpoint. Of texts that address the idea of erroneous productions, *Error* is notionally subtended between: *Failure*, L. Le Feuvre ed. (2010) which is focused on art practice; *The Queer Art of Failure*, Judith Halberstam (2011) which opens *Error*’s connections to Queer theory; the *Perspecta* issue on *Error* (2013), and more obliquely, *Architecture Depends*, Jeremy Till, (2013), in its debunking of the architect’s control and its all for tolerance. However, from my present perspective, *Error* maintains strongest ‘kinship of spirit’ with Easterling’s critique of techno-solutionism, and her call for wily and sly tactics to outwit its bombast, as expounded in the closing chapters of *Extrastatecraft* (2014) and more recently in *Medium Design: Knowing How to Work the World* (2021).

Full Summary

This review is necessarily gifted with and cursed by hindsight. Multiple dilemmas result from this: should the summary be written from the point of view of then, or the point of view of now? If the former, as I have here chosen to do, then it sits in a very different paradigm from this reflection. If the reflection is smug in its knowledge of what was to follow – for hindsight is often smug – then how might we invert this thinking? Could we ask how the past might have better or differently understood this present, the conditions we are immersed in now, than we currently do?

The summary below is written from the point of view of the then-present of 2012, when the manuscript was submitted for publication. Its footnotes however are written from the point of view of now.

The Premise and Argument:

When Robert Hooke first peered down the microscope at the needle point of his compass his reaction to the misshapen, blunt nub he saw was one of unmistakable, visceral horror. Though well acquainted with the (newly magnified) monstrous productions of nature, the architect in Hooke was deeply unnerved by this corruption of his instrument of precision. *The Architecture of Error* argues that the architect has long reserved a special fear for physical error. Only this can explain the fetishisation of precision that pervaded twentieth century architectural culture, and the gross margin of redundant precision – masonry walls now drawn to six decimal places with software designed to cut lenses or map brain tumours – daily underwritten by its practices.²² The constitution of error within architecture’s psyche and the fortification by precision deployed against it together make up a complex material, spatial, legal and cultural system: this ‘architecture’ is the object of this critique.

Behind the complex historiographies of the twentieth century that organise our relations to modernity —*materials got more honest, ornament was removed, solid became ephemeral, the closed plan opened, walls got whiter, linearity delivered the uniformity of mass production* — may lie a much simpler formula. As well as getting smoother, whiter, more transparent and more ephemeral, things just got more and more precise as the century ran its course. So exponentially precise, in fact, that in its surplus existence, ‘precision’ in architectural culture broke away from error mitigation, from veracity even, and became something else altogether. The argument posits that precision is yet another “unspoken obsession” of modernism “preserved by multiple institutional practices.”²³

The rise of precision and, by implication, its control of error, shadowed the dominant narratives that join the removal of (error-concealing) ornament at one end of the century to digitalised fabrication at the other.²⁴ The parallel rise of surplus precision rendered the economy between precision deployed and error controlled dysfunctional to the point of crisis. This book is an attempt to navigate this new landscape, and to map the unravelling of a logic on which so much once apparently hung. What has precision now become? How are we to understand it outside of its duty to exclude error, and potentially uncoupled from its contract with truthfulness?²⁵ And, given this, what is the newly reconfigured space of error? Precision, already a promiscuous term, no longer does what it says on the tin. Meanwhile error, and the always-political space of its dissent, has reconfigured, unobserved.

Symptomatic excess: The Precise and the Apparently Precise

As architects, the wall drawn to several decimal places remains an extraordinary methodological absurdity that, nonetheless, strangely does not seem to embarrass us. Quite the contrary—we exult in its exactitude, we ignore the false economy it exposes. Given the degree of precision employed likely far exceeds what is needed, or could ever be enforced, how then are we to understand the ‘function’ of redundant precision in architectural reproduction? Like other excess productions we know it is

²² Now to 16 decimal places. The current apparently asymptotic relations between a building and its digital alias (in BIM for example) are on the verge of presenting us with the ontological paradox that Jorge Luis Borges’ story of the 1:1 map of the world described in 1946. ‘On exactitude in Science’, *Collected Fictions*, trans Andrew Hurley (London, Penguin, 1998).

²³ Mark Wigley, *White Walls, Designer Dresses: The Fashioning of Modern Architecture*, (Cambridge MA: MIT Press, 2001), xv.

²⁴ It is curious to reflect now how much of digital fabrication’s development of its nascent syntax has been precisely through the routing or printing of not optimised joints but of ornament, most notably the work on the digital grotesque by Michael Hansmeyer and Benjamin Dillenburger, ETH. Even when the printed object is larger, at the scale of a pavilion and not a vase, it is neurotically haunted by ornament.

²⁵ Given truthfulness itself has unravelled during the interval, I could not write this sentence now with the same naiveté

symptomatic, but of what exactly? What are the mechanisms that drive this excess? And how does this new excess relate to the traditional occupier of the surface site of fetishised excess – ornament?

The ensuing analysis argues that the fetishisation of the apparently precise in architectural culture testifies to a set of relations that are anything but practical or transparent, and that the complex hold the discipline reserves for the category of error directs these relations. Once we choose to recognize the gross margin of redundant precision that makes up this architecture of anxiety (and the fear of error it barely conceals), not only can we no longer help but see it, but the logic of the architect's fetishisation of precision and the compensatory mechanisms amassed to manage this fear also start to reveal themselves.

While architects may be fearful of error we also (claim to) reject redundancy. Clearly, redundant precision does not count within this economy. A whole gamut of strategies for excluding material error lie instituted in architectural practice: The assigned margins for error, tolerance and material failure thresholds, or relevant standards and specifications simply deliver and enforce, at a systemic level, the various deeper strategies of inference and (that wonderful oxymoron) 'accurate approximation' at work. Add to this the ideological weighting and epistemic models, mostly imported from other fields, that we employ to ensure that any error that gets through is effectively neutralized. Put together, these defences also constitute an exquisite, encrypted portrait of the architect's anxieties about the unconsummated act of building (always done, when done, by others) and the necessarily remote relations this installs, about authorship and the dangerous fertility of material reproduction, and about the scientific method *manqué* that is the 'laboratory' of design and its 'experiments.'²⁶

Establishing a distinction between 'practicable' and 'redundant' precision, the chapters in this book construct a critique of the ever-increasing fetishisation of the 'apparently precise' in architectural culture. In so doing, they unpack the complex set of relations that organise the key categories at play: 'precision', 'error' (avatars for/referencing form and matter respectively), but also the construction of 'tolerance' and 'materiality' so central to architectural production.

Aims and Objectives:

To propose a comprehensive or even coherent theory of error would, by definition, be a fallacy: it is in the nature of error to evade containment, to mutate in order to escape. What the *Architecture of Error* proposes is an active elaboration of error as a category that acts critically on our relations to redundant or false precision, short-circuits its material interference, undercuts its turgid hold on our practice and imagination, and understands it for what it is: an architecture of fear whose politics we must question. It follows too that any elaboration of error is necessarily a critique of the politics whose 'interests' the powers of precision is in service to.

²⁶ While the metaphor of the laboratory continues to plague architecture (this year's Biennale is entitled *The Laboratory of the Future*, an impossibly nostalgic construction), and material continues to misbehave, architectural culture is now starting to embrace both collective authorship and material fertility. The latter, most recently in the choice of rendering material for Andrés Jaque/Office for Political Innovation's recent Reggio school: "a natural cork mixture, sprayed on to the walls to form a thick insulating jacket. Specifically developed for this project, it is unlike any other cladding around, with a texture somewhere between gritty, earthen plaster and sponge. It has an alluring, tactile quality, covering the building in globular lumps, forming creases and folds as it splurges around the corners, with the look of supersized Play-Doh. Beyond providing insulation, this coat is intended to take on a life of its own, becoming a habitat for fungi, insects and other organisms. Rainwater will follow the clefts in the cork, nourishing whatever microbial lifeforms take hold". Oliver Wainwright, 'Rainforest? Turn left after the drawbridge! Inside Madrid's eye-popping living school', *The Guardian*, 18 January 2023, <https://www.theguardian.com/artanddesign/2023/jan/17/reggio-school-andres-jaque-madrid-rainforest-zig-zag>.

Now that we have the ability to calculate perfection using no more or less gas than to calculate its approximation, surely it is time to ask (but we don't): what does this mean? What exactly does it do to the relations between the calculated or drawn and the materialized (digitally fabricated or conventionally)? Is this something we want? The fetishisation of precision in architectural culture, while testifying to a set of relations that are anything but transparent, also silences any critical interrogation of their inbuilt redundancy.

Consequently, via a critical elaboration of error and redundant precision, the aim and objectives of this project are revisionist: to speculatively ask to what extent does a deep-seated fear of error (and the matter that it is agent to) inflect the signal moments of architecture's twentieth-century transformation? As each of these signal shifts is reconsidered as a site of radical intensification in our already precarious material relations, *The Architecture of Error* asks: what if we were to consider these transformations to have been driven not so much by the causes that the historiographies of Modernism declare, as by an unspoken fear of a loss of control over error and everything it stands for? Thus, each shift is examined not so much to see what exactly happened to error, as to explore how a fear of error can be understood to have silently orchestrated what took place—and how, under each of the new regimes of control installed, error does not go away but necessarily reconfigures. How, in so doing, so too do its relations to precision and the architect's ever-precarious relations to material life.

The revisionist objectives of this analysis harbour projective desires. Given that error is defined as that which exceeds the constraints of required precision, and precision has radically strayed from its declared course and simple purpose of error control into the complex terrain of fetishisation, how now may we truly locate error so that we might engage with the possibilities its new configurations suggest, possibilities to which the perfection promised by precision could never pretend? Thus, via the simple ruse of the supposedly innocuous question of minor material error, the analysis takes us back through the seminal technological and cultural shifts of the last century that remapped the ground between material precision and error. In each we find an amplification of the architect's increasingly anxious relations to material life, and the ensuing radical reconstitution of material error. The rejection of organic materials saw wood epistemologically split from truth and metal rendered truth itself.²⁷ The rise of the instrumentalist premise and the concomitant invention of standards and specifications that erected with word and number an extraordinary cage around material behaviour and agency, were recast as 'performance'. The two-way epistemic traffic between architecture and biology that has both directed and burdened architecture's own epistemologies saw first to the drawing of foetal morphogenesis in architectural space and then, very much later, to the complex flirtations between early cybernetics and life sciences in the 1960's that prefigured architecture's 'death' of concept and the rise of the unauthored network with its own immaculate conceptions. Lastly, the removal of ornament, an always-localised surface treatment, paved the way for the ubiquitous surface precision of the digital surface.²⁸

Each shift is subjected to an examination and elaboration of the transformation of material tolerance—or, more precisely, intolerance—that took place under each arrival. Each revisionist return attempts to expose the complex architecture of the mechanisms at work. How, within the more technologically driven crises, inference and undeclared indeterminacy have been used to prop up the false precision of rationalized instrumentalism; while, within the more culturally defined episodes, the engineering of metaphoric infrastructures has preserved the security of form over material life (and its agent, error). This last, even as the digitization of architectural reproduction promises to undo, once and for all, the causal linearity that unfolds from 'the concept.'

In revisiting these pivotal transformations via the question of error, the book invites a critical reassessment of the role of redundant (rhetorical?) versus effective precision that would undercut its hold on our practice and imagination and expose it for what it is: an architecture of fear whose politics we must

²⁷ See footnote 15.

²⁸ Since writing this the ubiquity of precision has expanded from the surfaces that surround us to the many systems that script our daily existence and predict our futures. See 'The Rear-View Mirror' below.

question. The project of elaborating error as an active category in architectural thought could not be more political.

The Scope and Methodology:

Scope:

This study examines the construction of precision and material error relations and the peculiar economies they engendered in key operative and conceptual moments in architectural reproduction and its representation within twentieth-century architectural culture²⁹.

Therefore, the error subject here is not the epic error of catastrophe, the seminal images of acute structural collapse, nor the related but different category of the ‘accidental’ as discussed by Paul Virilio; it is not the chronic, performative failures of modernism and the ambivalent legacy of its urbanism; nor the errancy of syntax and the endless playful misreadings of “Eisenman’s Romeo and Juliet”; nor does it directly regard the erroneous forms of the monstrous and the ways in which this pertains to the ugly; nor the ethical errors delineated by morality (though, as we shall see, this is never far behind any physical error), but the humble, physical error that plagues all materialisation. Such error, not unlike its ethical counterpart, always starts small but has an infinite capacity for growth. To register its cumulative presence, to occupy a continuously expanding space as long as it exists unchecked.³⁰ It is against this symbolic threat that the dimensions to several decimal places, like the sharpened pencil point before it, stand ranked. From Wittgenstein condemning a newly plastered 3.8 metre ceiling for being out by 30 mm at 18 Parkgasse to CAD software in which we draw brick walls we know will be built on muddy sites, by workers wearing thick gloves, to six decimal places, architectural culture’s very particular construction of precision and error constitutes a powerful undertow in the course of its development and its relations to materialisation.³¹

This book explores the legacy of the architect’s conflicted and shifting relations to material tolerance in the twentieth century. Neither continuous nor exhaustive, the analysis brings into relief the complex architecture of relations between the use of precision and the control of material error in architectural culture. It does not pretend to construct or apply any comprehensive ‘theory of error’, nor does it reference the histories of error’s theorisation, but rather it critically examines the structure of precision and error relations at key moments of precariousness and transformation in material processes that directly or metaphorically attended to the making of twentieth century architecture.³² In so doing it exposes and unpacks the key moments of *intensification* in material intolerance of material’s twentieth century. Some such moments are technological. Some are cultural, and notably, epistemological: relating to the arcane fictions architects invoke when narrating how buildings arrive. Both are sites of a silent storm that saw precision radically stray from the declared course of error-control into a complex terrain of fetishisation

²⁹ Where necessary, diversions are made to Modernity’s Enlightenment innovations in representation that have direct bearings on twentieth-century questions of error.

³⁰ I am indebted to the late Mark Cousins for pointing this out to me and confirming why it is that, despite my endeavour to hold fast with error that is physical and not conceptual (ethical or spiritual), the two forms of error endlessly find their way back to each other.

³¹ At the time, in Microstation, one could set the minimal accuracy to up to six decimal places for coordinates and eight for angles. For the more technically curious: the shortest line one can draw is a line that connects two positional units, (pu) on the design plane. Microstation’s 2014 design plane had two to the power of 64 pu in each direction moving away from the centre (x, y=0,0 real world coordinates). This meant that working to a ‘worst case’ accuracy of 0.0001 metres between pu’s near the edge of the design plane where accuracy falls off, the ‘design plane’ would become 900 million kilometres along each axis: a very large piece of paper indeed. The actual accuracy is many millions of times higher when drawing near the centre (origin) of the plane, which is where we normally draw. Such are the hallucinatory ratios involved here.

³² Regarding histories of error’s theorisation in architecture, these would include: Leon Battista Alberti’s chapter in *De Re Aedificatoria*, 1485; parts of Marc-Antoine Laugier’s *Essai sur l’Architecture*, 1753; and Teofilo Gallaccini’s *Trattato Sopra gli Errori degli Architetti*, 1767, among others.

and redundancy. This trajectory rendered the economy fundamental to architectural practice – the exchange in the process of materialisation of precision deployed for error mitigated – no longer accountable to instrumental logics, and ultimately false. In the cleaving of error and precision from such logics, a space has opened up: a no-man’s land of alienation between line and material, intention and act. The sorties in this book are a series of walks through this terrain via which we gain an accretive understanding of the lay of the land and the repressed logics of navigation to which it is answerable.

