Building Materials: Conceptualising Materials via the Architectural Specification

A thesis submitted to Middlesex University in partial fulfilment of the requirements for the degree of Doctor of Philosophy

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May 2010

Acknowledgements

I am grateful to the many practitioners and specifiers who have discussed their specification practice with me and made documents available. Most particularly John Gelder at the NBS who has been very generous in sharing his research. Also to Colin McGregor formerly of the NBS, to Tony Brett of Schumann Smith and his colleague Geoff Taylor, Mark Taylor of Allies and Morrison, Jim Randall and Martin Mulchrone of DLG Architects, Sarah Wigglesworth of Sarah Wigglesworth Architects, Deborah Saunt of DSDHA, Helen Stratford of Mole Architects, Megha Chand formerly of Chetwood Associates, Simon Tucker of Coterell Vermeulen, RenéTobe, David Howarth, Annette Main at Rogers Stirk Harbour + Partners and to Fiona Orsini and colleagues at the RIBA Archives.

Others have discussed my work with me at various stages, particularly Stephen Walker, Tilo Amhoff and Cécile Malaspina, and also Niamh McDonnell, Nicholas Beech, Matthew Poulter, Chrysanthi Nigianni, Susannah Hagan, Alberto Péréz-Gómez, Adrian Forty, Liam Ross, Nathan Brown and Gerald Niederle.

I am also grateful to family and friends who have helped me make time: Anne, David and Sally Lloyd Thomas, Finbarr Finn and Barry O'Leary, Rachel Thomas and Charles Trevelyan and, above all, Christian Malnig.

Seven years ago I approached the CRMEP at Middlesex University about the possibility of this research. I had the enormous good fortune of being directed towards Adrian Rifkin as a supervisor (now at Goldsmiths) and then to Peter Osborne. I am grateful to them for their encouragement and intellectual generosity and for the quality – so often exhilarating – of their engagement. In light of recent shocking events and the imminent closure of the CRMEP, I can only hope that the efforts of staff, students and the international community will result in the reversal of Middlesex University's unfathomable decision, and that others will continue to benefit from the presence of this extraordinary open and demanding space for transdisciplinary thought.

My gratitude and love, finally, to my late grandmother Barbara Falk, for her support in so many ways.

Abstract

The last few decades have seen unprecedented levels of change both in the production of building materials and in the ways they are deployed in building. Despite rigorous debates about materials in architecture from very different areas of theory and practice – ranging from the new materialists' critique of the concept of matter to ecological concerns with embodied energy and life cycle analysis of building materials – the extent to which these developments might demand more adequate conceptualisations of materials remains unexplored. The position this research takes is that building materials cannot be assumed to be nothing more than particular instances of matter in general – whether matter is understood in its classical philosophical hylomorphic relation to form, or as the physical substances of science. Here, the architectural specification – a document usually considered to be merely 'technical' and therefore outside theoretical enquiry – provides descriptions of building materials drawn from *inside* architectural practice. It yields a number of types of description – from 'naming' to the 'recipe' to performance – and the differences between these 'forms of clause' and the degree to which each is contained by or exceeds the notion of hylomorphic matter are shown to involve radically different conceptualisations of materials. Moreover, the specification makes visible the changing historical and industrial contexts that constitute its format and content. Part I sets out this variation and constructs a typology of forms of clause, and Part II studies two of them in detail. The key philosophical move derives from Gilbert Simondon's work on individuation in so far as materials are considered not as substances or as matter (as already individuated individuals) but in terms of the dynamic processes through which they are constituted (individuation). First, process-based clauses provide found descriptions of form-taking in terms of such operations, and expand Simondon's account of the preparations which set up the possibility of individuation in a technical object to include statutory, social and other operations in addition to the physical ones he describes. Second, the performance clause requires us to understand how specific use (excluded by Simondon in his accounts of technical systems) might itself become preparatory in the new industrial conditions of performance-engineered materials. Part III takes up Simondon's 'complete system' of individuation and understands the variety of forms of clause as evidence of a variety of 'systems of material' which necessarily include the full range of the preparations which make possible the specific deployment of any given material in building. Furthermore, what is constituted in any individuating system is not so much an individual as the possibility of a transductive mediation between hitherto disparate realities. It is, in particular, the possibilities of new mediations that are produced in industry – between a terrorist threat and a piece of glass – in addition to more familiar ones – between a notion of form and a lump of clay for example, that demand attention and new conceptualisations. For Simondon, transduction is also a process of thought which derives problems and resolutions from within a domain rather than seeking a principle from elsewhere. If we are to understand how concepts emerge from applied practices and their productions, and not just from philosophy and science, then the transductive method has applications well beyond the question of building materials that is put into motion via the architectural specification in the process of this research.

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> Transduction, then, is not only a path taken by the mind: it is also an intuition, since it allows a structure to appear in the domain of a problematic yielding a solution to the problems at hand. In the sense contrary to *deduction*, however, transduction does not seek elsewhere a principle to resolve the problem at hand; rather it derives the resolving structure from the tensions themselves within the domain just as the supersaturated solution is crystallized due to its own potentials and the nature of the chemicals it contains, and not through the help of some foreign body.
>
> Gilbert Simondon, *L'indivdu*

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Chapter One: Introduction: From Matter to Materials via the architectural specification

> Histories of philosophy are full of discussions of the development of the concept of matter, yet hardly at any point do they touch on the nature and properties of materials.
>
> Cyril Stanley Smith[1]

For engineer Cyril Stanley Smith philosophy and the pure sciences have engaged with concepts of matter at the expense of any sustained enquiry into 'the nature and properties of materials'. By engaging only with the concept of matter, he argues, the kinds of knowledge of materials which an engineer acquires and mobilises are marginalised. In making this point, Smith also makes a distinction between matter and materials which is itself extremely pertinent yet almost entirely overlooked. In most philosophical accounts of matter it is assumed that materials are particular examples of matter[2], not as Smith suggests here, conceptually different to matter.[3]

An enquiry into the nature and properties of materials, such as the one Smith undertakes in his extraordinary histories of metallurgy, might then require concepts which cannot simply be drawn from the discourse and theorisation of matter. It might require looking at the materials themselves, or at accounts of them without already assuming that they are simply instances of one or other concept of matter. Such an enquiry might even be able to furnish philosophy and science with concepts better able to articulate 'the wonderful diversity of real materials' which was for Smith lost to them, 'at first because philosophical thought despised the senses, later because the more rigorous experimentally verifiable thought patterns of the new science could only deal with one thing at a time.'[4]

Smith's important distinction between materials and matter frames this enquiry into building materials in architecture. The elision between matter and materials is as common in theoretical accounts of matter in architecture as it is in general usage in histories of architecture and in surveys and handbooks of materials and construction. Materials are assumed to be particular instances of matter – or 'secondary' matter as the

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[1] Cyril Stanley Smith, *A Search for Structure: Selected Essays on Science, Art, and History*, Cambridge, Massachusetts: MIT Press, 1981, p.115.

[2] One very interesting exception is Wilfrid Sellars, 'Raw Materials, Subjects and Substrata' in Ernan McMullin (ed.), *The Concept of Matter in Greek and Medieval Philosophy*, Notre Dame: University of Notre Dame Press, 1965. He suggests that philosophers typically 'bully' the term matter 'to have the sense of: *the material of which x consists or is made,'* and that this meaning is not synonymous with matter, p.260.

[3] This distinction is explicit in the title of his essay 'Matter versus Materials: A Historical View' and is made a number of times elsewhere in the text; 'I want to use this opportunity to make some general remarks on man's attitude toward materials (in contrast to matter)' Smith, *A Search for Structure*, p.112, 'Throughout most of history, matter has been a concern of metaphysics more than physics and materials of neither,' p.115 and also 'A science of materials as distinct from matter became possible.' p.122.

[4] Ibid., p.115.

Scholastics described the real materials that things are made out of in order to distinguish them from matter as substratum[5] – rather than conceptually different to matter. In architectural discourse, however, the force of the term 'matter' is determined more by its traditional pairing with form, than by the scientific and primarily atomistic concept of matter Smith refers to.[6] Architects manipulate form, both by virtue of the tool they use in the design of buildings and, as Alberto Péréz-Gómez has described, because architecture - both as practice and as profession - is founded in its separation from the business of building, precisely through its alliance through drawing with the ideal discipline of geometry.[7] As such the form/matter or 'hylomorphic' schema is foundational to the architectural discipline, and within its terms matter is located in opposition to form. Here, following Smith, I want to ask might there also be specific limitations of 'matter' as a conceptualisation of *architectural* materials? What might be the implications of relying on hylomorphic concepts of matter for the conceptualisation of building materials and what might be more adequate concepts of materials in architecture?

There are a number of reasons to make this distinction between matter and materials in architecture now, and to ask if there might be better concepts of materials than as instances of matter. First and foremost, this is a period of great technological and industrial change. For example, materials are now being performance-engineered. Architects and constructors can design bespoke materials with the capacities they require rather than work with materials already in existence whose properties are known. Some of these new materials are 'smart' – that is to say they are adaptive and responsive, and no longer conform to the idea of inanimate unchanging material that is central to hylomorphic matter. In some cases they may even be 'immaterial.' The construction of space using sound, light and electric fields challenges the notion that materials must be substance in the conventional sense.[8] There are also changes in the ways materials are selected. Increasingly materials, products and building systems are not named but specified in relation to a set of parameters they must conform to and selection is given over to contractors. At odds with this rather abstract way of prescribing materials is the very specific approach of green specification. Life cycle analysis tracks the

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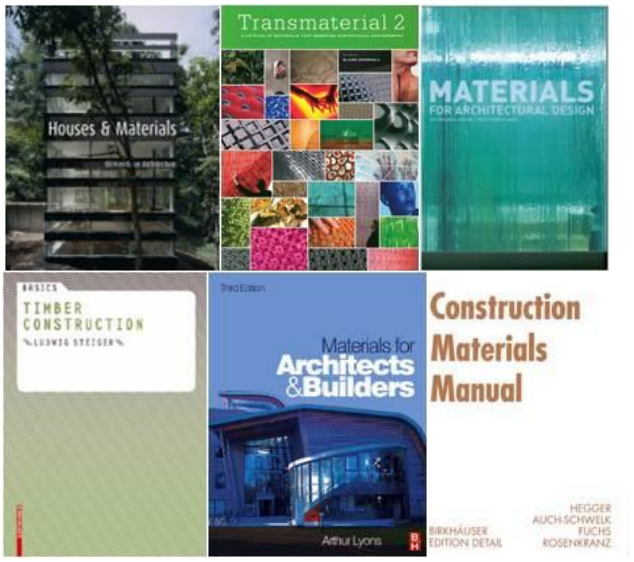
[5] Joseph Owens writes that 'materia seconda' only appeared as a term distinguishing materials from 'materia prima' in late Scholastic interpretations of Aristotlean matter, 'Matter and Predication in Aristotle' in McMullin (ed.), *The Concept of Matter,* p.82.

[6] For Smith the primary problem is that the physical sciences have concerned themselves more with elementary particles and principles, than with the aggregates which comprise the majority of the materials we encounter and produce. This level of physics fails to account for the properties and behaviours of materials which Smith shows gave rise to earlier concepts of matter.

[7] See Alberto Péréz-Gómez, *Architecture and the Crisis of Modern Science*, Cambridge, Massachusetts: MIT Press, 1983 and Alberto Péréz-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge*, Cambridge, Massachusetts: MIT Press, 1998. Werner Oechslin has also emphasised the work of painters, architects and engineers in producing a means of representation which would 'link architecture with mathematics in order to have it partake in the universal principles and 'truth' itself.' 'Geometry and Line; The Vitruvian 'Science' of Architectural Drawing' in *Daidalos*, Vol.1, 1981, pp.20-35.

[8] Developments in new materials are discussed incisively in relation to their broader implications in Michelle Addington and Daniel Schodek (eds.), *Smart Materials and Technologies for the Architecture and Design Professions*, Oxford: Architectural Press, 2005. See also Jonathan Hill, *Immaterial Architecture*, London: Routledge, 2006, for his more poetic alternative index of materials which includes air conditioning, fluorescent lighting and condensation.

'life' of any building material from its extraction, processing and transportation to its future maintenance and existence beyond the life of the building in order to evaluate its embodied energy and sustainability.[9] Each material is considered to have a specific history that goes beyond the physical or aesthetic properties it will lend to a building, or its status as a general type. Each of these developments might be seen to raise conceptual as well as practical questions. If the main framework we have for conceptualising materials is an unchanging ideal concept of matter (always in relation to form) to what extent can we properly consider the implications of these changes, and to what extent might we need to invent other concepts in order to incorporate new demands such as environmentalism?



1.1 Materials Publications

Second, despite the range of significant developments and the widespread interest in materiality through very diverse areas of architectural practice and theory, there tends to be a split into concerns on the one hand, with conceptual questions about 'matter' that hive off the practical and industrial context of building, and on the other with the practical and technical implications of material developments. Countless new publications collate the latest examples of innovative uses of materials or offer practical guidance for detailing and constructing with them (Fig 1.1). These tend to present materials as 'species' – typically glass, timber, concrete, steel[10] - from which designers can simply make their selections. Manuals for 'green specification'

[9]For a discussion of life cycle analysis see Paola Sassi, *Strategies for Sustainable Architecture*, Abingdon: Taylor and Francis, 2006, pp.144-148.

[10] It is interesting to note the exclusions from these lists and indexes. In *Materials for Architectural Design*, for example, Victoria Ballard-Bell does include plastics, but omits brickwork and stone as if they are simply out of date and not worth considering, Victoria Ballard-Bell with Patrick Rand, *Materials for Architectural Design*, London: Laurence King Publishing, 2006. In *Constructing Architecture*, Andrea Deplazes includes insulation in his survey of materials - a category that is almost never included despite the fact that it comprises a substantial proportion of the materials used in building, and acknowledges this with the incisive subtitle 'the "invisible" building material,' Andrea Deplazes (ed.), *Constructing Architecture: Materials Processes Structures*, Basel: Birkhauser 2005.

list some sustainable options or give complex advice on factors to considered in selecting materials.[11] In this technical literature it is rarely asked how these developments might challenge or be contained by existing conceptual frameworks. For a number of contemporary practitioners and theorists, the self-organising potential of materials is a vehicle to challenge hylomorphism. Typically in these architectural investigations material is considered only in as much as it inflects form and there is little interest in materials beyond the design stage. The possibility that technological or industrial developments might alter the kinds of roles materials play or demand new conceptualisations outside the traditional relation to form is once again foreclosed.

My intention here is not to amass a body of evidence to demonstrate that hylomorphism is the traditional architectural framework for conceiving matter, but we can see many ways that the form/matter binary shapes the architectural discipline, from the traditional practice of designing form using geometry prior to realisation in 'matter', to the professional separation from the world of building and the division of production information into drawings describing form and specifications describing materials. On the one hand there is an explicit hylomorphism in some architects' claims, as for example in Walter Gropius' statement: 'Matter in and of its own is dead and without character. It draws life only from the form that the creative will of the artist breathes into it.'[12] On the other hand, there is an implicit hylomorphism at work in aspects of technical practice, which are of more concern in this research. For example in his *Handbook of Technical Specifications* (1860) Thomas Donaldson outlines a skeleton specification for the 'Founder and Smith' which advises that any specially designed cast iron mouldings are to be returned to the architect after they have been used at the foundry, presumably so they cannot be used again by the founders. In this case then, the architect is not simply the form-giver, but has rights to the bespoke form as property.[13]

It is also the case that other architectural thinkers of matter have also assumed a grounding hylomorphism as I do. Contemporary architectural theorists and practitioners who mobilise a concept of matter-as-force (such as Manuel de Landa, Brian Massumi, Lars Spuybroek and Reiser and Umemoto), frame their engagement as a challenge to hylomorphism. For the feminist and deconstructive architectural theorists in the 1980s and 90s (who influenced my own interest in materiality) form was what was available to discourse and rationality and privileged in the form/matter binary. They looked at matter in terms of its relegation to the unrepresentable and irrational underside of the form/matter binary, and considered it in relation to the feminine, to excess, to sexuality and the Platonic chora.[14] Quite apart from the fact that these discourses retain the hylomorphic

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[11] See for example, Jane Anderson and David Shiers, *The Green Guide to Specification*, Oxford: Blackwell, 2009.
[12] Walter Gropius, cited in Annemarie Jaeggi, *Fagus: Industrial Culture from Werkbund to Bauhaus*, New York: Princeton Architectural Press, 2000, p.47.
[13] Thomas Donaldson, *Handbook of Specifications*, London: Lockwood and Co., 1860, p.xiv.
[14] See in particular Elizabeth Grosz's very influential essay 'Women, *Chora*, Dwelling' in *Space, Time and Perversion*, London: Routledge, 2005, Catherine Ingraham's work on the 'matter' of the geometric line in 'Lines and Linearity: Problems in Architectural Theory' in Andrea Kahn (ed.), *Drawing/building/text*, New York: Princeton Architectural Press,

schema, albeit making visible matter's necessary and destabilising presence, they leave us able to say nothing more about particular materials and the differences between them, than what it is possible to say about matter, and assume that the concept of matter has something to do with building materials. For architects such as Herzog & de Meuron and Peter Zumthor, materiality has a special role in countering the 'linguistic turn' in architecture.[15] Here the form/matter binary is configured in a slightly different way. There is matter (taken literally as materials – the medium of architecture) and there is signification. This framing owes more to Kant. The matter of the building is beyond meaning, it is what is available only to aesthetic experience. If the emphasis is on visual experience for these architects, the so called phenomenological architects and writers such as Juhaani Pallaasma, and Stephen Holl, for example, extend the notion of experience more properly to sound, touch, smell[16] and for Mark Hansen and Brian Massumi to proprioception.[17] Here the material becomes something beyond rationality but also beyond social forces. A 'material-based phenomenology,' Nick Coetzer has written, 'is political in its *erasing* of any overt political traces.'[18]

It does seem clear that just as in philosophy, there has been no single or consistent version of hylomorphism and that the form/matter binary in architecture is a hybrid or cluster of ideas. For example the correlation of form with geometry or shape is not central in Aristotle's classic account, in which the ordinary Greek word for timber 'hyle' is used for the first time to refer to matter. For Aristotle matter is that which is correlative with form in any substance but cannot bring about any change.[19] Aristotle's form could be a geometrical form, but

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1991 and Catherine Ingraham, *Architecture and the Burdens of Linearity*, New Haven: Yale University Press, 1998, and many of Jennifer Bloomer's texts and projects particularly 'The Matter of Matter: A Longing for Gravity' in Diana Agrest, Patricia Conway, Leslie Kanes Weisman (eds.), *The Sex of Architecture*, New York: Harry N. Abrams, Inc., 1996.

[15] For example, according to Zumthor: 'To me, buildings can have a beautiful silence that I associate with attributes such as composure, self-evidence, durability, presence, and integrity, and with warmth and sensuousness as well; a building that is being itself, being a building, not representing anything, just being. The sense that I try to instil into materials is beyond all rules of composition, and their tangibility, smell, and acoustic qualities are merely elements of the language we are obliged to use.' Peter Zumthor, *Thinking Architecture*, Basel: Birkhäuser, 2006. Or to Herzog & de Meuron: 'What interests us... is that a part of the intellectual quality of the design lies in the fact that a material is no longer a purely representative means,' Wilfried Wang (ed.), *Herzog & de Meuron: Projects and Buildings 1982-1990*, New York: Rizzoli, 1990, p.14. and also Philip Ursprung (ed.), *Herzog de Meuron: Natural History*, Montreal and Baden: Canadian Centre for Architecture and Lars Muller Publishers, 2002.

[16] For emphasis on the aesthetic experience of architecture see for example Juhani Pallasmaa who argues that with the 'hegemony of vision' contemporary architecture has neglected the body, and pays particular attention to materiality - suggesting for example that building with mud and clay engages with 'the tacit wisdom of the body' or that 'a weakened sense of materiality' may be another outcome of a scopic regime. Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses*, Chichester: Wiley – Academy, 2005, pp.17, 26, 31, and also Steven Holl, Juhani Pallasmaa, Alberto Péréz-Gómez, *Questions of Perception: Phenomenology of Architecture*, Tokyo: a+u Publishing, 2006.

[17] For engagements with proprioception, the body and architecture, see particularly 'Wearable Space' in Mark Hansen, *Bodies in Code: interfaces with digital media*, London: Routledge, 2006, and 'Strange Horizons' in Brian Massumi, *Parables for the Virtual: Movement, affect, sensation*, Durham NC: Duke University Press, 2002.

[18] Nicholas Coetzer, 'Between Birds' Nests and Manor Houses: Edwardian Cape Town and the Political Nature of Building Materials' in Katie Lloyd Thomas (ed.), *Material Matters: Architecture and Material Practice*, London: Routledge, 2007, p.191.

[19] According to Ernan McMullin form and matter cannot be separate for Aristotle. It is only with Aquinas that the distinction between them becomes an ontological question. See 'The Concept of Matter' in McMullin (ed.), *The Concept of Matter*, p.18.

it could also be a horse-form or a Socrates-form. It is only much later, when Descartes defines matter as extension that the concept of form (still paired with matter) is understood in terms of ideal geometry and relates back to the Platonic forms,[20] in the sense that will be so crucial for architecture.[21] Descartes' move made matter knowable and available to science. It disassociated the concept of matter from Plato's irrational and unrepresentable 'chora'[22] which feminist and deconstructive theorists attempted to retrieve for architecture. If Newtonian physics also understood matter as quantifiable but transposed Descartes' notion to mass, quantum mechanics would demonstrate that mass and energy are in fact interchangeable.[23] These discoveries would give rise to the materialism and vitalism which has been so influential for contemporary architects and theorists, for whom matter equals force. Contemporary philosophy is still looking at the challenge that matter-as-force mounts to hylomorphism, particularly in relation to the work of Gilles Deleuze and Félix Guattari, although Gilbert Simondon, the philosopher whose critique of hylomorphism I draw most heavily on, resists a return to materialism. He develops a theory of operations to augment the theory of structures and tries instead to understand transfers between structures and operations.

Rather than writing yet more about matter I want instead to follow Smith, and ask if we can derive concepts of materials from within the discipline, rather than by importing concepts of matter from elsewhere. I start with materials as they appear in practice. How are materials described without recourse to their relationship to form? What kinds of differences between materials might be decisive if they are not simply being understood as secondary matter? To what extent does the assumption that 'matter' can encompass 'materials' marginalise or exclude the possibility that conceptualisations of materials might arise out of architecture's own practices and what might these alternative concepts be?

1. Mobilising the architectural specification

In order to start from the variety of building materials, and hold open the possibility that there might be alternative concepts to matter, even a range a concepts of materials, this study examines building materials as they are used in practice, and mobilises the architectural specification and the kinds of descriptions of materials it comprises as a primary resource. The specification is a contractual description of materials and workmanship in building and is usually discussed only in manuals and guides to professional practice. It is treated as nothing more than a technical document and is almost never mentioned in more theoretical or

[20] See McMullin, 'The Concept of Matter' and Richard Blackwell, 'Descartes' Concept of Matter' in ibid.
[21] For general discussion of the relationships between Descartes' thought and architecture, see Claudia Brodsky Lacour, *Lines of Thought: Discourse, Architectonics, and the Origin of Modern Philosophy*, Durham NC: Duke University Press, 1996.
[22] 'The Concept of Matter' in McMullin, *The Concept of Matter*, p.17.
[23] See Stephen Toulmin and June Goodfield, *The Architecture of Matter*, Chicago: University of Chicago Press, 1962.

cultural accounts of the discipline of architecture[24] although its use in building can be traced to the ancient Egyptians and Greeks, and far pre-dates the emergence of gross tendering in the early 19th century – the form of contractual organisation which its contemporary specification is usually associated with. As John Gelder explains the specification has tended to be used alongside the architectural drawing[25] which has of course been the subject of numerous theoretical enquiries.

If the architectural drawing describes form and omits the materials of building, which appear there only as the spaces between lines, the blank empty whiteness or the page – as matter – the architectural specification describes materials in language. It is, to use Jack Bowyer's term, the 'supplement' to the drawing.[26] While the architectural drawing tends to use only one form of description – orthography or 'descriptive geometry'[27] – albeit at different scales, the architectural specification makes use of a variety of forms of description within its language. Materials may be specified in terms of their source, manufacturer or species. They may be prescribed in terms of how they are to be made up on site, how they are to perform in the finished building or, surprisingly rarely, in terms of their visual appearance. These different 'forms of clause' can appear alongside each other in any one document, they may tend to relate to particular kinds of materials (species of wood, in-situ concrete, paint finishes and so on) or types of building and contract, but they also emerge and disappear in different historical periods and circumstances.

The primary move of this research is to begin to identify and construct a typology of these forms of clause. I track some of the changes in specifications in the UK since the eighteenth century[28] and set out some of the different forms of clause that can be identified through this period. Apart from John Gelder's unique book

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[24] Exceptions to this include Katherine Shonfield's wonderful use of technical literature in her essay 'Does Your Flat Leak?' in *Walls Have Feelings; Architecture, Film and the City*, London: Routledge, 2000, Jane Rendell's 'Confessional Construction' which interspersed clauses from a specification for building a wall with autobiographical writing and was exhibited on an exterior wall of the bookartbookshop in Hoxton, in 2002 as part of LLAW curated by Brigid Mcleer, www.janerendell.co.uk/confessional-constructions accessed 11.12.2009, and Chapter 5 'Representation and Reality' in Richard Coyne, *Designing Information Technology in the Postmodern Age*, Cambridge, Massachusetts: MIT Press, 1995.

[25] See particularly his excellent chapter 'Historical Context' in John Gelder, *Specifying Architecture: A Guide to Professional Practice*, Milsons Point: Construction Information Systems Australia, 2001, pp.1-21.

[26] Jack Bowyer, *Practical Specification Writing*, London: Hutchinson and Co., 1985, p.9. It is only very rarely that drawings or any pictorial information is found in specifications and more will be said about this relationship in Chapter Two.

[27] Péréz-Gómez explains that it was Gaspard Monge's *Géomérie Descriptive* published in 1795 which would give the first 'truly synthetic system that could be universally applied to all arts and crafts' and is still in use today, see *Architecture and the Crisis of Modern Science*, p.279.