Methodology:

The above scope informs a suite of methodological decisions regarding terminology, historiographic tactics, and spatial tactics – the ex-disciplinary excursions and the active seeking of lacunae via inverted interrogatory frameworks.

i. Terminology: Error and Aristotle’s Matter:

There is another layer to the threat humble material error poses which originates from Aristotle’s conflation of error with matter.³³ Aristotelian ‘matter’, or ‘potentiality’, is a fertile elusive category that, while it haunts our every move as architects, we can’t by definition access, as the always-already closed question of matter undoes representation. We can however access its agent, error: the “accidental” splintering, cracking, rusting, rotting, curdling, buckling and slumping of degradation, Aristotle’s “privation of form.” In *Metaphysics* Aristotle set out how error is produced by the agency of matter, thus physical error embodies everything Aristotelian matter stands for, a complex intersection of: indeterminacy (as unreliability); difference (literally, gender-based and racial, although curiously not species difference which is the domain of form); existence (matter’s purpose is to lend existence); interiority (and all the suspicious concealment it may carry); process (product is reserved as the sole domain of form’s teleological desires); capacity for self-organisation; and, not unrelated, entropy (when things go wrong, it is because of matter).³⁴ It follows that any elaboration of error as an active category might then, if properly formulated, give us a crucial way into a thinking about matter. Thus, in as much as the relations between form and matter concern power structures, the question of error is always unavoidably political. And given Aristotle gendered matter (*matrix* and *mater*), they are also always unavoidably feminist.³⁵

ii. Historiography: Recursive structures

From the absurdity of the flightless aircraft, to the slapstick ball-tossing-splatch-dropping antics of concrete testing, or from Erwin Schrödinger’s designation of his all controlling, executive gene as ‘Architect’ to Georges Perec’s parodying of the bureaucratic space of the algorithm’s looping course that would undo the causal linearity this ‘architect’ was to execute, the analysis explores the diverse, artful mechanisms that have reorganised our relations to material systems and their housing of error. It unpacks how each has ensured that the active, critical and potentially generative capacity of error is read as a threat to be excluded, and how under each new regime error did not go away, but simply regrouped.

Throughout the analysis the space of enquiry is recursive, firmly written not only from the point of view of the (then) contemporary, but also with a view to critically rethinking the (then) contemporary: the rampant optimisation and reductive modelling at large. Thus we find in the signature passive-voice rhetoric that surrounds the form finding in parametricised design a prefiguration of Le Corbusier’s ecstatic reception of reinforced concrete, of buildings that *would pour themselves*, or, in the emphatic exclusion of the soma and its feedback in Schrödinger’s Gene Action a premonition of the autonomy of code, or in Wittgenstein’s ubiquitous use of extreme precision in every wall, door and radiator in the house for his sister a similar

³³ Somewhere behind all the accounts of what happened to form under the modern experiment, beyond the question of materiality and the engineering, in every sense, of its meaning, must lie the problematic tale of what happened to “matter.” This has more recently been addressed in New Materialism’s rehearsing of a lineage that spans the century: Althusser, Bergson, Deleuze, Heidegger, Marx, Wittgenstein.

³⁴ Contrary to common conceit, Aristotle’s matter as described in *Metaphysics* is far from inert, and in many ways is what we might now call the ultimate intersectional medium.

³⁵ As Feminist New Materialism has since secured although again this is part of a longer lineage – see ‘Left-Wing Mirror’ below.

prefiguration of the ubiquitously precise digital surfaces to come. That is to say: so much of how we *understand* the quantum precision of the 3D printouts of our drawings in goop, glass, or steel, was decided in the early modern pursuit of material control in the material testing laboratories of the Midwest, the public lecture halls of Dublin, and the domestic spaces of Vienna.

iii. *Transdisciplinary: Excursions*

The central questions poised here are homeless – they have no single disciplinary turf to call their own. However the politics of our addiction to precision has been considerably developed in other disciplines for which, not surprisingly, measure is crucial: the exact sciences (most obviously) and the history of science, in particular the work of Lorraine Daston, Ian Hacking, and M. Norton Wise; more recent critiques of the role of instrumentalism from within science and technology studies; critiques of inference and approximation in explanatory systems by Nancy Cartwright in physics / philosophy of science; critiques, too, of the hijacking by metaphor, and the singularizing distance it installs, by Evelyn Fox Keller in biology and life sciences / philosophy of science. Despite this, architecture's very particular addiction to redundant precision (physical or metaphoric) remains largely uninterrogated. Thus to pursue the questions being explored I have had to frequently exit architecture as I sought resonance (and answers) in peripheral disciplines in which I found them more keenly posed. Such sorties are to disciplines to whose technologies, and very icons, architecture explains itself and, more keenly, it's precision/error relations through: the purity of aeronautical engineering and the liquid flood of the concrete industry that Le Corbusier flirted with, and the more complex flirtation between early computing and the life sciences that led to today's cybernetic architectures. I refer at length (chapters 3, 6, 7) to the revisionist critiques of Nancy Cartwright on inference in explanatory models and Evelyn Fox Keller on metaphors in explanatory models, and their call for a coupling of distance and intimacy ("intimate distance") in negotiating the hazards of abstraction. Both address the consequences of the chosen epistemological pathways, a blind-spot in architectural culture with its compulsion to constantly explain itself, the origin, and autonomy of its objects.

Explanation rests on representation. These transdisciplinary exchanges hang on the joint concern with representation. Both Cartwright and Keller organise their critique around the problematic mediation of representation: biology dominated, for better or worse, by visibility (and thus its formal loyalties); physics not, but rather, paradoxically, by that which by definition remains out of sight – the arch-form of the theoretical laws behind the observable. Similarly architecture's anxieties around error control are most evident in the (necessary) mediation by representation of the key operative moments of production: the status of the concept and the heavy rhetoric of its representation; the eclipsed middle phase of project development and its thus usually absent representation; the easy artifice of the rendered perspective (and the problematic cleaving of visibility and veracity it conceals) in the use of the degree of precision, long past saturation point, that define the glossy surfaces and their hyperreal promises.

Parallel excursions of a different nature are taken into the practice of five artists – four visual, one textual – who entertain error: Barbara Hepworth, Rachel Whiteread, Gordon Matta-Clark, Georges Perec, Vija Celmins, (chapters 2, 4, 5, 7, 8 respectively). These sorties find lessons not in the products of these artists, but in their methods, choice of technologies employed, and economies of production. Each constitutes a case study for an anterior production economy where the role of precision and error is critically active, either technically, or intellectually, or both. From Barbara Hepworth's technical notes on the predation of flaws in stone carving, to Rachel Whiteread's submission to the liquid intelligence of the pour, to Gordon Matta Clark's negotiation of error with improvisation in his *Unbuilding* projects, to Georges Perec's looping sabotage, to Vija Celmins indexical mimicking of the drawing machine that counts its subject.

Both sets of external voices help address a perhaps obvious questions: what is the problem with excess precision? Why not make soup with a calibrated pipette, or prune a tree with nail scissors? All argue for the desire to see the arching of abstraction meet and firmly touch the material processes to which it attends. All challenge the price of the reductive impulse to which abstraction answers. This physicist Nancy Cartwright understands, in her critique of inference and Hooke's law, and biologist Evelyn Fox Keller in her critique of the pull of the metaphoric in reproductive biology and its cleaving of visibility from veracity.

All have important ramifications for the thinking around materiality and the currency of metaphor in architecture as they interrogate assumptions we have long grown too comfortable with. When Gordon Matta Clark replaced the 0.05 technical pen of his architectural education with the sledgehammer and chop saw used in *Splitting* he understood, like Cartwright, that false precision is above all political.

Implicit in the transdisciplinary forays is the argument that it is precisely by being not more apparently about architecture, that the research is able to be *absolutely* architectural. Indeed, I suspect the lessons from others on this subject offer perhaps more critical potential and value to architecture now than they do to their native disciplines. Similarly, throughout the book, rather than refer to specific contemporary architectural projects, the analysis addresses instead more generalized ways of working in architectural practice and production: the language we employ in our accounts of form-finding; the differing precision roles we assign to different drawing types in the tracing of process; the ongoing eclipsing of the middle phase of any design process; and the application to technology's constructed neutrality in the face of the cultural *indeterminacy* that both riddles and makes a riddle of our epistemologies.³⁶

iv. Revisionist: lacunae and inversions

The research into the reconfiguration of precision and error relations that led to a gross inflation of precision in architecture's twentieth century and its subsequent decoupling from veracity, the subject and site of this book, requires three inverted logics. The first, to invert the question of *why did precision increase so?* to *how and why did the tolerance of material error get smaller and smaller?* The second, to understand that the answers to these questions are to be found less in the consideration of the set icons that structure the landscape of architecture's twentieth century than in the blind spots they conceal. The third, as mentioned above, to examine these blind-spots not from the point of view of precision, but of error, or to be precise, of our fear of error as the silent architect of their make-up.

v. Artefactual tactics:

Through the course of this study a cast of artefacts act as key protagonists, each interrogating the material accounting of their own historiographies. Like flotsam washed up in the material tolerance storm that made them, their hardware histories tell of the fallout of a crisis in material tolerance, of the ensuing corruption of relations between technical choice and precision hidden in an ideological eclipse that lies at the material heart of modernism: Hooke's needle that was found blunt and Sutherland's window that wasn't; Hepworth's stone that hid a flaw; Gallaudet's airplane that was too heavy to take off; Verne's stream that knew the way down; Matta-Clark's jigsaw that could draw; Schrödinger's dolls' house that defied entropy; Perec's corridor with no end; and (Hermine) Wittgenstein's radiator that was razor sharp. All are difficult objects, both witness to and evidence of architecture's pathologies concerning error and precision.³⁷

Structure:

The book is structured topographically as the arc of a dive: We enter at the surface (with the drawing's interrogation of precision) and exit there too (with the substitution of ornament by redundant precision in the closing chapter).

The first two chapters set out an understanding of the terms 'precision' and 'matter' with reference to recent work in Exact Sciences and Philosophy of Science (by Wise, Hacking and Cartwright) and to Aristotle's *Metaphysics* respectively.

The following chapters move through key moments of technological and cultural crisis, and intensification in the relations between error and precision.

³⁶ See 'The Sat-Nav' below for further thoughts on the state of the neutrality of techno-solutionism today.

³⁷ This now might be better articulated through Thing Theory as expounded in Bill Brown's *A Sense of Things*, 2003, of which I was unaware at time of writing. Certainly these things played a very important role in the process. See 'Obdurate objects: Thing Theory' below.

Chapters three and four on error and materiality examine how two technologically defined crises in the early twentieth century radically reconfigured the relations between error and precision in architectural culture in ways that have crucial ramifications for digital architectural production today. As the technologies of ‘flight’ and ‘flow’ (aeronautical engineering and concrete casting) became quintessential battlegrounds for the politics of precision, we find Aristotelian form and matter relations are further conjugated in their respective hardware histories. Both hang on the question of ‘materiality’ and material tolerance as constructed in architecture, but always with an eye on the engineering of material – this, in more senses than one. The first explores how precision and error reconfigured the construction of the airplane, and by extension aeronautical engineering itself, by importing architecture’s rejection of organic materials. The second examines why the invention of standards and specifications took place in the newly liquid construction sites of concrete, rather than in other ‘drier’ industries, and how the figure of controlled irrigation of ‘liquid’ (data) is now installed in the design interfaces of digital algorithms for the production of form. Both trace the architecture and action of the methodological, political and theoretical mechanisms *via* by which architectural culture has staked out its defences against error, and which shape the terrain of contemporary relations to material precision.

The argument then turns from the technological to the cultural crises architecture underwent with respect to reproduction (the epistemic realignment which now follows from the declared ‘death of concept’), and to surface (the removal of ornament and representation and the digital surface). The former is addressed first through three chapters (5, 6, 7) that deal with the metaphoric epistemologies of reproduction in architecture and their control of erroneous productions. If we turn to the ways in which architecture accounts for the struggle between form and matter in the production of *form resolved*, when concept must somehow traverse the terrain of potential error to the safety of perfected form, we find two dominant strategies at work: the terrain is either eclipsed or colonised. Eclipsing is employed in Le Corbusier’s rhetoric about concrete houses that could be simply ‘poured as if from a bottle’ and later in the ‘instantaneity’ which parametric optimisation now procures (as seen in chapter 4). While the bridging action of morphogenetic models that safely carry ‘form-making’ from A to Z effectively colonise its inherently terrain, as figured first in the eighteenth century intervention by architecture into the representation of foetal development, and later in 1960’s intervention by embryology into the cybernetics that now incubates all architecture (chapters 5, 6, 7).

The concluding chapter returns to the surface, where we consume precision and detect error, the ultimate site of the form/matter, precision/error proxy battle. In Wittgenstein’s house for his sister all surface points are built to an equal degree of precision, irrespective of need. In his prefiguration of the ubiquity of digital precision we find surplus precision substituting the traditional occupier of the surface site of fetishised excess: ornament. The argument concludes that surplus precision is the ornament of our (then) age.

Chapter by Chapter Precis:

1. Error & Precision: The Troping of Precision

Hooke’s Needle:

This opening chapter sets out the terms for a critique of the economy of error and precision in architectural culture and practice, focusing on the changing meaning of ‘precision’.

From Hooke’s horror on observing the magnification of his sharpest needle to Wittgenstein’s crisis over the gap between calculation and physical counting, we find the spectre of error at large in all material processes, not least in those of architecture. Architecture, it is argued, reserves a special horror for the category of error. Establishing a distinction between effective, or at least *enforceable*, and redundant precision, this chapter identifies a large margin of surplus precision quietly underwritten by the reproductive cultures of architecture and its practices, now radically inflated in digitalised production. In so doing it addresses the following set of questions:

What does this symptomatic excess of precision in architectural culture indicate? What is the symbolic or other function of the redundant margin it establishes? Exactly which anxieties drive the fetishisation (Freud) of precision in architectural culture? From where might they originate? The chapter moves on to explore the historic transformations of the term ‘precision’ – itself a most ‘imprecise’ term – and the consequent ramifications for the role of approximation in the mitigation of physical error. Not least, that complex, approximative and mediative vehicle ‘materiality’, without whose ability to deliver measurement from calculation, and materialisation from description, the bridge that is practice would not stand up. With reference to recent work in the field of Exact Sciences and Philosophy of Science, (Wise, Cartwright and Hacking), the analysis argues for a critical reconfiguring of the hierarchy of the calculated over the counted or measured, of description over materialisation that underpins architectural production. But such a shift necessarily requires the elaboration of error as an active category and radically exposes the inbuilt redundancies, indeed the quiet fetishisation, of precision that has been harboured within architecture’s productive cultures.

2. **Error and Matter:** *Anatomy of an Accident: Aristotle in the Garden*

Hepworth’s Quarry:

Sculptor Barbara Hepworth described herself spending whole afternoons ‘stalking’ and ‘prowling’ around the stones in her studio garden before choosing which one to bring her chisel to. Her predation of material for the flaws it might conceal reminds us that Aristotle’s original alignment of error with ‘matter’, and not ‘form’, stands: When things go wrong it is because of ‘matter’. This chapter transports Aristotle’s schema as set out in *Metaphysics* to Hepworth’s St Ives studio in order to unpack the networked relations between error and the various properties assigned to matter: indeterminacy, difference (gender and racial), existence, interiority, labour and process, and entropy.

Despite the many changes twentieth-century matter has undergone, Aristotle’s schema to this day underpins almost all of our material and formal thought. Within its gendered structure error is crucially conflated with matter, emerging as both its agent and only physical (formal) register. That is, error provides a way (our only way?) into the closed question of matter. Within this construction, the ‘accident’ or ‘spontaneous’ is pivotal. It is only by coupling error with matter that Aristotle is finally able to explain the many anomalous productions that so trouble the concise architecture of his account of all production: the sterility of hybrid offspring, the instigation of ‘dancing’ and the accidental ‘fire’ that won’t bid to the doctrine. A close reading of Aristotle’s struggle to incorporate erroneous production is brought to bear on Hepworth’s account (from her writings, letters and interviews) of how she carved her way around flaws in stone and wood as she cut her way through material. Behind her zealous, apparently form-driven role in nascent British abstraction, we find a subtler practice at work of quiet negotiation with the recalcitrance of matter, the threat of error, and the ambivalence of gender.³⁸ Her technical notes on the circumventing of flaws in carving stone reveal a practice of exquisite true precision, zero surplus, that is in constant renegotiation with error as a codirector of form. Her practice ultimately painted Adrian Stokes and his gendered treatise on carving and modelling into a corner he could not wriggle out of: the combination of Hepworth’s own corporeal fertility and indubitable mastery of carving was somehow irreconcilable, irreducible. As Hepworth navigates her complex identification with and

³⁸ Clearly Hepworth’s alertness to the recalcitrance of matter finds much resonance in recent work in Feminist Materialism, the collections by Samantha Frost and Diana Coole and writings of Jane Bennett et al. (See ‘Left-Wing Mirror’ below). The same is true for the aeronautical engineers struggling to replace spruce with metal in chapter three, and Rachel Whiteread’s delegation to the pour in chapter four.

rejection of matter, error and gender, we find the status quo of Aristotle's *Metaphysics* at residence, instituted even, in the very architecture of her St Ives garden studio – until it is interrupted by the accidental.

3. **Error and Materiality I: Room for Doubt: Instrumentalism, Inference and Ideology**

Gallaudet's Dodo:

The architect's engagement is of course not with matter *per se*, but with materiality, under the auspices of the instrumentalist premise. In the period between the wars a massive cultural shift in material tolerance saw the rejection of organic materials, not just within the ideologies of architecture, but even in that most sacred site of technological instrumentalism: aviation engineering. The almost forced wholesale replacement of spruce by aluminium in the construction of aircraft, on the basis that metal was 'more precise', resulted in a generation of aircraft too heavy to take off. The engineered flightlessness of these airplanes, rendering the sublime ridiculous overnight, was orchestrated by ideologies incubated in architecture. This chapter asks what exactly was it about the conjunction of timber and flight that was so problematic it rendered the already successful wooden airplane intolerable? To answer this it explores some of the methodological and political mechanisms behind precision's inflation, looking in particular, (with reference to Nancy Cartwright's critique of inference), at the role the instrumentalist premise plays in the concealment of indeterminacy in material technology. Within this interpretive framework we find the fear of error to be a highly effective curator—one that is able, for example, in the face of the latent indeterminacy often at play in material choice, and the opportunity for ideological colonization this allows, to render metal almost not material but the embodiment of calculation, and wood, 'uncalculable'. Thus metal, being crucially, epistemologically separated from error, bypassed the phenomenological and promised a direct representation of theoretical material behaviour: perfection itself.

With further reference to Paul Ricoeur on ideology, the analysis addresses the following questions: What happens when, haunted by error, technological sites become ideological? How does the latent indeterminacy inherent in technological instrumentalism provide prime territory for ideological colonisation? How do the mechanisms of 'inference to best explanation' facilitate such colonisation? Lastly, given that the figuration crucial to ideological action on material error was imported, not from material sciences but, from architecture, what does it then mean when architecture re-imports ideologically compromised technology back into the rhetoric of its own production as 'neutral arbitrator' of its own conflicts? The technological absurdity of the flightless aircraft is important for architecture to consider not simply because *explananda* such as these disrupt the historiographies of instrumentalist rationalism that dominate our accounts of modernity, but because they disrupt our explanatory enterprise *per se*.

4. **Error & Materiality II: Abdicated Measures: Liquid Automation, Anxiety and the Politics of Optimisation**

Axel's Stream:

One hundred years before parametric optimisation entered the architecture studio, in pursuit of the miraculous potential of concrete buildings that could literally be poured into being, the construction industry embarked on the frenzied invention of Standards and Specifications and precision and error relations in architecture were reconfigured forever. As lab coats first walked into the dust of the construction site to contain unruly slurry, obsessiveness peaked around the

vexed question of wetness. This second of two chapters on technology-driven changes in material tolerance examines how the very materiality of a subject, here the wetness and chemical activity of concrete, called into being a vast body of legislative, social and cultural change. Not only did this affect a radical socio-political restructuring of the building site as cultural site, but also, and more curiously, the eclipsing of construction it set up paved the way for the abdication of authorship and the assigning of immaculate authority we witness in the rhetoric surrounding parametrically optimised design. The chapter asks: why did the invention of standards and specifications first take place in architecture and the liquid building sites of concrete construction, and not in the burgeoning but drier steel or railroad industries? What does this eruption of rules reveal about our relations, not to materials *per se*, but to certain physical properties (chemical activity, opacity and, most crucially, liquidity) and their ability to harbour error? With reference to the role of liquid automation in the interior exploration central to Rachel Whiteread's casts – her ever-so-actively passive delegation of the interrogation of space to the liquid intelligence of concrete – and the interior explorations of Jules Verne, the analysis further explores what it is about the agency of liquid intelligence that posed such a threat to the previous control of form and matter relations in construction legislation and practice.

As the seamless flow of liquid eradicated overnight the block-by-block, rivet-by-rivet incrementality of all prior construction, it delivered a physical instantaneity that prefigured that of digitalised construction. Thus, parametric optimisation can be understood as a latter-day echo of the first ecstatic reception, a century earlier, of that other equally miraculous, instantaneous, and apparently autonomous form-finding material system: Le Corbusier's flood of concrete that, like the flowing data to follow, "self-navigated" the (also networked) formwork of the newly also "labour-free" building site. The rhetoric we find in the accounting of parametric production, where instantaneous form 'is found' in many ways rehearses Le Corbusier's euphoria at his drawn houses being "poured in from above".³⁹ An examination of the literature that has accompanied the arrival of both technologies, (from the pedantic instructions for the testing of concrete patties to the recent, almost evangelical writings on the role of augmented components in parametricised production), considers their eclipsing of material negotiation in instantaneous construction, and questions what exactly such instantaneity does to the economy of precision and error in architectural production. When properly marketed, the instantaneous has the authority of the immaculate and, more curiously, the new neutrality of the 'optimised'. Be it the immaculate construction of form arriving 'from above' or the more secular construction of form 'finding itself' from within the matrix of technology – in both the net effect is the same: authorship (and its accountability) is strategically absent, this to the point of abdication. How then are the relations between author and error as mediated by material reconfigured?

5. Error & Representation: *The Blind Spot and the Bridge*

Matta-Clark's jigsaw:

In architecture's seminal epistemologies concerning the arrival of form a crucial middle stage is always eclipsed, usually by an over-emphasised beginning (concept sketch) and end (rendered perspective). Architecture's longstanding investment in the dominant metaphor of biological reproduction, and its procurement of hermetically sealed and thus concealed middle phase or morphogenesis, can be understood in terms of the security it lends to precision and error relations. Returning to architecture's role in the eighteenth-century 'invention' of the foetal morphogenesis and the later exchange between embryology and early cybernetics, the next three

³⁹ Le Corbusier, *Towards a New Architecture*, trans. Frederick Etchels (London: Architectural Press, 1970), 231.

chapters examine the combined action of morphogenetic and metaphoric models that secure, organise and export form and matter relations in reproduction.

Gordon Matta-Clark's video documentation of the 'construction' process of his *Unbuilding* works reveals a process of zero redundancy of precision. As if this in itself were not a sufficient challenge to the architect, this *unconstruction* process also threatens to return us to the instability of the interiorised middle phase of all architectural production. Through its radical exteriorisation of *form unresolved* we glimpse matter still at large. Like Mary Shelley, Matta-Clark understood that by turning morphogenesis inside-out temporally, as well as spatially, one is exposing something that is not to be seen in the first place. But what exactly is the threat the exposure of this interim methodological phase poses to architectural production and its representation? Why is the suppression of this phase so key to the maintenance of the *status quo* between form and matter and, more relevant here, precision and error in the production of architecture? Architectural culture has traditionally invested deeply in metaphors of reproduction in order to hide the middle phase of *form unresolved*. So deeply, that architecture itself interceded in the construction of the quintessential representation model of the 'middle phase' – embryological morphogenesis. With close analysis of Matta-Clark's *Unbuilding* footage and Samuel Thomas Soemmerring's *Icones Embryonum Humanorum* this chapter returns to a critical moment at the very end of the eighteenth century when the abandoning of perspectival space for parallel projection led finally to the 'invention' of the foetus as a morphogenetic register *par excellence* in the construction of formal origination. Unlike the rest of the human body, the foetus was first truly drawn not in the perspectival space of anatomical representation, but in parallel projection, in architectural space and using architectural survey techniques – measured and plotted, like a building. Within the domain of medicine, architecture's space of representation fabricated a one-way morphogenetic bridge that spanned the terrain of *form unresolved* and safely delivered *form perfected*, within the metaphoric security of a teleological train that in turn served architecture's metaphoric needs so well. It is precisely this secured directionality that Matta-Clark's *Unbuilding* works crucially expose and reverse.

Only parallel projection could erect the architecture of simultaneous radical autonomy of and separation from the amorphous fetal matter on the dissection table. Only in architecture's register was it possible to exclude context (the mother, the whole environment upon which the foetus depended) and the particular (all individual traits erased, the model is rendered universal). If Soemmerring reminds us of modernism's eighteenth-century morphogenetic debt, Matta-Clark reminds us that we should default. The extreme exteriorization of the essentially interiorized phases of architectural reproduction that constitute his *Unbuilding* works, like the reproductive spatial inversions of Shelley long before him, radically disrupt the security of architecture's reproductive infrastructure. These carved-up buildings do not simply reverse the trajectory of epigenesis, but strip it away: exposing construction without the artifice of order, careering toward entropic oblivion in its materialisation of doubt itself.

6. **Error & Reproduction I: Miniature Giants: Colonial Adventures in Entropy and Scale**

Schrödinger's Doll House:

Following on from the previous chapter, this chapter and the next continue to examine the epistemic traffic which flows between architecture and biology in their managing of entropy and error in copying/the form making that is reproduction.

Within the cybernetic machine that is increasingly central to the way we not only fabricate but also think architecture is the body that has always been embedded in architecture's discourses

of production: the reproducing body – the trope of motherhood is still turning within the epistemologies of architectural reproduction.

In his formulation of negative entropy physicist Erwin Schrödinger was so drawn to the chromosome's "astonishing gift of concentrating a stream of order on itself and thus escaping the decay into atomic chaos—of drinking orderliness" that he temporarily moved into the space of biology, developing his modernist theory of Gene Action in 1943.⁴⁰ This theory, set out in his Dublin *What is Life?* lectures, firmly established a spatio-temporal morphogenetic model in which the role of matter was kept to an absolute minimum (by excluding the somatic body), and fertilisation (concept) was point zero, thus anchoring causal linearity. In order to convey the totality of the chromosomes' centralised control over the precarious transmission of a species' genetic blueprint (and archive) via mere matter – an anxiety architecture happened to share and had (somewhat) mastered – he chose to (metaphorically) name them 'architects': "they are architects plan and builder's craft in one".⁴¹ The security of hereditary transmission and the development that followed driving linear execution from code into material organization, ensuring zero feedback from the said material, could only be explained under the regime of his über-architects .

Modernist biology's split of genetics from embryology, of genotype from phenotype, split many other properties more normally pertinent to the domain of architecture and central to its management of error: form from matter; instruction from materialisation; linear production from more complex modes of production; and the singular author from the labouring collective. Gene Action was predicated on the attribution of power to the miniature – only this could cut matter out of the picture. Then, to explain how something so small could control so much, the term codescript – at that point still metaphoric – was introduced. Thus Schrödinger's feat was the housing of the supreme power of self-replication on the inside of something, via the miniature, which must then be exteriorized, via the rhetorical architecture of Gene Theory.

This chapter examines what was at stake in the epistemological negotiations surrounding the housing of 'negative entropy' in the miniature, and the eclipsing of material agency (now lost in a rhetorical lacunae) it achieved, with reference to the revisionist work of Evelyn Fox Keller, and to the miniature via the dolls houses made by IBM/Peter de Normanville, Schrödinger himself and by Sir Edwin Lutyens (while he was also making the vast house that was The Viceroy's house for the 80-mile-wide site of Imperial Delhi). Schrödinger's dolls' house directly imported from architecture to biology the belief in the superiority of intellectual labour over material labour; of linear, one-way direction and execution over networked exchange by the many and the consequent centralisation of authority: the singular entity that, in embodying both the law and its interpretation, is able to organize vast quantities of material in space. But this 'house' of Schrödinger's, hid a fault line deep in its make-up – its architecture was to be undone by the post-war cells that would not toe the line of Gene Action's architect, that is, by question of difference and feedback.

7. **Error & Reproduction II: The Copying Machine Fails: The Double Helix and the Loop**

Perec's Corridor:

This third and last chapter on error and reproduction examines how within the metaphoric engineering of Gene Action, error reconfigured as the 'difference' and 'feedback' that ultimately

⁴⁰ Erwin Schrödinger, *What is life?* (Cambridge: Cambridge University press, 1992), 77.

⁴¹ Ibid 21

undid it, and led to the regulatory networks and the looped causality which make up today's cybernetic reproductivity. The other quintessential morphogenetic model of form and matter relations in which the control of material error is paramount is the serial reproduction of evolution, in which the transmission of message must be entrusted to matter.

Gene action's insistence on causal linearity in the production of form was a precondition to single authorship. While embryologists witnessing somatic feedback that disrupted this model were without the metaphoric arsenal of Gene Action, they did have a material arsenal of sorts – the networked behaviour they observed in the cells before them—not unlike that of the bemused technicians of the interwar aircraft construction shop floors handling spruce when faced with the metaphoric arsenal of metalization. But so entrenched was Schrödinger's legacy, that it ultimately took epistemic interventions by nascent cybernetics, itself busy using the (also metaphoric) organism as a model for a newly complex machine that might better navigate the messy complexity of the Cold War world, for biology to admit the evident distributed authorship, nonlinearity and feedback that is key to any system's self-coordination and regulation, including that of the fertilised cell.

The foetal morphogenesis (invented in the representational space of architecture) whose scripting gene (invented with the ambitions for autonomy and executive scope of the twentieth century architect) Schrödinger had endowed with the ability to both embody the law and interpret it (to be both code and its decoding) in an exchange with cybernetics, became Norbert Wiener's dematerialized human, message-as-code, that could be “sent down the telegraph line”. In Wiener's breath-taking conflation of organism and computer regarding the question of reproduction, the copying organism (as machine) is transposed onto the copying machine (as organism). The *what* of Schrödinger's formal question, *What is Life?*, became the performative *how* in Georges Perec's 1978 answer: how life works *and* how to work it, *La Vie: Mode d'Emploi*. As the ‘architect’ gene, origin and engine of a causal linearity that delivered resolved form gave way to the looped passage and the recursive logics of the new machines of life, the space of reproduction and its control of error —first biological, then architectural—was transformed.

The trope of the reproducing body, so central to architecture's own reproductive discourses (with their metaphoric biological baggage, and now their cybernetic promiscuity as well), was pivotal to the development of the cybernetic space that now incubates all architectural reproduction. The singular pathway to error-free form, as conceived in embryology, molecular biology, cybernetics and finally, belatedly, in architecture (a pathway promised and policed by the concept sketch) gave way to the deliberations of the network. Thus the tyranny of the line gave way to the tyranny of the loop.⁴² As with any new jurisdiction, this too became a new space and opportunity for the dissent and proliferation of error. Within the cybernetic machine that is increasingly central to the way we not only draw and fabricate but also *think* architecture is the body that has always been embedded in its discourses of production: the reproducing body. The trope of motherhood—now concept, now system housed in the machine—is still turning within the epistemology of architectural reproduction.⁴³

The chapter concludes with reference to Evelyn Fox Keller's critique of “static objectivity” which she identifies as responsible for the complex legacy of declared radical detachment coupled with an always-undeclared subjectivity in the life sciences. She proposes that the radical autonomy of the subject be reconfigured to a “dynamic autonomy” that does not “seek power over

⁴² So artfully parodied by Perec's expression, “*faire le tour*”, equally artfully translated by David Bellos as “circumperambulation”.

⁴³ And conversely, architecture is implicated in the construction of radical detachment that governs our engagement with the control of error in the real reproducing body.

phenomena but acknowledges instead the ways in which knower and phenomena are in relationship as well as ways in which the phenomena themselves are complexly interdependent.” (Such dynamic autonomy is clearly at play in the arts practices addressed). If architecture is to think critically about its use of precision, its penchant for the reductive, it must challenge the cognitive authority sustained by its use of epistemic privileges and the lazy isomorphism to which we so often resort; itself no different from the isomorphism that allowed ‘architect’s plan’ to be ‘genetic pattern,’ ‘organism’ to be ‘computer,’ and the complex inter- and intracellular chemical signals to be ‘program’.