[28] I start from this period, first, because it marks the beginning of architecture's professionalization in the UK. According to John Wilton-Ely it is only in the latter half of the eighteenth century that 'the idea of a single figure, responsible for both design and supervision, began to be widely accepted.' 'The Professional Architect in England' in Spiro Kostof (ed.), *The Architect: Chapters in the History of the Profession*, Berkeley: University of California Press, 1977, p.183. Second, the earliest British specifications I have been able to look at in the RIBA's drawings and archives collections date from the mid eighteenth century, although John Gelder has traced earlier examples throughout Europe. The range of documentation used in building varies enormously and I will look at the question of what might constitute a specification, even under a different name, in Chapter Two.

Specifying Architecture, there is very little historical work on the practice of specification, and my research is based primarily on the rather haphazard mix of specifications held in the RIBA drawings and archives collection and on documents given to me by architectural practices. Distinctions between types of clause are sometimes made in technical guides to specification and in some of the correspondence and reports that surrounded the establishment of the standardised National Building Specification (NBS) in 1973. There are more formalised and consistent categories of clause in the recent bespoke specifications of Schumann Smith, but the forms of clause I identify are my own categories even if they sometimes correspond with distinctions made in the industry. The forms of clause – as descriptions which are embedded in architectural practice – become a starting point for establishing concepts of materials within this specific practice.

If building materials could just be understood as particular instances of matter we might expect their specification to involve no more than filling in the name and details of one material or another for any given part of the building. There are examples of this kind of specification but they are by no means typical. What is interesting and decisive about the forms of clause is the degree to which very different aspects of the material are important in each type. For example, in the process-based clause materials are specified through how they are to be made up and fabricated. It is the manner of achieving the end result which is given rather than the criteria the material is to meet. In the performance clause the material is specified in terms of its behaviours – whether strength or thermal resistance or acoustic properties – and details of fabrication are entirely excluded. While we might explain these differences in terms of contractual requirements or industrial trends, we can also ask what kinds of concepts of materials these descriptions suggest and to what extent might each be contained by or exceed the hylomorphic concept of matter? To what extent do the radical differences between descriptions of materials in the forms of clause suggest that there they may also be a variety of concepts of materials?

To make the architectural specification central to a study of concepts of materials is necessarily to encounter them as they are produced and mobilised within industry. The use of the process-based clause for example appears to have peaked in the 1960s and since the introduction of the NBS it is gradually being eradicated from the specification while the performance clause is increasingly widespread in contemporary specification in part because it gives flexibility to contractors and saves architects from making costly mistakes. Since the earliest example in the RIBA collection from 1734 until today, the specification has varied greatly in its format and content as well as in the forms of clause it uses. It seems obvious to suggest that these changes reflect developments in the industrial context, a point which Gelder also demonstrates, but this is in sharp contrast to architectural drawings which display, conversely, a remarkable consistency in their means of graphic description across the same period despite the enormous changes in technology and the way buildings are produced. The drawing is also deployed in building but its relationship to the context in which it is embedded is peculiarly invisible because it is only what is drawn that changes and not the manner of drawing itself. The

description of materials in the specification does not let us overlook the industrial context in which they are mobilised in the same way.

While Smith does not address the industrial context of metallurgy directly, he points out again and again that discoveries and innovations in materials science rarely arise out of new scientific theories but often out of practical observations and discoveries of new techniques and their results. At least in this respect, concepts of materials which arise out of engineering relate to historical and contextual developments. Not only might we ask how materials are different to matter, we might also need to acknowledge their necessary relationship to the context in which they are manufactured and deployed, and ask to what extent material developments might themselves demand or even produce new conceptualisations. The choice to look at the forms of clause in the specification as a means to develop alternative concepts of materials moves this study beyond a history of construction and technical practice, but at the same time necessarily makes it impossible to consider those concepts outside their relationship to the building industry.[29] For those who consider the technical and practical aspects of building to be necessarily outside the proper concerns of architectural discourse, this approach to materials may be problematic, but their position may itself be one of the effects of conceiving materials in terms of hylomorphic matter. If the privileging of form over matter is precisely what supports the possibility of an architectural profession that is separate from the work of building then materials will always be relegated to the practical underside of architecture. Here it is hoped that it might it be possible to include the context of industry and production in an account of materials rather than to banish these forces to architecture's outside.

2. Towards a materialist approach to materials

If one problem in architectural discourse is the assumption that building materials are simply instances of matter, another is that they may be excluded from what is considered properly architectural, so that the material becomes a category that must be lifted out of the dirty world of building and realisation. In his very interesting work on architecture and matter, Andrew Benjamin recognises the growing interest in 'material possibility' in contemporary practice as an addition to the more traditional concern with the possibilities of 'plans' (or drawing and form). He makes the incisive argument that to engage seriously with 'material

[29] A thorough study of the history of the specification which would track its relationship to changes in the building industry, to other forms of architectural documentation and to the impact of these changes on the buildings produced remains to be done, but it is not the remit of this research. John Gelder has written widely on this subject, not just in *Specifying Architecture* but also in various articles of his which are published in the online *NBS Journal* available at www.theNBS.com. Discussions of the specification can also be found in architectural journals, particularly at times of change, for example in the journal *Specifications* which tried to collate examples of good practice in a format that could be updated and nationally distributed, or in journals such as the *Architects Journal* and *Building* during the period from the 1960s to 1970s when work began on the standardised specification, the *National Building Specification* (NBS) and was finally introduced in 1973. The available literature on specification will be explored in Chapter Two.

possibility' is also to make necessary 'a materialist account of the work of matter.'[30] For him, a properly materialist concern with matter must entail a rethinking of the history of architecture in as much as attention shifts to ruptures and discontinuities within the conception of the architectural object. This point raises a serious problem for the tectonic approach of Kenneth Frampton[31] and others in which architectural design is supposed to follow the logic of materials (or rather 'types' of materials such as masonry or textiles which depend heavily on the categories Gottfried Semper developed[32]) rather than simply being given presence by them. The tectonic approach, he suggests, is idealist in as much as materials and concepts of the material are understood to be ideal and unchanging categories. In proposing that these categories are themselves subject to change Benjamin's approach provides an opening here, but it is not clear what version of materialism he refers to.[33]

On the one hand, grounded in philosophical debates about what constitutes reality, there is classical materialism or what philosopher David-Hillel Ruben calls 'reductive materialism' which 'claims that everything, including the mind and its contents can be reduced to matter, or the physical.'[34] This version of materialism is influential for a number of contemporary architectural theorists and practitioners who resist a separation between matter and an ideal realm. But this materialism, in Marx's own words 'the abstract materialism of natural science' is one 'that excludes history and its process.'[35] More specifically however, the problem for Marx is that 'the dispute over the reality or non-reality of thinking' in which reductive materialism is located, 'isolates itself from practice.'[36] Practice is what constitutes 'the ensemble of social relations,'[37] and according to Étienne Balibar, for Marx it is these relations which define what humanity has in common (and not some prior or natural essence).[38] Hence Marx goes further than historicising material process and constructs a 'practical materialism',[39] 'a strange "materialism without matter"'[40] that foregrounds practical activity.

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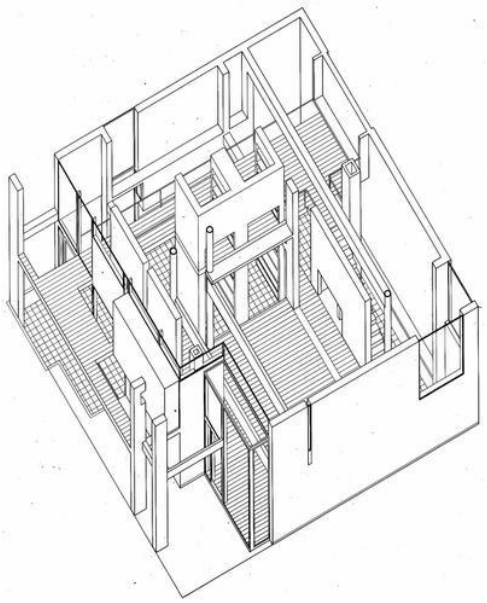
[30] Andrew Benjamin, 'Plans to Matter' in Lloyd Thomas (ed.), *Material Matters*, p.25.
[31] See particularly, Kenneth Frampton, *Studies in Tectonic Culture*, Cambridge, Massachusetts: MIT Press, 1995.
[32] See for example, Gottfried Semper, *Style: Style in the technical and tectonic arts*, Los Angeles: Getty Research Institute, 2004.
[33] Manuel DeLanda is more explicit. He distinguishes his 'neo-materialism' from Marxist materialism: 'The only good thing that Marxism ever gave us was its materialism, the idea that we need to explain things that happen right here without appeals to God, without appeals to Platonic essences, without appeals to anything transcendental.' See 'Interview with Manuel DeLanda' www.t0.or.at/deland/intdelanda, accessed 31.04.10 (unpaginated).
[34] David-Hillel Ruben, *Marxism and Materialism: A Study in Marxist Theory of Knowledge*, Brighton: Harvester Press, 1979, p.5.
[35] Karl Marx, *Capital Vol.1*, cited without reference in ibid., p.5.
[36] Karl Marx, 'Theses on Feuerbach' in *Karl Marx Frederick Engels, Collected Works, Vol.5, Marx and Engels 1845-1847*, London: Lawrence and Wishart, p.6.
[37] Ibid., p.7.
[38] Étienne Balibar, *The Philosophy of Marx*, London: Verso, 1995, p.30. Balibar goes on to suggest that this position is further clarified in the later notion of transindividuality which he ascribes to Simondon (as well as to Kojève and Lacan), and will be discussed in Chapter Nine.
[39] Ibid., p.15.
[40] Ibid., p.23.

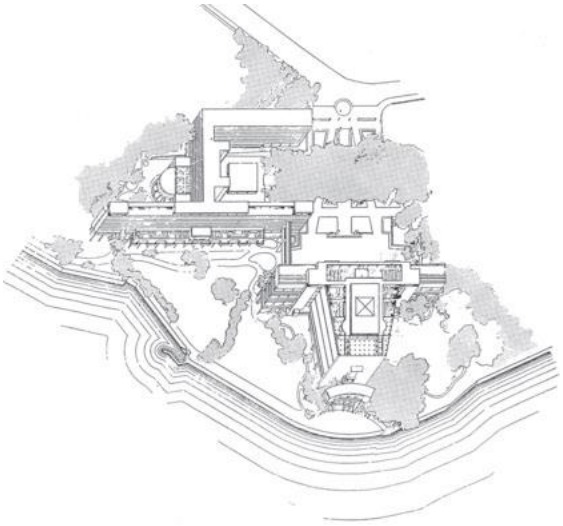
Architectural theorists such as Benjamin and the practitioners of 'material possibility' such as Spuybroek or Reiser and Umemoto work within a critical tradition which, to use Peter Eisenman's term, understands the 'interiority' of architecture as a specific concern with spatial problems and potentials. Benjamin is concerned only with changes which he considers internal to the discipline of architecture – such as the meaning or 'possibility' of a drawn line in different historical periods. This notion of what is proper to architecture is grounded in the exclusion of the social, economic or technical practices which in Marx's materialism must also define the conceptual and material relations which would constitute any practice such as architecture. One of the design implications of this critical tradition is that the presence of the material is typically subdued in order that spatial manipulations are brought to the fore. In a relatively early text 'Cardboard Architecture'[41] Eisenman describes how the architectural planes of his House I (Fig 1.2) were to be white with occasional use of primary colours, in order precisely to suppress material readings[42] and 'provide an awareness of formal information latent in any environment that previously was unavailable to the individual.'[43]



1.2 *House I,* Peter Eisenman (1967)

In Colin Rowe and Robert Slutzky's enormously influential text 'Transparency: Literal and Phenomenal' the observer who pays attention to the formal and spatial complexities (the phenomenal transparency) of the Le Corbusier's League of Nations Palace (Fig 1.3) needs also to be 'a man of moderate sophistication.'[44]

[41] Peter Eisenman, 'Cardboard Architecture' in *Eisenman Inside Out: Selected Writings 1963-1988*, Newhaven: Yale University Press, 2004 and first published in Arthur Drexler (ed.), *Five Architects: Eisenman, Graves, Gwathmey, Hejduk, Meier*, New York: Oxford University Press, 1972.
[42] 'The white color and the flat texture are closer to an abstract plane than say a natural wood or a cut stone wall.' Eisenman, *Eisenman Inside Out*, p.30.
[43] Ibid.
[44] Colin Rowe and Robert Slutzky, 'Transparency: Literal and Phenomenal' in *Perspecta*, Vol.8, 1963, p.53.



1.3 *Palace of the League of Nations*, Le Corbusier and Pierre Jeanneret Geneva (1927) Competition entry axonometric

Throughout the text those architects, painters and commentators who are dazzled not by the spatial phenomenon of transparency but by the 'literal' material quality of transparency (Laszlo Moholy-Nagy, Walter Gropius, Pablo Picasso Juan Gris, Gyorgy Kepes, Sigfried Giedion) are shown to be less than sophisticated. To work with material effects is to 'deny' the observer's pleasure of phenomenal transparency, to anaylse cubism in these terms a 'simplification'[45] and a building such as Gropius' Bauhaus school which relies on the effects of transparent glass 'is like a reef gently washed by a placid tide.' [46]

1.4 James Stirling and James Gowan, Leicester University Engineering Building, England (1963)

In a later essay Eisenman performs a strikingly similar analytical procedure to Rowe and Slutzky on Stirling and Gowan's Leicester engineering building (Fig. 1.4). But here, in contrast to theirs and his own earlier

[45] Ibid., p.52.
[46] Ibid., p.54.

privileging of formal and spatial play, he claims that it is precisely in the material register that the criticality of this building operates, through numerous uses of building materials, particularly brick, which counter structural expectations or their 'metaphoric' meaning.[47] In this essay Eisenman finds a way to extend Rowe and Slutzky's analysis and include the question of the material as part of the 'intrinsic formal vocabulary of architecture'[48] but it is nevertheless in a strangely abstracted version that has no relationships to the industrial or social context of production, only to the meanings of materials in so far as they have been constituted within architectural design, if indeed that is possible.

So building materials may be considered altogether outside the proper concerns of architecture or where matter has to some extent been reconceived they may be in some sense themselves abstracted or formalised, so that the context of their production and mobilisation is not a concern. In 'What's the Matter With Material?' the one architectural text I am aware of which distinguishes between matter and materials, Robert McAnulty calls matter reconfigured as force 'thick matter'. Thick matter is 'never inert,' it is 'thick with potential' and 'never fixed by any specific organization.' Thick matter 'resists being catalogued as the useful,' it is 'always enacted and 'interacting' and 'happens in time'.[49] If this concept of matter offered architecture new opportunities after the waning of the critical project, it has, according to McAnulty been widely misunderstood and confused with the growing preoccupation with building materials which can only ever repeat the 'standards of an architectural practice firmly grounded in capitalism.'[50] McAnulty's thick matter is not hylomorphic, but it is nevertheless separated out from the industrial context and must not, according to him, be confused with 'the particularity of materials.'[51] In McAnulty's argument, it seems that only architecture, as the manipulation of thick matter, can produce 'ideas and effects through the volatile medium of artifacts.'[52] Why repeat the abstraction of the material, and once again safeguard it from the forces of production and capital in this reconfigured matter? Couldn't it also be the case that other material practices, even those deeply embedded in industry, produce volatile artifacts with their own effects and concepts?

Benjamin offers a way into this research in as much as he insists that we attend to ruptures and discontinuities in the constitution of the objects or concepts we study. To study the specification is necessarily to be confronted with enormous changes in the ways materials are described and to engage with the historical conditions which produce them. But rather than limit my enquiry to a piece of construction history because it includes industrial and social forces that would be by definition outside architecture proper,

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[47] 'Real and English: The Destruction of the Box I' in Eisenman, *Eisenman Inside Out*. These include planes of glass overhanging concrete structure, the horizontal laying of bricks and vertical cladding with tiles, brick walls constructed so it is obvious that they don't carry load and so on.
[48] Ibid., p.78.
[49] Robert McAnulty, 'What's the Matter With Material' in *Log*, Spring/Summer 2005, p.89.
[50] Ibid., p.89.
[51] Ibid.
[52] Ibid.

I want to hold open the possibility that building materials (and their specification) might themselves be internal to architecture. This proposition cannot be validated by insisting from the outset that the specification can necessarily give evidence of concepts of materials, or that such concepts might have any relation to the traditional architectural concept of matter. It can only be described as a 'hunch', as a holding open of a possibility and as the creation of conditions in which that possibility might become meaningful and productive. But if indeed, as I will hope to show, an analysis of the forms of clause reveals a variety of material concepts and relations (and not just a range of representations) that are produced out of changing industrial, economic, regulatory and social conditions, then we might also recognise that these too affect and in part constitute the 'material possibilities' available to architectural thought and practice.

3. Materials as technical objects and the philosophy of technology

> It is only because we have not undertaken an anthropology of our modern world that we can overlook the strange and hybrid quality of matter as it seized and implemented by industry.
>
> Bruno Latour[53]

To retain idealised and abstracted models for our accounts of materials may be to ignore the very specific ways matter is 'seized and implemented by industry' for building and the possibility that developments in materials technology and deployment might produce new material configurations which also demand new conceptualisations. In this research I try to avoid the reduction of architectural materials to either the physical and technical or to what I have identified as the idealised materials in critical approaches to architecture such as that of Eisenman or the celebrators of self-organising matter. This has led me to accept many of Bruno Latour's propositions concerning 'nonhumans' and technical objects and to follow arguments that are made within what can broadly be characterised as the philosophy of technology, and most significantly, in the work of Gilbert Simondon, whose influence on this work extends well beyond his discussions of technical objects and systems. Famously, in *We Have Never Been Modern* Latour insists that the modern separation between 'facts, power and discourse' or physical substance (and its sciences), the social (and its sciences) and language and ideas (and the meditations on them) makes no sense.[54] Since this book was written in 1991 with the waning of the deconstructive project, it seems less important to debunk discourse, but Latour's attack against the sciences and the social sciences remains powerful. For him it is not tenable to hold that the world is reducible to mere physical facts any more than that it can be accounted for as a social construction.

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[53] Bruno Latour, *Pandora's Hope: Essays on the reality of science studies*, Cambridge, Massachusetts: Harvard University Press, 1999, p.206.
[54] Bruno Latour, *We Have Never Been Modern*, Cambridge, Massachusetts: Harvard University Press, 1993, p.6.

Moreover, increasingly the objects we need to study – the hole in the ozone layer or the failure of the Columbia space mission are complex hybrids which are simply not accountable in either of these views.

Thus for Latour there is no pure object of science and the kind of materialism which claims that there is nothing other than force or substance, is seen itself to be idealist.[55] Latour's approach to the practices and objects of science is always to extend his analysis to their specificity and their interrelations with institutions, other kinds of objects and to the mediations involved.[56] This aspect of his work is not limited to actor-network-theory (ANT). It can be found, for example, in Andrew Barry's work on technology and his account of the molecules in new pharmaceutical research[57], in Bernadette Bensaude-Vincent and Isabelle Stengers' *History of Chemistry*[58] and in Pablo Jensen's work on the electron and materials science.[59] Nor, for Latour, should we make the mistake of sociologists and those in science studies working under the rubric of the Social Construction of Technology (SCOT) and imagine that the world and its objects are merely products of social relations, for that is to do away with the world of objects and their possible intervention in human affairs and render them as mere conduits for social forces.[60] In Latour's work these interventions are often described in terms of the 'detours' or 'translations' which arise when actions that might otherwise be carried out by humans (a policeman signalling drivers to slow down) are 'delegated' to nonhumans (a speed bump) and produce new conditions (the driver responds to the speed bump not through any legal or moral obligation but because they don't want to damage the undercarriage of their car).[61] The implications of these detours via the material may be planned or unexpected. Latour highlights the shifts involved in the delegation to the nonhuman and refuses a determinist account. This insistence is also found in Simondon's work on technical objects, where he distinguishes between 'abstract' technical objects which are literal translations of ideas into the material

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[55] See Bruno Latour, 'Can We Get Our Materialism Back, Please?' in *Isis*, 2007, Vol.98, No.I, pp.138-142.

[56] It should be noted that Latour is keen to differentiate his approach from contextualisation, since that already implies a pre-existing separation between the entity and its conditions which he wants to avoid. Latour has also suggested that the category of 'the social' itself cannot be an ahistorical unchanging concept. I use the term 'context' throughout this research as a useful shorthand, although as we will see, my own position will also resist this separation. However, unlike Latour I see this the impossibility of separations as an aspect of 'systems' rather than as a general ontological condition and will explore this in Chapter Nine.

[57] Andrew Barry, *'*Pharmaceutical Matters: The Invention of Informed Materials' in Mariam Fraser, Sarah Kember, Celia Lury (eds.), *Inventive Life: Approaches to New Vitalism*, London: SAGE, 2006.

[58] Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry*, Cambridge Massachusetts: Harvard University Press,1996.

[59] Pablo Jensen, 'Making Electrons Public' in Bruno Latour and Peter Weibel (eds.), *Making Things Public: Atmospheres of Democracy*, Cambridge, Massachusetts: MIT Press, 2005, pp.334-7.

[60] For a detailed discussion of the question of the social and the technical in SCOT, Latour and Simondon see Adrian Mackenzie, 'Problematising the Technological: The Object as Event?' in *Social Epistemology*, Vol.19, No.4, Oct-Dec 2005, pp.381-399. This is one of very few discussions of Latour's work in relation to Simondon's, and the only one I have come across which reads Simondon closely, rather than reading him through the very particular distortions of Deleuze and Guattari (as say Graham Harman will do in his very interesting book on Latour as metaphysician, *Prince of Networks: Bruno Latour and Metaphysics*, Melbourne: re:press, 2009, p.6 and p.160). However Mackenzie tends to include Latour's work within SCOT, suggesting that he and actor-network-theory in general also hold that 'technologies are social relations in another form.' (p.382) This is to ignore the extensive criticism Latour mounts against this position.

[61] The speed bump example is used a number of times in Latour's work but for his most detailed account see Latour, *Pandora's Hope*, pp.186-190.

world, and the 'concrete' objects which evolve their own logics out of opportunities which present themselves once they are material.[62] It is in part, this aspect of Simondon's analysis, which Bernard Stiegler has drawn on to put forward his account of technical evolution.[63]

Latour often commends an ethnographic approach to the study of objects because it insists on a cultural explanation of the construction of facts and prefers to track relationships rather than limit its studies to any one domain of knowledge. But the aspect of his method which is central to this study is his refusal to start from general concepts or progress towards them through increasing abstraction, and his insistence, instead, on starting with specific objects. As will become apparent in Part II I will prefer Simondon's 'allagmatic' or process-based theory to Latour's rendering of human and nonhumans as actors, and as will become clear in Part III I will take up Simondon's account of the 'complete system' rather than Latour's notion of the unbounded network as a basis for my own argument about relations. But Simondon shares with Latour, and with most of the other commentators from science and technology studies who I draw on, a meticulous concern with specific objects and systems and a method which draws on them for the articulation of concepts.[64] In *Reassembling the Social*, a kind of text book on ANT which addresses itself to research students, Latour emphasises again and again the importance of *describing* the objects under study, and of tracking their interrelationships and the mediators which construct them. In one hilarious section he tells his reader that an ANT researcher simply needs no more tools and resources than a set of four notebooks. In another he tells them what the finished text should be like:

> If connections are established between sites it should be done through *more* description, not by taking a free ride through all-terrain entities like Society, Capitalism, Empire, Norms, Individualism, Fields and so on. A good text should trigger in a good reader this reaction: 'Please more details. I want more details... It's the character of the social to be specific. The name of the game is not reduction, but irreduction.[65]

Although I have not found any explicit references by Simondon to this aspect of his method, he too starts from specific examples. In *Du mode d'existence des objets techniques* he compares the differences between particular car engines in extraordinary detail, and includes his own photographs of them covered in hand written annotations, and draws from these analyses his notions of abstract and concrete technical objects. His famous re-description of the form-taking of a wet clay brick in *L'individu et sa genèse physico-biologique*

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[62] Gilbert Simondon, *Du mode d'existence des objets techniques*, Paris: Aubier, 1989, pp. 19-23.
[63] Bernard Stiegler, *Technics and Time*, *Vol.1*: *The Fault of Epimetheus*, trans. Richard Beardsworth and George Collins, Stanford: Stanford University Press, 1998.
[64] We might suggest that for these commentators concepts cannot be separated out from specific material configurations, any more than a Platonic ideal form.
[65] Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford: Oxford University Press, 2005, p.137.

takes up most of the 42 pages of the first chapter, and each chapter of *L'individu* introduces new systems – both technical and living - from pendulums and crystal solutions to micro-organisms.[66]

The descriptions of materials and workmanship I use here from the architectural specification are, in contrast, 'ready-made.' If they show us something about what the material is intended to do (as in the case of the performance clause and in some other examples) they are also found instances of what Latour has, following Madeline Akrich, called 'scripts', which usually have to be recovered by research:

> Objects, by the very nature of their connections with humans, quickly shift from being mediators to being intermediaries, counting for one or nothing, no matter how internally complicated they might be. This is why specific tricks have to be invented to *make them talk*, that is, to offer descriptions of themselves, to produce *scripts* of what they are making others – humans or non-humans – do.[67]

In the first instance however, my own interest in these 'descriptions' was not informed by the work of Simondon or Latour, but by the project of the poet Francis Ponge to speak 'on the side of things'. He calls his method 'adequation' and because it finds different textual strategies which share qualities or operations with each thing he writes about (from pebbles to doors to wooden crates) what is usually seen as the singular unrepresentable matter of language is pluralized in a variety of materialities. It was only at the very end of this research that I found a footnote to Ponge's work in *Reassembling the Social*, where Latour advocates looking at the ways artists have endeavoured to describe objects:

> The resource of fiction can bring – through the use of counterfactual history, thought experiments and scientifiction – the solid objects of today into the fluid states where their connections with humans may make sense.[68]

In some sense then, Ponge's work made me alert to the differences between the forms of clause in the specification and made it possible for me to find them interesting and productive. If in the earlier stages of this work the attention to specificities and description of Latour, Simondon and Smith amongst others, grounded and influenced my own work and the ways it tracks processes and relationships, it was only in the later stages that this approach became more clearly attached to a position – that concepts and problematics might themselves be produced from inside specific encounters with objects rather than imposed from outside – a position which it turns out Simondon puts forward in his account of transductive thought. Because this position is developed out of the study of the variety of forms of clause, and not prior to it, and emerged

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[66] Gilbert Simondon, *L'individu et sa Genèse Physico-Biologique*, Press Universitaires de France, Paris,1964.
[67] Latour, *Reassembling the Social*, p.79.
[68] Ibid., p.82.

gradually through the deepening involvement with Simondon's thought, the discussion of it appears towards the end of the text – with a nod to both Latour[69] and Simondon.[70] I develop a number of more specific arguments throughout the text, but it is the possibilities that adopting this particular position might offer the study of materials (both here and elsewhere[71]) of buildings and more generally of other applied disciplines, which I see as a principle outcome of this work.