8. **Error & Surface II: Ornament:** *Counted Away: indexicality and the Sublimation of Ornament*

*Hermione Wittgenstein’s Radiator:*⁴⁴

Architecture’s fear of error and fetishisation of precision surfaces most acutely at the cathexis of the surface of the building and the surfaces of the drawing. For the building, ornamentation has traditionally been the key surface strategy for the concealment (via incorporation) of error: the fertile sites of ornament are the seminal low-tolerance junctions, the meeting of wall and floor, wall and ceiling. An analysis of Loos’ writings on the mirror-like surface of Lake Geneva and his reflected lineament of veneers argues that ornament might better be considered not ‘removed’, but sublimated into the surface. In a different world, but in the same Vienna, Wittgenstein was measuring and re-measuring work on the house he had designed for his sister Margarethe. Returning to his doubts about the relations between calculating and counting introduced in the opening chapter, we find them neatly transposed onto the precision gap between the calculation of the drawn and the measurement of the built. In his acute desire to close the gap between the two, the margin for error he enforced on plasterer and blacksmith, documented by another sister, Hermione, was less than one percent. This bare house is thickly coated in numbers: Loos’ sublimated ornament here resurfaces as a new manifestation of excess – that of extreme precision. Wittgenstein’s precision is however quite unlike the previous occupant of excess (ornamentation), as it is not localised and focused on need, but uniformly distributed, irrespective of need. The indexical surfaces of this house with their ubiquitous precision prefigure those of the digital. The uniformly precise surfaces of Wittgenstein’s house are revisited via the surfaces of Vija Celmins’ hand drawings, and her self-erasure in the indexical mimicking of the drawing machine that counts its subject. We find, in Celmins drawings of the surfaces of anonymous “matter,” a commentary on the surface life of precision itself. The analysis argues, with reference to their doubling of their measured subjects and to Wittgenstein’s doubling of counting and calculating ever, that this indexical house is a machine not for *living in* but for *counting with*.

This chapter concludes the book by positing that surplus precision, now firmly occupying the site of material, fiscal and other excess previously reserved for ornament is, in fact, the ornament of our age.

⁴⁴ The radiator in question belonged to Margarethe, the other sister and client, but it is a topic of Hermione’s diaries, cited in the chapter, and thus hers also.

Reflection:

On Travelling: The Rear-view and Other Mirrors:

If hindsight is a rear-view mirror, then this review is written looking in the rear-view mirror, the wing mirrors and at the predictive ‘mirror’ of the sat-nav – itself also a recursive structure, as all predictive systems reliant on the loop of induction (using past data to calculate future ‘facts’) are. This array of rear and forward-facing mirrors, and their very different constitutions, are employed to convey and attempt to address my discomfort with the assumption of linear progress in anything, least of all architectural theory – an assumption so often encapsulated in the expression ‘ahead of its time’. We might, for instance, say that Bloomer’s work, upon which much of my thinking rests, was absolutely ahead of her time in its anticipation of Feminist Materialism and New Materialism; and its thinking about multispecies, entangled, life; its drawing on a multi-scalar range that is now a central trope of Ecocriticism – all very much part of today’s more diverse and intersectional thinking in architecture. But at the same time, Bloomer’s work was also *absolutely* of its time: absolutely of the ludic syntax recently gifted by Jacques Derrida; of the corporal license from Hélène Cixous; of Bloomer’s own reckoning with her Appalachian childhood and then motherhood; and of the economic climate of the construction sector and its effect on architectural education’s turn to theorising. To understand a body of research with hindsight as being ‘ahead of its time’ is to sign up to the belief that ideas progress, that thinking necessarily becomes more progressive – which, as we have recently been reminded, it often does not – that research develops and builds upon itself in a linear fashion, informed by the legacies it inherits. Much feminist work going on now amongst younger academics today suffers from wheel-reinvention syndrome. The same is true of some decolonisation work, as it circles over areas already considered in Post-Colonialism, in enthusiastic ignorance of past labours. Maybe every generation needs make anew their stake-holding in an intellectual movement. Fortunately or unfortunately we do not neatly and efficiently build upon past works, we do not progress in an orderly fashion. Architecture has, over the interval in question, clearly reconfigured back around to certain ideas, so one can now see, with hindsight, that *The Architecture of Error* was ‘ahead of its time’ regarding its anticipation of several areas: Critical and Queer Computing; New Materialism and Feminist Materialism; the embracing of History of Technology as a fertile site within architecture’s discourses; anticipation of Ecocriticism, embodied walking and thinking around entangled life and the more general return of subjectivity with its reference to Fox Keller’s and Cartwright’s critique of abstraction and call for intimate distance, not to mention the very recent focus on exactitude since 2018. And yet, it was absolutely of its time. Its time *made* it: The pressures, frictions, configurations of arguments in different corners of the discourse at that moment; the questions from students in those history and theory seminars before new climatic regimes; the debates at those end-of-year examining AA tables when I was presenting portfolios obstinately devoid of climaxing renders to colleagues that demanded them, all shaped its critique of redundant precision, and all make it absolutely of its moment. Equally, none of these aforementioned discourses were invented in the decade of its writing, as a quick glance to the 1960s and 1970s will reveal – so much of Bloomer for instance is foregrounded in Susan Griffin’s 1978 *Woman and Nature*. And so much of that in Spinoza and Milton. And theirs in Epicurus and Aristotle. Otherwise put, how useful is it to say of something that it was ahead of its time? Perhaps it is more useful to say of the many Vico-esque spirals that shape thought over time, across the many inductive loops that structure that thing we call ‘progress’, that we are now at a point of content-coincidence, that the *sympathies* embedded in *Error* are relevant anew now, in the full knowledge that during its writing it was likely then already itself reinventing wheels, blissful in its ignorance.

In my endeavour to get critical distance from a project to which I remain intimately connected, but which at the same time, paradoxically, sits very much in my past, I have taken multiple excursions. These have taken me through contemporary thought pertinent to the questions raised in *Error*, fellow travellers in the form of New Materialism, Feminist Materialism and Queer Theory, as Queer Theory has increasingly engaged with what had been the project of Feminism – a critique of the power structures of the hetero-normative status quo, most recently listed by Paul B. Preciado in *Dysphoria Mundi* as: “Plein, vide. Sain, toxique. Homme, femme. Blanc, noir. National, étranger. Culturel, naturel. Humain, animal. Centre, périphérie. Ici, là. Analogue, numérique. Vivant, mort”.⁴⁵ It is a list that if recited by Aristotle, the former terms would all have neatly been assigned to form or ‘actuality’, the latter to matter or ‘potentiality’. Accordingly, our left-wing mirror reflects how *Error* is suspended between French Feminism and Feminist Materialism, the corporeal body and the wider body of all matter and its agency, most recently New Materialism and architecture’s own Material Turn. While the right-wing mirror reflects how its critique sought and ultimately contributed to the dethroning of parametric optimisation, and participated in the beginnings of Critical and now Queer Computation and their ongoing interrogation of techno-solutionism.

The Rear-View Mirror:

Interval: Then and Now

What defines the nature of the interval between the book’s writing and now? What defines the many shifts that have taken place in the way we understand our lives and think about the making of cities and their buildings, and about the educating of our architects? There has been an acceleration of extraordinary changes to our world during this decade – spectacular, devastating, shocking changes – that now rightly dominate our thinking, as we try to figure out what they means and how to decarbonise and decolonise every aspect of what we do. But there has also been a change that is as deeply permanent as it is subtle. While our relations to material precision have remained somewhat unchanged (if anything, we have become more critically aware of its redundancies and more open to material’s own agency – see Left-wing Mirror below), our relations to precision in the immaterial aspects of our lives, in the verbs rather than the nouns, have again witnessed a quantum increase. How we manage organisations; how we navigate; how we travel and transact; how we medicate; and how we communicate are all fundamentally changed. Their change hangs on our transformed relations to time: to the precisions of computationally augmented predictive systems and how they increasingly mediate our relations to chance. Big-data-fed predictive AI has reorganised our relations to the future, arguably as never before. It is genuinely difficult to remember what existence was like before the floodwaters of big data had reached every corner of our lives; before data itself had become the new gold to the point that our every interaction became an opportunity to harvest yet more to feed into an array of predictive models that would design our next tailored futures – the books we will read, the weather we will dress for, the routes by which we will navigate an unknown or even well-known city, the food we will eat, the people we will attempt to fall in love with. Our every turn must be optimised. To return to and invoke Ian Hacking’s ever prescient book, the *Taming of Chance*, the now near ‘quarantining’ of chance has transformed our relations to architecture’s oldest design project – the future itself – via the use of the quantum calculatory powers of machine learning AI, big data and data-driven capitalism: a formidable trinity.⁴⁶ Although of course chance, like error, is by definition never-to-be-conquered. Just as with the intensification of material intolerance in the twentieth century, here again a new no-mans-land has opened up between the future (future events, profits, emotions, consumptions, transits) predictive systems design for us and what actually takes place. Instances when things don’t happen as predicted, when things “go wrong”, can be understood as

⁴⁵ Paul B. Preciado, *Dysphoria Mundi: Le son du monde qui s’écroule* (Paris: Grasset, 2022), 300.

⁴⁶ Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990).

the twenty-first century's echo of the airplane too heavy to fly, or Gene Action's metaphoric enterprise, unable to explain feedback.⁴⁷

The extreme precision of these predictive systems, like all systems of precision, installs first an expectation of, and second, a desire for *compliance*. Precision as prediction is still compliance. At its most innocent: it will rain in exactly 10 minutes for exactly 20 minutes in exactly that part of town only. More problematic: this body-weight in a toddler will mean that they will be an obese adult without the intervention of these surgical and hormonal treatments during their childhood. The world this book was written in still had a sense of the, now eclipsed, present moment, that was more than the space in which past predictions are confirmed and future predictions are announced, solicited or not, with a ping or buzz. Consequently, the world this book was written in was not yet optimised: indeed optimisation was an epistemic luxury, an aspiration, that held sway only in certain sectors of certain disciplines, oil extraction from networked shallow wells for example, or hedge-fund and venture capitalist calculations, and in the architecture studios of a handful of dominant schools that had zealously signed up to its redemptive logics. The world this book was written in was *sub-optimal*, still co-habiting with chance, “that being living and conscious”, still uncomfortable with but resigned to accommodating a certain amount of risk.⁴⁸ We still perceived the present as an interval between the past and the future that had a (perhaps deluded) sense of autonomy from both. We understood, we did not think to question even, that the future was by definition somewhat uncertain and yet to be discovered – a space of projection and speculative imagination in which things would unfurl. We would adapt as they did so – this was our skill. This *was* existence. Determinism was viewed with a healthy degree of scepticism – who was doing the determining and for whose benefit? We were generally happy, or again, resigned, to waiting-and-seeing, trial and error. Put crudely: the subject of analysis and its promise of certitude was the past. Now increasingly it is the future. As if we have all taken up residence in an alternative reading of that famous Soviet joke: *the future is certain; it is the past that is unpredictable*. In the world this book was written in, everything that arrived and has since changed us was just turning the key in the lock. Foot in the door, it was just calling out an indifferent ‘hello!’. We could all hear it coming, feel its impending impact. In 2012, when the manuscript was submitted to the publishers, I consciously excluded the existing AI and big data presence from the book on the basis that, with proper historiographic caution, hindsight had not yet arrived, it was ‘a process still unfolding’, but in full knowledge that it was going to hit hard and fast and that therefore to address it would have been to build in an imminent expiry date to the argument. As it was I got the book done just in the nick of time. In the writing of the book, I had kept my gaze firmly on the past. Despite this, everything about my recursive historiographic thinking was already influenced by this new arrival that would sever our relations to things past in ways we could not imagine.

Chance: Prediction and Compliance:

The ‘digital-turn’, and the arrival of the ‘smart’, in its myriad costumes, from dumpsters to cancer treatments, arrived as if without a history. The rhetoric of parametric optimisation, and the evangelical discourse that celebrated it, implicitly declared the end of history. As if optimisation had no history, as if precision had no history, as if its extrusion of the Enlightenment project was not seamless. This is yet another part of its immaculate conception and its redemptive promise. The ‘digital’ was going to fix us, again. It was outside of – and therefore untarnished by – everything that came before. Its proponents acted as if the End of History was to be taken literally. Except of course it wasn't. As if the history of the project of computation, of thought (logic and

⁴⁷ See ‘The Sat Nav’ below for Keller Easterling on the need to design things that should go wrong. *Medium Design: Knowing how to Work the World* (London: verso, 2021).

⁴⁸ C.S. Pierce in his ‘Reply to Necessitarians’, written in 1893. Ian Hacking, *The Taming of Chance*, 200.

memory) disembodied, was not as old as the history of architecture; as if their histories were not already complexly intertwined.⁴⁹ Paradoxically, we now see that the digital turn brought not the end of history but, via the Oedipal determinism of the many predictive and management systems we have used it to install, that now effectively colonise the future (a once unknown, open space of speculation and imagination) as a space for profit secured and risk avoided, the end of the future.⁵⁰ If the future is architecture's oldest and longest project, this changes what we do. This changes our relations to error and precision, now reorganised around chance, compliance and risk, irrevocably.

Redemption: Disrupt and Derail

The project of *The Architecture of Error* was to critique and disrupt the ascendancy of architecture's increasing uptake of what I saw as the essentially harmful, unchecked abstraction on steroids.⁵¹ Its immediate driver was the way parametric optimisation was being used in architecture studios in the UK, Germany, Australia (RMIT) and the US; the techno-determinism it blindly espoused, namely the reductive models and thinking it instituted; the (highly questionable) unquestionable 'neutrality' it engineered; and, when that failed, the abdication of authorship it procured.⁵² Via a revisionist history of twentieth-century material relations, the project sought to use what was the then-nascent Material Turn and Feminist Materialism to do so. If the ascendancy of parametric optimisation (the henchman of the Digital Turn) resulted in a further control of error, then an articulation of error, including a thinking about architectural computation's foundational moments (morphogenesis and Schrödinger metaphoricity, cybernetics, the tyranny of the line giving way to the tyranny of the loop, etc.) was a way of dealing with it. The project continues. Otherwise put, were I to write this book again now, I would write it as the book I am currently writing that looks at architecture's historic relations to the long project of computation, the ultimate correctional endeavour – its decorporalisation of thought - all matter being the harbourer of error, and in the case of the body, sin. This project again addresses the declining tolerance for the sub-optimal, not least in the designing of our futures, and the near elimination of chance or the accident, that other avatar of error.⁵³

True to my reactive pattern, my current research and writing since *Error* has arisen from its failure to effectively address architecture's long entanglement with the ultimate error-corrective project, not the law of elasticity nor the metaphoric traffic with biology in the production of new form, but the long project of computation. Thus it explores some of the many indiscrete moments

⁴⁹ As intimated earlier this 'intertwining' is the subject of my current research, and with hindsight its beginnings are clearly evident in chapters six and seven of *Error*.

⁵⁰ Jacques Derrida famously rehearsed the distinction between the future that is predicted, *le futur*, and the future that will arrive regardless, *l'avenir*: "In general, I try and distinguish between what one calls the future and "l'avenir" [the 'to come]. The future is that which – tomorrow, later, next century – will be. There is a future which is predictable, programmed, scheduled, foreseeable. But there is a future, l'avenir (to come) which refers to someone who comes whose arrival is totally unexpected. For me, that is the real future." Kirby Dick and Amy Ziering Kofman, *Derrida: Screenplay and Essays on the Film* (Manchester: Manchester University Press, 2005), 53.

⁵¹ As Keller Easterling has since argued in her work on blockchains and other smart systems, see *Medium Design*.

⁵² See Francesca Hughes 'Head Banging: Engineered Neutrality + the Parametric Ceiling', *AD*, Wiley, Autumn 2009: 128-131.

⁵³ Recent chance-eliminating design platforms, in this case profit-optimising, include AI applications that combine information metrics with form finding, using real time data flow, for property developers such as *Archistar*, which "helps property professionals to find profitable development sites, assess for feasibility and generate dozens of architectural design strategies—all within a few minutes," and *Blox*, whose platform's dashboard incorporates "real time adjustable inputs, deep data insights," allowing a developer to "project assets and financials", adding "live data enables rapid decisions." Antonio Pacheco, 'Gensler Launches Blox, an Algorithm-powered Design Visualization and Computation Tool,' *Architect News*, June 16, 2020, <https://archistar.ai>, <https://architect.com/news/article/150202814/gensler-launches-blox-an-algorithm-powered-design-visualization-and-computation-tool>.

in architecture's shared history with computation. As with *Error*, the feminist project is embedded: the argument pits 'feminine indiscretions' against the history of the (binary) discrete.⁵⁴ With *Sick Architecture*, Colomina has recently argued that the history of illness is as old as the history of architecture – that sickness starts with enclosure. In a parallel vein, computation's historic exchanges with architecture make them difficult to separate: autopoiesis; the rule-set or algorithm; measure, order and logic; space and distribution; memory storage and retrieval; forgetting and deletion; the window, screen and the interface; modelling and simulation; analysis and the optimising of conflicting interests; origin and centre (homing) coordinates. All are shaped by the overarching desire to eliminate error. All are tasks that have also long belonged to architecture, and to the process of design's essentially corrective remit, no least in the production of 'true' and 'honest' architecture. From Ramon Llull's thirteenth-century religious correction by conversion that in his ternary system allowed for 'maybe', to Leibniz' ratiocination that would end all disagreement, to big data's debt to Victorian Statistics, to Babbage who, while correcting the (predictive) calculations in tide timetables, lamented that their arithmetic had been powered not by steam but by humans, all seek to excise the error (sin) of corporealised thought, the body and its soma.⁵⁵

Doubt: Impact as Doubt

Ultimately the aim of *Error* was to install a degree of *doubt* into our all-too-comfortable (if not lazy) relations to precision and optimisation (by exclusively quantitative values) and to stall the fast arriving eclipsing of all that evades measure.