To propose that we consider building materials in the context of these bodies of work is to suggest that we think of them as technical objects. This is already to assume that building materials are never simply separated 'from their immediate connection with their environment' as Marx describes 'timber felled in virgin forests'.[72] It is not whether they have been worked, or have or have not literally 'undergone some alteration by means of labour'[73] which is decisive, although technical literature also tends to put 'natural' materials, manufactured materials and products into separate categories.[74] Rather, on the one hand, building materials in my account are necessarily grounded in their mobilisation for construction rather than by the degree they have been worked or the kind of physical substance they are. This is perhaps to accept that they are necessarily 'equipmental' in Martin Heidegger's sense and to agree with the architect Peter Salter when he insists that a material for building is always 're-coded as it leaves the ground, gaining a new aspect and experience' in what he describes as a 'natural and artificial metamorphosis.'[75] In Salter's account this necessary metamorphosis 'changes the material,' for example it 'enables structural members to extend beyond their original capabilities, to be more flexible and for good or bad, to be programmatically multifunctional.' On the other hand, if it is mobilisation for and in building which is decisive for these materials, then the degree to which they may or may not be products of advanced technology or innovation is not the

[69] According to Harman, Latour tells him in an email that 'any argument about my "philosophy" has to start with 'Irreduction*s*' which is a 96 page appendix at the end of Bruno Latour, *The Pasteurizaion of France*, Cambridge, Massachusetts: Harvard University Press, 1988. See Harman, *Prince of Networks*, p.12.

[70] I tend to use the first published edition of Simondon's *L'individu* which is only half of what was originally his doctoral thesis, but in the recently published full text *L'individuation à la lumière des notions de forme et d'information*, Grenoble: Editions Jérôme Millon, 2006, Simondon attaches a very dense 'supplément' entitled 'Allagmatique' and presents a theoretical overview of his thesis and method, much more explicit than the accounts which appear in the main text of the book, both in terms of his position in relation to other philosophies and in relation to his intentions, pp.550-566.

[71] Developments of this method in my own work have included an essay on the use of materials at the house at Stock Orchard Street by Sarah Wigglesworth Architects, 'The Excessive Materiality of Stock Orchard Street: towards a feminist material practice,' in Sarah Wigglesworth (ed.), *Around and About Stock Orchard Street*, London: Routledge, forthcoming, a paper contrasting the metaphor of transparency and the performance of glass in parliament buildings 'New Glass Performances: constitutions of the material in performance engineering and specification' given at the Visuality/Materiality conference in London, July 2009 and a paper '"Rendered Plastic by Preparation": constant materials in philosophy and building,' presented at the Precious Stones symposium at the University of York, June 2009.

[72] Karl Marx, *Capital Volume 1*, London: Penguin, 1990, p.284.

[73] Ibid. p.285.

[74] Email from Colin McGregor, who worked with the NBS from its inception until retirement in 2006.03.06.

[75] Peter Salter, *TS: Intuition and Process*, London: The Architectural Association, 1989, p.48. Susannah Hagan has also noted the advantages for an environmentalist analysis, of Salter's account of materials which recognises change and modification, Susannah Hagan, *Taking Shape: A new contract between architecture and nature*, Oxford: Architectural Press, 2001, p.90.

point here. In relation to practices, Adrian Mackenzie makes a useful distinction between the technical and the technological:

> Any human practice can be understood as technical without too much effort, since everything has a materiality that can be artificed or worked on. However, only occasionally do practices become technological.[76]

In this research building materials, whether straw, mud or performance engineered glass are all understood as technical objects. Whether or not they become technological, which for Mackenzie involves changes in relations, is not really my concern. As such, when I come to discuss aspects of Heidegger's work in Chapter Six, I do not refer to any of his texts concerning technology. I am concerned more with specific local changes than with seeing them in terms of large scale technological or epistemic shifts.

4. Preparations, operations and transduction: Simondon's technical system

The notion of the technical object or 'system' which will be most central to this enquiry is that of the philosopher Gilbert Simondon. Simondon became known initially as a philosopher of technology through *Du Mode d'existence des objets techniques*, which was his first published work and appeared in 1958.[77] However his most important work was his doctoral thesis, which was only published in full as *L'individuation à la lumière des notions de forme et d'information* in 2006, almost 50 years after it was written.[78] The first half of this work was published in 1964 under the title *L'individu et sa genèse physico-biologique*,[79] with the second half *L'individuation psychique et collective* only appearing in 1989.[80] The theme of these works is not technology, but individuation. For Simondon, a particular problem with the hylomorphic schema is that it renders the operations of individuation invisible. He looks to the processes and mediations involved in individuation in order to account for the genesis of the individual rather than to the identity of the already individuated individual. His overriding intention, explicitly stated in 'Allagmatique', the appendix to *L'individuation à la lumière*, is to establish a theory of operations that has hitherto been neglected but is symmetrical to the theory of structures. The theory of structures is the concern of the sciences which develop specific forms of knowledge such as astronomy, physics, chemistry and biology to account for their different

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[76] Mackenzie, 'Problematising the Technological', p.382.
[77] See John Hart's preface to *Du Mode* for an account of the context and reception of this work, in Simondon, *Du mode d'existence des objets techniques*, op.cit., and in translation by Ninian Mellamphy, as *On The Mode of Existence of Technical Objects*, op.cit., London, Ontario: University of Western Ontario, 1980, and posted at http://accursedshare.blogspot.com/2007/11/gilbert-simondon-on-mode-of-existence, accessed 18.04.2010.
[78] Simondon, *L'individuation à la lumière des notions de forme et d'information*.
[79] Simondon, *L'individu*.
[80] Gilbert Simondon, *L'individuation psychique et collective*, Paris: Aubier, 1989.

objects, but the theory of operations or 'allagmatic' theory can understand operations within each of these frameworks as analogous.

Simondon is most certainly not a philosopher of materials, and although the first chapter of *L'individuation à la lumière* and *L'individu* consists of a long discussion of a technical system (the form-taking of the wet clay brick) this is only one of a range of individuating systems he studies, from the single cell organism to the psychic individual (which is the primary interest for Mark Hansen's appropriation of Simondon's work towards towards an understanding of the 'reciprocity between my body and the body of the other'[81]) and the collective (which Paolo Virno has developed in his work on the transindividual[82]). Even *Du Mode*, an extended enquiry into technical systems, concludes with a long discussion of individuation and the veiling of operations in the hylomorphic schema. For those who read Simondon largely as a philosopher of technology, the significance of individuation is often underestimated. Paul Dumouchel, for example, takes up Simondon's account of concrete and abstract technical objects and, problematically, sees in *Du Mode* the setting out of criteria for technical progress.[83] For John Hart the primary interest of Simondon's work is its contribution towards the long overdue establishment of a mecanology or science of machines, that started with Jacques Lafitte's *Reflexions sur la science des machines* in 1932.[84] Hart is less interested in Simondon's arguments about individuation, than in his use of the (then) new cybernetic theory to explore mecanology and introduce to it the question of value.

More recently, at least in the English speaking world,[85] Simondon's work has been more widely known for his concept of the 'preindividual' which Gilles Deleuze developed, particularly in *Difference and Repetition* and with Félix Guattari in *A Thousand Plateaus*.[86] It is not unusual to find Simondon's thought referenced almost

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[81] Mark Hansen reads Simondon's notion of the transindividual through Maurice Merleau-Ponty's (to whom Simondon dedicates L'individu) notion of the 'écart.' See Hansen, *Bodies in Code*, pp.84-88. For a more detailed exegesis of Simondon's thought see also, Mark Hansen, 'Internal Resonance, or Three Steps Towards a Non-Viral Biology,' in *Culture Machine*, No.3, www.culturemachine.tees.ac.uk/cmach/Backissues/j003/hansen.htm accessed 31.04.10.

[82] See for example his brief but incisive discussion of Simondon's notion of collective (or 'transindivual') individuation Paolo Virno, *A Grammar of the Multitude*, Los Angeles: Semiotext(e), 2004, p.79: 'By participating in a collective, the subject, far from surrendering the most unique individual traits, has the opportunity to individuate, at least in part, the share of pre-individual reality which all individuals carry within themselves... Only within the collective, certainly not within the isolated subject, can perception, language, and productive forces take on the shape of an individuated experience.'

[83] Paul Dumouchel, 'Gilbert Simondon's plea for a philosophy of technology' in Andrew Feenberg and Alastair Hannay (eds.), *Technology and the Politics of Knowledge*, Bloomington: Indiana University Press, 1995, pp.97-107. Hart also refers to some early responses to *Du Mode* which understood it primarily as an account of technical progress. See Simondon, *On the Mode of Existence of Technical Objects,* trans. Mellamphy, p.7.

[84] Jacques Lafitte, *Reflexions sur la science des machines*, Bloud et Gay, Paris, 1932, discussed in John Hart, 'Preface' *On the Mode of Existence*.

[85] It has not been possible to survey the rapidly increasing number of works on Simondon in French. First, availability to these texts is limited in the UK. Second, I am hampered by my rather basic capacities with the French language. During the period of this research interest in Simondon has been growing, some further translations of extracts into English have appeared and, according to a recent edition of *Parrhesia* devoted entirely to Simondon, translations of *Du Mode* and *L'individu* and *L'individuation psychique et collective* will be published in 2010.

[86] Gilles Deleuze, *Difference and Repetition*, trans. Paul Patton, London: Continuum, 2004 and Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism & Schizophrenia*, trans. Brian Massumi, London: Athlone Press,1988.

entirely through Deleuze's interpretation (for example in Manuel DeLanda's accounts of the preindividual[87]) or to what was, for some years, the one published translation of Simondon's work 'The Genesis of the Individual' – the introduction to *L'individu* which appeared in *Incorporations* in 1992 (for example the multi-authored article 'Individuation and Feminism' refers only to this text and seems blithely unaware that this was in fact part of a much larger piece of work[88]). Indeed it was in John Protevi's *Political Physics* - an attempt to explore self-organization in relation to the work of Deleuze and Derrida – that I first came across Simondon's critique of hylomorphism.[89] Protevi pays a great deal of attention to the example of the forming of the wet clay brick, and reads it as a problem of the imposition of form in explicitly architectural terms. Like Deleuze, Protevi reads only *L'individu* and ignores the technological concerns of *Du Mode*. For him, as for Miguel de Beistegui and others, what is most important in Simondon's work is that it is possible to understand the genesis of the individual as immanent and emergent and not as the result of the imposition or dominance of some external force.[90] As for Deleuze, the significance of the preindividual is that it is a field of potential which gives rise to individuation, and that the possibilities of individuation are multiple. They are not predetermined or foreclosed.

This emphasis is typical of many of the commentaries which take up Simondon's work, including Alberto Toscano's excellent *The Theatre of Production: The Philosophy of Indviduation from Kant to Deleuze*[91] which includes a close reading of Simondon's account of individuation in relation to self-organisation, as well as of the few texts which address architectural theory and practice. In his book *Earth Moves* Bernard Cache looks to Simondon to elaborate an account of ongoing individuation that might avoid ejection 'from the great oscillation of life' as happens when all that remains of the energetic process of crystallisation is the crystal form.[92] In Brian Massumi's essay about wetGRID, a temporary exhibition space designed by Nox for the Museé des Beaux Arts in Nantes (1999), he argues that the installation works with the body of the visitor at the level of force which would have to be 'in a word (Simondon's)... transductive.'[93] This, he explains, is achieved through 'a series of transductive steps' from digital through to material (models made out paper

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[87] See for example, Manuel DeLanda, *Intensive Science and Virtual Philosophy*, London: Continnum, 2002. Here DeLanda discusses the preindividual entirely through Deleuze's use of the term (pp. 79-83) and fails to credit Simondon in the establishment of a 'process ontology'. Presumably this lack of engagement with Simondon's thought except via Deleuze is what allows him to describe Simondon's work as one of the 'early versions of complexity theory.' Manuel DeLanda, 'Uniformity and Variability: An Essay on the Philosophy of Matter,' www.t0.or.at/deland/matterdl.htm, accessed 31.04.10 (unpaginated).

[88] Olivia Harvey, Tamara Poppowski and Carol Sullivan, 'Individuation and Feminism: A Commentary on Gilbert Simondon's 'The Genesis of the Individual' in *Australian Feminist Studies*, Vol.23, No. 55, March 2008, pp.101-112.

[89] John Protevi, *Political Physics: Deleuze, Derrida and the Body Politic*, London: Athlone Press, 2001.

[90] See for example, Miguel de Beistegui, *Truth and Genesis*, Bloomington: Indiana University Press, 2004 and 'From Merleau-Ponty's 'Reduction' to Simondon's 'Transduction' in *Angelaki*, Vol.10, Issue 2, August 2005, pp.286 –7.

[91] Alberto Toscano, *The Theatre of Production: Philosophy and Individuation between Kant and Deleuze*, Basingstoke: Palgrave Macmillan, 2006.

[92] Bernard Cache, *Earth Moves: The Furnishing of Territories*, trans. Anne Boyman, Cambridge, Massachusetts: MIT Press, 1995, pp.105-117.

[93] Brian Massumi, 'Building Experience: The Architecture of Perception' in Lars Spuybroek, *Nox: Machining Architecture*, London: Thames and Hudson, 2004, p.328.

strips) and back to the digital before a further 'transduction'to the wood and fabric installation and 'the architecturally contained, art-enjoying human body.'[94] In these readings the material is recast as a field of potential for the emergence of form. As for Protevi, what is at stake is self-organisation and multiple possible outcomes, and as DeLanda has put it, allowing materials 'to have their say.'[95]

Although *L'individu* is structured in such a way that the technical system is left behind in the move towards living systems, and appears to be a secondary concern, Simondon will devote much of his later research and writing to its study. The theory of individuation, and many of the ideas he develops from cybernetics, prove fertile for his ongoing interest in the relations between individuals, collectives and technical systems, in particular in the contemporary context of changing technological realities. Simondon's detailed and ongoing concern with the technical system is largely ignored in the Deleuzean appropriations of his work, but perhaps their greatest limitation in terms of this study is that they tend to present individuation as a generic system. It is as if the meticulous attention Simondon pays to setting out the *differences* between individuating systems – from the technical through the physical to the living and the collective – is of no significance. In 'Allagmatique' Simondon is explicit about this tension in his theory of operations. It would, he says, be a better aim to find a single fundamental type of operation than to define a number of broad categories of operation based on objective study,[96] but his method in *L'individu* appears to do both at once. He also proposes that any relation between two operations must necessarily be analogical, as for example between the form taking of a brick and the reproduction of a simple organism. [97] Technical individuation and living individuation are a 'single fundamental type of operation' only in so far as they are analogous. As such, and despite his aim to outline a fundamental type of operation, in Simondon's work the differences between what Massumi has called 'modes of individuation' are retained.[98]

Although Simondon's formulation and critique of hylomorphism provides the starting point for my own discussion of the form/matter schema (introduced in Chapter Four on the process-based clause), and his method of using specific examples to generate problems and concepts has been exemplary, it is by considering the material within the specific terms of his technical system, rather than as a kind of generic individuating system, that his work becomes particularly productive for this enquiry into materials. I draw most heavily on *L'individu* in order to understand the 'complete system' of individuation with particular reference to the chapter on the form taking of the wet clay brick, and for Simondon's broader concerns with

[94] Here Massumi's use of the term 'transduction' replaces 'translation' which would normally be used. Ibid., p.329.
[95] Manuel DeLanda, 'Material Complexity' in Neil Leach, David Turnbull, Chris Williams (eds.), *Digital Tectonics*, Chichester: Wiley-Academy, 2004, p.21.
[96] Simondon, *L'individuation à la lumière des notions de forme et d'information*, p. 559.
[97] Ibid., p.561.
[98] Brian Massumi interviewed in '"Technical Mentality" Revisited: Brian Massumi on Gilbert Simondon' with Arne De Boever, Alex Murray and Jon Roffe, in *Parrhesia*, Number 7, 2009, p.37.

technical objects and systems I turn to *Du Mode*. English translations of the introduction[99] and most of the first chapter[100] to *L'individu* are available, as well as a translation of the introduction and chapters I and II of *Du Mode*.[101] Apart from a translation of a very interesting short text by Simondon published as 'Technical Mentality'[102], I have used the French versions of Simondon's texts and any translations are my own, except where I have cited other authors' translations in their own discussions of Simondon.

I have been limited to the few French texts on Simondon's work that are available in the UK and have concentrated mostly on commentaries in English. Although Toscano's account of Simondonian individuation in *The Theatre of Production* follows Deleuze in the main and does not explore *Du Mode*, his discussion of Simondon's notion of the system in general and of the role of relations and transduction is very helpful for my own arguments about the technical system.[103] Simondon uses the terms 'technical system' and 'technical operation' in Chapter 1 of *L'individu*, where they refer to the individuation of the wet clay brick. In *Du Mode* he makes some rather different distinctions between technical elements and ensembles and between abstract and concrete technical objects. I understand the term 'system' as denoting any preindividual and individuating being with the potential for individuation. Thus a wet clay brick is a technical system, but a formed and fired brick is simply a technical object. What distinguishes a system from a set of parts is its capacity for individuation. In some more recent and extremely interesting articles Toscano goes beyond Deleuze's appropriation of Simondon to explore his notions of work, shuttling between a particularly difficult passage on hylomorphism, the technical operation and the social organisation of work, from Chapter 1 of *L'individu* and Simondon's much more explicitly social analysis of the technical operation and labour in *Du Mode*.[104] If the Deleuzian appropriations of Simondon tend to concentrate on the physical operations involved in individuation, Toscano's later articles focus on the kinds of relations between individual and the collective that can be organised by technical objects. For Simondon, the development of new technical systems can alter these relations and, moreover, can produce new conceptual frameworks.

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[99] Translated by Mark Cohen and Sanford Kwinter and published as 'The Genesis of the Individual' in Jonathon Crary and Sanford Kwinter (eds.), *Incorporations*, New York: Zone Books, 1992.

[100] Translated by Taylor Adkins and posted at http://fractalontology.wordpress.com/2007/10/03/translation-simondon-and-the-physico-biological-genesis-of-the-individual/ Accessed: 04 December 2008.

[101] Simondon, trans. Mellamphy as *On The Mode of Existence of Technical Objects*. Extracts from Chapter I have also been translated by Karen Ocama as 'Technical Individualization' in Joke Brouwer and Arjen Mulder (eds.), *Interact or Die!*, Rotterdam: V2_Publishin/NAi Publishers, 2007 and by Glenn Adamson, who passed to me his translation of extracts from the first chapter of *Du Mode* which was planned to appear in Glenn Adamson (ed.), *The Craft Reader* Oxford: Berg Publishers, 2010.

[102] Gilbert Simondon, trans. Arne De Boever, 'Technical Mentality' in *Parrhesia*, Number 7, 2009, pp. 17-27 and originally published in eds. Jean-Hughes Barthélémy and Vincent Bontems, *Gilbert Simondon. Revue philosophique 3*. Paris: P.U.F., 2006.

[103] Toscano, *The Theatre of Production*.

[104] See in particular, Alberto Toscano,'Technical Culture and the Limits of Interaction: A Note on Simondon' in Brouwer and Mulder (eds.), *Interact or Die!*.

Interest is growing in Simondon's philosophy in its own right and even if, as Massumi suggests, 'there seems to be a tendency to concentrate on Simondon's theory of the technical object to the exclusion of other aspects of his thought – physical individuation, vital individuation, and psychic individuation'[105] there is very little work available in English which looks at the technical object across Simondon's texts. Adrian Mackenzie, however, has traced Simondon's arguments about the technical system between *Du Mode* and the texts on individuation, although he has not yet covered the new collection of Simondon's copious lectures and writings on technical invention, imagination and creativity which includes some essays on architecture and building.[106] Interestingly he also applies them to examples of technical objects and contemporary technologies. Mackenzie's work is particularly helpful in locating Simondon's thought in the context of technology studies. Although references are frequently made to Latour's apparent interest in Simondon (but I have found nothing but the borrowing of his phrase 'the mode of existence of technical objects' in Latour's work[107]), Mackenzie's article 'Problematising the Technological: The Object as Event' actually takes the trouble to compare their work and sets up some incisive contrasts between the role of relations in each of their accounts of technical objects. His earlier book *Transductions: Bodies and Machines at Speed* is rather more wide-ranging and ambitious in its scope, but it also includes lucid accounts of Simdondon's work on hylomorphism, individuation and technical objects.[108] For Mackenzie, Simondon's arguments shift the discussion of technology away from the supplementary or originary role it had for deconstruction, towards the ways that specific technical configurations construct and intervene in collective life. As his title suggests, it is Simondon's notion of transduction - individuation as at once the genesis of an individual and a coming into relation of previously incompatible potentials – that is central for Mackenzie, because what is decisive about the technical element or ensemble is not its physical form or capacities but its 'technicity' which 'is deployed *in relation to other elements and gestures, to other practices and institutions*.'[109] It is the kinds of relations which are made through and across technical objects – or their capacity to form individuating systems with heterogeneous realities which interests Mackenzie, and also informs my own ideas about materials as technical systems.

Mackenzie gives a very thorough account of Simondon's description of the form-taking of the wet clay brick and he touches on a distinction between the kinds of operations Simondon describes in this chapter which will become very important in my discussion of the technical system. On the one hand:

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[105] Massumi, '"Technical Mentality" Revisited', p.38.
[106] Gilbert Simondon, ed. Jean-Yves Chateau, *L'invention dans les techniques: cours et conferences*, Paris: Éditions du Seuil, 2005.
[107] See Latour, 'Can We Get our Materialism Back, Please?', p.41. More often, Latour ascribes the term 'mode of existence' to Étienne Souriau. See for example, 'A Textbook Case Revisited: Knowledge as a Mode of Existence' in Mike Lynch et al. (eds.) Cambridge, Massachusetts: MIT Press, forthcoming.
[108] Adrian Mackenzie, *Transductions: Bodies and Machines at Speed*, London: Continuum, 2002.
[109] Ibid., p.15.

> Moulding the clay into a brick depends on *a prior set of operations*, involving preparation of the mould, and preparation of the clay.[110]

On the other there are operations which constitute the 'individuation in process':

> For only an instant, the moment at which the informing occurs, both mould and the whole mass are in dynamic relation. In the system composed of limiting mould and homogenized clay under pressure, forces propagate reciprocally throughout the mass of the clay, not just across the interfaces between clay and mould.[111]

The 'prior set of operations' or 'preparations' make ready the preindividual field for the possibility of individuation and the transductive operations through which individuation takes place. 'Preparations' are unique to Simdondon's account of the technical system. They describe the creation of preindividual conditions that occurs in technical production but not in other modes of individuation. Preparations become a crucial concept in this study because they can include more kinds of operation than the physical ones that Simondon tends to concentrate on, and open up the possibility that preparations might also be statutory, procedural, institutional and epistemological. They also introduce the possibility of preindividual conditions that are intentionality produced, although intentionality and determination are usually considered to be one of the targets of Simondon's theory of individuation. As far as I am aware, this aspect of his theory of the technical system has not been explored elsewhere.

Finally, Mackenzie's also takes up Simondon's notion, discussed in the introduction to *L'individu* and again in 'Allagmatique', that transduction might also be a process or mode of thought. Transductive thought, like the analogous operation, puts diverse realities into relations with each other, so that it is the operation of putting them into relation which yields problematics and resolutions. Transductive thought does not seek resolutions from conceptual structures outside its own system, just as individuation is internal to a individuating system and is not imposed from outside as form is understood to act on matter within the hylomorphic schema. Here, perhaps, the putting into relation of the architectural specification with the question of concepts of materials might be understood as a transductive method in Simondon's sense.

Rather than beginning with an extensive discussion of Simondon's theory, and then attempting to apply it to some examples of descriptions of building materials drawn from the specification, his arguments are introduced gradually throughout the text. The notion of the building material as a technical system develops with and out of discussion of the forms of clause in the specification. Since there is little material available on

[110] Ibid., p.46, my emphasis.
[111] Ibid., p.47.

the history of specification practice Part I draws heavily on technical literature and the documents themselves and works at a detailed level to build up a general picture. Chapter Two sets out some of the more general variations in the organisation and content of the specification in its historical and industrial contexts. Chapter Three outlines the various forms of clause I have identified as a starting point for asking how we might think of materials without recourse to a concept of matter.

Part II explores two of these forms – the process-based clause and the performance clause – and asks particularly how they might be understood to exceed or trouble the hylomorphic concept of matter. Chapter Five looks at some appearances of Aristotle's classic formulation of hylomorphism in architectural practice and theory before introducing Simondon's specific process-oriented critique. In Chapter Six process-based clauses for concrete casting in rigid formwork provide a parallel to Simondon's descriptions of the form-taking of a wet clay brick. Simondon limits his analysis of the preparations for form-taking to the physical, but process-based clauses drawn from practice include preparations that are social and regulatory. Chapters Six and Seven examine the performance clause, which specifies materials only in terms of their capacities to function in the finished building. Chapter Six takes up Heidegger's argument that the hylomorphic concept of matter covers over the equipmentality of material, and proposes that the performance clause be seen as evidence of a material's selection and preparation for specific use. In Chapter Seven performance specification is shown to dramatically extend the preparations for mobilising a material from the physical operations of fabrication to the 'extra-physical,' incorporating testing, standardisation, the design of materials 'on demand' and even makes it possible for effects on the inhabitants of buildings to be a determining use in the specification of a material.

Part III returns to the variety of forms of clause to suggest that they are evidence of a variety of 'systems of materials' in the terms of Simondon's technical system. Each system is characterised by the ways they are prepared and mobilised, and by the relations which hold them together as systems. Chapter Eight explores how technological, physical, organisational, statutory and industrial developments can all prepare the potential of a material to be mobilised in a particular way, and Chapter Nine proposes that the mobilisation of a building material may well effect compatibilities between other diverse realities than abstract form and plastic matter. These transductive relationships are at once material and conceptual. While they are embedded in the conditions which make them possible they may nevertheless be exploited in ways which exceed their normative mobilisation.