A brief review of the Google Scholar entries for *Error* (see appendix item *e.i.*) shows the (incomplete) footprint of its citation impact in the form of books, chapters, articles, theses and curricula in a wide uptake across cultural studies, social sciences, architectural history and theory and computational fabrication. The relative lack of uptake in the area of Feminism is as surprising as the significant uptake in the area of digital fabrication. Below I have roughly categorised the entries, noting some works span two categories, they are as follows:

'*Technical*' – 2 entries
 '*Digital Fabrication*' – 8 entries
 '*Error and Precision as theoretical categories*' – 10 entries
 '*Instruments and Processes of Practice*' – 12 entries
 '*Feminist*' – 1 entry
 '*Digital Fabrication*'/ '*Error and Precision*' – 3 entries
 '*Practice Processes*' / '*Error and Precision*' – 3 entries

Clearly the recent interest in the theorisation of practice processes and methodologies (such as *Industries of Architecture* and *Design Technics: Archaeologies of Architectural Practice*) has seen the greatest uptake of *Error*'s thinking, directly (cited) in the following related books: *Precision in Architecture: Certainty, Ambiguity and Deviation*, 2019; *Patologías Contemporáneas: ensayos de arquitectura tras la crisis de 2008*, 2019; and *Exactitude*, 2022 (to which I contributed a chapter).⁵⁶

⁵⁴ An earlier publication entitled *Architectures of Prediction* is a rehearsal for this strategy: *Architectures of Prediction*, ARQ docs, (Santiago: Ediciones ARQ, 2019). <http://www.edicionesarq.cl/2019/francesca-hughes-arquitecturas-de-la-prediccion-la-verdad-esta-en-la-torre/>

⁵⁵ See Francesca Hughes *Architectures of Prediction* and 'Filthy Logics: In Praise of Pointlessness', *Exactitude*, Pari Riahi, Michael Davis eds. (Amhurst: University of Massachusetts Press, 2022).

⁵⁶ See Katie Lloyd Thomas et al. *Industries of Architecture* (London: Routledge, 2015); Zeynep Çelik and May eds. *Design Technics: Archaeologies of Architectural Practice* (Minneapolis: University of Minnesota Press, 2020); Francisco Diaz, *Patologías Contemporáneas: ensayos de arquitectura tras la crisis de 2008* (Santiago: Uqbar Editores, 2019); and *Ibid.*

Amongst the twelve or so articles in the category of ‘practice processes and their theorisation’, the critical framework of *Error* is applied to architects as diverse as Will Alsop, Sverre Fehn, Enric Miralles, Felix Candela and Eladio Dieste and artists Jackson Pollock, John Cage, and Robert Smithson. In the same category, *Error*’s focus on process is combined with that of theorists such as Tim Ingold, Richard Sennett, Donald Schön and David Pye, and architects: Dana Cuff, Dalibor Vesely, Alberto Pérez-Gomez & Louise Pelletier, Manfredo Tafuri, Kenneth Frampton, Jonathan Hill, Jeremy Till, Nader Tehrani, Marco Frascari, Edward Ford, Michael Cadwell, David Leatherbarrow, Juhani Pallasma, Katherine Schonfield and Katie Lloyd Thomas. This last list takes the form of Mhairi McVicar’s survey of positions on precision in architecture in *Precision in Architecture: Certainty, Ambiguity and Deviation*, 2019 (based on her 2016 PhD). Here, *Error*’s argument regarding redundant precision is deployed in an analysis of the mortar joints of the Sigurd Lewerentz’ Church of St Peter, Sweden 1966 in an early chapter and at length in a chapter entitled ‘Disputing Precision’, which asks: how precise is enough? Mc Vicar refers to *Error*’s analysis of Hepworth and Matta Clark’s resistance to redundant precision and intimacy with the medium they are working with – a distinct position from the fellow references. *Error* is given a dedicated section in a second survey text, Franca Trubiano’s densely researched *Building Theories: Architecture as the Art of Building*, 2023. Trubiano examines the long history of treatises and letters about the process itself of building (*l’art de bien bastir, fabrica e ratio, Baukunst*) from Vitruvius (via de l’Orme, Le Camus de Mézière, Boullée, Laugier, Rondelet, Semper, Viollet-le-Duc, Wagner and Gropius, amongst others) to Ove Arup. Her project is to resurrect the value of words in the making of buildings and invert the primacy of design over construction. She concludes a chapter entitled ‘From Ethics to Aesthetics and Back’ with a section on *Error*:

*“A final text which allows us to rethink the art of building in the context of contemporary makings is that offered by Francesca Hughes in The Architecture of Error: Matter, Measure, and the Misadventures of Precision (2014). It is the all-pervasive terror that exists and persists in the gap between matter and form that is the subject of Hughes’s focus. Her thesis brings to light a subject hidden in the very darkness of architecture’s subconscious. It surfaces with courage the dread that architects are quick to disregard, if not destroy, for the sake of appearances, for the sake of seeming in control, in control of one’s expertise, authority, and professional agency. Hughes’s feminist perspective is central and foundational to the argument.”*⁵⁷

Trubiano’s analysis harnesses *Error*’s argument to draw a parallel between the fall of theory and the fall of making: “For in the same way that theory has inverted its previously held relationship to practice, visual representations of architecture (in the form of drawings and models) host levels of precision that exceed the humanly and materially possible.” ‘Humanely’ is clearly the point, and she adds: “Surely, the earnestness with which architects have embraced robotic construction only points more acutely to this desire for eradicating all error in human-centered making.”⁵⁸ The chapter closes with a pairing of *Error* with Hilary Sample’s *Maintenance Architecture* that surprisingly rests more on their shared eclipsing in architecture’s representation than in the common politics they espouse:

“Maintenance Architecture and The Architecture of Error provoke new ways of thinking about subjects normally marginalized by hegemonic definitions of architecture. It is still the case that both ‘maintenance’ and ‘error’ are peripheral to architectural theory, even if central to those who labor in building. Cleaners, property managers, building occupants, fabricators, artists, financiers, and material suppliers are often more interested in these commonplace outcomes of artifice than are architects. The discipline has conveniently avoided the politics they engender, not because they’re invisible, but because they’re difficult to diagram and quantify. In this, they are poorly given to the geometric descriptions of plans, sections, and elevations. Indeed dirt, decay, swelling, and splitting are forms of becoming that occur in and through time; so too are stained

⁵⁷ Franca Trubiano, *Building Theories: Architecture as the Art of Building* (London: Routledge, 2023) 475.

⁵⁸ *Ibid.* 476

surfaces and misaligned door frames. Rarely, however, are they the subject of architectural descriptions.

And hence, if architectural theory remains but a handmaiden to 'design', it will scarcely be motivated to struggle against the divide which persists between aesthetics and building, between representation and ontology. But struggle to this end it must. This chapter has demonstrated how in a realignment of architecture with the edifying topics of making, craft, details, tectonics, surfaces, metamorphosis, maintenance, and error, the return to an ethics of building is indeed possible.”⁵⁹

More curious (and certainly more satisfying) are the instances in which *Error* is instrumentalised to make trouble: by ACADIA to frame the 2018 conference on *Recalibration: On Imprecision and Infidelity* (addressed in detail in ‘Right-wing Mirror’ below); or by Francisco Diaz in his use of the critique of instrumentalism in *Error* to frame issue 96 of ARQ in 2017: *Instrumentos para que?*

“Having evicted theory in the past decade, architecture has once again relied on instruments” that provide verifiability of process and an aura of neutrality, noting, as does *Error*, that such instruments are not neutral and their use is always political.” Although Hughes acknowledges (in a footnote) that her use of the idea of instrumentalism is not precise in conceptual terms, it is possible to appreciate the craftiness of her misrepresentation: she is not only playing with the usual lightness with which architects borrow concepts from other disciplines, but her imprecision also echoes the provocative title of her book. In this way, her goal goes in another direction. Hughes claims that, with certain nuances and without so much theorizing, this instrumental vision would lie behind not only the modern alliance between architecture and technology but also the contemporary obsession with precision. It is the fear of imprecision, the terror of error, which leads architecture to yield towards technological pragmatism or to rely on instruments – from typology to software – to guarantee the validity of the result within an uncertain and chaotic design process.”⁶⁰

With contributions from Andrés Jaque, Enrique Walker and Zeynep Çelik Alexander, amongst others, the issue widens the critique of instrumentalism’s alleged neutrality to include architecture as a political instrument, architecture’s legal and typological instruments, architecture’s creation of new instruments and architectures lost (or unnoticed) instruments. Establishing a distinction between the instrument (Heidegger’s hammer that is a hammer not because of its shape but because of its use to hammer things) and the *dispositif*, or apparatus, of Giorgio Agamben which has a specific goal, he argues for a double analysis of architecture’s relations to instrumentality: the instruments that produced it and its own instrumentalisation post production – “In other words, if an instrument is something that serves a purpose and its use is independent of its nature, architecture, understood this way, would be foreign to the intentions of the architect. As with the National Stadium of Chile, a building can serve for joyful or heinous purposes, depending on who is managing.”⁶¹ No doubt haunted by this very Chilean legacy, he concludes that as architects the only ‘error’ we should fear is naïveté, or worse still, ignorance.

⁵⁹ Ibid. 477.

⁶⁰ Francisco Diaz, editorial, *Instrumentos para que?*, ARQ, Pontificia Universidad Católica de Chile, no. 96, (August 2017), pp14-15, 14

⁶¹ Ibid, 15

Elsewhere *Error* is cited in and networked to extensive writings in media studies and the expanding pedagogy of failure.⁶² Amongst them *Glitch, the Post-digital Aesthetic of Failure and Twenty-first Century Media*, in which Jakko Kemper references *Error* alongside *Cracked Media: The Sound of Malfunction* and *Imperfections: Studies in Mistakes, Flaws and Failures* to evidence a growing body of work that signals the Imperfect Turn.⁶³ He references glitch theorist Rosa Menkman who defines a glitch as an “actual and/or simulated break from an expected or conventional flow of information or meaning within (digital) communication systems that results in a perceived accident or error.”⁶⁴ Like material error, a glitch constitutes an interruption as it interferes with expectations and thus “has the capacity to rip the user from immersion,” just as the aircraft too heavy to fly rips the aeronautical engineer from metallic immersion.⁶⁵ However, unlike material error, a glitch “can only be defined as a glitch *after* it has disappeared.”⁶⁶ Kemper quotes Olivier, “a glitch is already dead when we name it.”⁶⁷

Most compelling, in relation to my thinking about the perceived threat of error and its agency in architecture’s materialisation (remember Hepworth’s ‘prowling and stalking’) is Kemper’s unpacking of the double spectrality of the glitch. Firstly, as the ghost in the machine, it signals our incomplete grasp of the technologies in which we are increasingly immersed and through which we increasingly mediate. Secondly, (and referencing Derrida’s portmanteau of haunting and ontology, ‘hauntology’), in making the user suddenly aware of the presence of a technology whose main objective is to remain invisible, inaudible: “Most computing power is used in an attempt to make people forget about computers.”⁶⁸ The glitch, like a ghost, straddles the line between two realms, the evident and that which must recede or be forgotten. Similarly the effort and purpose of the construction of materiality, standards and specifications³⁶ and the many related instruments of practice is to make us forget matter, make it disappear. When error erupts, matter returns, thus error too spans two realms: the haunted and the haunting.

The irony does not escape me that had *Error*’s feminist project been more overtly declared, so that feminist uptake would have been more clearly invited, it likely would have not been picked up so extensively by those working in digital fabrication and computational design. This is further confirmed by a review of the various invitations (see appendix item *e.ii.*) to write chapters or give keynotes that followed its publication: robotic landscapers struggling with surreal precision bottlenecks between their lidar-scanned point clouds and a construction process where a component is a boulder, and struggling also with a design project that is by definition never complete (*Robotic Landscapes: Designing the Unfinished*); architect-surveyors grappling with precision and incompleteness in a state-of-the-art cartographic project involving a national border defined by a melting glacier (*A Moving Border: Alpine Cartographies of Climate Change*); cutting-edge digital

⁶² See: Korolkova, Maria, and Bowes, Simon, ‘Mistake as Method: Towards an Epistemology of Errors in Creative Practice and Research.’ *NECSUS European Journal of Media Studies*, University of Amsterdam Press 9.2 (2020): 139-157. Zboinska, Malgorzata A., ‘From Undesired Flaws to Esthetic Assets: A Digital Framework Enabling Artistic Explorations of Erroneous Geometric Features of Robotically Formed Molds’, *Technologies*, MDPI 7.4 (2019). Also, with Dumitrescu, Delia, ‘On the Aesthetic Significance of Imprecision in Computational Design: Exploring Expressive Features of Imprecision in Four Digital Fabrication Approaches’, *International Journal of Architectural Computing*, SAGE, 19(4), (December, 2020), pp1-23.

⁶³ Kemper, Jakko. ‘Glitch, the Post-digital Aesthetic of Failure and 21st-century Media.’ *European Journal of Cultural Studies*, 1-17, SAGE (2022): 13675494211060537. Kelly C, *Cracked Media: The Sound of Malfunction* (Cambridge, MA: MIT Press, 2009). Kelly C, Kemper J and Rutten E eds., *Imperfections: Studies in Mistakes, Flaws and Failures* (New York: Bloomsbury, 2021).

⁶⁴ Menkman in Kemper, Jakko. ‘Glitch, the Post-digital Aesthetic of Failure and 21st-century Media’, 3.

⁶⁵ *Ibid*, 3.

⁶⁶ *Ibid*, 3.

⁶⁷ *Ibid*, 3.

⁶⁸ *Ibid*, 3. Kemper quotes Olia Lialina and Dragan Espenschied’s 2009 argument. See also Jacques Derrida, trans. Peggy Kamuf, *Specters of Marx*, (London: Routledge, 1994).

fabricators trying to tackle the idea of calibration and ‘homing’ in machine space, and how this sits within architecture’s history of relations to origins (0,0) and ultimately the navel of the Vitruvian man (*Homing the Machine*); computational design and fabrication collectives wanting to rethink their critical values and agendas with respect to errors and fidelity (*Recalibration: On Imprecision and Fidelity*, ACADIA 2018).⁶⁹ These invitations were not from the quarters I expected to hear from first. They taught me an enormous amount, and no doubt have shaped my work since. It is as if the book’s audience knew better than me where the project was relevant, where it must go next. The closure of the book actively excluded the present, for the reasons given above, but it is always the present that receives a book. *Error*’s questions and argument clearly hit a raw nerve, and now resonate anew for a generation of researchers and architects whose engagement in computation is post-optimisation, seeks a critical, cultural dimension and its integration into the wider discourses of architecture.

All of which is to say the ‘impact’ of the book is best manifest as its successful introduction of doubt to an area of architectural culture that was defined by its total lack of doubt, indeed that promised design without doubt, if not the end of doubt itself.

Sublimation:

Via this doubt, *Error* clearly played a part in the demise of parametric optimisation (see ‘Right-wing mirror’ below). Techno-determinism is very much on the back burner in the schools it once dominated (Columbia, AA, Bartlett, MIT, RMIT etc.). Despite this, its exit from the studios of many architecture schools has simply seen it sublimated into society’s wider incorporation of techno-determinism and the digital solutionism this has secured. Witnessing the rise of saturation metricisation for optimised management in the universities whose architecture schools once played with this curious new toy, I suspect it has simply exited the studios to only enter the whole ecology of the institution, the whole system. It is in the water now.

Obdurate objects: Thing Theory

At same time as writing *Error* I was running a diploma unit at the AA with Noam Andrews. In 2009 we decided to take the leap and decouple the units’ briefs from geographic sites routinely used as the ‘problem’ to be solved: to cut from physical place entirely and make technology itself (its logics and history) the site.⁷⁰ The unit brought in Historian of Technology David Edgerton and Classicist Mary Beard for two years while we worked on Victorian and Antique technologies, their world-making, temporal orders, internal and external spatial paradigms.⁷¹ We used these to construct what we termed ‘hypercontexts’, inspired by Barthes’ definition of hypertexts in *S/Z*, whose abundance of determinate and indeterminate parameters and refusal to come up with an all-solving object-product was conceived as a direct foil to the shiny, parametrically optimised,

⁶⁹ See ‘Right-wing mirror’ below. ‘The State of Play: Digging in the Sandbox of all the Worlds’, *Robotic Landscapes: Designing the Unfinished*, Christophe Girod, Gramazio Kohler eds. (Zürich: Park Books, 2021) 122-139. ‘Inequalities of Ice’, *A Moving Border: Alpine Cartographies of Climate Change*, Marco Ferrari, Elisa Pasqual and Andrea Bagnato eds., foreword by Bruno Latour (New York & Zürich: Columbia University Books on Architecture and ZKM, 2018) 122-137. ‘On Nozzles and Navels’, *Homing the Machine*, Zach Cohen and Galo Cañizares eds. (New York: Routledge, forthcoming 2023). Conference proceedings: *Recalibration: On Imprecision and Fidelity*, Azalone, Del Signore and Wit eds. ACADIA 2018.

⁷⁰ This to the very great consternation of our colleagues with the notable exceptions of Charles Tashima and John Palmesino/Territorial Agency.

⁷¹ See Francesca Hughes, *Drawings That Count* (London: AA Publications, 2013).

undulatingly-surfaced objects appearing in all the units around us.⁷² Continuing in this vein, an undergraduate studio taught with Gergely Kovács at the Bartlett in 2015/16 worked with Tilly Blyth, then Keeper of Technologies at the Science Museum, on its Large Object Collection housed in Wroughton. The implicit assertion was a reclaiming of the cultural content of technology: that all technology is a cultural production (and indeed that culture is a technological production); that, like culture, technology embodied irresolvable and contradictory values, that it could not deliver on its promise of objectivity, that technological objects are complicated and messy things, like us. This was clearly counter to the culture of both schools at the time, despite the Archigram DNA of the Bartlett.⁷³ At the time, the work of Bruno Latour was still not much read in architecture, nor that of Peter Galison and Lorraine Daston. Thing Theory and Bill Brown's *A Sense of Things* had not yet reached the discipline. For architecture, technological objects remained autonomous things to fetishize, not entangling agents, difficult protagonists with complicated heritage, non-linear histories and sub-optimal futures. Having learnt so much from the objects we invited into the AA and Bartlett studios, I quickly realised I too needed things in researching *Error*; I needed their support deeply, not simply as narrative devices. In the company of obdurate objects I felt fortified by our common critique of abstraction and daily reconnected to Latour's insistence on working with particularity outwards, itself an already feminist strategy (Naomi Schor), and the particular being already networked to the anomalous and the erroneous.⁷⁴ Thus the 'artefactual protagonists' were my allies in the making of the book; my witnesses, my evidence, my moral support, my critics and my companions. It seemed obvious to me that history of science and STS are fields that are of undeniable import to architecture, and vice versa, given their intimately entangled spatial, resource, labour and other histories. This now has become more generally accepted and is evidenced by projects such as *Aggregate* at Princeton, the *Design Technics: Archaeologies of Architectural Practice* series (Çelik Alexander & May eds., 2020), the recent volume *Exactitude* (Riahi & Davis eds., 2022), *Industries of Architecture* (Katie Lloyd Thomas et al., 2015), and *Precision in Architecture: Certainty, Ambiguity and Deviation* (Mhairi McVicar, 2019).

Irresolution:

Steven Connor warns of the point in writing a book at which you have to sever it from future writings: to be clear in the act of closing down a project what belongs to it and what is sabotaging its closure because it belongs in the next book. Colomina similarly talks about the phenomena of the 'exploding footnote'. *Error* suffers from both I suspect. Clearly chapters six and seven, with their propagating footnotes, can now be understood as the beginnings of a focus on architecture and computation's shared histories. Does this explain why the presence of the body as matter with agency in the book, as soma that confounds form, is the fertile, reproducing, unstable and ultimately cybernetic body, and not the body resisting twentieth-century ergonomics instead? This latter may have seemed, as respondee Diaz suggests, a more obvious choice, one that was recently and wonderfully returned to in Colomina and Wigley's *Are We Human?*⁷⁵ Like Wigley's avoidance of race in *White Walls*, my instinct was that this topic was too obvious, and would have drawn the research into questions of eugenics, race, decolonisation that required their own book; their own dedicated, deep and lengthy research, now thankfully taking place. This was not my project. The controlling of reproduction however was – it remains a feminist matter, as we have recently been reminded.

⁷² See Roland Barthes, *S/Z*, trans. Richard Miller (New York: Farrar, Straus & Giroux, 1974).

⁷³ Liz Diller, external examiner at the Bartlett that year, understood what we were doing. Prof Bob Sheil did not. As has been observed before, The Bartlett, for all its Archigram inheritance, and perhaps because of it, is paradoxically bizarrely disinterested in technology, in *techne*.

⁷⁴ And to Aristotle's matter or 'potentiality'. In *Metaphysics* the particular or singular repeatedly trip up his schema. Rather than dismiss them as miscellany, Aristotle almost perversely amplifies their impact in his struggle to incorporate their detailed existence: a literal comedy of errors.

⁷⁵ Beatriz Colomina and Mark Wigley, *Are We Human? Notes on an Archaeology of Design* (Zürich: Lars Müller, 2016).

I have wondered in the process of writing this review whether chapter five should not have been set as part of a triptych on reproduction with six and seven rather than standing alone on representation; although all the reproduction discussion in the book centres on its representation, its struggle with the explanatory models to which it is subjected, so all three could conversely have been a triptych on representation. Perhaps this dilemma confirms the inseparability of all representation from all reproduction. In a sense, chapter 5 is the transitioning middle chapter, that refuses resolution, that insists upon its messy end. I retain a special affection for it – it remained my leitmotif for the book’s refusal to neatly conclude and render itself prescriptive and instrumental. The same resistance with which I defended Dip 15’s refusal to produce the final render in the portfolio, the resolved building-object, was, in *Error*, the refusal to become a formula, a prescriptive manifesto. To do so would, amongst other things, have been antithetical to precisely the critique of instrumentalised bombast that it puts forward: a reductive wrap-up to a critique of reductivism is oxymoronic. I decided the best critique of excessive conclusiveness and premature resolution was to remain obstinately inconclusive.

While the book was with the publisher, Andrés Jaque’s intervention at the Barcelona Pavilion, *Mies as Rendered Society* was built.⁷⁶ It embodied everything I had been trying to do in resisting the aesthetics of completeness (precision’s kiss of closure) and confounding the instrumental impetus. In this installation many of the items used to maintain the immaculate state of the pavilion and stored in its basement were relocated and displayed in the iconic spaces above: “The upper floor is physically transparent, but in order to provide access to an experience of everyday *non-calculability* it conceals the social pacts in which it occurs. The lower floor is opaque, yet it is the place where the contracts, experiments, and disputes which construct the pavilion gain transparency. The Pavilion constructs a belief through the way in which its two floors operate: ‘the exceptional emerges in the absence of the ordinary.’”

Testing the Inconclusive

The reflexive nature of the arguments in *Error* hinge upon my double refusal to conclude and to make reference to specific examples of then-contemporary architectural practice. The use of art practitioners was a tactic that allowed me to engage with certain properties that are fundamental to the making of architecture, while being able to remain absolutely un-prescriptive and detached from the distraction of formal loyalties.⁷⁷ For the purposes of this reflection I set out to test this effect by inviting a selection of respondent colleagues engaging with different facets of architectural production (education, feminist practice, publishing, criticism and theory, digital fabrication and landscape architecture) to respond to the following three questions:

Cast of Respondees:

The Publisher – Francisco Diaz

The Educator – Miguel Rodriguez Casellas

The Practitioner – Liza Fior

The Theorist – Keller Easterling

The Digital Fabricator – Brian Slocum

The Robotic Landscape Architect – Ilmar Hurxkens

⁷⁶ Andrés Jaque, ‘Phantom: Mies as Rendered Society’, *Mies Files 03*, (Barcelona: Fundació Mies van der Rohe, 2013) 3.

⁷⁷ It also had the delightful effect of *Error* being selected by Rachel Whiteread as the only architectural book in her selection of favourite books for her Tate 2017/18 retrospective.

Questions:

1. *Content or internal life: what are the salient lacks of the book (arguments, questions, precedents, topics, images etc)?*
2. *Context or external life: which books come to mind as its key antecedents and descendants with whom it resonates or provides frictions?*
3. *If one imagines the field as determined by an ever-shifting constellation of conversations, how over time have the conversations the book partook in seen the field reconfigure (2014 was another world)?*

Their responses inform this reflection throughout and can be found in the appendix, item *e.v.*). But what one can say immediately is that to my very great delight all six respondents testified that *Error* meant different things to them and was employed in very different ways within their thinking and practice. *Error* has succeeded in remaining ambiguous, in maintaining indeterminacy in a world that increasingly demands conclusion, demands the determinacy that leads to instrumentalisation and ultimately transaction-based solutions. The book stands as a resistance to the culture of solutionist optimisation that was the backdrop to its production.

The Right-Wing Mirror:

From the Digital Turn to the Imperfect Turn

Error put doubt into the system. This found its way, somehow, to a younger generation of architects working in computational design and digital fabrication, in particular those working with robotic fabrication and the newly possible ‘printed building’ that echoed Le Corbusier’s concrete house that could be poured, “as if from a bottle”.⁷⁸ If the wall drawn to six decimal places (now incidentally sixteen) to be built on a muddy building site by gloved hands presents one form of absurdity, then the gap between the design of an algorithm for robotic fabrication, whose geometric precision and resolution is predicated on the calibration and homing of the machine and the regularity of feedback loops between deposited goop and the input instruction, not to mention the viscosity of the deposited goop or sharpness of the router, all destined ultimately for the same muddy site, presents these relations complexly reconfigured, but evermore absurd. It is curious to see amongst the various more recent computational focused publications in which *Error* is cited how many of the authors have gone back to David Pye’s seminal 1968 text, *The Nature and Art of Workmanship*, looking for answers as to where the human touch, the touch of error, now might enter the system.⁷⁹ Reflecting on this, one can understand how the decorporalisation of making (resulting from the decorporalisation of thought) – the printed building – induces a yet-further crisis in our relations to materials and their manipulation. There is extraordinary craft latent in the wrestle that those who are refining nozzle heads, tweaking algorithms and slowing the print are engaged in as they operate on making with robots. But it is deliciously unclear in whose *body* the craft now sits.

This same generation of digital fabricators attended the 2018 ACADIA (Association of Computer Aided Design in Architecture) biannual conference. Convened outside of the US for the first time, in Mexico, this calculated move represented two things: the desire to start to decolonise computational design discourse, and the not-unconnected desire to recalibrate its relations to precision, and the brands of determinism it espoused, and to learn from the unique material traditions of Mexico. The conference title was, accordingly, *Re-Calibration: On Imprecision and Infidelity*, held in Mexico City over three days.⁸⁰ I was invited to give a keynote (alongside Philippe Block, ETH) applying the thinking set out in *The Architecture of Error*. Some fifty papers were given by an international selection of architects working with truly pioneering architectural robotic fabrication research in labs from around the world, including one by Monica Ponce de Leon, the then-newly appointed dean at Princeton, on her work setting up such labs in architecture schools and transforming curricula for the so called Industry 4.0. The introduction to the published proceedings made my desired role clear:

“Either directly or obliquely, the projects included here all undoubtedly deal with these imperfections and deviations. It is our hope that this year’s conference provides a forum for addressing them head on as the product rather than the residue of research. Framing the entire discussion is not simply the understanding of, but also a call to rejoice in the faults and eccentricities in the systems, situating ourselves within and celebrating the history of an epistemics of uncertainty, from Norbert Wiener’s ‘negative feedback’ in Cybernetics, to chaos theory, and more recently to the reaction to this uncertainty in architectural practice described as a “surplus of precision” in Francesca Hughes’ *The Architecture of Error*. This requires a constant questioning of the validity of the paradigms that condition our work within these contexts: how we view the problem at hand (indeed whether or not we even perceive a problem), formulate hypotheses, and later evaluate the fitness of the solutions. In the face of indeterminacy, uncertainty, and unpredictability, this year’s ACADIA

⁷⁸ Le Corbusier, *Towards a New Architecture*, 231.

⁷⁹ David Pye, *The Nature and Art of Workmanship* (London: Bloomsbury 2015).

⁸⁰ October 18-20.

‘recalibration’ aims to understand the inherent infidelities of systems *in which we have been working* and then *to embrace them as a means to new tactics and increased knowledge, rather than attempt to reinvest in mechanisms for control.*”⁸¹

This last sentence (the emphasis is mine) thrilled me – it formulated exactly what I had attempted to argue, and confirmed the effectiveness of the joint tactics of stealth feminism and reluctance to prescribe: that each corner of architectural culture, each practice or position, might take up the thinking in their own terms, with their own logics and methodologies.

The lecture I gave applied the framing of surplus precision from *Error* to the beginnings of my thinking on the history of computation. In a sense it was a bridging moment in my work, suspended between the previous book and the next. Patrik Schumacher gave a dinner lecture at the conference in which he spoke in the most redemptive terms of designing-in optimised user movement in public space by using flocking algorithms through which the crowd of ‘actors’ or ‘boids’ (illustrated by moving triangular arrows in an animation) might be most precisely controlled by the ‘architect-director’s’ form-making in a kind of post-occupancy, post-Spinoza dystopia.⁸² It was a moment of sea change: after the first twenty minutes half the audience walked out, leaving their food cooling on their plates. Had it been at the ACADIA conference two years earlier they would have stayed. Convener, Brian Slocum, has since written that for the computational design community ACADIA 2018 was a pivotal moment of self-reflection, a changing of the guard as the younger generation brought different desires and fears to the table:

“Discussions of glitch and error are now common in work presented, mistakes less so, but still present in a way that did not happen before our conference in 2018. I think there was something in the zeitgeist, so I will only claim partial credit for introducing the ideas to the community and inviting you (who inspired me to push the community in this direction in the first place) to speak at the conference. I have been told by several folks who have longer histories in ACADIA than I do that 2018 was a watershed conference, and made the 2020 and 2021 conferences (which dealt very directly with ideas of bias, equity, and other issues once considered peripheral to the community and its work) possible.”⁸³

Since then, the critical computation I have long been calling for is finally arriving and is starting develop sophistication in its discourses, both around the material quandaries occurring at the navel-like nozzles but also around the socio-political implications of flocking algorithms.⁸⁴ This last not least driven by Queer Theory in the form of queer computation, but also in feminist computation. As Kara Keeling points out in *Queer OS*, as queer computation moves beyond the sexuality of its authors, it is now very much picking up on the project that in earlier decades would have been labelled Feminist: “It understands *queer* as naming an orientation toward various and shifting aspects of existing reality and the social norms they govern, such that it makes available pressing questions about, eccentric and/or unexpected relationships in, and possibly alternatives to, those social norms.”⁸⁵ The ambitions of this are clear: “Queer OS seeks to make queer into the logic of ‘an operating system of a larger order’ that unsettles the common senses that secure those presently hegemonic social relations that can be characterized by domination, exploitation, oppression, and other violences.”⁸⁶

⁸¹ *Acadia Conference Proceedings: Recalibration: On Imprecision and Fidelity*, 8-9.

⁸² He had not been invited to do so, but the late Zaha Hadid’s office had financially sponsored the proceedings, so he claimed the right.

⁸³ Brian Slocum in ‘Responses’ in appendix, *e.v.*.

⁸⁴ See Francesca Hughes ‘Head Banging: Engineered Neutrality + the Parametric Ceiling’, *AD*.

⁸⁵ ‘Queer OS’, Kara Keeling, *Cinema Journal*, vol. 53, no. 2 (Austin: University of Texas Press, 2014), pp 152-157, 153.

⁸⁶ *Ibid*, 154.