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Chapter Two: From Particulars to the NBS: Historical variation in the specification

> Make yourself an ark of gopher wood; make rooms in the ark, and cover it inside and out with pitch. This is how you are to make it: the length of the ark three hundred cubits, its breadth fifty cubits, and its height thirty cubits. Make a roof for the ark, and finish it to a cubit above; and set the door of the ark in its side; make it with lower, second, and third deck.
>
> Genesis 6.14-16[1]

God's instructions to Noah for building his ark read much like an architectural specification. As in the earlier examples of specifications from the 18th century in the RIBA collection, the emphasis is on dimensions and a description of the layout of the structure, along with the particular species of timber to be used, information which is less common today now that the more generic classifications 'softwood' and 'hardwood' tend to be used unless the timber will be visible. As in most of the documents I have seen, including those used in contemporary practice, the description of materials is only one aspect of the specification, and the nomination of a material (whether by natural species, product or proprietary name) is only one mode of specification among many. Gelder, who includes the longer set of instructions God gives Moses for constructing the ark of the covenant[2] as well as Noah's ark amongst his examples of early specifications in *Specifying Architecture*, even interprets God's instruction 'to bring two of every sort into the ark' as a performance specification in so far as it is describes what the ark is intended to do rather than how it is to be.

The term 'specification' can cover many descriptions of building and the difficulty of definition is exacerbated by the diversity of titles found in historical examples – from 'paradigm'[3] or 'particulars'[4] to terms such as 'will,'[5] 'indenture'[6] and 'covenant'[7] which suggest the legal force of these documents. Moreover the way these descriptions are used in construction varies considerably. One example Gelder includes is of a text

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[1] *The Holy Bible*, Revised Standard Version, New York: Collins, 1971, p.5. This passage is referred to as a specification by Gelder, *Specifying Architecture,* p.189. Gelder even makes the not entirely unreasonable suggestion that given their wide distribution and readership, these biblical texts may even have influenced specification writing through history!

[2] God begins by saying, 'According to all that I show you covering the pattern of the tabernacle and of all its furniture, so you shall make it,' *The Holy Bible*, Exodus, 25.9, p.69. Also see Robin Kent, 'The Tabernacle: the oldest building specification known,' *RIBA Journal*, May 1985, pp.30-32.

[3] 'Paradigm' denotes a specification which could provide the basis for duplicate buildings, for example, as in the case of the Latin 'paradigm' for Cluniac Monasteries in the Farfa Consuetudinary (1043) as discussed in Gelder, p.5 and cited and translated by Gelder, *Specifying Architecture*, pp.195-6.

[4] For example, Particulars for a Bakehouse, dwelling and lofts in parish of St Anne, Middlesex (1770), contractor – Robert Wilson, client - John Steinmetz, RIBA Archives WiR/1.

[5] Henry VI's 'will' for the building of Kings College Chapel, Cambridge (1440) as described and cited in Gelder, ibid., pp.196-197 was more like a brief that a contemporary specification.

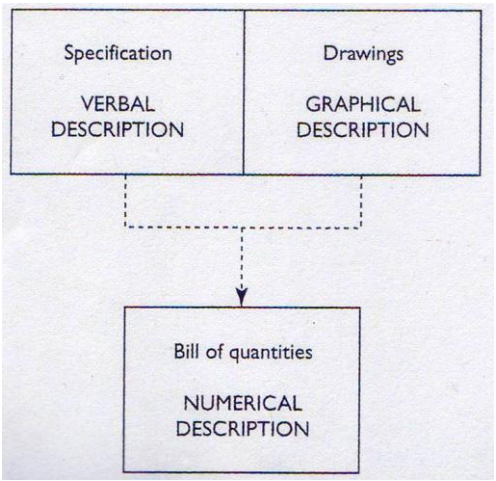
[6]' Indenture' appears in Gelder's unpublished translation for a specification for a Chamber for Philip of Englefield, contractor – John the Rede, England (early 14th century), published in French as example #2 in Louis Francis Salzman, *Building in England down to 1540: A documentary history*, Oxford: Clarendon Press, 1952.

[7] 'Covenant' appears in Gelder's unpublished translation for a specification for a Tenement for Sir John of Mundene, carpenter – Richard of Rothinge, England (1310), published in French as example #4 in Salzman, *Building in England*.

carved into stone at the base of an ancient Greek arsenal which must have had roles beyond the specifying of construction.[8] Another of his examples gives the detailed breakdown of building works at Kings College Chapel but was also an accounting document.[9] There was no fixed price for the work and so careful records of each expenditure were crucial. A number of the 18th century specifications I have seen are hybrid documents which also act as contracts: signed, witnessed and sealed.[10] Throughout the 19th and 20th centuries specifications increasingly outline the processes builders are to follow, and might sometimes be read as instructions, particularly where innovative construction techniques are described.[11] More recently, specifications are written to allow contractors to select materials and components post-novation. They outline parameters and standards the construction must meet without in fact specifying particular materials. In each of these cases the role of the specification will inform both the structure that the document takes and the nature of the content included. To define the specification from the narrow perspective of the role it plays in current construction practice (at least in the UK) would be to overlook these dependencies and their many configurations in other contexts, and it is precisely this variation which makes the specification such a rich resource for study.

1. Defining the architectural specification

Despite this complexity there are some broad criteria which inform the selection of documents in this research The first – that the specification is the 'written description' of the building, as opposed to its 'graphic description' or what is drawn - is put simply in a table Gelder includes in his study (Fig. 2.1):



2.1 Figure 5.2 *Specifying Architecture*, p.97

[8] Specification for an ancient Greek arsenal at Zeia (347-6 BC), Gelder, *Specifying Architecture*, p.190.
[9] Will for the building of Kings College Chapel (1440), ibid.
[10] For example, Particulars for a Bakehouse, dwelling and lofts (1770), and Articles of Agreement for a town house for Sir William Heathcote at St James Square, London architect – Henry Flitcroft (1734-6). RIBA Archives, HeW/1/1/2.
[11] For example, particularly in relation to reinforced concrete, Specification of Works for a House at Farnham Common, Bucks, architect and client – Valentine Harding (1934), RIBA Archives, SaG/17/3, discussed in detail in later chapters.

It is not just that specifications use language to describe the building, and that this language is written down, rather than spoken like God's words to Noah. In general they also exclude drawings, diagrams or photographs and exceptions are few and far between. For example, In DSDHA's specification for two kiosks in Potters' Fields Park, London (2006) where the timber cladding is to be charred a photograph of a recommended propane gas burner is appended.[12] In David Mocatta's Specification for the London Fever Hospital adjoining the Liverpool Road (1833-43) a tiny drawing is included of the special 'chamfered fillet' which is to be fixed horizontally 'to keep beds from wall' in the wards.[13] In the Particulars for a bakehouse, dwellings and lofts (1770) a set of small drawings showing a front elevation, a plan and a rear elevation cut away to show the configuration of timbers in the roof are included on the front page. References to drawings are given in the text but since no architect was involved in this project (the agreement is between carpenter Robert Wilson and the client, and work is to be supervised by an appointed surveyor, John Powsey) it may well be that these 5 large parchments were the only building description and the small sketches were the only drawings.

It has not always been the case that documentation included both specification and a set of drawings as it does today. In the period of debate about specification practice in the 1960s and 70s prior to the establishment of the National Building Specification (NBS) most commentators seemed to agree that the distinction between written and drawn information was decisive. John Carter, an executive member of a committee who prepared an early feasibility study for the NBS, wrote that it was essential 'to trace a boundary between drawings, quantities and specification' and that certain information is 'better expressed in words than graphically.'[14] This restriction to the written description does not necessarily delimit the content of the specification. As we saw in the case of the Particulars for a bakehouse, dwellings and lofts (1770) the specification may sometimes have been the only description used. In the absence of scale drawings the specification gives the dimensions of the building in words, as God had to for Noah. By the 18th century scale drawings were often in use but dimensions are still given in the specification. The earliest specification in the RIBA collections, the Articles of Agreement for a town house for Sir William Heathcote at St James Square, London (1734-6), is also a contract between the client and carpenter Benjamin Timbrell. It is written in illegible and ornate script on two large sheets of parchment, and refers to a set of drawings by the architect Henry Flitcroft. The first section of text gives the overall dimensions of the new building:

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[12] Architectural Specification for Parkside and Blossom Square Kiosks, Potters' Fields Park, London, architects - DSDHA, (2006). I discuss this example further in Chapter Eight.

[13] 'Specification of work to be done in the Erection of the London Fever Hospital adjoining the Liverpool Road', in David Mocatta, *Specifications* (circa 1833-43), RIBA Archive, MoD/1/1. It should be pointed out that it has been prohibitively expensive to include illustrations of the specifications from the RIBA archive, since it is only possible to reproduce any of the material by using in-house photography of single pages. There is surprising variety in the look, production, text and material qualities of these documents, and the technique I have adopted of using a different typeface as a shorthand to reflect different eras, does little justice to these differences.

[14] John Carter, 'National Building Specification', *The Architects' Journal Information Library*, 19 March 1969, p.760.

> One New Brick House to contain in front from East to West next the Said Square forty two foot and in depth from North to South Sixty five foot or thereabouts together with a kitchen and Scullery under the back Court to be made and laid out to the said new intended house with vaults behind the same and also stables for Neine hourses and three coach houses to contain such height of Storeys, thickness of walls and scantlings of timber and such dimensions and to be done in such manner as in hereinafter mentioned and as the same are more particularly set forth and described in the drawings of the plans elevations and sections.[15]

Gelder explains that dimensioning moved to the drawing only after the Renaissance when the technique of drawing to scale had been developed, but it seems that vestiges of this practice are retained well in to the 18th Century.[16] It is also common to find the specification defined as a *qualitative* description. As early as 1969, Anne Plowden cites the following categorisations of construction documents:

1. Graphic description is given by drawings
2. Qualitative description is given by specification
3. Quantitative description is given by bill of quantities
4. Economic description is given by estimate[17]

Gelder mentions quality too: 'In effect the specification is split between the drawings and the written document... For quality matters (for example), the right place is in the specification, not the drawings.'[18] And Stephen Emmitt and David Yeomans make the same distinction:

> Drawings indicate the quantity of materials to be used and show their finished relationship to each other. It is the written specification that describes the quality of the workmanship, the materials to be used and the manner in which they are to be assembled.[19]

Unusually, they discuss drawing and specification as if they are both primarily descriptions of materials. Drawings are usually considered as describing form but in this account they are reconceived as abstractions or quantifications of the materials of building, as opposed to the specification whose task it is to differentiate

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[15] Articles of Agreement for a town house for Sir William Heathcote (1734-6).
[16] According to Gelder, *Specifying Architecture*, p.80.
[17] O. Tichy speaking at the CIB conference in Oslo, 1963, as cited by Anne Plowden, 'Unscrambling the SMM omelette' in *Building*, 17 October 1969, p.42.
[18] Gelder, *Specifying Architecture*, p.69.
[19] Stephen Emmitt and David Yeomans, *Specifying Buildings: A Design Management Perspective*, Oxford: Butterworth Heinemann, 2001, p.24.

between them, in terms of type, assembly and quality of workmanship. Emmitt and Yeomans go on to suggest that given the perceived lack of quality of most modern building the specification may warrant more attention by practitioners than it currently receives. They also point out that quality means something very different to each of the parties involved in building (whether designers, financiers, constructors, building control or users). Their concerns have particular significance given that in contemporary specification quality is usually given in reference to a standard, which is defined institutionally so that any debate about what constitutes quality or in whose interest is already curtailed.

We might also note that Gelder's table distinguishes between the graphic and written descriptions of the building and the 'numerical description' or bill of quantities which, typically, in contemporary practice the quantity surveyor derives from them, so that the work can be priced. This distinction is not so neatly drawn in historical examples of building documentation, and as such some of the examples Gelder draws on include accounts, and some of the examples included as specifications in the RIBA archive have in fact been used as pricing documents. For example the printed leaflet produced by architect Thomas Hardwick entitled 'Particulars of Carpenter's and Joiner's Work to a Church intended to be erected at Wansted in the County of Essex' (1787) gives each item in terms of a rate, and includes a column for pounds shillings and pence, as well as 'form of proposal' at the end. This tender document enables the contractor to put together a proposed cost.[20] Even today, if a job is too small to allow for the production of separate documents, a schedule of works may function both as specification and the basis for pricing, but the facilitation of pricing is not one of the roles of 'pure' specification.

It seems however that Gelder's definition of the specification as a *description* is a simplification. Certainly, the researcher might read it as such, and I will often refer to it in these terms, but because it is necessarily written prior to the building's existence and has an effective force, it might more properly be called a 'pre-scription' than a description. When God gives his commands to Noah they don't so much describe the ark as determine the shape and specific materiality it will take. This is not to say that the specification is necessarily a set of instructions, although it may be used this way but, rather, to draw attention to the fact that the specification stands in for the as yet un-built building, particularly when it has legal force. We have already seen examples of two contracts which also include the specification of the building. The Particulars for a bakehouse, dwellings and lofts (1770) are signed and sealed in red wax by both the carpenter Robert Wilson (who acts as the general contractor here) and his client, the gingerbread maker John Steinmetz. The inscription on the reverse is signed by the witnesses, including John Salter, the public notary who also delivered the documents. The Articles of Agreement for a town house for Sir William Heathcote (1734-6) is written in an elaborate script, which fills the page and leaves no breaks between words on separate sections. It is gives details of the materials and kinds of ornamentation to be used in each of the rooms of the house,

[20] Particulars of Carpenter's and Joiner's Work to a Church intended to be erected at Wansted in the County of Essex, architect -Thomas Hardwick (1787). RIBA Archives AC/HAR/Add/1.

but this information is almost illegible and has not been written to be read or used on site. The document appears to have the sole purpose of representing the promise of the contractor to the client to provide this particular building (and the client's agreement to pay). Indeed contemporary specifications are themselves often thick bound documents, unwieldy to use, too full of references to standards that are given elsewhere to be of any use on site, and referred to only for pricing prior to building or after building in the case of a dispute.

We might say then, that while the medium of the specification may be description, its force is constitutive. I mean this in two senses. The first is that the specification plays a determining role in the construction of the buildings it details and in its existence as a legal entity both before and after realisation. This is also true of architectural drawings where they are part of the contractual documentation, although this is rarely acknowledged outside technical literature.[21] The role of the specification is not merely representational. The second is that the manner of its organisation and particularly of its individual descriptions of specific materials – or clauses – also plays a part in the formation of the concepts of the materials it describes. Michel Foucault has called the systematic presentation of the statements and discourses he explores 'grids of specification.' [22] For Foucault, particularly in his studies of natural history and grammar, the overall organisation of these statements together with the individual statements themselves, form the discursive 'practices that systematically form the objects of which they speak.'[23] In the specification it is not just the clauses for materials and products which 'form the objects of which they speak' but their relationships with other statements inside and outside the document. What is striking in the specification, even within the limited 270 year period which I look at in this chapter, is the degree of change and the very evident relationships of those changes to the industrial practices in which specification is embedded.

2. The changing format and language of the specification

> In the seventeenth and eighteenth centuries Natural History was not simply a form of knowledge that gave a new definition to concepts like 'genus' or 'character', and which introduced new concepts like that of 'natural classification' or 'mammal'; above all, it was a set of rules for arranging statements in series, an obligatory set of schemata of dependence, of order, and of succession, in which the recurrent elements that may have values as concepts were distributed.
>
> Michel Foucault[24]

[21] An exception is Stan Allen who proposes that we think of the architectural drawing as abstract and nevertheless active, and that architecture is 'a transformation of reality carried out by abstract means.' Although Allen asks us to look at 'not what a building, a text or a drawing means, but what it can do: how it operates in – and on – the world,' he is more inclined to explore the drawing in terms of its projective force than its contractual operations. Stan Allen, *Practice: Architecture, Technique and Representation*, Amsterdam: G+B Arts, 2000, p.xxv and p.6.
[22] Michel Foucault, *The Archaeology of Knowledge*, trans. Alan Sheridan, London: Routledge, 2000, p.42.
[23] Ibid., p.49.
[24] Ibid., p.57.

We can expect the detailed content of the specification to change enormously as building techniques develop and proliferate. Gone today are the instructions to well-sinkers and bell-hangers, replaced by work sections on piped supply systems and communications/security/control systems. The location of the work of plumbers gets relocated when lead-working is no longer their main trade, and sections for asphalters become more prevalent with the introduction of the flat roof.[25] If concrete was only used in foundations in the early 19th century it now appears in many sections throughout the specification from groundworks to cladding and surface finishes. Where glass was once specified according to standards - 'best seconds' 'good thirds' – it is now engineered to meet a complex range of very specific performance criteria whose description requires the terminology of materials science. But changes in specification practice go beyond the gradual replacement of traditional materials and techniques with new material technologies. It is the changes in the manner of specifying a material – in how it is described and what is considered relevant to its prescription at any given time or in a particular context – that will be the main focus of this research. These forms of clause will be set out in Chapter Three. To some extent, I understand them in terms of the concepts Foucault describes in *The Archaeology of Knowledge*. Just as the mammal is a new concept in as much as it doesn't refer to the discovery of a new animal but a new way of thinking about them, a change in the form of clause need not relate to the production of a new kind of material, but rather constitutes it anew. As Foucault makes clear in relation to natural history, if we are to understand these new concepts we also need to look at the kinds of rules determining the ordering of statements in relation to each other and at their 'associated field.' 'The coordinates and the material status are part of its intrinsic characteristics,' he writes.[26] Concepts and statements, in his terms, cannot be separated out from the ways they are organised and structured in relation to each other, nor should they be abstracted from the conditions of their emergence or their effects:

> [Statements] are invested in techniques that put them into operation, in practices that derive from them, in the social relations that they form, or, through those relations, modify.[27]

Although the forms of clause I will identify are not always limited to one period of time (and indeed one of the questions this study raises, contra Foucault, is why it is that some descriptions of materials in the specification do *not* change, even when practices and knowledge formations undergo radical transformations) and to some extent in order to construct a typological category I lift them out of their associated field, the documents they appear in show enormous variation, at the level of their material status, in terms of their organisation and in the ways they are put into operation. A specification may satisfy all the parameters already outlined in as much as it is a written description of the building-to-be with some contractual force but nevertheless be a very different kind of object; a beautifully scripted legal parchment that will be stored away, signed and sealed, in

[25] We find bell-hangers and well-sinkers but not asphalters included as trades in the first edition of *Specification*, Vol. 1, 1898. But there is a brief section for Asphalters included in the specification for Harding's modernist reinforced concrete house which incorporated flat roofs, see Specification of Works for a House at Farnham Common (1934).
[26] Foucault, *The Archaeology of Knowldege*, p.98.
[27] Ibid., p.123.

the client's bureau[28] or a list of materials typed hastily on to a few sheets of foolscap telling the contractor which of the most expedient construction techniques to use for the quick assembly of a factory shed.[29] It may be organised around the form of the building, by the various trades or indeed, as in some contemporary specification practice, by grouping types of clause together. What is clear, however, is that each of these configurations is embedded in the conditions of the industry. Most commentators agree that it is with the rise of gross tendering in the early 19th century particularly for large scale building projects that the scope and importance of the specification greatly increases. Since then, we also see the gradual standardisation of the format and clauses of the specification which culminates with the launch of the NBS in 1973, as well as the increasing use of references to standards. Before moving on to look at the forms of clause themselves I want first to outline these broader changes with particular reference to examples drawn from the specifications themselves which make these changes visible.

The current version of the NBS is organised in work sections, each titled with a letter of the alphabet according to the Uniclass classification system, but in the late 18th century we still find specification organised according to the structure of the building. In the Articles for a town house for Sir William Heathcote (1734-6), the building is described floor by floor and the titles appear in the following order:

> No.1 A plan of the lower story
>
> No.2 A plan of the hall and parlour floor
>
> No.3 A Plan of the Chamber floor
>
> No.4 A Plan of the Attick storey
>
> No.5 A Plan of the garrets or upper storey
>
> No. 6 The kitchen and scullery or washhouse under the court behind the house. [30]

The organisation of this specification is structured much as a drawn section would be - from the lowest point in the house, the cellar, to the highest, the garret, with the outbuildings last. It has been set out as if it is a drawing of the house in words. The detail of each section names many of the materials to be used but includes few of the references to quality, workmanship or methods that will characterise the lengthy specifications of the 19th and 20th centuries. We can assume that there would be so little variation between the construction of one London townhouse and the next that it was not necessary to supply this information. The Particulars for a bakehouse, dwelling and lofts produced just a few years later in 1770 is also organised by floors, but it also introduces some sections for specific trades:

[28] Articles of Agreement for a town house for Sir William Heathcote (1734-6).
[29] Specification of Works for a smoked sausage manufactory, 5 Fairhazel Gardens, NW6 (1934-5), architect - Gerhard Rosenberg, RIBA Archives, SaG/17/7.
[30] Articles of Agreement for a town house for Sir William Heathcote (1734-6).

1. Dimensions
2. Bakehouse: bricklayers work
3. Bakehouse: tylers work
4. Dwelling house: bricklayers work
5. Dwelling house: tylers work
6. Bakehouse: carpenters work
7. Roof
8. Westside
9. Front
10. Capenters: dwelling
11. Inside [arranged from the top floor down]
12. Garret
13. Chambers
14. Parlour and Kitchen
15. Cellar
16. Stairs
17. Floors
18. Finishing the Room
19. Plasterwork
20. Masons work
21. Painters work
22. Glaziers work
23. Plumbers work
24. Smiths work[31]

Here the highest point of the building – the roof – is described first. The sections drop down through the garret, the chambers and the kitchen to the cellar. Around these sections, are a set of work descriptions divided up by trades. As dimensioning disappears from the specification, its organisation by trade will become the norm. Titles of sections sometimes refer, as here, to the work of each trade (Painters work), or direct to the tradesman (Painter). Usually the trades are introduced in the order that the works will be done on site. The example above marks a transitional stage between the two formats and the order of sections is haphazard, but broadly the work of trades who will finish the building - plastering, painting, windows and ironmongery – is given at the end of the document. 19th and 20th century specifications tend to begin with sections for the 'demolisher' and 'excavator' and move through to the 'glazier,''smith' and 'painter'. Although the work sections of the contemporary specification are arranged in alphabetical order, the logic of building sequence is retained to some extent, but the groupings are now structured more around the kinds of products, materials and systems than by who will carry out the work.

In Tilo Amhoff's study of the contractual changes of the early 19th century and their impact on architectural documentation he also notes the shift from describing 'the shell of the house' by individual storeys to the

[31] Particulars for a bakehouse, dwelling and lofts (1770).

division of trades in the early 19th century.[32] Amhoff suggests that earlier specifications needed only to give 'literal descriptions' of the building since the craftsmen could be trusted to carry out the work to expected quality, whereas later specifications were let out to unknown contractors and their legal obligations including the method of work had to be described in detail. He suggests that the practice of organising the specification by trades simply followed the order of building. This is the general order we find the trades in, but since trades work simultaneously, and often in many stages of the process it can't be the only factor. The trade-based organisation of the specification also makes subcontracting easier. If traditionally carpenters had tended to organise work on site (and hence the early contracts at St James Square and for the bakehouse, dwellings and lofts are signed by their carpenters) this new system also allowed different parcels of work to be let out to the different trades.

A

DESCRIPTION

OF THE

PLUMBER's WORK,

To be done in building the

SESSIONS-HOUSE in the *Old Bailey*,

Agreeable to the Drawings herewith exhibited.

TO lay all the Gutters with caſt Lead, of *eight Pounds* to the Foot, which Lead ſhall turn up not leſs than *eight Inches* under the Slating of the Roof, and lap over the Top of the Blocking-Courſe *two Inches*. The Lead to turn up in the middle Gutters not leſs than *eight Inches* on each Side, under the Slating of the Roof.

The Hip and Ridge-Poles of all the Roofs to be covered with Lead, not leſs than *ſeven Pounds* to the Foot, which Lead ſhall be of a ſufficient Width to turn down *nine Inches* on each Side upon the Slating.

To make and fix up two Stacks of Rain-Water Pipes in the Back Front, made out of milled Lead, not leſs than *nine Pounds* to the Foot, which Pipes ſhall be *five Inches* in Front, and *four Inches* in Depth; the ſaid Pipes to have a neat Ciſtern-Head, *&c.* at the Top, to receive the Water from the Gutters.

To lay Lead Flaſhes in the Flank Walls of the great Dining-Room, to turn down *nine Inches* in Breadth upon the Shed, or lean-to Roofs, which Lead ſhall not weigh leſs than *ſeven Pounds per* Foot; and to lay Lead Flaſhes in the Shafts of Chimnies, of the ſame Breadth and Subſtance.

To fix a leaden Bog-Pipe to the Water Cloſet, of Lead of *ten Pounds* to the Foot, and to provide and fix a proper leaded Stink-Trap to the ſame.

To provide a proper Service-Pipe and Waſte-Pipe to the ſaid Water Cloſet, and to provide and fix all proper Braſs Cocks, a Fan and Plug, and all other Braſs and Ironwork, to render the ſame compleat.

To lay the Water into the Kitchen and Water Cloſet with proper Pipes from the Main.

The Plumber is to obſerve, that all Lead before it is delivered at the *Old-Bailey* for the Uſe of this Building, is to be meaſured, marked, numbered, and weighed, at the Contractor's Warehouſe or Shop, by a proper Perſon to be provided by the Architect; and if any Lead proves to be under the Weight *per* Square Foot, according to the foregoing Particulars, the Contractors ſhall immediately remove and take it away, and make good the Deficiency with other Lead which ſhall be of the full Weight *per* Foot before deſcribed in theſe Particulars.

2.2 Plumber's Pamphlet, Specification of Works at Newgate Prison, London (1770)

[32] Tilo Amhoff, *Adapting the architect's products to the capitalist building production: The development of the Legal Obligations, Building Specifications and Working Drawings in the first half of the nineteenth-century in England*, Unpublished dissertation submitted for the MSc in Architectural History, The Bartlett, University College London, 2003/ 2004, p.23.