Meanwhile, the collective Queer Code's recent interactive digital art installation, entitled *Flocking QT Stories*, 2020, takes a flocking algorithm very similar to that presented by Schumacher in 2018, but assigns 'normative' and 'non-normative' values to white and pink 'boid-actors' and 'normative' and 'non-normative' values to the 'institution-obstacles' they bounce off.⁸⁷ As the algorithm plays out, the boids cluster and dissipate in unexpected ways, and lines of 'harm' or 'support' appear between them. The parameters here are not the quantitative-only values typical of optimising models: "Proximity to normative boids and institutions drains energy from the non-normative boids, and proximity to other non-normative boids and institutions increases their energy."⁸⁸ Click on a pink boid and you will hear their personal story of institutional harm or support. "when a non-normative boid's story is activated, all the non-normative boids' movements are also affected in part by the frequencies of the audio file which is broadcasted to all non-normative boids in the simulation. Higher-frequency sounds affect the cohesive motion, lower-frequency sounds affect the separation, and medium-frequency sounds align their directions with neighbouring boids. The overall effect is that the movement pattern of the non-normative boids is visually distinct from the normative boids while a story is being played."⁸⁹

This neat hijack of flocking algorithms is an exquisite parody. It immediately undoes the exclusion of the qualitative (and the personal) from the optimising system and thus exposes its inbuilt biases, not least towards the hegemony of an abstraction that is itself always already loaded. Through the lens of queer theory, *Error* is received as a queering of the unquestioned hegemony of precision, of the normalisation of its surplus presence, that is more performative in maintaining certain power relations than useful. Such precision "is a drag show," as one respondent wrote.⁹⁰

Among feminist thinkers in architectural computation, the troping of error as a tool of disruption has taken the form of the glitch, with Glitch Theory in computation, and its metaphoric cousin Glitch Feminism (Legacy Russel). In architect Behnaz Farahi's video *Can the Subaltern Speak?*, based on Gayatri Spivak's eponymous article, two women wear niqabs adorned with multiple AI operated blinking camera eyes and turn to face each other as their camera eyes blink out "*can the Subaltern Speak?*".⁹¹ A glitch starts to scramble the phrase, and blink out alternate anagrams, suggesting the making of female glitch-generated language, an AI generated *écriture féminine*, that subverts the male gaze.

While the glitch risks becoming error fetishized, it does directly extrude, via a thinking about the materiality of data and Norbert Wiener's equation of matter and information, the question of error. Within contemporary robotic landscaping research at ETH, we find the ultimate precision bottleneck at such equating of information and matter: the 'point' in a lidar scanned point cloud and the boulder on a Swiss Alps slope.⁹² Robot handler Ilmar Hurxken's, working at the both precision and literal cliff-face comments: "The encounter of such an autonomous system with the chaotic and dynamic natural environment triggered spontaneous reaction that resulted in responsive and open-ended material formations. Instead of predefined manipulations, a feedback loop between the natural terrain and the designed procedure caused ever changing interactions. Without intent, it was error and related resolutions in the digitization of the material world that

⁸⁷ See <https://flocking.queercode.org>

⁸⁸ Ibid.

⁸⁹ Ibid.

⁹⁰ See Miguel Rodríguez Casellas' response in appendix.

⁹¹ See <https://behnazfarahi.com/can-the-subaltern-speak/>

⁹² See Christophe Giroto, *Robotic Landscapes: Designing the Unfinished*.

made the digital-physical system come alive. A real-time choreography between matter and machine causing indeterminate and uncertain evolutions”.⁹³

As precision increases so does error. But error brings vitality to a system and this in turn has induced criticality within a regime once utterly seduced by saturation precision. A retreat is now taking place:

“As described in the *Architecture of Error*, precision can be looked at in function of resolution and in function of repeatability. Landform scale plays a significant role when we look at precision in terms of ever higher resolutions. As illustrated by the coastline paradox, the length of a landmass may be close to infinite depending on the method used to measure it... A quest towards increasing the resolution of digital models as a quality signifier *has mostly ended today since higher levels of resolution may just as well represent higher levels of noise*. Instead, scale optimisation techniques are now the priority. This way, it is not the discrete number that is either true or false, but relations in a field of values that is looked at. Just as form is nothing but a single frame of continuously moving matter, so is precision a place you can move towards or away from over time.”⁹⁴

It is perhaps not surprising that critical precision arrives, not from the quarters of architecture but of landscape architecture. This is the beginning of the end of the paradigm of ubiquitous precision, irrespective of need. It is also the beginning of the end of blindly confident techno-solutionist thought. Errors are omnipresent within this new robotic landscaping practice, and, as Hurxkens explains, “suddenly we have to engage critically with the inputs of the system instead of fixing the errors it produced. Fortuitously this notion is embedded throughout *The Architecture of Error*. It is not optimal results we should strive for, it’s the questions we need to ask.”⁹⁵

⁹³ See Ilmar Hurxkens’ response in appendix, *e.v.*

⁹⁴ *Ibid.* My emphasis.

⁹⁵ *Ibid.* – note the resonance with the embracing of the sub-optimal in Keller Easterling, *Medium Design: Knowing how to Work the World*.

The Left-Wing Mirror:

Well before architecture's Material Turn and its typically delayed uptake of New and/or Feminist Materialism, Jennifer Bloomer had already described to us a lively material world of agency and kinship and complex capacities for co-production, including misbehaviour. This was the material world I was attempting to bring to bear on the very-much-less materialist regimes of aeronautical engineering and concrete testing specifications. But also to bear on the models that attempt to organise the morphogenetic processes in biological reproduction and the form-and-matter stories they tell: parallel projection, causal linearity, metaphors, code, lines and loops. Both domains – material instrumentalism and reproductive morphologies – play important roles in architecture's own epistemologies about its own autopoietic traditions. Both were ripe for parody – continuing the practice already established by Diana Agrest and Bloomer of parodying the tradition in which male architects see their buildings as offspring.⁹⁶ Throughout my writing of *Error* I was consciously paying heed to Bergren's caution, that given "this troping of the feminine creates a slimey mess, a situation that ... is a paralysing quagmire for women who make objects" (Bloomer's words), we would be wise to work not inside or outside the feminine but beside it, something she called the 'para feminine'.⁹⁷ *Error*'s critique of reductive abstraction, and behind it, objectivity and the concomitant Cartesian conception of matter as inert, was already a well-established feminist project.⁹⁸ My 'para feminine' strategy was to rehearse this not by the deployment of the subjective or any overt *écriture féminine*, but in objectivity's own terms, on its home turf: interrogating the systems of measure and precision that deliver its truths. Nonetheless, true to Hélène Cixous' instruction, the project's driving *crise* had indeed started from and in my own body, its own sexuality and autopoietic capacities: I knew the quagmire well.⁹⁹ It had also started with the collective (albeit repressed) bodies of the contributors of *The Architect: Reconstructing Her Practice*.

The sympathy for material, its recalcitrance, resistance, desire and agency, that permeates *Error* and is the key it is written in, first found expression in a lecture I gave at Princeton, in 1997, entitled *Cleavage*, on the process of editing the various essays by the ten women architects that made up its contributors: Catherine Igraham, Nasrine Seraji, Merril Elam, Jennifer Bloomer, Dagmar Richter, Diana Agrest, Beatriz Colomina, Margret Hardadottir, Martine de Maeseneer and Christine Hawley. In the course of editing the essays (by fax and on a tiny 128KB Apple Macintosh, an astonishingly arduous interface by today's standards) I became acutely aware of the almost material resistance of the words and letters, of the labour involved in heaving them around and welding their messages; aware too of their sabotage and their will. At the time I was yet to read *Metaphysics* but had already come across Barbara Hepworth's technical notes and was struggling, in my practice with Jonathan Meyer, with the design of an astronomical observatory. Something about the precision of Tycho de Brahe's wall was already bothering me and had found its way into the lecture about the words that had been giving me such trouble:

"Tycho de Brahe's wall is... both building and instrument. With this de Brahe made readings that we have only quite recently had the technology and the need to improve, the built-in error (as low as 1%) being so incremental that it is almost insignificant."¹⁰⁰

⁹⁶ See Diana Agrest, *Architecture from Without* (Cambridge: MIT Press, 1991).

⁹⁷ See Ann Bergren, 'Dear Jennifer,' in 'Architecture and The Feminine: Mop-up Work,' *ANY*.

⁹⁸ See Nancy C. M. Hartsock, 'The Feminist Standpoint: Developing the Ground for a Specifically Feminist Historical Materialism,' in Sandra Harding and Merrill B. Hintikka (eds) *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science*, (Berlin: Springer, 1983), pp. 283–310.

⁹⁹ See 'The Laugh of the Medusa,' *Signs*, University of Chicago Press, vol. 1, no. 4 (Summer, 1976), pp. 875–893.

¹⁰⁰ Francesca Hughes, 'Cleavage' lecture at Princeton University, School of Architecture, 26 February 1997.

The private observatory we were designing was to house two state of the art telescopes that would have to negotiate the ambient light pollution and humidity of the Burgundy site. What redundancies of precision were at play in this brief? Lines – many – that remained in *Error*'s introduction some seventeen years later, were formulated for this lecture:

“Returning to Tycho de Brahe and his wall, the effective precision of the naked eye and a wall is very telling. Telling about de Brahe's skills in observation, his understanding of the materiality of error, the abstraction of accuracy, the value of incremental, repetitive practices (his accuracy was achieved by rereading and rereading the same measurements). But there is something more, that is important here: the fact that the instrument was a wall, and masonry at that, reveals our whole obsession with not precision and technology per se, but with the aesthetics of precision and technology. A precision that is frequently redundant (doesn't need to be there, functionally or symbolically) or fake (it isn't actually precise). In such instances precision can only be understood as standing in for something, but what? Precision is the aesthetic of control, of purpose uncompromised by the reluctant, recalcitrant and unpredictable matter. The desire to mimic the aesthetics of precision, and not to actually be precise, is the desire to firmly repress the threat of matter directing, even for a moment, form. Precision as the excessively laborious dominance of matter by form, a dominance that reaches an almost hysterical pitch.”¹⁰¹

The lecture concluded:

“The repression of matter by form shadows other repressive actions in architectural culture – matter, gender, sexuality, the body, all slip in and out of each other's roles, crudely united, as it were, in the face of opposition. The suppression of matter is the suppression the the eroticism of matter and all that it stands for. That which not only weeps and seeps and oozes, and all those words which connect us to the now much elaborated dirty body, but also fractures. Not the cool fracturing that produces the formally seductive fragment of so many architectural conceits, but the real fracturing of material that is cataclysmic or inconsequential, that is sudden, loud, produces shards and dust, that reveals a previously unimaginable vitreous interior, shockingly naked, a new exterior.”¹⁰²

Five months later I would be pregnant with my fist born and her labour would equip me with everything that powered the book, as its preface admits. But clearly, I had already inherited so much, from both Bloomer and from the process of editing all the words of all the women (architects) whom in ‘reconstructing’ their practices did not mention their bodies, their fertility, their own corporeal ‘quagmires’.

As I make clear in the acknowledgements, the book would not exist without the foundational influence of Bloomer's clinamenal scholarship. In my very early thoughts about *Error*, in 1999, the project was to be about ‘matter.’ Indeed I was stuck with ‘matter’ for a while, confounded by its own confounding of representation. At the same time I was in frequent conversation with Bloomer who in her extraordinary work was already shifting from a thinking around *écriture féminine* and the female body in French Feminist theory (Irigaray, Kristeva and Cixous) to one about all bodies, animate and inanimate, and all matter, and its erasure – a now key tenet of contemporary feminism, or the so-called 4th wave feminism. At the time I never imagined

¹⁰¹ Ibid. The lecture continued: “This is not about the architecture of plasma cut steel versus that of lumpy walls, but about a symptomatic mimicking of the precise. A predilection in architects that one suspects is more than the usual control freak response to the hopelessly imprecise nature of the construction process. The aesthetics of precision present the form of precision, the formal rather than the material, or even programmatic, properties of precision. The aesthetics of precision serves to further press form down onto matter.”

¹⁰² Ibid.

Bloomer's work was going to be forgotten, we assumed we had a good three decades more of her brilliant and daring crafting ahead. Indeed a brief glance at several key volumes on New Materialism show they were published just after Bloomer exited architecture, no doubt thus delaying their ultimate and only recent entry into architectural thought, but also missing the opportunity to consolidate with her project and effectively counter the post-critical decade, a dark-age of techno determinism. Just as the optimising doctrine that had driven *Error's* critique is, in its sublimation, gone, but ever more present, similarly, feminist thought – thought that could have resisted it, thought about material agency, about the messiness of entangled and embodied life, about non-conforming and dysphoric possibilities – was effectively excluded and now has, in its intersectional strategies, become less distinct. This latest 'wave' is more like a slow flood, rising up through the floorboards. Published in 2014, *Error* came out in the long quiet between the 3rd and 4th waves, or between the wave and the flood; a lull in proceedings.¹⁰³ Outside of architecture Occupy was getting going, transgender and queering theory just starting to touch architecture (Lucas Crawford *Transgender Architectonics*, 2015), but Françoise Vergès *Decolonial Feminism* would not come out for another three years. Like Keller Easterling's *Extrastatecraft*, which came out the same year as *Error*, its feminist project is embedded deep within its logics. Both play a longer game.

The new footprint of the myriad feminisms that make up contemporary feminism is a distributed and embedded network (Bloomer, would have said 'mantle') that is inseparable from the many struggles it engages with: decolonisation; indigenous rights; queer theory and the rights of non-conforming bodies; the posthuman and interspecies world; the practices of care and repair. Ideally, though I fear this is not the case, it is now irrevocably sublimated into all our registers as architects: pedagogy, historiography, theory, practice, programming, and materiality, there to stay in the form of experimental pedagogies, expanded histories, embodied theories, collaborative practices and alternative programs and materialities respectively. The *ARCH+ Feminist Spatial Practices Map* (2022, see appendix item *e.iii.*) illustrates just this.¹⁰⁴ It is an, albeit Western-centred, ambitious endeavour which attempts to map the rich diversity of feminist spatial practices by architects and non-architects alike (Ursula K. Le Guin is included, as is Judith Butler), now distributed across architectural culture's many fields and their borderlands, listed as: Reclaiming Public Space; Foregrounding Intersectional Justice; Re-writing History; Re-thinking Domestic Space; Transforming Pedagogies; Depatriarchizing Cyber Space; Queering Spaces; Decolonizing Spaces; Emphasizing Care; Lobbying for non-exploitative Labour; Advocating for Institutional Change; Repairing Ecologies. In this map my name appears between Re-writing History and Transforming Pedagogies.

In 'The Unbearable Being of Lightness' Bloomer famously treats the erasure of matter as a proxy for the erasure of *mater*: "What is at stake in the translation of a world into a diagram, into electronic impulses, is 'Now you see it, now you don't.' (What disappears here? Mommy, that's who). The large-scale abstract diagram constitutes a repression of the matters of *mater* and her etymologically-linked *material*."¹⁰⁵ Echoing Griffin, Bloomer's work reminded architecture that repression of matter is always a feminist concern, an argument repeated in *Error* and that Feminist Materialism has since secured – though the materialist tradition clearly long predates all.¹⁰⁶ Bloomer's way into the question of matter was via its avatar, gravity, or gravidity: "All material

¹⁰³ Perhaps this more than anything explains why the Google citations footprint is not more feminist.

¹⁰⁴ Created by ARCH+ "as part of the research on this issue and collects important contemporary feminist positions and (space) practises. It represents a selection with a focus on positions from the Western Hemisphere and does not claim to be complete". *Feminist Spatial Practices Map*, 'Zeitgenössische Feministische', N246, 2021, coverleaf.

¹⁰⁵ Bloomer's argument uses Freud's analysis of the *Fort-da* game suggesting that the repression of matter by architecture rehearses our desire to flee our first home. See 'The Unbearable Being of Lightness' in *Thresholds*, no.20, Spring, 2000, p.15.