In some cases the specifications for different trades are made up as separate documents, as if each would be given in turn to the subcontractor. For example, as early as 1769, George Dance the Younger's specification for Newgate Gaol and the Sessions House at the Old Bailey is divided up into slim folded pamphlets, each one covering the work of the various trades - the Bricklayer, the Carpenter, the Glazier, the Mason, the Painter, the Plaisterer, the Plumber (Fig. 2.2) and the Smith/Ironmonger – with one for each building.[33] Each pamphlet varies greatly in length. The 'Description of the Painter's Work to be Performed in Building A New Gaol in the Old Bailey' comprises of just one clause on the title page while the 'Description of the Carpenter's Work to be Done in Building the Sessions-House in the Old Bailey' runs to eight pages.

The Newgate Gaol and Sessions-House specifications give much greater detail about the materials and process of building than appeared in the specifications for the St James Square house or the Bakehouse, dwellings and lofts. To some extent this is explained by the buildings' complexity – it isn't possible to simply repeat a conventional formula for building as at the St James Square house, and construction details cannot be assumed, but a number of factors contributed to the proliferation of building techniques and the need to specify one over the other. Bowyer points out for example that as the transportation of materials increased with industrialisation, buildings were less often made with tried and tested local materials.[34] As a result, a builder might be working with an unfamiliar material and require guidance.

Furthermore the proliferation of architectural styles in the 18th and 19th centuries also added to the increase in techniques a builder might be called on to use.[35] Gelder explains the effects of the multiplication of techniques on the specification:

> If construction is conventional, the specification could be fairly brief – the contractor could reasonably be expected to know enough to fill in the gaps, and the contractors would have a clear enough understanding of normal practice to not require it to be spelt out in the specification. On the other hand, if construction is innovative, the specification will need to be extensive perhaps even being specific about methods and buildability issues that are normally the contractor's domain.[36]

Furthermore, as Gelder notes, literacy rates had climbed enormously by the end of the 19th century with approximately 75% of adult males able to read, making specifications more accessible.[37] But all commentators seem to agree that the most significant change at this time was the shift from individual craft

[33] Specification for Newgate Gaol and the Sessions House at the Old Bailey, London (1769), architect - George Dance the Younger, RIBA Library Early Works.
[34] Jack Bowyer, *A History of Building,* Eastbourne: Orion Books, 1983, p.198.
[35] Gelder, *Specifying Architecture*, p.15.
[36] Ibid., p.68.
[37] Ibid., p.8.

contracting to gross tendering.[38] Although gross tendering took place in the 18th century, and at other times (according to Gelder the ancient Greeks used this method) it really took off with the London-based large scale developments of Thomas Cubitt in the early 19th century.

Gross tendering requires a single specification which the general contractor can make a fixed price for the whole contract, and the retention of the work divisions which set out each parcel of work for the different trades. In this form of tendering the specification needs to do more than specify one method or material over another, or provide information about an unfamiliar technique. It becomes a tool in ensuring the quality of work, that the main contractor or architect can use if subcontractors are trying to cut corners in order to maximise their profit. According to Bowyer, John Nash foresaw this aspect of the impact gross tendering would have on specification in his contributions to the parliamentary debates of the early 19th century on building contracting:

> John Nash, the architect, was one of the early advocates of contracting in gross. He maintained that the new system would require the architect to prepare a detailed specification setting down all materials and labours. Not only would this ensure that the architect carried out his work properly in the first instance, but also that the supervision of it would be more effective, the clerk of works having a technical document at his disposal stipulating the exact technicalities of the work.[39]

The specification yields an authority which enforces quality of materials and workmanship on site. Here it sets out that the painter is to apply four coats of oil, not three, to all exterior timber and iron surfaces, and to use colours only as directed:

> Description of the Painter's Work
>
> To paint all the outside Wood and Iron-Works, in every Part of this Building, *four Times in Oil*, and to paint all the inside Wood and Iron Works, in every Part of this Building, *three Times in Oil*, of such plain Colours as shall be directed.[40]

Bowyer explains that if the specification is comprehensive it also prevents contractors adding extras to their bills where items were not included. In his 1860 *Handbook of Specifications* Thomas Donaldson explained that in situations where getting the lowest price for a tender became more important than working with tried and trusted contractors, the specification had a particularly important role in mitigating against 'fraud and bad work by unscrupulous men':

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[38] For an excellent analysis of the impact of gross tendering on the practice of specification see Amhoff, *Adapting the architect's products*.
[39] Boywer, *A History of Building*, p.239.
[40] Specification for Newgate Gaol and the Sessions House at the Old Bailey (1769), 'A Description of the Painter's Work', RIBA Library, EW No. 789.

> Where Builders of high established character undertake a work, great minuteness of description may not be necessary; but the Architect cannot be too elaborate or cautions, when having to do with a stranger or person of doubtful reputation, as sometimes happens in the case of open competition for public bodies. These boards are less cautious as to the character of the Contractor than anxious to secure the lowest amount; trusting to remedy any defect by the stringency of the contract and elaboration of the specification; forgetful that, even with these precautions, a wide door is still left open for fraud and bad work by unscrupulous men.[41]

This situation of general distrust of between contractors and architects has only intensified. For a number of high-end practices working today, the NBS does not protect them sufficiently from the substantial claims which can arise from errors or ambiguities in the specification. They choose to use bespoke specifications which better 'close the door', such as those provided by Schumann Smith, a company set up by two former claims surveyors who once trawled documents for errors on behalf of contractors and know exactly what to protect architects from. As more of the detailed design is given over to contractors, litigation is increasingly becoming the main driver in the format of the specification and the methods it uses, but it has long played a role in the complex relations between the parties involved in building. To what extent these issues which play such a crucial part in organising the description of the building might also have material effects is a question we should hold open.

The enormous expansion in specification production in the early 19th century is clear to see in the documents from the time. They are often printed and put together with great care, well-organised, detailed, thorough and cross-referenced to the drawings package. Some of the specifications available in the RIBA collection are for private houses and shops but many detail the large public buildings – hospitals, railway stations and asylums – which were new typologies and fuelled the building boom at the time. At this stage specifications were still produced in-house, office by office. Each new document built on earlier ones, editing them where necessary to suit the project.[42] This was also how I produced specifications for small residential projects in the first practice I worked for in the early 1990s. The wording of a particular clause is copied over from one specification to the next, and becomes sedimented. The phrase 'clean sharp river sand' for example, appears in recipes for mortar at the beginning of the 19th century[43] right through until the early 20th century.[44] Whole clauses get repeated from one document to another, even if the reasons for their inclusion are long

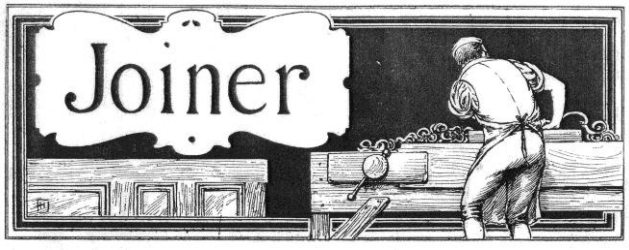
[41] Donaldson, *Handbook of specification*.
[42] Harold J. Rosen refers to this cut and paste technique when he describes 'the specification writer of yesterday with glue pot and scissors' (who will be replaced by the materials scientist) in 'The Future of Specifications Writing – Part II' in *Progressive Architecture*, September 1969, p.206.
[43] For example see the Specification for the Erection of a School house at Hammersmith (1819), architect - Charles Fowler, RIBA Archives, FOC/1/1.
[44] For example, see Specification for Shops/Offices, Oxford St./Rathbone Pl. (1909), architects - Holden and Adams. RIBA Archives, AHP/1/18/1 and Specification of Works for a House at Farnham Common (1934).

since forgotten. No-one dares omit them in case they contain something important. John Carter describes specifications generated this way as 'progeny':

> In studying job specifications it becomes evident that many of them are the progeny of 'model' specifications written years ago, on which each successive job has left its deposit of 'protectionist' clauses to tie down the next contractor.[45]

Unlike the drawing which starts each time from a blank sheet, these specifications are additive. They get longer and longer, repositories of everything that has been written before.

It is during the 19th century that a discourse about specification practice starts to emerge. The prolific architect David Mocatta, who built many of the new railway stations and established a highly commercial practice, collated hand copied duplicates of his practice's specifications and bound them in red leather embossed with the title *Specifications* in gold and donated them to the newly formed RIBA,[46] hoping presumably to showcase his expertise and promote good practice. Later in the century books giving guidance on specification writing appeared such as Bartholomew's *Specifications for Practical Architecture*[47] first published in 1840 and Donaldson's *Handbook of Specifications* in 1860. In 1898 a new journal *Specification* was launched to give architects guidance on writing specifications. It is still in print today, but is no longer set out as an authority on specification. The first edition was organised according to the order of the trades that was by this time conventional (Fig.2.4). Although there are 37 trades in this index, the general guidance for ensuring 'a well-written specification' recommends as few as nine categories for most building works. 'In this arrangement,' it is explained, 'the trowel-using trades are kept together as are also the hammer-using trades, the metal trades and the finishing trades.'[48] Here the kind of work to be carried out still determines the categories of the specification rather than the type of product or their location in the building. After some general notes on specification the rest of the journal is divided into the trade sections, with some wonderful title blocks showing each craft in progress in rather anachronistic medieval form (Fig. 2.3).



2.3 Joiner title block, *Specification*, 1898

[45] Carter, 'National Building Specification', p.759.
[46] The RIBA was established in 1834. No date is recorded for Mocatta's donation but the volume includes a specification for the *London Fever Hospital* (still standing and converted into flats) which was not designed until the late 1840s. Mocatta, *Specifications*, (circa1833-43).
[47] Alfred Bartholomew, *Specifications for Practical Architecture*, London: John Williams & Co., 1840.
[48] *Specification*, Vol 1, 1898, p.6.

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For Advertisers' Directory see Page 8.

2.4 Contents page, *Specification*, 1898

These sections each contain general advice about techniques and materials followed by exemplary clauses. The editors are clear that their new publication should replace the inaccessible notes and files of most practitioners and 'become a storehouse of information, readily at hand, invaluable to the experienced man or the beginner in practice.'[49] Moreover, they explain, the advice it contains should be followed for good reason, because:

> Sometimes the construction of a phrase, or the position or specifics of a single word, may lead to disputes involving the question of many thousands of pounds.[50]

[49] Ibid., p.6.
[50] Ibid., p.5.

The journal invited readers to send in improved clauses and each edition offered updates, discussion, overviews of 'buildings in progress' and when necessary the introduction of new techniques and trades and the removal of redundant ones. As such it shares features with the current NBS which Gelder calls a 'master specification' in as much as it sets out a consistent order for the description of the building and a database of exemplary clauses which can be selected to suit each project. The various forms of the NBS are constantly updated in response to changing technologies, standards, regulations and contractual developments, but unlike the journal *Specification* these are products to which practices must subscribe.

The early issues of *Specification* made use of the two techniques through which specification practice would become more standardised during the 19th century. The first is that examples of good practice are collated and circulated as may have happened with Mocatta's *Specifications* or was the case with Donaldson's *Handbook of Specifications* which included 46 exemplar project specifications for buildings ranging from prisons to the New Royal Exchange, some as long as 70 pages. The second is by establishing master specifications. Bartholomew's *Specifications for practical architecture* (1840) was probably the first attempt to do this in the UK. In 1898 Frank Macey put together *Specifications in Detail* which included more than 500 pages of sample technical specifications for building work.[51] By the 1960s some larger building organisations such as the London County Council's architects' office had put together their own master specification which set out the order and wording of clauses to be used on all jobs,[52] but theirs was immensely wordy and included every detail of the work from washing out buckets to cleaning paintbrushes.[53] Despite radical changes in construction techniques and organisation most practices were still using the old cut and paste techniques. In 1963 the 'specifications panel' was formed as part of the RIBA technical committee to look at the problems the profession was facing. Their work would lead to the launch of the NBS in 1973. During this period there was intense debate surrounding specification - a subject which is usually at the margins of architectural practice – both in the architectural press and between the members of the panel and others contributing to the process of developing the new standard specification. As such, the articles and letters published in architectural journals and the reports, minutes of meetings and correspondence in the archive of the Specifications Panel provide some of the clearest articulations of the role of the specification and the factors shaping its organisation and descriptions.

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[51] Frank Macey, *Specifications in Detail*, London: E. & F.N. Spon, 1898. This book was re-edited and published throughout the 20th century and the 1904 edition has been reprinted, *Specifications in Detail*, Shaftesbury: Donhead, 2009.

[52] See letter from Miss Sylvia Locke, RIBA Technical Section, to Roderick + Innes and Co. Ltd., chartered surveyors, 16 April 1964, RIBA Library, Specifications Panel (of the technical information committee) Papers Box 1: 'A great many architects have developed standard specification clauses for their architecture offices and so have some local authorities such as the LCC and the Yorkshire Development Group for Housing. There is the annual publication of the Architectural Press 'Specification' which gives... examples of appropriate specification clauses.'

[53] See for example, The Specification for the Works at the Elfrida Rathbone School for the Educationally Subnormal, London (1961), architects – London County Council (LCC) with John Bancroft, project architect. RIBA Archives, LCC/AD/1, which will be explored in detail in later chapters.

A number of reasons for changing specification practice can be identified in the records of the Specifications Panel. In a report presented to the panel in 1963 Mr Michelmore emphasises the lack of clarity of the documents produced by most offices:

> The traditional 'specification' has the serious defects of no legal status, repetitiveness between the various documents, the danger of discrepancies, and an archaic form of wording and presentation.[54]

Other contributors mentioned the fact that there was no integration between the format of the specification and the bill of quantities. Some could already see the potential for the use of computers and argued that an integrated system that would be compatible with computerisation was required. But the most serious concern seemed to be that specification was moving out of the architect's control and into the domain of quantity surveyors and building systems manufacturers. Allen Ray-Jones saw this as an effect of new 'industrialised building' which produces a 'closed system' in which manufacturers specify their own products and take away any choice from architects.[55] According to Ray-Jones the answer was not to rail against the new methods but to find ways to at least control the way these components are put together, through specification. Others put their concerns more clearly in terms of power relations between the parties:

> The architect has to some considerable extent delegated the specifying and choosing of materials and sub-contractors... the quantity surveyor and other interested parties including the contractor often avail themselves of the opportunity to influence what materials and whose services should be used.[56]

The recommendation here is 'to make the choice of a product to be specified both quicker and easier for the architect.' After an initial interim report, the Technical Information Committee met on 5 March 1964 and agreed to fully endorse the report's conclusion 'that a coded Standard National Specification should be prepared.'[57] Such a national specification was already in use in Sweden but it would take more than a decade of reports and research, and the establishment in 1969 of the new RIBA Limited Company to finance and run the new NBS. Carter's first report on the RIBA proposal for the NBS was concerned with assembling data and a working group to begin the research, but also with establishing the business case for the new NBS (which he suggested should include a clause that 'obliges the contractor to have a copy' and therefore presumably to pay for one!).[58] Although of course there were professional concerns for the quality of building

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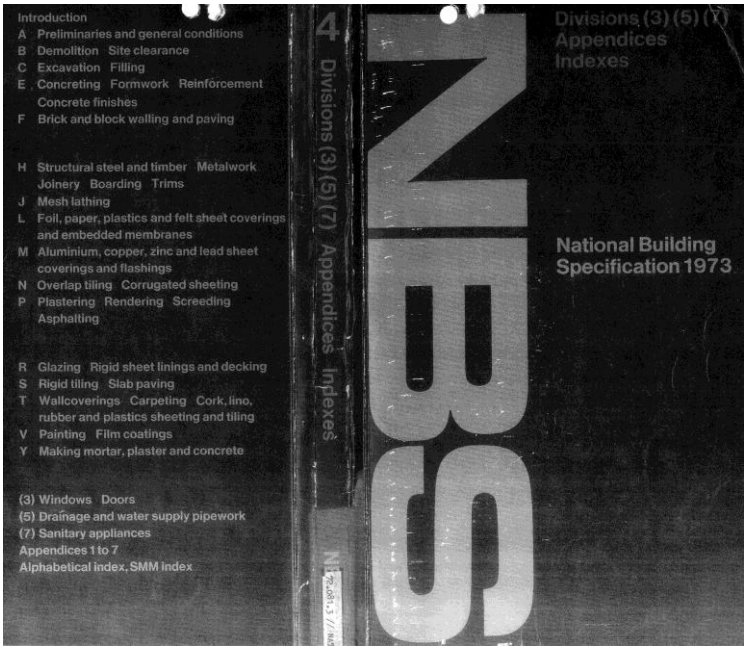
[54] Michelmore's Report, Panel meeting in 1963, RIBA Library, Specifications Panel Papers Box 1.
[55] Allen Ray-Jones report, Panel meeting notes, 1963, RIBA Library, Specifications Panel Papers Box 1.
[56] Maurice Golding (assistant secretary to the RIBA technical section) in notes to Anthony Laing, chair of the Specifications Panel, 9 July 1964, RIBA Library, Specifications Panel Papers, Box 1.
[57] Letter from Anthony Laing to Maurice Goldring, 20 October 1964, RIBA Library, Specifications Panel Papers Box 1.
[58] Report by John Carter on RIBA proposal for the NBS, November 1968, RIBA Library, RIBA Services Working Group Papers, Box 1.

at stake here, to some extent this was also a power struggle over the role of the architect. As Mr George insisted in his 1963 report to the Specifications Panel;

> The Architect must be the initiator of the specification. He alone must determine the materials, workmanship and components to go into the building.[59]

In addition to the discussions about how to build up a collection of exemplary clauses and the details of content, a major concern of the panel and later of the NBS development committee was the organisation of the document and the way it would relate to other building information. The first version of the NBS used SfB,[60] a Swedish classification system that had been adopted in the UK for technical library filing as laid out in the *Construction Indexing Manual*.[61] This system was organised by products and classified each product according to construction 'form' and material. It used letters rather than words as titles so what was once the 'Concretor' section becomes 'B' ('Concreting Formwork Reinforcement Concrete finishes') and what was titled 'Painter' becomes 'V' ('Painting Film coatings'). Although the sections do not form a complete alphabet they are arranged alphabetically and suggest an immutable logic to the organisation of construction that is in stark contrast to the old system of division by trades in which the range of headings followed changes in building methods and practices (Fig. 2.5).[62]



2.5 Front Cover, National Buildling Specification, 1973

[59] Mr George report, Panel meeting notes, 1963, RIBA Library, Specifications Panel Papers, Box 1.
[60] SfB stands for 'Samarbetskommitten for Byggnadsfrågor' translated as 'Cooperative Commitee for Building Issues.' The roots of SfB – 'the very beginning of a systematic thinking' – were in the Swedish Department of Military Building in 1942. See L.M. Giertz, *SfB and Its Development 1950-80*, Dublin: CIB/SfB International Bureau, 1982, p.3.
[61] *Construction Indexing Manual*, London: RIBA Publications, 1969.
[62] Of course there was scope to change and extend the work sections, as the introduction states 'The first edition contains 80 work sections but others exist and remain to be defined.' *National Building Specification*, London: RIBA Publications Ltd., 1973, p.14.

CI/SfB would prove limiting for future updating and in 1997 it was replaced by a new system UNICLASS (United Classification for the Construction Industry) developed by the NBS which also enabled computerisation and compatibility with other forms of building documentation. Letters were also used here as titles for the main work sections but referred to different sets of products. For example 'B' now refers to 'complete buildings/structures/units' and 'Y' is for 'services reference specification' including heating systems, air conditioning and electrics.

As is explained in the introduction to the first edition, the sections of the new NBS emphasised products rather than the trades who worked them:

> Each work section deals with one main type of product in a defined range of applications. No attempt has been made to identify these kinds of work with 'trades'.[63]

The editors explain that this allows contractors to divide up the work sections and distribute it more easily amongst subcontractors since, 'the division is almost always by kinds of finished work in place eg. asphalt work, brick work, clay tiling.'[64] This emphasis on finished work in place continues to be an important principle in the most recent forms of specification and has an impact on the detailed ways that materials and components are described. It was not just the general structure of the specification and the ways that it should relate to other aspects of building documentation and practice that was under review in the years that led up to the production of the NBS. Commentators also recognised that there were different ways materials and workmanship could be specified, some of which might describe the work in place, with others describing for example, the means of achieving it. Some degree of variety in the forms of clause in use is evident in all the specifications I have looked at – even God's instructions to Noah include naming, dimensioning and performance – but it is during this period that they are categorised. If the appearance or dominance of certain forms of clause had previously been subject to a similar web of forces which brought changes about in the general organisation and content of the specification, but had gone unnoticed, in the 1960s the question of which forms of clause were most appropriate for use in specification itself became important and the subject of much debate. It became apparent that the forms of clause were not simply alternative kinds of description but that the use of one rather than another produced effects in the process of building.

[63] Ibid.
[64] Ibid., p.13.

Chapter Three: 'Of Their Several Kinds': towards a typology of forms of clause

> Our aim should be to find a form that states once only what is required; where it is required, and how much is required, and also define how it is to be done and when it is to be done. We must state what we want compactly. It can be in the form of
>
> a) a performance specification (fence the site)
> b) a particular appearance description (*close boarded* fence)
> c) a description of the specific composition of an item (*softwood* close boarded fence)
> d) a statement of the method of the work (softwood close boarded fence *creosoted before erection*)
>
> Mr Michelmore, 'Report to the Interim Specifications Panel' (1963)[1]

Alongside shifts at a general scale in the format, organisation and use of the specification as it reconfigures in relation to changes in technology and building practice are another set of variations at the more detailed level of the clauses within each document. Where these clauses specify materials, a number of rather different kinds of description are used. As we would expect, in many cases materials are simply named, but what constitutes a name – a generic type of material (hardwood), a particular species (Honduras mahogany) or a product (ThermoWood®) for instance – is itself subject to variation. In other cases, how the material is to be made up or worked is given in detail. Sometimes, the material is defined with reference to some other condition; the material it will adhere to, or a sample held at the architects' offices or a building standard. More recently the definition may not even suggest the type of material to be used, only the performance criteria it is to meet. Contemporary technical literature recognises this range, albeit using a variety of terms from Michelmore's 'forms' of specifying, to Carter's 'family of definitions'[2] and Gelder's 'methods,' but what discourse there is on the forms of clause emerges during the debates of the 1960s and 70s and is concerned primarily with identifying best practice. In the absence of any examinations of the methods of specifying prior to this period (apart from some material on the emergence of performance specification) the discussion of forms of clause appearing earlier draws mainly on my own survey of archival documents.

If for the industry the 'forms of clause' are now of interest in so far as some forms may be more efficient or appropriate or litigation-proof than others, what is primarily of interest here in relation to the question of

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[1] Michelmore, Report, 1963.

[2] Carter gives eight categories of information - identification of material; performance standards and tests for material before fixing; techniques to prepare or assemble for use; techniques for placing, applying or fixing; edge and junction details; technical conditions for the work; contractual conditions for the work; performance standards and tests for material in situ - and refers to them as 'a family of definitions'; 'As the eight categories listed above show, performance standards and tests are really only one item in a family of definitions by which we tell the industry what the client wants.' Carter, 'National Building Specification', p.761. The categories are given on p.760.

concepts of materials is the very fact that they are plural. There is no one way of describing any given material and more than one form of clause for the same type of material might be in use during any particular period, and in any one document. First, as with the more general organisation of the specification, there are clearly historical and contractual factors at work in shaping the forms of clause that might be prevalent at any one time, or that might determine the selection of one form of clause over another in a particular use of a material. The possibility of use of any given form of clause is tied into a wide range of factors. Second, if as Foucault has proposed the form of description of any object is in part constitutive of that object, or might even constitute a concept, we might ask if the differences between these forms of clause constitute rather different 'concepts' of materials. The form of clause is more than one descriptive alternative amongst many. It is also part of the mechanism which determines how a material will be conceptualised and put into use. It is by considering the forms of clause in this way that they become the vehicle in this research both for examining the limits of the hylomorphic concept of matter as a framework for conceiving of building materials, and for developing an extended set of concepts. Before moving on to these arguments in relation to the process-based clause and the performance clause, this chapter sets out a typology of some of these forms based on my own readings of specifications as well as on the categories in use in the industry.

1. Industry categories

Michelmore set out the typology of four 'forms' of specifying cited above in his report to the RIBA specifications panel in 1963. This list appears to be based more on his own observations of clauses in existing documents than on a set of categories in common use. He notes the differences between each of these descriptions without relating them to where they appear or the circumstances of their use. More recently, in a table in *Specifying Architecture* from 2001, Gelder set out his own list of four 'methods' of specifying in which only two – 'performance' and 'construction methods' - directly tally with Michelmore's 'forms':

> Performance (open)
> Descriptive (closed)
> Proprietary (also known as brand or outright)
> Construction methods (also closed)[3]

Gelder divides these into 'open' and 'closed' methods in reference to their contractual force. 'Open' methods are those which leave the final selection of material or construction system to the contractor while in 'closed' methods the selection is determined by the architect or specifier. In contemporary technical literature the 'closed' type is usually referred to as 'prescriptive' specifying, with 'performance' specifying used to cover the

[3] These categories are described in full in Gelder, *Specifying Architecture*, pp.121-141.

'open' method although in fact there are more ways of making open specifications than this.[4] Emmit and Yeomans, for example, use these two general types when they claim (wrongly in my view!) that the specification has changed little since the early twentieth century but that 'what does tend to change is the fluctuating fashion of the use of performance over prescriptive methods and vice versa.'[5] It is not just that Gelder's list of categories differs from Michelmore's because their content is different. For Michelmore it is the way in which the fence is described which is decisive, while for Gelder the meaning of the clause is necessarily tied to its contractual context. For example in Michelmore's terms we could consider the following clause from the Particulars for a bakehouse, dwelling and lofts (1770) as a performance clause:

> Bricklayers Work
> To carry up a flew in such a place in the East Wall as shall be directed sufficient to vent the smoke of the oven.[6]

The clause specifies the flue by its capacity to ventilate the baker's oven but does not give the means by which this is to be achieved and in this sense it is an example of performance specification. But since this clause predates the 1930s and 40s which is according to building standards expert George Atkinson, when performance specification was first identified as 'a concept' in the UK, and came into use as such, [7] it does not yet have the contractual force which would be decisive in Gelder's terms.

What is surprising then, is that Gelder supplies another table which associates his methods with particular materials and systems (Fig. 3.1).

Method	Submethod	Item
Performance	Custom	Curtain walls, airconditioning system
	Reference	Switchboard components, tests for curtain walls, safety of electrical equipment, access floors and tests, tests for soils, thermal insulation, efficiency of hydraulic fixtures
Descriptive	Custom	Groundworks, roadworks, terrazzo, stonework repair, landscape, parquet, rammed earth walling
	Reference	Painting, screws, demolition, adhesives, masonry walling, hydraulic systems, roof tile installation
Proprietary	Custom	Sanitaryware, door hardware, tiles, paints, carpets, plasterboard, bricks, plastic laminates, access floors
	Reference	Manufacturer's requirements
Construction methods	Custom	Floor sanding, concrete curing, roadworks equipment
	Reference	Codes of practice e.g. BS 8000 (various), manufacturer's instructions

3.1 Table 6.5 Typical specification methods used for selected items, John Gelder, *Specifying Architecture*

[4] For example, somewhat confusingly in relation to Gelder's list, the specifications consultancy Schumann Smith contrast prescriptive specification with 'descriptive' specification, a method they have developed which ties performance specification with 'visual intent'. I will look at this in more detail in Chapter Eight.
[5] Emmitt and Yeomans, *Specifying Buildings*, p.11.
[6] Particulars for a Bakehouse, dwelling and lofts (1770).
[7] George Atkinson, 'Performance Specification,' *Building*, 17 March 1972, p.115.

Here he suggests that the performance method is used typically for the specification of curtain walling, while the descriptive (or appearance) method is appropriate for landscape, roadworks, parquet or rammed earth walling. The proprietary method will be found where tiles, paints, bricks and plasterboard are specified and construction methods will be useful for floor sanding and concrete curing. While my research has not covered all these areas, it is certainly the case that some forms of clause will be persistently associated with particular kinds of materials. In situ concrete for example is still often specified in terms of methods of fabrication (or 'process-based' clauses) despite the fact that this form of clause is now much more rarely used in the specification, and although 18th and 19th century specifications rarely name brands (but often give products through where they are quarried or procured, a kind of precursor of the proprietary specification) some manufactured products such as cements or items of ironmongery do get named even in the early specifications. Methods of specification are not equally applicable to all materials and products, and where the use of certain materials persists across historical periods, the form of clause may not deflect even in the face of more general contractual and industrial trends.

It seems to me that Gelder's two approaches to categorising the methods of specifying pull in rather different directions. On the one hand he asks us to think about his four 'methods' as the result of different objectives in contractual practice. On the other he notes that the methods are tied to particular materials and processes of fabrication, although these may need to be specified in both open and closed contractual situations. Does the form of clause used in any given situation depend on the kind of material it describes (and therefore any one form might persist as long as that material is in use in building) or on the contractual organisation of the day (in which case we would expect its variation to coincide with changes in the way building is organised)? The advantage of Michelmore's categories is precisely that they hold these questions open. The forms of clause are recognised without necessarily tying them to any particular condition of their emergence. Since my concern here is to ask what we might learn from this variety of descriptions of materials, rather than to demonstrate any one set of causes over another, I follow Michelmore in as much as it is the kinds of descriptions rather than the context of their appearance which are the starting point for the distinctions I make betweens forms. Since these distinctions are not recognised at all in the earliest handbooks to specification practice produced in the 19th century (despite the fact that they are in evidence in the skeleton and sample specifications the authors include[8]) it is not possible to apply contemporaneous categories to them. In some cases the groupings I use coincide with Michelmore's list or with others in use in contemporary literature on

[8] For example, in Donaldson's *Handbook of Specfications*, the skeleton specification he sets out describes what should be included under the category of materials for each of the different trades. The timber the Plasterer is to use is only to be described as follows 'as heart of oak or fir, free from sap; whether single lath, and half, or double laths' while the timber the Joiner is to use is to be given 'where from,' pp. xix and xvii. In the case of the 'doorways and doors' Donaldson goes to some lengths to advise on specifying for 'dark situations in London and elsewhere' where 'as much of the partitions as possible' should be glazed 'thus giving a cheerful aspect to what would otherwise be a sombre position,' p.xviii. In these examples some timber is specified by type, other timber by where it is from, and glazing is specified in relation to the cheerful aspect it gives. Each of these are different forms of description but Donaldson only shows them, without recognising their differences.

specification, but in others the distinctions I make between forms of clause are idiosyncratic, and are not referred to elsewhere. The fact that contemporary technical literature recognises that there are distinctions between forms of clause lends weight to the idea that they may be significant beyond the highly specific parameters of this study, and clarifies some of the distinctions I make, but the forms of clause I identify are not limited to the categories in current use.

2. Naming the material

'Make yourself an ark of gopher wood'[9]

Despite the difference in time and context, God's prescription to build the ark in a specific timber is as much an example of 'a description of the specific composition of an item,' to use one of Michelmore's 'forms,' as is the specification of '9.5mm Finnish Birch Plywood' for a stressed skin roof to a new architecture school studio building (Fig. 3.2) in the clause below:[10]

310 STRUCTURAL PLYWOOD FOR STRESSED SKIN ROOF

- Standard: To the relevant national standards and quality control procedures specified in BS 5268-2, and so marked.
- Type: 9.5mm Finnish Birch Plywood.
- Grade: as above.
- Nominal thickness/ number of plies: as above.
- Finish: Unsanded.
- Treatment: none.

3.2 Mole Architects, Stressed Skin Roof at School of Architecture, Cambridge (2006)

The naming of a material is probably the most basic form of clause and the one we would expect to see. It is used in the all the documents that I have seen, whether in a generic sense – putty, glass, iron, powder coatings, polymeric sheets – or in the case of natural materials such as timbers where the species which would also be found in the classification systems of natural history are sometimes used. Within any one type of material, there may be further varieties which need to be distinguished. In setting out his own argument

[9] Genesis 6.14-16, *The Holy Bible*, p.5. Gelder refers to this passage a specification in *Specifying Architecture*, p.189.
[10] Specification for Refurbishment of Scroope Terrace & New Studio Building, University of Cambridge Faculty of Architecture (14 July 2006), architects - Mole Architects.

about the relationship between a genus and its varieties in *The Critique of Pure Reason* Kant writes that 'the various species must be regarded merely as different determinations of a few genera, and these, in turn, of still higher genera, and so on.'[11] For Kant, the difference between the numerous salts that chemists of his own time were engaged with studying 'is merely a variety, or diverse manifestation, of one and the same fundamental material.' Variety, in this view, is only the other side of the concept of a genus 'or of any other universal concept.'[12] The simple mode of specifying materials by name seems to confirm the notion that any material is simply one of the diverse manifestations of material in general, and lends itself to the idea that any one material can be substituted for another. It is the notion of the material that Aristotle refers to when he asks rhetorically 'is there a house *over and above its bricks*?'[13] since for him any substance such as a house must involve both form (the house form) and matter (its bricks).

Despite the ubiquitous appearance of naming in specifications throughout different periods, the ways these names are given varies. In the Articles of Agreement for a town house for Sir William Heathcote (1734) stone is named by where it is quarried - 'portland stone' or 'purbeck paving' while the various types of timber are given simply in terms of species; 'oak joysts,' 'teaked flooring' to be laid on 'good fir timber Beams':

> No.3 Plan of the Chamber floor The same to be thirteen foot six inches high in the clear when finished the teaked flooring framed of sound and good fir timber Beams fourteen inches by twelve the ceiling joysts a little below the Girder to preserve the Ceilings from cracking the upper joyst not less then neine inches by two and an half to be floored with clean deal dowelled except the landing of the two staircases[14]

Wainscoting is to be 'dry yellow deal' and the doors on the floor where the great parlour is located are to be 'mahogany.' In the specification for Newgate Gaol and the Sessions House at the Old Bailey (1769), compiled just 35 years later, stones are named in the same way, but a new practice for naming timber has emerged which will become more detailed and continue well into the 20th century:

> A Description of the Carpenters Work To be Done in Building the Sessions-House in Old Bailey
>
> Floors
> To lay all the rest of Floors in every part of this Building, with the best whole, dry, Christiana Deals, free from Sap or Broad Knots, in straight Joints, with planed and tongued heading Joints, and all the Boards are to be Edge-nailed; and to lay clean Deal mitred Borders to all the Slabs of Chimnies throughout this Building.[15]

[11] Immanuel Kant, *The Critique of Pure Reason*, trans. Norman Kemp Smith, London: Macmillan and Co., 1933, p.538.
[12] Ibid., p.539.
[13] Aristotle, *The Metaphysics*, trans. Hugh Lawson-Tancred, London: Penguin, 1998, p.195.
[14] Articles of Agreement for a town house for Sir William Heathcote (1734-6).
[15] Specification for Newgate Gaol and the Sessions House at the Old Bailey (1769), 'A Description of the Carpenter's Work to be Done in Building the Sessions-House in the Old Bailey', RIBA Library, EW No. 783.

Quite apart from the new details concerning the quality of the timber and the manner in which it is to be jointed and laid, the deals are named in reference to Christiana - the port where they are traded. By the 19th century this practice has become widespread as in Mocatta's specification for two houses on Marylebone Street from the 1830s:

> Carpenter and Joiner
> The whole of the Fir Timber used in the building to be of yellow crown Memel [German name for Klaipėida, port town of current day Lithuania], Dantzic [Gdansk], or Riga fir, to be sanded free from sap and all large knots... the deal to be Christiana [Oslo] or deals equivalent in quality to be well-dried and seasoned and free from large knots shakes and other defects.[16]

The naming of the timbers incorporates the patterns of timber imports from the Baltic which supported English construction after local supplies of oak became scarce during the 17th century.[17] As sources move to the 'White Sea Ports' of Murmansk and Archangelsk, and to the west coast of Canada with the building of the Panama Canal and the economic depression in Europe at the end of the 19th century, these changes are reflected in Harding's specification for his own house at Farnham Common in 1934:

Carpenter & Joiner	
General.	225. Deals for Joiners work to be first quality yellow deals perfectly sound and open air seasoned.
Fir.	226. The fir timber is to be from approved White Sea Ports or from British Columbia.
Deal.	227. The deal is to be first quality Swedish or Baltic.[18]

By this time, there is increased grading and standardisation of timber carried out by national timber associations and in the US by the Department of Commerce, and the North American timber industry has begun to develop timber products such as plywood which can utilise more poor quality timber and the waste produced by the sawmills. These materials need not be specified by species. They are themselves more consistent and therefore lend themselves easily to standardisation. By 1964, the exemplar specification published in the journal *Specification* names most timbers simply as 'hardwood' or 'softwood' and supplies the information about the sources of timber and their species in a separate table entitled the 'nomenclature of commercial softwoods' (Fig. 3.3).[19]

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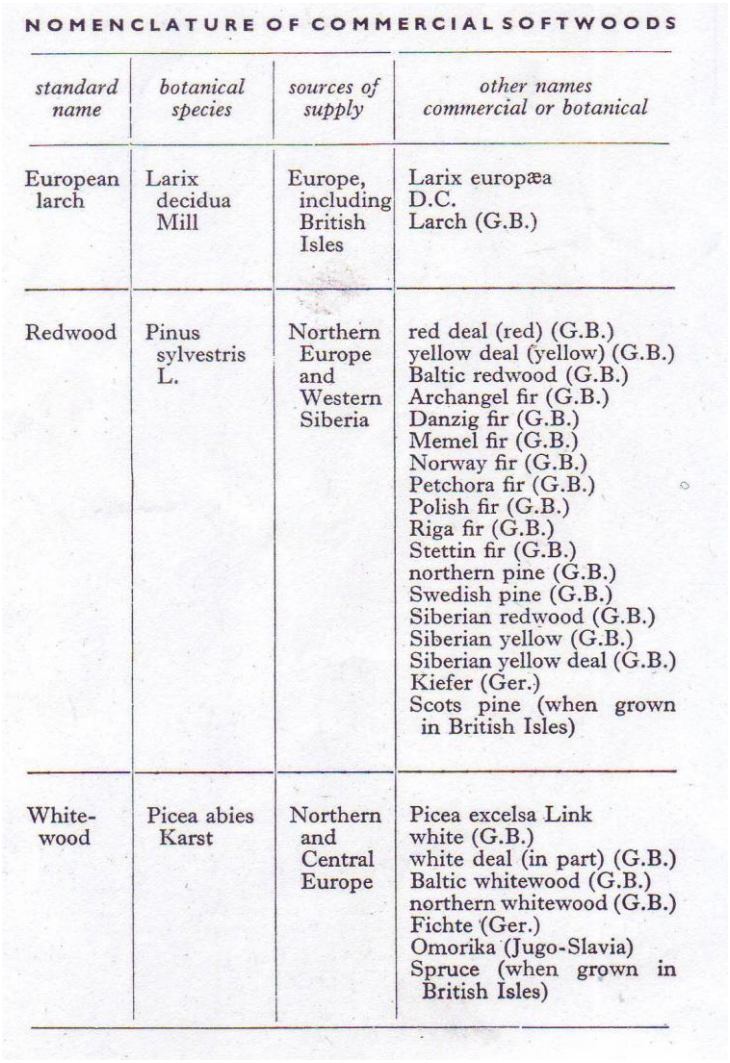
[16] Specification for two houses on Marylebone Street in Mocatta, *Specifications* (1833-43).
[17] For an account of the timber trade see Sing C. Chew, *Logs for Capital: The Timber Industry and Capitalist Enterprise in the 19th Century*, Westport: Greenwood Press, 1992.
[18] Specification of Works for a House at Farnham Common (1934).
[19] *Specification*, 1964, p.619.



NOMENCLATURE OF COMMERCIAL SOFTWOODS

standard name	*botanical species*	*sources of supply*	*other names commercial or botanical*
European larch	Larix decidua Mill	Europe, including British Isles	Larix europæa D.C. Larch (G.B.)
Redwood	Pinus sylvestris L.	Northern Europe and Western Siberia	red deal (red) (G.B.) yellow deal (yellow) (G.B.) Baltic redwood (G.B.) Archangel fir (G.B.) Danzig fir (G.B.) Memel fir (G.B.) Norway fir (G.B.) Petchora fir (G.B.) Polish fir (G.B.) Riga fir (G.B.) Stettin fir (G.B.) northern pine (G.B.) Swedish pine (G.B.) Siberian redwood (G.B.) Siberian yellow (G.B.) Siberian yellow deal (G.B.) Kiefer (Ger.) Scots pine (when grown in British Isles)
White-wood	Picea abies Karst	Northern and Central Europe	Picea excelsa Link white (G.B.) white deal (in part) (G.B.) Baltic whitewood (G.B.) northern whitewood (G.B.) Fichte (Ger.) Omorika (Jugo-Slavia) Spruce (when grown in British Isles)

3.3 Softwood Nomenclature, *Specification*, 1964

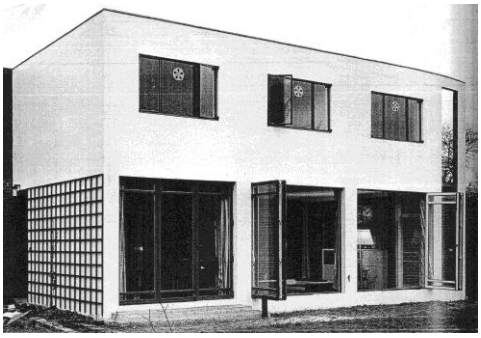
The editors explain that some merchants may still use the names of shipping ports to identify timbers and that the builder may still refer to European softwoods as yellow, red or white deals. Presumably because of this the architect will need to be familiar with their outdated terminology, although they should no longer use it in their own professional language. It is clear that the naming of timber in the specification depends on more than genus and species as it is understood in the classifications of natural history. Even if, as Kant argues, the 'higher concept' of genus is in a logically necessary relationship to species or variety, in the case of building materials what determines distinctions between the 'diverse manifestation' of varieties and more general groupings , is not limited to intrinsic physical similarities waiting to be uncovered but also to social, industrial and economic developments.

Neither Michelmore nor Gelder use the simple term 'naming' in their typologies of clause. Michelmore relates this form to 'composition' and Gelder defines them as 'Proprietary (also known as brand or outright).' It is telling that his category for the nomination of a material is given primarily in terms of trademarks and brands (and as 'outright' which relates again to the contractual force of the clause), although some materials,

particularly stone, are still named in the specification in relation to their geographic source. Manufacturers' names do appear in the late eighteenth century specifications. For example, the windows in the Sessions-House at Old Bailey (1769) are to be 'glazed with Ratcliff Crown Glass '[20] (which had been made in Southwark since 1677[21]) but it is only in the 19th century that product names become more evident. In Mocatta's specification for the London Fever Hospital (1833-43) there is a reference to Parker's Roman Cement which is commonly specified in the documents of the period:

> The columns pilasters cornices piers division walls of wards &c tinted red or darker in the accompanying drawings are to be executed in cement which is to be Parker's Roman Cement mixed with sand in good proportions.[22]

Thomas Little's specification from 1843 for a house on Princes Street also includes a specification for 'Roman Cement (Parker & Wyatts No 2)' which makes it clear that the manufacturer made a variety of cements. He names other products; 'Bangor Duchess Slates' '4" Redmond's rising butts' and 'Queensware Hopper basins.'[23]



3.4 Elisabeth Benjamin, East Wall, Hedgerley Lane, Gerrards Cross (1935-6)

In her specification from the 1930s for a house at Hedgerley Lane (Fig. 3.4), Elizabeth Benjamin specifies Sirapite and rather than include details of its correct usage she refers the contractor to the manufacturer's literature:

> L Plasterer and Pavior
> L5 Plastering throughout to be of Sirapite used in accordance with company's printed instructions.[24]

[20] Specification for Newgate Gaol and the Sessions House at the Old Bailey (1769), A Description of the Carpenter's Work to be Done in Building the Sessions-House in the Old Bailey, RIBA Library, EW No. 783.
[21] Sydney Maddocks, 'Ratcliff' in *The Co-partnership Herald* Vol.V, No.59, Christmas 1935-January 1936, www.mernick.org.uk/thhol/ratclif1.html accessed 18.02.2010.
[22] Specification of work for the London Fever Hospital (1833-44), Mocatta, *Specifications*.
[23] Specification of sundry works required in rebuilding the house no.1 Princes Street Leicester Square (1843), architect - Thomas Little, RIBA Archives LIT/1/1 + 2.
[24] Specification for house at Hedgerley Lane, Gerrards Cross, Bucks (1936), architect - Elisabeth Benjamin, RIBA Archives, SaG/9/4.

Benjamin's project files are full of correspondence with manufacturers and trade literature. There are also examples of standard clauses produced by manufacturers such as Critalls and The Reinforced Steel Company Ltd for incorporation into the specification. She must have been very conscientious in her attention to the selection of products, but nevertheless references to them in the specification are not that frequent as is generally the case in the specifications of the period.[25] This is in sharp contrast to specifications today produced using the NBS. By 1973 when the first edition of the NBS is published all products, whether natural materials[26] or manufactured components or systems are referred to as 'commodities.' The clauses which name them are 'commodity clauses' which 'describe the materials, products and components to be bought by the contractor for incorporation into the finished work.'[27] The emphasis is on their status as items to be purchased. Many of the names given in contemporary specification refer to manufacturer's products as in the following example from DSDHA's NBS-based specification for roofing at Sure Start, St Anne's Ward, Colchester (2004).[28] Apart from the insulation the products are all manufactured or supplied by the same company:

TYPES OF COVERING

110 WARM ROOF COVERING
- Substrate: WBP ply as clause G20/310.
  - Preparation: Ensure the substrate is secure and with no lipping between sheets.
- Roof covering:
  - Manufacturer: Sarnafil Ltd, tel 01603 748985.
  - Lower protective layer (loose laid):
  - Vapour control layer: SarnaVap 1000.
    Laying: Loose laid.
  - Insulation: Kingspan TR27 90mm thick.
    Attachment: Mechanical fastenings.
  - Separating layer (loose laid):
  - Waterproof membrane: Sarnafil G410 15EL.
    Thickness:
    Colour: Light grey.
    Attachment: Fully adhered using Sarnacol adhesive.
  - Upper protective layer (loose laid):

[25] Although Gelder mentions in passing that proprietary specification only begins with the industrial revolution and says that it has been in use since the late 19th century he doesn't track the appearance of product names in the specification. The take up of brands in the specification is much slower and more gradual than we might expect. See Gelder, *Specifying Architecture*, p. 128.

[26] There are examples of clauses which instruct the contractor to value and deduct from the contract sum any materials they dig up and use from the site itself. The material's use in building is enough to turn it into a commodity. For example Philip Webb instructs contractors to price any sand dug from a well-sinking; 'The clean sand from the well is to be levelled up and measured and the price per cubic yard to be allowed for in the quantities as the sand is to be used by the builder for the works. See Specification of Works, House and Office for A. H. Cocks, Puttenham (1898), architect – Philip Webb, RIBA Archives Web/1/2. Similarly the Elfrida Rathbone specification produced by the LCC architects' department contains the following clause relating to 'sand, ballast etc; 19. Any sand, gravel or ballast obtained from the excavations shall be the property of the Council and may, if approved be used in the works. The quantity so used shall be measured and the value assessed by the Architect and deducted from the Contract Price.' Specification for the Elfrida Rathbone School for the Educationally Subnormal (1961).

[27] *National Building Specification,* Volume 4, p.17.

[28] Specification for Sure Start, St Anne's Ward, Colchester (2004), architect – DSDHA, Section J42 Single Layer Roofing.

In the same specification a product name is given for the timber weatherboarding and described curiously as a 'species'[29]:

> Section H21
>
> 115 TIMBER WEATHERBOARDING, EXTERNAL WALLS
>
> - Boarding:
> - Quality of timber (exposed surfaces): To BS 1186-3, Section 4, Class: 2.
> - Species: Thermowood (proprietary thermally treated softwood) or equal and approved

Naming appears, albeit using changing terms, throughout specification practice. Even where contracts need to avoid 'outright' modes of specifying, phrases such as 'or equal and approved' or the more convoluted 'indicative material' incorporate allow naming to be used with some flexibility. Naming confers with the conventional notion of a material. There is material (or matter) in general. It can be divided into types or genus, such as timber or glass, and then into further divisions, whether these are trade-based such as hardwood or softwood, exchange-based such as Baltic Ports and White Sea Ports or proprietary as above. Within these divisions there may be further 'diverse manifestations' or 'species' – Crown Memel, Archangel Fir or Red Deal or Pine Thermowood D (dark) and Pine Thermowood S (light). The forces which bring these categories about are more various than the activities of the chemist Kant described, but nevertheless the principle of genus and species organises them, whether their diversity proliferates through natural evolution or the invention of manufacturers.

3. The 'recipe' and the process-based clause

> The recipe is an affirmation, coded or uncoded, which permits the achievement of a desired result.
>
> Bertrand Gille[30]

In his marvellous *History of Techniques* Bertrand Gille traces the development of written descriptions of techniques as well as the evolution of the techniques themselves. The recipe was sometimes the title for such works (at least in French) as well as the means of description. It is, he writes, 'an accumulation of concordant observation in a given domain' based on experience and memory, rather than on the causes of the facts. And because it can be transmitted in writing (and not just by demonstration and gestures as in other modes of transmitting technical know-how) 'it allows the birth of a technical literature which covers

[29] ThermoWood® is the name for wood which has undergone a treatment process patented by the Finnish ThermoWood Association. Both hardwoods and softwoods can undergo this process so a variety of products come under this name. See brochure at www.alternativewood.ca/brochures/English/Thermowood%20Summary%20Brochure.pdf accessed 18.02.2010, DSDHA Specification for Sure Start (2004), Section H21 115.

[30] Bertrand Gille (ed.), *History of Techniques Vol.2 Part 3, Techniques and Sciences*, trans. J. Brainon, K. Butler et al., New York, Gordon + Bream Scientific Publishers, 1986, p.1146.

certain domains of material life.'[31] Gille mentions a wide range of treatises covering such domains as agriculture, locksmithing, pottery and metallography and cites the recipe Vitruvius gives for making mortars; '1 part of lime to 3 of quarried sand; 1 part of lime to 2 of sea or river sand.'[32]

While the recipe has a long history in architectural treatises such as Vitruvius' it is not found in the earliest specifications I have looked at. Its first appearance amongst these is in Thomas Hardwick's Description of the several works to be done in erecting a new chapel and wing buildings in St James Burial Ground, Tottenham Court Road (1791-2). The document is written in longhand with many crossings out and is not always legible. It includes long descriptions of the methods the bricklayer is to use in making up his mortar:

Brickwork Foundations Top Of Plinth	The joints of all the brickwork of the vaults to be struck and jointed the mortar used in the said work to be compounded of good and well burnt lime made from chalk or stone and mixed with clean sharp grit sand attested to be taken from the river Thames, between Fulham and London Bridge. The mortar to be made up in as small quantities as the nature of the business will admit and to be thoroughly beaten with stampers. All the lime shall be Sieve'd very fine and well chafed slaked under cover and mixed in such proportions as the surveyor shall approve [33]

The appearance of this kind of clause is almost certainly due to the shift away from craft-based tendering where expertise in how to achieve 'the desired result' remained within the domain of each trade. The proliferation of recipe-based specifications is not gradual but emerges quite suddenly and is already prevalent in documents from the first quarter of the 19th century which is also when gross tendering becomes more common.[34] Charles Fowler's Specification of the several artificers work for a school house in Hammersmith

[31] Ibid., p.1147.
[32] Ibid., p.1149.
[33] Description of the several works to be done in erecting a new chapel and wing buildings in St James Burial Ground, Tottenham Court Road (1791-2), architect - Thomas Hardwick, RIBA Archives AC/HAR/Add/2.
[34] I am not aware of any remarks upon the proliferation of process-based specification in the 19th century. According to Brian Hanson it is precisely in this period, beginning in the late 18th century, that architects become engaged with the question of the separation between their own 'intellectual' work and the material work of the builders who will realise their forms, in part he suggests because of the cementing of class distinctions between them. According to Hanson, craft emerges as a concern for the first time since the Renaissance for architects such as Pugin and Ruskin, and also awareness of this separation also leads to a marked increase in the degree of control architects attempt to establish over the building process. While he sees the great expansion in the detail and extent of the specification as part of the construction of architects' authority and looks at Bartholomew's 1841 *Specifications for Practical Architecture*, he does not observe the emergence of process-based specifying, which would greatly support his claims. Following his analysis we could add to the economic and industry based causes for this form of clause a more generous interpretation involving an interesting cultural shift towards construction and craft as a valid concern for architectural practice. See Brian Hanson, *Architects and the 'Building World' from Chambers to Ruskin; Constructing Authority*, Cambridge: Cambridge University Press, 2003.