¹⁰⁶ Althusser traces this tradition through Epicurus, Spinoza, Marx, Wittgenstein, Heidegger and himself. We might add Aristotle, Hobbes, La Mettrie, Deleuze, Bergson's *élan vital* and Hans Driesch's *Entelechy*

assemblages exhibit gravitation among themselves. When I stand before a building or a tree or another human being, there is gravity at work between us. In a sense, all bodies of matter, great and small, are components of one great assemblage held together by an invisible and elastic structure of gravitational forces.”¹⁰⁷ Note the already-relational (ecological even) thinking at work. Note also the concomitant struggle with abstraction: “The line, bulging thing, has swallowed a great deal of matter in the hope of hiding her, that little matter of matter.”¹⁰⁸

As my thinking around matter and its erasure sought the one thing that had evaded erasure, the argument segued into a thinking about matter’s other avatar and came to rest upon its agent, error. Matter may have been erased but she left us trouble, in the form of error. Thus any critique of our systems for the control of material error cannot but be feminist. Thinking about matter through the question of error has since allowed it to segue into the queer logics of errancy and that which evades definition in the infrastructures of value. If we are to seek meaning in the Google citations footprint mentioned earlier, my para-feminine route may have been too para – too sly, too prematurely networked in its make-up – to alert a (at the time) brow-beaten feminist audience. The same is likely true of Easterling’s *Extrastatecraft: the Power of Infrastructure Space* (2014) but not of her *Medium Design: Knowing how to Work the World* (2021) – the two decades constituting such different audiences.¹⁰⁹ But I maintain that the net effect of Bergren’s advice is the expanding of feminism’s collective footprint, embedding it into and across all registers. In the introduction to the book I wrote, “the personal stops here,” but as one of the respondees observed: “that was not really true, was it?” He is correct. It was a lie; planted to not exclude precisely the readership I was critiquing. It worked.

Looking back, it is curious to observe that somewhere between the publication of Steven Johnson’s *Emergence* (2001, the bible for optimisation proponents and those working in computation and fast fixating on optimisation) and Coole and Frost’s *New Materialism: Ontology, Agency, and Politics* (2010, with essays by Grosz, Braidotti, Ahmed, Bennett collectively critiquing matter as inert and causality as linear), architecture lost its own discourse on matter – somewhat paradoxical given that self-organisation theory comes from matter. It synchronously also lost its own feminist discourse until feminist materialists seeking what I would call, for want of a better word, the *sub-optimal*, paved the way for architecture’s own material re-turn. My enormous regret for architecture (if I may) is the ill-timing that delayed the advent of feminist critical computation: the two projects, computationally modelled emergence and feminist materialism, could have, *should* have, converged.¹¹⁰ Architecture’s first foray into computational design processes *should* have been feminist. Had Bloomer stayed on, it might have been – in a public lecture in Paris in 1999 she had shown a slide of Piranesi’s *Ampio Collegio* and provocatively stated it was a plan of the internet.¹¹¹ She was the missing link, but she left. It was not until very much later (2017) that feminist computation and materialism would find each other:

“This is a call for the development of a more robust theoretical position about the gender implications of advanced parametric design and the use of machines to design and fabricate

¹⁰⁷ Bloomer, ‘The Unbearable Being of Lightness’, 13.

¹⁰⁸ Bloomer, ‘The Matter of Matter: A longing for gravity’ in eds. Diana Agrest et al., *The Sex of Architecture* (New York: Harry N. Abrams, 1996), 163. I am indebted to Katie Lloyd Thomas for recently reminding me of the neatness of this particular formulation of an argument that repeats across Bloomer’s writings.

¹⁰⁹ (London: Verso, 2014) and (London: Verso, 2021) respectively.

¹¹⁰ Diana Coole and Samantha Frost’s words, albeit coming from very different corners, could have been Johnson’s: “If such patterns of organisation are not predictable or determinable, this is in part because there is no longer a quantitative relationship between cause and effect.” Coole & Frost eds. *New Materialisms: Ontology, Agency, and Politics*, (Durham: Duke University Press, 2010), 14.

¹¹¹ *Altérités, International Conference*, Ecole d’Architecture Paris Villemin & Ecole Nationale Supérieure des Beaux-Arts, 4-5 June 1999.

architecture. As digital fabrication has made material the network conditions of cyberfeminism, it is time to revisit the relationships between feminism, architecture, and technology. We propose a framework that relies upon intellectual traditions of feminism and deliberately focuses on developing technologies as a locus of power and influence in architecture.”¹¹²

Revisiting Bloomer’s work, we now see that she had already insisted upon the both/and, and had rehearsed cybernetic loyalties to process over product: the how over the what. Implicit throughout her writings is a more complex thinking about causality and agency, later articulated anew in Coole and Frost’s introduction to *New Materialisms*:

“the whole edifice of modern ontology regarding notions of change, causality, agency, time, and space needs rethinking [...] For materiality is always something more than “mere” matter: an excess, force, vitality, relationality, or difference that renders matter active, self-creative, productive, unpredictable. In sum, new materialist are rediscovering a materiality that materializes, evincing immanent modes of self-transformation that compel us to think of causation in far more complex terms; to recognise that phenomena are caught in a multitude of interlocking systems and forces and to consider anew the location and nature of capacities for agency.”¹¹³

Error’s unpacking of the fallacy of the apparent autonomy of Soemmerring’s foetus; of the modernist concept sketch; of Schrödinger’s ‘gene’; of François Jacob and Jacques Monod’s ‘program’ and the linear causality they anchor, and too the fallacy of near virtual elastic behaviour, points to exactly this. That is to say, the project of rethinking causality is inseparable from that of gross matter and the question of error: “material forces themselves manifest certain agentic capacities and in which the domain of *unintended or unanticipated effect is considerably broadened*.”¹¹⁴ The aeronautical craftsmen exploring beyond the elastic range with spruce, Hepworth’s listening hand, Whiteread’s delegation to the intelligence of liquid concrete in the pour, Axel following his stream, Matta-Clark’s entropic accelerations, the embryologists watching the cell as they would an individual wild animal all require and enact a sense of material agency in which its domain is broadened via a tolerance of error. All pay attention to the “vibrant, constitutive, aleatory and even immaterial indices that characterise the new senses of materiality and materialisation.”¹¹⁵ In their already post-human practices as they interrogate the “anthropological machine of humanism,” they implicitly enact the dismantling of static objectivity, and practice the dynamic objectivity that *Error*’s postscript calls for.¹¹⁶ It is a call that, as well as being feminist, is also necessarily nostalgic. Matter is our home. Manuel De Landa’s 2015 introduction to AD’s *The New Materiality* heroically declares “gone is the Aristotelian view that matter is an inert receptacle for forms that come from the outside”.¹¹⁷ But the matter, or potentiality, described in Aristotle’s *Metaphysics* is already unreliably inert; it already has a tendency to make trouble – most keenly in bodies – but also in other things that rot, decay, turn sour (wine for instance), and in animals that prove infertile (hybrids such as mules). From the ‘beginning’ matter was never truly inert, just under various regimes of control, and from the get-go its worst behaviour was found in the body and the

¹¹² Shelby Doyle and Leslie Forehand, ‘Fabricating Architecture: Digital Craft as Feminist Practice,’ *The Avery Review*, 25, 2017, 1-10. <https://averyreview.com/issues/25/fabricating-architecture>

¹¹³ Coole and Frost, *New Materialism*, 9.

¹¹⁴ Ibid, 10. My emphasis.

¹¹⁵ Ibid, 14-15.

¹¹⁶ Giorgio Agamben in Coole and Frost, *New Materialism*, 20.

¹¹⁷ Manuel DeLanda, ‘The New Materiality,’ *Architectural Design*, 2015, pp.16-21, 16.

reproducing body. Thus, the reproducing body, that still turns in architecture's own epistemologies, remains an acute site for architecture to think through its material practice.

The Sat-Nav:

The View from the Future or Education is the Conclusion

Both at a practical and a symbolic level, precision has historically been part of the project of whiteness. Norton Wise argued that measure was central to the management of the empire – quantities travel, qualities don't.¹¹⁸ We know from Edward Said the role that precision has played in the colonial imaginary, and the recasting of relations between the colonised and white accuracy. He quotes Lord Cromer's *Modern Egypt*:

Sir Alfred Lyall once said to me: "Accuracy is abhorrent to the Oriental mind. Every Anglo-Indian should always remember that maxim." Want of accuracy, which easily degenerates into untruthfulness, is in fact the main characteristic of the Oriental mind. The European is a close reasoner; his statements of fact are devoid of any ambiguity; he is a natural logician, albeit he may not have studied logic; he is by nature sceptical and requires proof before he can accept the truth of any proposition; his trained intelligence works like a piece of mechanism. The mind of the Oriental, on the other hand, like his picturesque streets, is eminently wanting in symmetry. His reasoning is of the most slipshod description [...] They are often incapable of drawing the most obvious conclusions from any simple premises of which they may admit the truth. Endeavor to elicit a plain statement of facts from any ordinary Egyptian [...] He will probably contradict himself half-a-dozen times before he has finished his story."¹¹⁹

With the arrival of new climatic regimes, new gender paradigms and the surfacing of indigenous counter histories and sciences, the Enlightenment modern mind that needs singular solutions, measured in singular terms within its ideational monotheism is finally starting to collapse.¹²⁰ Its many constructions of deluded autonomy, several of which *Error* attempts to dismantle (the concept, the program, the chromosome, the foetus, the performance of metal and concrete and measure itself) no longer stand up to scrutiny. More recently, Keller Easterling's *Medium Design: Knowing how to Work the World* (2021) argues that solutions are mistakes: they are weak and things will always go wrong. That to address the intractable problems we face we need to abandon the idea of the single, or even multiple, solutions and instead bring our many problems together into productive combinations – to design systems that shouldn't work, that are indeterminate in order to out-manoeuvre singular solutions for our "homogenised, pasteurised, Turing complete worlds".¹²¹ The error we need to engage with next in the redesigning our future is likely not material, but systemic. And the system that most directly impacts architecture's future is its education. As an educator I have long argued for the value of error, risk and failure in every dimension of the learning process.¹²² The postscript of *Error* called for the building of approximatory and explanatory models that mediate with more equanimity between what we control and what we don't; for the declaring of the full indeterminacy at large in our material (and other) processes; for the designing of more democratic epistemological models that incorporate feedback, co-production and the production of that which is by definition unfinishable. If architectural education is to decolonise and decarbonise, as it must, the necessary transformations of curriculum, accreditation, school governance and knowledge exchange will by definition require us to embrace all three such imperatives. Anyone who has toiled at the cliff face of design teaching knows that what Joan Ockmann calls the "unfettered desire" of the studio is paramount.¹²³ Yet the risk-averse

¹¹⁸ See M. Norton Wise ed., *The Values of Precision* (Princeton: Princeton University Press, 1995).

¹¹⁹ Edward Said, *Orientalism* (London: Penguin, 1991) 38.

¹²⁰ See Paul Preciado, *Dysphoria*.

¹²¹ See Keller Easterling, *Medium Design: Knowing How to Work the World*.

¹²² See Francesca Hughes 'Failing to Fail', *The Architectural Review*, no.1494, Sep 2022: 96-8; and 'A School Willing to Take Risks', joint interview with Lesley Lokko in 'Where do we go from here?', *The Architectural Review*, issue 1486, November 2021.

¹²³ See Joan Ockman ed. *Architecture School: Three Centuries of Educating Architects in North America* (Cambridge MA: MIT Press, 2012).

university's increasing desire for certainty, for teleology and solutions fetters us in our present endeavour; indeed, it makes fools of us. The greatest risk for architectural education's future is to remain in a risk averse environment. The current ascendancy of digital solutionism, and the exactitude of the inexact now proffered by big data, combined with university buy-in to mediocre management protocols, many developed decades ago for quite different industries and settings, has resulted in the present excess of instruments of measure that have a vice-like grip on education – all this precisely at the moment when education needs to be free to take risk and shape-shift.¹²⁴ As with other domains this mass-metricisation feeds the transactional compliance paradigm; in education too “capital disrupts the incalculable productivity of things that are alive”.¹²⁵

In 2018 I paused writing architectural theory and teaching in order to run an architecture school of 1500 students at the University of Technology Sydney, for two years. In that the Australian project of the neo-liberal university is ten years further down the road than its European counterparts, I return as if reporting from a future all in education should fight to reject. In my management role I faced head on so much of what I had been concerned with in *Error*: the concealed backfiring of systems of measure; the manifest intolerance their repressions institute; their always-conservative action. A curious property of systems of measure, and the precision that they must answer to, is that the more rigorous and precise a system is, the more exquisite and unpredictable the error that surfaces to outwit it. Such is the tragicomic nature of measure's always-already-thwarted project. Measure literally produces error. The many instruments of measure a school is now required to think and operate *through* are presently doing just this.¹²⁶ This is particularly problematic for architectural education. The architecture school has always been an outlier in any university and now it seems it is the canary in the coalmine of education that is increasingly under attack from transactional logics – logics that require metricisation – that in turn have the undesired effect of entrenching mediocrity.¹²⁷ As architectural education communities attempt to transform themselves, they find themselves ring-fenced by instruments of measure that block precisely the change the school's collective intelligence (of its students, academics and administrators) knows it needs to make. The many instruments of ‘improvement’, as they insist upon solutions, hold the productive space of error and doubt and hesitation that schools need in order to be free to explore always just out of reach. They do not let us ask: What happens when skill is error? What do we lose in excluding failure? They do not allow us to step outside of the comfort zone of the quantified-in-order-to-be-optimised so that we might explore the potential unravelling of carbon logics embodied in the project of decolonisation via their own fertile errant routes. Metricisation in education fossilises our ‘intelligence that works like a mechanism’ – itself part and parcel of the problem – and blocks our access to precisely the ‘slipshod’, the ‘wanting in symmetry’ and the ‘contradictory’ via which we might design our way out of the future cul-de-sacs

¹²⁴ See Francesca Hughes and Urtzi Grau, ‘Cul-de-Sac’, *e-flux Architecture* and Charles Jencks Foundation, ‘Chronograms of Architecture’: <https://www.e-flux.com/architecture/chronograms/524739/cul-de-sac/> published 9 March 2023.

¹²⁵ Keller *Medium Design* lecture keynote held at 3rd International Conference “Spatial Refiguration: Dynamics, Challenges and Conflicts” (28/29 October 2021) by the Collective Research Center 1265 “Re-figuration of Space”.

¹²⁶ They also are deciding the frames of reference, even the words (or should I say acronyms) that a school is to make decisions through: KPI (key performance indicators); SFS (staff/student feedback surveys); SLO (student learning outcomes); research audits and indexes (REF, ERA, H-Index, Symplectic et al); SMART goals (Specific, Measurable, Assignable, Realistic and Time-related); OHS (Occupational Health and Safety) and risk assessments, to name a few.

¹²⁷ Exactly how this happens is complex. In instances, and echoing parametric optimisation at its feverish height, instruments of measure are lent disproportionate (near-total) authority as arbitrators in nuanced and complex decisions, while subtle judgement is pushed aside. Elsewhere, as a form of lazy abdication to the epistemological autonomy of measure, they are harnessed as guarantor of a path of least resistance through the greater system – who dares argue with a number? Elsewhere again, they are brutally weaponised in management projects that recall statistics’ eugenic forays. In all instances, the problem is not measure *per se*, but the abuse of measure where the dominant form of abuse is simply believing in it too much.

we have fabricated for ourselves. Present managerial instruments of measure miss the complex alchemy that is learning, and in so doing deny truly fertile knowledge exchange. In their promoting of the quantitative over the qualitative, they entrench the predictable, the safe, the satisfactory (and the satisfied), the repeatable, the easily representable, the timetabled, instrumentalised and attainable, and of course, the profitable – thus effectively devaluing to the point of exclusion precisely what we need right now: the unpredictable, the risky, the anomalous, the unrepeatable, the uncertain, the slow, the non-linear, the multivalent, the inconclusive and that which evades all representation or instrumentalization. Conversely, error, like failure “takes us beyond assumptions and what we think we know and can be represented.”¹²⁸ If we were to dismantle the mechanism that block our access to failure, we would automatically be creating a space for the fertile productions of error that by definition are not mediocre. As Lisa Le Feuvre points out, “rather than producing a space of mediocrity, failure becomes intrinsic to creating open systems and raising searching questions: without the doubt failure invites, any situation becomes closed and in danger of becoming dogmatic”.¹²⁹ Thus architectural education, as our vehicle to the future, needs to redesign our relations to measure; to enshrine doubt, not certitude, as we resurrect nuanced measure’s self-awareness of its tragicomic poignancy; and to tie this to the weaponizing of that state deemed weak: generosity. That is the lesson of those that work with error. That is what I wait for in the future, predicted or not.

¹²⁸ Lisa Le Feuvre ed., ‘Strive to Fail’, *Failure* (Cambridge MA: MIT Press, 2010) 18.

¹²⁹ *Ibid.*, 17.

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