(1819) gives a typical clause for mortar, concentrating, like Vitruvius, more on the proportions of lime and sand rather than the processes which Hardwick described:

> Bricklayer
> All the brickwork to be of good hard and sound bricks, and no soft bricks to be used in any part... the mortar to consist of three fourths of clear sharp sand, and one fourth of good Mersham or Dorking Lime. Well incorporated. No secreted rubbish to be admitted.[35]

19th century specifications are full of lengthy clauses like these covering many aspects of the mixtures and methods of building and the practice continues, with increasing intensity of detail until the1960s. Val Harding's specification for his house at Farnham Common (1934) includes a clause for the measuring vessels themselves: 'The materials shall be measured in vessels or containers of a nature which make reasonably accurate measurement possible.'[36] In a similar general clause in the specification for the Elfrida Rathbone School (1961) the 'means of measurement' must be approved and mixing must all take place on 'an approved impervious platform':

> Mixing of Materials
> 25. In all cases where materials are specified to be mixed in defined proportions, proper approved means of measurement shall be provided and all gauging and mixing shall be performed on an approved impervious platform. [37]

It could be argued that the details for such mixtures are just a variant of Michelmore's 'description of the specific composition of an item' but these clauses usually include methods of mixing as well as ingredients. Moreover methods are given for other kinds of techniques as we saw in the specification for the 'Carpenters Work To be Done in Building the Sessions-House in Old Bailey' (1769) which included details of how to lay and fix timbers as well as naming them. Process and mixture appear together in what Michelmore defines as 'a statement of the method of the work' and Gelder terms 'construction methods'. It might also be argued that these are, strictly speaking, descriptions of techniques and not of materials at all, but in many cases what these clauses are describing when taken together is the method of producing another material, whether a mortar as in the examples above, or cast concrete which will provide the examples I draw from in the detailed studies I make of the process-based clause in Chapter Five In this sense the material that will be used in building is not so much its constituent parts as that which is produced through the set of highly specific processes which amalgamate them in a particular way for a particular desired result. It is always the case

[35] Specification for a school house in Hammersmith (1819).
[36] Specification for a house at Farnham Common (1934).
[37] Specification for the Elfrida Rathbone School (1961).

that building materials are processed prior to their mobilisation on site (even if only to the extent that sand is dug and transported from a stretch of the River Thames between Fulham and London Bridge) but in rare instances such as clause for the cast iron columns and girders at the London Fever Hospital in the 1830s these off-site processes are given in the specification itself:

> Smith & Founders &c.
> All the castings are to be of a perfect character and subject to hydraulic pressure if required. The cast iron to be the best soft grey iron and the wrought iron to be well tempered and hammered. These trades are to leave their works generally in a perfect state *and fit for paint.*[38]

Other methods of specifying such as performance or reference to industry standards are used in contemporary specification to ensure the quality of materials produced off-site, while in the earlier specifications it is usually left to terms such as 'good' 'sound' or 'hard'.[39] Typically process-based clauses concern only the processes which constitute materials on site.

The significance of the process-based clause and the conceptual questions it might raise for the traditional notion of materials as instances of matter will be explored later, but it is clear that it allows for different distinctions to be drawn between materials than the practice of naming does. Materials might differ because of tiny adjustments in the manner of their making; a different size of aggregate in the case of a concrete mix, or in the method of its agitation or in how the micro-appearance of its finished surface is achieved. Furthermore a material that is specified by process is clearly something that is made. It is clear that is constructed and worked and not simply given. It is described as subject to time and labour and as more than what gives presence to form.

One of the most significant conclusions of the long enquiry in the 1960s and 70s into specification practice was that this form of clause should be eradicated wherever possible or at least drastically edited. John Carter's 1968 first report on the RIBA proposal for the NBS still includes 'preparation and assembly techniques' and 'fixing or placing techniques' amongst his 8 categories of information.[40] But according to Colin McGregor who was one of the team who prepared the first NBS in the early 1970s, a guiding principle of their work was that 'the specification describes "work in place", ie the finished result rather than the process of achieving it.'[41] Tony Allot, another member of the team, makes the same point in an article from 1971:

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[38] The last phrase 'fit for paint' is a performance clause. Specification for the London Fever Hospital, (1833-43), Mocatta, *Specifications*.
[39] In specifications where quality is less of an issue process-based clauses might be omitted. For example the Specification of Works for a smoked sausage manufactory (1934-5), just specifies some steps to be formed 'in cement Mortar,' and supplies no details about its mix or making.
[40] Carter, Report on RIBA proposal for the NBS.
[41] Colin McGregor, email correspondence, 06.03.2006. McGregor adds that 'there are exceptions to this.'

> NBS policy is based on the belief that specification should state requirements in terms of ends rather than means, but that there are practical limits in most cases.[42]

It is important, he continues, to avoid 'petty restrictions on the contractor' by describing methods only where necessary and as briefly as possible. This approach was intended to allow contractors to find expedient methods which suited them and to avoid architects' giving instructions which were not useful or even mistaken. Today the NBS consists of a mix of forms of clause, used adjacent to each other, some open (or performance-based) and others closed, including methods of work, although these are much reduced in detail and number than in specifications before the NBS. It is only in the performance-based specifications of in-house specifiers of some architectural practices or consultants such as Schumann Smith that the process-based clause has almost entirely disappeared. To some extent this is only possible because these descriptions are now given elsewhere in industry standards. If the recipe was once transmitted from craftsman to apprentice within a trade, and then took central stage in the specification for two centuries it is now in the domain of statutory and industry control.

4. References and appearances

> And will all the timbers of said Cellar Shops Sale-rooms Chambers Larders Kitchens Houses and Roofs undersaid made of good oak cleanly and sufficiently and also well by all well made and proportion like is the timbers of the Rente of Robert..in soper-lane in the parish of Saint Auntelyn[43]

Michelmore makes no mention of the practice of referring to building and other industry standards but Gelder includes 'reference specification' as a fifth category in his typology. They are, he writes, a 'sub-method' of specification and they can apply equally to any of the four methods of specifying he identifies. Gelder's book was written in the Australian context (when he worked with NATSPEC, the Australian version of the NBS) and he begins his brief discussion of this type by noting that this type of specification has only been possible there since the early 20th century when Standards Australia were introduced.[44] References to standards and other regulations emerge gradually in the English specifications I have seen as new standards and laws were introduced throughout the 19th century and by its end they have become reasonably common. Building standards move information outside the document where it is no longer in the hands of the specifier, as we saw with respect to methods of construction. What is of interest here is that these clauses and others specify materials by referring to information which is outside the document itself. Gelder's term 'reference

[42] Tony Allot, 'NBS; A Progress Report' in *RIBA Journal*, February 1971, p.82.
[43] Specification for three shops with accommodation above, Friday Street, London (1410). Unpublished translation from the French by Gelder from Salzman, *Building in England*. I have made some minor modifications to Gelder's phrasing.
[44] Gelder, *Specifying Architecture*, p.131.

specification' only relates to building standards but it might be adapted to include other kinds of clause which defer specification or locate it outside the confines of the document.

Perhaps the most common and obvious reference clauses are those which relate to the drawing package. At some point the description in words fails or is no longer the appropriate mode and we are referred back to the drawings. Even in the 15th century specification cited above, the three shops and houses are to be made according to the 'patron' or plan 'in parchment made and [de]limited.' Furthermore in this specification, the timbers are to be proportioned and made 'like is the timbers of the Rente of Robert.' The specifier has instructed his two carpenters (John and John) to build in the same manner as some houses in the vicinity. The standard they have been supplied with is a material one that can be visited on foot.[45] These references to other buildings are rare but references to physical samples to be conformed to begin to appear in the specification during the late 19th century. In the following example the architect holds a brick marked Sample No 1 which the contractor is to use as a standard:

Bricklayer Quality of executed stocks for external walls	10.	All the brickwork unless whereinafter differently described to be of good sound hard well burnt full sized square stock bricks of approved quality as per sample marked No 1 to be seen with the Architect at No 1 Westminster Chambers, obtained from the Medway.[46]

In the specification for the Elfrida Rathbone School (1961) the preambles include a general clause covering all the samples, 'where such are specified as being on view' (such as the 'approved range of colours' for painting), and states emphatically that '[the architect] shall have the power to reject all such materials and condemn such workmanship as do not correspond with the approved samples.'[47]

Samples stand in particularly where visual appearance is concerned, and words cannot adequately convey colour, texture or quality. There are limits to what can be described in words, and it is noticeable how few clauses in the specification are in fact concerned with appearance. Even the ever-present prescription that timber be 'free from knots' is more concerned with the ease of working and durability of the wood than with its look. A blank version of the NBS from 2004 was the first specification I trawled through for this research, and given that surface and appearance are central preoccupations for architects it seemed surprising that only one set of clauses directly concerned visual appearance:

[45] Friday Street and Soper Lane were adjacent streets in the city of London before the fire of 1666. Robert appears to have been the local landowner.
[46] Specification of works for a 'Gothic' villa at Godden Green, near Sevenoaks, Kent for Mr Usborne (1879), architect – Joseph Fogerty, RIBA Archives, FoJo/1/1. References to other samples can be found in clauses 15, nos. 2 and 3.
[47] The clause detailing paint samples is in the Paint Section numbered 26.4. This section also instructs the contractor to bring samples of all paints made up to London County Hal for testing by the LCC scientific adviser. Authority over the materials in use is located at County Hall. Specification for the Elfrida Rathbone School (1961).

M61	INTUMESCENT COATINGS FOR FIRE PROTECTION OF STEELWORK
440	BASIC FINISH
-	Definition: Reasonably smooth and even. Orange peel, other texture, minor runs and similar minor defects are acceptable.
450	NORMAL DECORATIVE FINISH
-	Definition: Good standard of cosmetic finish generally, when viewed from a distance of 5m or more. Minor orange peel or other texture is acceptable.
460	HIGH DECORATIVE FINISH
-	Definition: High standard of evenness, smoothness and gloss when viewed from a distance of 2m or more.
490	TOP SEALER COAT
-	Application: To achieve dft recommended by manufacturer and to give an even, solid, opaque appearance, free from runs, sags and other visual defects.[48]

Of course the decorative finishes that can be achieved with intumescent paint are hardly a significant aesthetic concern for architecture, but generally prescriptions for the look of materials and components are almost entirely absent from the document at least where specifications are complemented by drawings.

3.5 DSDHA Sure Start, St Anne's, Colchester (2004)

One rare example is in the specification for Sure Start, Colchester (2004) where DSDHA clad the exterior wall with timber boards fixed like decking (Fig 3.5) and needed to consider the appearance of the breather membrane behind that would usually be hidden but here would be visible between the gaps[49]:

[48] *National Building Specification: Standard Version (Update 38)*. London: RIBA Enterprises Ltd. 2004.

130 BREATHER MEMBRANE
- Material: Durable spun bonded fibre membrane, with vapour resistance lower than the sheathing behind; assume breather membrane vapour resistance of 0.25 MN/sq m.
- Manufacturer: Contractor selection to meet the performance described.
  - Product reference: A type without logos / lettering, as it may be visible through the boarding.

Much earlier Charles Fowler instructed the plasterer at the School House in Hammersmith that 'the whole of the cement facing to be neatly coloured, and painted in imitation of stone.'[50] At Mocatta's Brighton Railway Station, a prescription for a decorative relief for the spandrels on the front elevation demonstrates just how little the visual and symbolic aspects of the building are the remit of the specification:

> Plasterer
> [the front spandrels to be] cast from approved designs and models. The subjects to be selected by the Architects and if agreeable to the Contractor such designs and models to be furnished by Mr Hemming the sculptor. A large subject composed expressly for the position is to be fixed on the centre pedestal or blocking of front representing some emblem suitable to the occasion or the arms of the company.[51]

Despite the scarcity of clauses concerning appearance both Gelder and Michelmore include description of appearance as one of their four modes of specifying. Perhaps it is precisely because architecture is concerned with appearance that they assume it must have a more prevalent role in the specification than it appears to. Michelmore's phrase is 'a particular appearance description' and Gelder's category is 'descriptive' which is, he writes, 'still used, as in specifying colours, thicknesses, dimensions, and shapes.' It is, according to him, the oldest kind of specification and is usually replaced by drawings in contemporary practice. Since Gelder's book was published, Schumann Smith have developed a new kind of specification which they also call 'descriptive' (as opposed to 'prescriptive'). This is a peculiar form of performance specification which still avoids outright prescription and retains the contractor's freedom to find solutions, but ties the performance parameters to what Schumann Smith call 'visual intent' or the drawings.[52] In a sense, this new category of clause takes us full circle to when the specification had to do the job of the drawing and set out the dimensions of the building, as God did for Noah's ark. At the point where the specification stops nominating particular materials and components, or ways of fabricating them, it becomes more like the drawing again.

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[49] Specification for Sure Start (2004), Section H21 11517.
[50] Specification for a school house in Hammersmith (1819).
[51] Specification for the London and Brighton railway terminus, Brighton (1833-43), Mocatta, *Specifications*.
[52] Information about Schumann Smith's specification practice is based mainly on an interview with Tony Brett at their offices on 01 November 2007.

There are a wide range of factors which may contribute to the deferral of specification to drawings, samples or standards beyond its own text. The 1940 specification for an air raid shelter at Bedales school, which was to be built over a garden wall in the a terraced area of the grounds, includes a reference to building standards which had only just been drawn up as part of the Civil Defence Act of 1939:

> 21. All materials shall be in accordance with the Statutory Rules + Orders 1939. No.920, in respect of Air Raid Shelters for Persons Working in Factories, Mines and Commercial Builidngs, Revised Code, Aug 1939 (Section 13 of the Civil Defence Act)...
>
> 53. The steel rod reinforcement to be of British Manufacture complying with the British Standard Specification for mild steel quality 'A'.[53]

That the steel should be British may also be a result of conditions in wartime. Here the reference to standards allows the specification to respond quickly to external factors without the information being set down. According to Gelder, the earliest use of standards is found in military construction in the 18th century and the first to appear in the UK concerns the size of bricks.[54] This may well explain the earliest reference to a statute that I have seen in a specification for a Temple Printing office by architect William Pilkington: 'All the bricks to be of statue size.'[55] This document is extremely thorough in all its descriptions and also contains the earliest reference to a Building Act; 'The Flues in the Party Wall to be lime-whitened as directed by the Building Act.' But according to Peter Kingsford in *Builders and Building Workers* building regulations in London long predated the 19th century with the first set as early as 1189 in an attempt to avoid the frequent fires which broke out. However their efficacy was limited because unlike the later Building Acts there was no way of enforcing them.[56] In London, the first building act followed the Great Fire with detailed regulations about the use of materials in building and put surveyors in post to enforce the act.[57] Kingsford relates the next Act of 1774 to the great expansion in London's size and the later Public Health Acts to the outbreak of cholera in the early 19th century. What he terms 'the social control of building' would really start to take hold in the late 19th century and would be concerned with fire, the structural integrity and density of buildings, their effects on inhabitants' health and with the standards of materials themselves.

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[53] Specification for Air Raid Shelter for Bedales, Hants. (1940-1), architects - Erno Golfinger with Mary Crowley, RIBA Archives, GolER/409/5

[54] Gelder, *Specifying Architecture*, p.201 and p.8.

[55] Particulars of the Materials to be made use of and the works done for Temple Printing Office, Bouverie Street (1824) architect - William Pilkington, RIBA Archive, PiW/1.

[56] Peter Kingsford, *Builders and Building Workers*, London: Edward Arnold, 1973, p.212.

[57] Ibid., p.216.

It is beyond the scope of this study to track the emergence of the various statutes, Building Acts, Building Regulations, British Standards, Codes of Practice and Agrément Certifications which the specification will refer to, but it is important to point out that the increase in the number of these standards and regulations has been exponential. The use of standards is a means of control over the selection of materials and methods of work. One of the advantages of the online NBS that has recently been made available is that standards are linked into their citations in the specification, so that the specifier has easy access to their content. The performance clause, which I turn to now, also defers responsibility for material solutions, but in this case the transfer is not from specifier to statutory authority, but from the architect to the contractor.

5. The performance clause

> Those specifications written in terms which clearly point to one construction solution, with materials named, sizes given, and perhaps even suppliers named, are within the traditional category. The newer range of specifications are based on terms which describe what the material, construction detail or component is expected to do and how it must behave during and after placement; these are categorised as *performance specifications*.
>
> Ian Chandler[58]

The performance clause is the most widely and unanimously accepted of the forms of clause I identify. In Emmit and Yeomans' account it is simply the alternative to prescriptive specification, which would include both naming and method of work as well as many forms of referential specifying, although as we have seen reference to visual intent can also be a form of open specifying. In 1989 Ian Chandler could still refer to performance specifications as a 'newer range of specifications' although Atkinson writes that the idea of specifying 'requirements which have to be satisfied' rather than prescribing the materials themselves had been under discussion in the UK since the 1930s, and was used as a principle in the 1940s for British Standards and Codes of Practice.[59] Atkinson asks to what extent performance can and should be used in specification - a question which was much debated in the lead up to the formation of the NBS.

For the industry the significance of the performance clause is that it allows contractors flexibility to select materials and solutions that best suit their (profit) purpose, and enables the architect to avoid some of the pitfalls of nominating a material or component which turns out to be insufficient for its purpose, or, in extreme cases, has been specified inconsistently and can therefore allow the contractor to make a legal claim. New forms of contract shift requirements for detailed design to contractors and subcontractors, new technologies may require specialist contractors to do the detailed design or enable new materials and components to be designed 'on demand'. But, as Chandler observes, the performance specification also marks a significant

[58] Ian Chandler, *Building Technology 2; Performance,* London: Mitchell, 1989 p. 183.
[59] Atkinson, 'Performance Specification', p.115.

change in how materials are defined towards how they are to *behave* and what they are expected to *do.* In this way it is markedly different from naming a material – which is only concerned with its identification – and from describing the processes of its making. The performance clause looks only to how the material will behave as part of the finished building. It is concerned only with the 'desired result' and has nothing to say about the means of achieving it. This is the sense in which we might understand some of the clauses in traditional specifications in performance terms. For example, at the gothic villa for Mr Usborne (1879) a timber floor is specified in so far as it may be used for dancing:

Flooring	71.	These floors to have knots no larger than a sixpence therein...
Narrow floors		The drawing room floor to be partially traversed for dancing.[60]

The slabs in Rosenberg's sausage factory (1930s) are drawn but in the specification they are described only in terms of what they are to do:

20.	Fix precast slabs as shown on Drawing No.3 to control to the air circulation in the chambers.[61]

The concrete slab to the air raid shelter at Bedales (1940-1) is to be good enough to serve as a floor with no additional finishes:

57. Foundations	The surface [of the floor] is to be trowel finished and suitable to serve as flooring. No screed is to be allowed for.[62]

These clauses each describe the result rather than the means of achieving it but they do not share the language and quantification of contemporary performance specifications. Contemporary clauses may not even name a type of material, leaving this choice with the contractor. In general, most accounts of the performance specification in technical literature focus on the contractual significance of its openness, but it is rarely asked what might be the implications of the shift away from specifying materials in terms of how they are procured and worked, towards describing their effects and behaviours. These questions will be explored in much greater detail in Chapters Six and Seven. Here I will just set out some of the characteristics of performance specification, particularly as it appears in contemporary practice.

[60] Specification of works for a 'Gothic' villa (1879).
[61] Specification of works for a smoked sausage manufactory (1934-5).
[62] Specification for Air Raid Shelter (1940-1).

The contemporary performance clause is easily identifiable because of the language it uses to specify a material by its properties or behaviours – acoustic insulation, heat or UV light transmission, strength in compression, traffic noise resistance and so on – as they will perform in the finished building. Its language is the clipped abstracted terminology of materials science, a discipline which emerged out of the study of polymers and was only established in the 1950s and 60s. Properties are defined using scientific units of measurement – Megapascals (Mpa), Relative Humidity (RH), Watts per Metre squared Kelvins or u-value (W/M^2K) – and stated in quantities, grades and percentages. For example the following clause from Mole Architects describes the performance of a suspended ceiling above a car park in the Studio extension to the school of architecture at Cambridge (2006)[63]:

K10 Plasterboard dry linings/
partitions/ ceilings

215 SUSPENDED CEILING SYSTEM

TO SOFFIT OF FIRST FLOOR ABOVE CAR PARK/ WORKSHOP/ WALKWAYS

- Structural performance: The ceiling system must safely support loads including services fittings.
  - Subject to wind/ upward pressure: No.
  - Uniformly distributed loads (maximum): 0.6 kN/m².
  - Additional loads/ pressures: None.
  - Deflection (maximum) of grid between points of support: Span ÷ 400 mm. Test standard: To BS 8290-2, Appendix A.
- Fire performance:
  - Fire resistance of complete floor and ceiling assembly: To BS 476-21, 60/60/60 minutes (Stability/ Integrity/ Insulation).
  - Ceiling resistance: Not required.
  - Protection to structural beams: To BS 476-23, 60 minutes.
- Airborne sound insulation performance:
  - Sound insulation of complete floor and ceiling assembly. Weighted sound reduction index, Rw (minimum) to BS EN ISO 717-1: Not applicable.
  - Other requirements: None.
- Suspension system: As recommended by the board manufacturer to complete the ceiling system and achieve specified performance.
- Linings:

The clauses detail structural, fire resisting and sound insulating performance - information generated and understood mostly by experts outside the architectural office. Shifts in building technology and metallurgy did not bring the materials analyst into the architectural team as Harold Rosen predicted in 1969, but it would have an enormous impact on specification practice:

> The specification writer of yesterday, with glue pot and scissors, will have to be replaced by a materials analyst of the future. The growing increase in manmade materials, the advances in metallurgy, and the advent of systems design and construction will necessitate the creation of a

[63] Specification for Refurbishment of Scroope Terrace & New Studio Building (2006).

> specialist on the design team who is versed in the science of materials, in the interrelationship of components, and in the techniques of construction.[64]

As Rosen notes, there were many changes taking place in the production of materials and the use of systems building was escalating. These factors contributed to making the use of performance specification a possibility at all. Manufacture needs to be large scale and standardised itself, and materials and components must be subjected to tests whose results are quantifiable and recognised by the industry. Commentators in the period leading up to the formation of the NBS recognised these changes and were behind the introduction of performance specification but in general considered its use would be partial. Even today a range of forms have been retained with performance clauses interspersed amongst them. They also thought the use of performance specification would be limited to certain materials and criteria, as Carter explains, rather disparagingly, in response to the idea that performance might become the prevalent form of specification:

> From the wilder fringes of theory the suggestion has come that the NBS should be wholly in performance terms. This is quite impracticable at the moment. For many materials and methods adequate performance criteria are very difficult to define and the tests to assess performance criteria either too difficult or too expensive to carry out. 'Non-slip-ness' of floors (if there is such a word) is one obvious example.[65]

Carter's argument against wholesale performance specification is based on the fact that only some materials and properties can be tested. At any given moment this can be true of course, but he may not have envisaged the scale of change that would in fact take place and ensure that ever greater numbers of materials and criteria could be subjected to performance testing and specification.

3.6 Pendulum test being undertaken at CERAM Research Ltd.

For example, there are now quantitative assessments of the 'non-slip-ness' of floors which make it possible to specify this property in performance terms, and as a recent article in *NBS Journal 14* explored, at least three

[64] Rosen, 'The Future of Specifications Writing – Part II', p.206.
[65] Carter, 'National Building Specification', p.761.

different methods of testing 'slip resistant performance' in Europe have led to difficulties in specifying flooring that is manufactured outside the UK. The author Kevan Brassington (a member of the SlipSTD group who have been set up to improve and standardised slip classification) explains that the UK uses a pendulum test in which a shoe-shod pendulum is swung over the dry and wettened surface to derive a 'pendulum test value' (Fig. 3.6).[66] The problem for UK specifiers is that Germany derives a different value - a 'slip-angle' or 'R' value - by using a human tester in a safety harness walking up a ramp sprayed with various solutions, which is gradually inclined (Fig. 3.7) and Italy uses a trolley-like vehicle to find the friction coefficient or 'tortus' value of the surface. Depending on the tests in use, the slip potential is given in ranges of low, moderate and high PTV or the slip angle in degrees. Despite the fact that all methods involve quantitative abstraction the different values are not directly comparable.

3.7 DIN Ramp text being undertaken at CERAM Research Ltd.

There is a peculiar disjunction between the abstracted and authoritative quantities of the values derived from these tests as they appear in the scientific language of the performance specification, and the motley array of test mechanisms, which at least in the case of the ramp test pictured above rely on subjective criteria - the slip-angle is just the angle when the tester 'feels insecure or slips.'[67] What is clear is that despite the variation in approaches to deriving quantities for 'non-slip-ness', the drive to increasing performance specification motivates manufacturers and regulating authorities to find ways to quantify an ever greater range of properties, even those which once seemed well outside the scope of performance testing. Furthermore the requirements involved in making performance specification possible have much in common with requirements for the establishment of standards, including the supporting framework of testing and control (Agrément Certification is a centralised system now in place for the evaluation of materials performance) and the fact that materials and products need to show no variation from sample to sample (or presumably between lab and site) if these values are to have meaning.

[66] Kevan Brassington, 'Pendulum, Ramp and Tortus Slip Resistance Test Methods – Are you confused?' in *NBS Journal 14*, May 2009, pp. 9-10.
[67] Ibid., p. 10.

Contemporary specification by performance marks a radical departure from conventional modes of specifying, but it is rarely asked what impact it might have on how we think about materials or how we design with them, despite the fact that it challenges traditional notions of the material as a species, or as that which is worked. Performance specification mobilises another notion of a material as an assemblage of active and quantifiable properties. Furthermore, in what I will argue is more a partial than overarching development, the performance specification is gaining dominance in the industry while the use of the process-based clause is decreasing. These two types of clause are radically different; one is concerned with the material in the fabrication of the building, the other only in so far as the material acts in the completed building. Unlike the practice of naming the material, which only confirms a conventional concept of matter, neither of these descriptions of material tally with the concept of matter as it is given in the form/matter schema which I set out in Chapter Four. In Chapter Five, which explores the process-based clause in detail and in Chapters Six and Seven which examine the performance clause, I am particularly interested in the conditions which make both these descriptions possible. In this sense, both of the analyses I undertake of these two forms of clause follow the philosopher Gilbert Simondon's process-oriented critique of hylomorphism in so far as they make the processes through which the form of clause can be constituted central. The specification and more particularly the forms of clause, become a vehicle for looking at the processes through which materials and concepts of materials are themselves constructed. If we take these constitutive processes into account we might say that building materials are not just used in building, they are also built in building. How and to what extent might these two varieties of forms of clause, embedded as they are both in the industrial conditions of their use and in other ways tied to particular mobilisations of material, challenge and extend our conceptualisations of materials?

PART II

Chapter Four: The Forgetting of Process: Hylomorphism in philosophy and building

1. Hylomorphism in practice: building materials in Table 2/3
2. Hylomorphism in theory: liberating material from the imposition of form
3. Hylomorphism and process in Simondon's *L'individu*

Chapter Five: Going Into the Mould: Operations in process-based clauses for concrete casting

1. Processes of concrete casting in rigid formwork
2. Operations: the 'matterisation' of a dynamic system
3. Preliminary operations: the preparations of a plastic material

Chapter Six: 'Grounded in Such Usefulness': Material as equipment in the performance clause

1. Heidegger's account of specific use
2. Specific uses in the performance clause
3. Performance specification as the inscription of goals

Chapter Seven: Informing Materials: The pre-inscription of materials 'for a given service'

1. Testing the material and quantifying the goals
2. Materials 'for a given service' in the expanded context of performance engineering
3. Informed materials: the performance-led material as a 'complete system'

Chapter Four: The Forgetting of Process: Hylomorphism in philosophy and building

> In speaking here of matter I have in mind, say, the bronze of a statue, while by shape-form I mean the geometry of the object's appearance and by the composite the statue itself as a whole entity.
>
> Aristotle[1]

In Aristotle's classic formulation of hylomorphism in Book Zeta of the *Metaphysics* a material – bronze – appears as an instance of matter and is distinguished from the 'shape-form' or geometry which in conjunction with the material constitutes the 'composite' which is the 'whole entity'. Although Aristotle will include other kinds of form in addition to geometric form, a horse-form or a Socrates-form for example, form is differentiated from matter in as much as it alone can bring about change. When particular instances of materials are given to stand in for matter they are also conceived of as inert and available to formation. In the case of the production of a bronze sphere, is produced 'from something' (the 'substrate' bronze) and 'as something' (the sphere) which is accidental or changeable:

> Anything that is produced by something (and by this I mean that from which the origin of the production comes), and it is produced from something (let this not be the privation but the matter – we have already defined in what way we are speaking of this), and it is produced as something (i.e. either a sphere of a circle or whichever it might be of the other figures). And just as the output of the production is not the substrate, bronze, so also is it not the sphere, except accidentally, in so far as the bronze sphere *is* a sphere and it is a bronze sphere that is produced.[2]

Neither matter nor form bring about the output here. The bronze sphere is also produced 'by something,' a third term which Aristotle does not name. This may be the 'thought' that he refers to later as producing a building,[3] the intention which determines the building's coming in to being, but it may also be a reference to the mould or the act of casting which are unmentioned but implicit here. Substance, form and matter require each other in order to be, but are not in themselves substances.[4] The ease with which form and matter can

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[1] Aristotle, *Metaphysics*, p. 174.

[2] Ibid., p.194. Here 'matter' is translated from the Greek term *hyle* which also means wood (and is occasionally used for other materials) and is, as I understand it, a positive term which refers to an instance of the material. Aristotle uses a second term *hypokomenon*, which is translated here as 'substrate' and refers to prime matter. This word literally means 'that which lies beneath' – it has the sense of something behind, that can perhaps be deduced rather than touched.

[3] See 'Everything is produced either (i) from a bearer of the same name, as in the case of things produced naturally – an example of this among artifacts is a building, which is produced *from* a building to the extent that it is produced *by* thought, in that the skill is the form of the building,' ibid., p.198.

[4] At the end of Zeta 8 Aristotle make a strange comment that while the form of Callias and Socrates is the same, 'they differ materially' which might suggest that they are in some way made out of stuff that is qualitatively different but seems, in relation to his previous comments, rather to mean that they because they are two coexisting 'this-thing-here's they are rather made of separate matter. Ibid., pp.195-6.

appear as separable in these terms is in part due to the example Aristotle chooses. First, as he himself points out, in the case of a circle it is easy to separate out form and matter because the same shape 'may be imposed on bronze, on stone and on wood.' In contrast, in the case of man who is always made of the same stuff - 'in flesh, bone and the familiar parts' - we are more inclined to imagine that his substance is not divisible into matter and form. Second, there is a specificity to the material he chooses. Bronze, at least in its liquid state, can be formed into any shape. Once formed it can be melted down and re-formed from sphere to statue to sphere again. Aristotle makes use of a plastic material to develop his main hylomorphic argument and only includes the non-plastic materials wood and stone when he uses them in this supplementary way. Stone is not as pliable and available to infinite transformation as bronze. Wood is both a product and a (once) living thing. This important distinction between product and living thing is made in Zeta 9 where Aristotle differentiates between substances which 'can only be set in the relevant process by something else' and substances which are 'self-initiated'.[5] When bronze stands in for matter it is its *particular* properties which lend Aristotle's argument its force. But they remain in the background and we are happy to accept that bronze is just an instance of generic matter, pliable and available for the imposition of form.

In this account of 'artificial production' Aristotle sets out the main characteristics of the hylomorphic model. There is plastic matter – whether his bronze, Descartes' wax[6] or the architect's concrete cast in situ – and there are external forces which impart form, and like the circle '*imposed* on bronze' are active, even dominant.[7] These elements and the tendency to conceive of matter in terms of plastic materials are common to the various critical accounts of hylomorphism in philosophical and architectural discourse I will refer to, although they are not always faithful to other aspects of Aristotle's formulation. The version of hylomorphism which has passed into general use in architectural discourse, for example, reduces his notion of form to geometric form, an emphasis which Heidegger also makes when he claims that hylomorphism is a model of production which belongs only to art-making. Contemporary commentators often locate their re-conceptualisations of matter as active and generative in critical relation to hylomorphism, although Aristotle does in fact not ascribe generative power to form. My main concern here is not to unravel the developments of hylomorphism in the history of philosophy, and explore these differences in detail, but to ask how conceiving of materials in the general terms of hylomorphic matter might be limiting and what aspects of materials as mobilised in practice it might omit. The first concern is that the hylomorphic model renders specific materials as mere instances of matter that are equivalent and substitutable for one another. Differences between materials are rendered insignificant to the schema, although its persuasive power relies on them. A statue made from charcoal would, for example, become black dust if you tried to change its

[5] Ibid., p.198.
[6] René Descartes, *Discourse on the Method and Meditations*, trans. F.E. Sutcliffe, London: Penguin, 1968, pp.108-112.
[7] Here there is a slippage in Aristotle's account of form. Although he distinguishes between form and what sets formation in motion, here form is itself doing the forming. This is, in a sense, the slippage in how we might think about the mould or the formwork. We can imagine it as passive, nothing more than the negative of the positive artefact (or vice versa), or as active, imposing a form on the inert matter.

shape. A sphere made of dough would quickly deform. Only specific plastic materials (such as concrete) can be formed and re-formed (such as bronze) in the way the schema suggests. We have already seen that building is rarely specified in the simple terms of form and 'matter.' If Noah's Ark could be prescribed by its 'shape-form' and its material 'gopher wood', architectural specification has at least since the late 18th century required more forms of description than dimensions and the naming of materials. Where attempts are made to organise materials in the terms of the hylomorphic schema, as in Table 2/3, a system for the classification of building materials from the 1960s, exceptions and difficulties emerge.

The second concern is that where hylomorphism is understood as a model in which form actively imposes itself on matter materials are rendered as passive and inert. Rigid formwork, for example, can be seen to directly impart form on to concrete in an apparent series of transitions form the architect's intention, to the formal drawing, to the building of the formwork, and its realization in matter. For some philosophers and architectural theorists this is a hierarchy which needs to be challenged and reversed. Some of them turn, as I will, to Simondon's lengthy account in the first chapter of *L'individu* of the processes through which a wet clay brick takes form. Simondon provides a redescription of matter (clay) as active and dynamic which supports their arguments.

What is more central in Simondon's exposition for my argument however and leads to the third concern explored in this chapter, is that he shows that by emphasising only form and matter, the hylomorphic schema makes no account of the processes through which form-taking occurs. In concrete casting (as in bronze casting) the form 'work' through which a composite such as a concrete wall (or bronze sphere) arises, is discarded and disappears from view after production leaving only form and matter, as if that is all that needs to be accounted for. For Simondon, there is a forgetting of process in hylomorphism, which will shape the general approach I take to the forms of clause in the specification, and in particular, in Chapter Five, to the process-based clause.

1. Hylomorphsim in practice: building materials in Table 2/3

> All outputs of production can be split up, with this component and that component… the one is matter and the other form.
>
> Aristotle[8]

In Aristotle's schema materials – bronze, wood, stone - appear as subsets of matter as if the same form can be realised in any one of them. Aristotle's materials are assumed to be interchangeable because they are

[8] Aristotle, *Metaphysics*, p.194.

simply particular instances of matter, but in selecting bronze as his main example he makes use of its particular properties as a plastic matter–like material. Other philosophers choose different materials with other properties to support their model of matter. Brian Massumi and Deleuze and Guattari both select wood as an example in their materialist alternatives to hylomorphism – and make much of its 'singularities or haecceities',[9] its variegations, knots and grains - 'the variable undulations and torsions of the fibers guiding the operation of splitting wood' – in marked contrast to the homogeneity of concrete or bronze. Wherever a named material stands in for the concept of matter the implication may be that the particular material could equally be substituted by any other, but it seems clear that the material has been selected for its specific properties which lend force to each concept.

Aristotle's example of the circle which might equally give its shape to bronze, stone or wood suggests the simplest mechanism of specification. There is a form, given either as dimensions in words, as in the case of Noah's Ark or to some extent in the specification for town house for Sir William Heathcote (1734-6), or more typically in the drawings produced in conjunction with the specification, and there are materials in which that form is to be realised. Where the specification simply names materials – an ark in gopher wood, a floor in Christiana deal, a roof in Finnish Birch Plywood or a wall cladding in ThermoWood® - they are described as if they are substitutable. Master specifications such as the NBS leave blanks in their clauses where the names of materials can be inserted and in the digitised version of the NBS, these can literally be selected from a list which appears in a drop-down menu. But as we have seen there are more ways that material are specified than this simple mechanism, some relating obviously to the fact that some materials are made up on site, and others more obviously meeting the demands of the different ways that contracts are let out. We might not expect these details to affect the hold that hylomorphism has on the ways architects conceive of materials as they draw and design buildings, but it is more surprising to find the form/matter schema shaping the ways materials are categorised in technical practice.

A striking example of this is found in Table 2/3 (Figs. 4.1, 4.2), which was developed as part of the SfB classification system used to organise technical information in the libraries of architectural practices in the 1960s, and would also be adapted to provide the structure and categories of for the first version of the NBS.[10] The SfB system is organised into four categories of information, the finished built environment, its elements (walls, floors and so on), what it is to be made out of and 'activities and requirements' each is given in a table as follows:

[9] Deleuze and Guattari, *A Thousand Plateaus*, p.408.
[10] SfB was developed in Sweden in the 1950s and adapted for use in Swedish specifications with the aim of replacing the 'outgrown' trade-based arrangement of the specification with a logical, government-funded system. See Giertz, *SfB and Its Development*, pp.5–6.

No. 0 the built environment, ['the what'] 'the final result of the construction process'

No. 1 the different parts or elements of building, ['the what'] 'parts which form in combination the building types and spaces in Table 0'

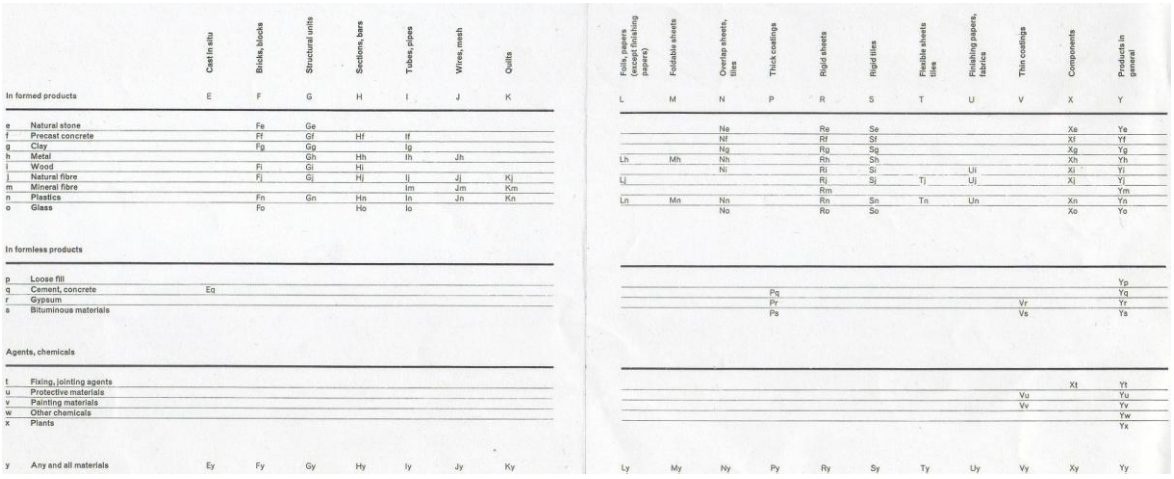
No. 2/3 'construction forms and materials' ['the how'] 'construction forms and products (table 2) and materials (substances) (table 3) which form singly or in combination the elements in Table 1'

No. 4 'Activities and Requirements' 'abstract concepts unlike the objects in Tables 0, 1, 2/3'[11]

The peculiarity of Table 2/3 is that it is organized with two axes. Table 2 'Construction Form' runs along the horizontal axis and Table 3 'Materials' runs down the vertical axis. Unlike the other three tables used in SfB, components of tables 2 and 3 can never be referred to independently. They must always be given in conjunction:

> 'Table 2 **Construction Form** is never used without Table 3 **Materials**, and for this reason both tables are combined in this section as table 2/3.'[12]

Like Aristotle's substances, the materials out of which a building is made can only be given as composites. Neither form nor matter are substances in themselves.



	Cast in situ	Bricks, blocks	Structural units	Sections, bars	Tubes, pipes	Wires, mesh	Quilts	Foils, papers (except finishing papers)	Foldable sheets	Overlap sheets, tiles	Thick coatings	Rigid sheets	Rigid tiles	Flexible sheets tiles	Finishing papers, fabrics	Thin coatings	Components	Products in general
In formed products	E	F	G	H	I	J	K	L	M	N	P	R	S	T	U	V	X	Y
e Natural stone		Fe	Ge							Ne		Re	Se				Xe	Ye
f Precast concrete		Ff	Gf	Hf	If					Nf		Rf	Sf				Xf	Yf
g Clay		Fg	Gg		Ig					Ng		Rg	Sg				Xg	Yg
h Metal			Gh	Hh	Ih	Jh		Lh	Mh	Nh		Rh	Sh				Xh	Yh
i Wood		Fi	Gi	Hi						Ni		Ri	Si		Ui		Xi	Yi
j Natural fibre		Fj	Gj	Hj	Ij	Jj	Kj	Lj				Rj	Sj	Tj	Uj		Xj	Yj
m Mineral fibre					Im	Jm	Km					Rm						Ym
n Plastics		Fn	Gn	Hn	In	Jn	Kn	Ln	Mn	Nn		Rn	Sn	Tn	Un		Xn	Yn
o Glass		Fo		Ho	Io					No		Ro	So				Xo	Yo
In formless products																		
p Loose fill																		Yp
q Cement, concrete	Eq										Pq							Yq
r Gypsum											Pr					Vr		Yr
s Bituminous materials											Ps					Vs		Ys
Agents, chemicals																		
t Fixing, jointing agents																	Xt	Yt
u Protective materials																Vu		Yu
v Painting materials																Vv		Yv
w Other chemicals																		Yw
x Plants																		Yx
y Any and all materials	Ey	Fy	Gy	Hy	Iy	Jy	Ky	Ly	My	Ny	Py	Ry	Sy	Ty	Uy	Vy	Xy	Yy

4.1 Table 2/3, *Construction Indexing Manual* (reprinted1969)

In Table 2/3 this results in two curiously abstract general categories which appear at the end of each axis. One is named 'Any and all materials' or lower case 'y' or and the other is 'Products in general' or upper case

[11] Table 2/3 and the definitions of each of the other tables are taken from the section openers in the *Construction Indexing Manual*. The distinction between 'the what' (building elements, such as car parks, assembly halls, or ceilings) and 'the how' (components of constructing that building and those parts) was another of SfB's aims and is discussed in Giertz, *SfB and Its Development,* pp. 8-9 from where I have taken the 'what' and 'how' categories.

[12] *Construction Indexing Manual*, p. 63.

'Y'. They are used to index literature which is concerned with a material such as clay, but not with any one form of it, or with forms of construction such as bricks which encompass more than one material (e.g. clay, glass, concrete, etc). Furthermore the categories along each of the axes are placed next to each other as if they have the kind of equivalence Aristotle assumes. Along the top the 'forms' loosely reflect the traditional trade divisions of the specification – foundations, structure, walls and ceilings, finishes - a logic from practice that becomes inaccessible once it is abstracted into the elements here. But the categories down the side – 'formed' 'formless' and 'agents' – might inspire the kind of 'wonderment' Foucault has described in his encounter with Borges' Chinese encyclopaedia of animals.[13] The building rationale behind the divisions is hard to ascertain even if their poetry is delightful.

Table 2/3 is riddled with gaps and anomalies that demonstrate the inadequacy of Aristotle's composite model for use in relation to building materials. The structure of the table suggests that, like the periodic table, all positions in the grid could be occupied. In a couple of cases new technologies such as structural glass have been developed since the table's production and would now fill some of its gaps (such as 'Go'). But many of the columns, such as 'Quilts' or 'Foldable sheets' mostly comprise of null values because so few of the building materials can or do take these 'forms'. The table shows the extent to which specific 'construction forms' can only be made in materials with particular properties, and make it clear that Aristotle's example of a circle which can just as easily be realised in bronze, stone or wood is not one which is so readily applicable to all substances. It also demonstrates the pervasiveness of the schema in as much as it is used in a situation which conforms so little to its logic.

It may be possible to denote each of the materials with a letter of the alphabet and suggest some equivalence, but they are separated into categories which share no forms in common with each other. None of the 'formed products' are associated with the categories of form 'Thin' or 'thick coatings', or with 'Cast in situ'. It is only cements, concrete, plaster and bituminous materials such as asphalt which can take these forms. These are the same 'formless materials' that are so often described in the specification with recipes and process-based clauses and here test the logic that is applied to others. A single category of materials 'cement, concrete' can be given as 'Cast in situ', a category which gives no indication of the form of the finished object, only of the method of its making. The performance of materials cannot be given at all in Table 2/3 and remains outside its parameters. This attempt to classify the materials of building in terms of the hylomorphic schema reveals some of the ways in which they cannot be contained by it. In particular, Table 2/3 makes it clear that the notion of materials as substitutable is problematic when it is confronted with materials in practice and begins to suggest why a variety of forms of description emerge in the specification.

[13] 'In the wonderment of this taxonomy, the thing we apprehend in one great leap, the thing that … is demonstrated as the exotic charm of another system of thought, is the limitation of our own, the stark impossibility of thinking *that*.' Michel Foucault, *The Order of Things* (1966), Tavistock Publications, London, 1974, p. xv.

		Cast in situ	Bricks, blocks	Structural units	Sections, bars	Tubes, pipes	Wires, mesh	Quilts	Foils, papers (except finishing papers)	Foldable sheets	Overlap sheets, tiles	Thick coatings	Rigid sheets	Rigid tiles	Flexible sheets tiles	Finishing papers, fabrics	Thin coatings	Components	Products in general
In formed products		E	F	G	H	I	J	K	L	M	N	P	R	S	T	U	V	X	Y
e	Natural stone		Fe	Ge							Ne		Re	Se				Xe	Ye
f	Precast concrete		Ff	Gf	Hf	If					Nf		Rf	Sf				Xf	Yf
g	Clay		Fg	Gg		Ig					Ng		Rg	Sg				Xg	Yg
h	Metal			Gh	Hh	Ih	Jh		Lh	Mh	Nh		Rh	Sh				Xh	Yh
i	Wood		Fi	Gi	Hi						Ni		Ri	Si		Ui		Xi	Yi
j	Natural fibre		Fj	Gj	Hj	Ij	Jj	Kj	Lj				Rj	Sj	Tj	Uj		Xj	Yj
m	Mineral fibre					Im	Jm	Km					Rm						Ym
n	Plastics		Fn	Gn	Hn	In	Jn	Kn	Ln	Mn	Nn		Rn	Sn	Tn	Un		Xn	Yn
o	Glass		Fo		Ho	Io					No		Ro	So				Xo	Yo
In formless products																			
p	Loose fill																		Yp
q	Cement, concrete	Eq										Pq							Yq
r	Gypsum											Pr					Vr		Yr
s	Bituminous materials											Ps					Vs		Ys
Agents, chemicals																			
t	Fixing, jointing agents																	Xt	Yt
u	Protective materials																Vu		Yu
v	Painting materials																Vv		Yv
w	Other chemicals																		Yw
x	Plants																		Yx
y	Any and all materials	Ey	Fy	Gy	Hy	Iy	Jy	Ky	Ly	My	Ny	Py	Ry	Sy	Ty	Uy	Vy	Xy	Yy

4.2 Table 2/3 (enlarged)

2. Hylomorphism in theory: liberating material from the imposition of form

> We may now be in a position to think about the origin of form and structure, not as something imposed from the outside on an inert matter, not as a hierarchical command from above as in an assembly line, but as something that may come from within materials, a form that we tease out of those materials as we allow them to have their say in the structures we create.
>
> Manuel DeLanda[14]

We have seen that Aristotle is not explicit about how it is that the circle is 'imposed on bronze' or to what he refers when he says that substance is produced 'by something'. It is clear however that, at least in his hylomorphic account of artificial production[15] there is an imposition of form which comes from the outside. For a number of contemporary commentators sometimes referred to as 'the new materialists' such as Manuel DeLanda, one of the problems of the hylomorphic schema is that form and matter are in hierarchical relation to each other with form dominant. This problem gets identified (both in philosophical and architectural discourse) at a number of different levels. First, as DeLanda suggests in the passage above there is a tendency to ignore the possibility that the origin of form 'may come from within materials'. For DeLanda, as for a number of architectural theorist-practitioners who experiment with the self-organising potential of materials, this is a possibility that we could 'tease out' from materials by developing different design and manufacturing processes. Second, some kind of relationship is frequently made between nurturing the form-generating potential of materials and a kind freedom of the material from the imposition of form. In DeLanda's terminology, for example, by working with their emergent properties we would allow materials 'to have their say'. It is hard to see this as anything more than a metaphor – inherited perhaps from a certain architectural tradition of confusing a 'respect' for the specificities of materials with an ethical position.[16] Third, in a more complex politicising of the hylomorphic relation, the imposition of form is seen as coming not from the mould,

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[14] DeLanda, 'Material Complexity', p.21.

[15] The distinction between substances which must be set in motion by external forces and which are self-initiating is central to Aristotle's distinction between non-living and living. In Chapter 4 I will discuss the different ways that both Simondon and Heidegger avoid making this distinction. By doing so they try to find other means to distinguish between living and non-living which do not rely on an external force or first cause.

[16] This is a tendency of many critics and architects, from Frampton to Salter, particularly in the aphorisms of Louis Kahn, most famously: 'And if you ask brick what it wants, it will say, "Well, I like an arch." And then you say "But, uh, arches are difficult to make. They cost more money. I think you can use concrete across your opening equally as well." But the brick says, "Oh, I know, I know you're right, but you know, if you ask me what I like, I like an arch." And one says, "Well now, why be so stubborn, you know?" And the arch says, "May I just make one little remark? Do you realize that you are talking about a being, and a being in brick is an arch? That's knowing the order. It's knowing it's nature. It's knowing what it can do. Respect that tremendously… Put it into absolute glory, and that is the only position it deserves.' Louis Kahn, *Louis I. Kahn: Writings Lectures,* Interviews, Alessandra Latour (ed.), New York: Rizzoli, 1991, p.288. And also, 'You can have the same conversation with concrete, with paper or papier-mâché, or with plastic, or marble, or any material. The beauty of what you create comes if you honour the material for what it really is.' Louis Kahn, *Between Silence and Light: Spirit in the architecture of Louis I. Kahn*, John Lobell (ed.), Boston: Shambala Publications, 2008, p.40.

but from the person who commands the moulding. Hylomorphism, the suggestion appears to be, implies hierarchical structures of work relations which are somehow related to the activity of imposing form on matter.

I draw attention to this set of concerns because they are the ones raised by architectural practitioners and theorists who problematise the hylomorphic schema, and I want to show how my own approach to hylomorphic matter differs. In addition, many of the commentators who are interested in self-organising matter, including philosophers such as DeLanda and Protevi, draw on Simondon's work but arrive at different conclusions to my own concerning his position on the question of hierarchy and hylomorphism. Furthermore, to take up imposition as a key problem of hylomorphism might also lead to a reductive reading of the specification as a series of commands by the architect or specifier. It is important to set out why this is not the direction I take. In this section I will summarise the most overtly political discussions of the schema first and move towards the micro scale of the technical operation that will be exemplified here by Simondon's re-description of the forming of the brick and in Chapter Five by found descriptions drawn from specifications for the forming of concrete walls cast in situ.

In *Political Physics* the philosopher John Protevi makes a detailed interpretation of a short section of Simondon's 'Form and Matter' chapter in which he raises the question of the schema's relationship to the social. Protevi cites the following passage from *L'individu*:

> The technical procedure which imposes a form on a passive and indeterminate substance is not just a procedure considered in an abstract way when a spectator sees what goes in and out of the workshop without knowing the process itself. It is essentially an operation commanded by the free man and carried out by the slave.[17]

Here Simondon extends the problem of hylomorphic imposition to the 'slave' who is commanded to carry out the technical operation. Protevi takes this still further and represents Simondon's free man who imposes form on passive matter, who despises 'surrender' to matter and 'only sees and commands' as an architect.[18] The architect, in imposing form, treats not only the material but, importantly, the slave who carries out his commands, as if *both* are passive and will receive his directions accordingly. In Protevi's reading a direct parallel is suggested between the architect's imposition of form on matter and their commanding of the builder. Moreover, the architect is represented as a 'free man' and the builder as a 'slave'. If we followed this logic, the clauses of the specification which specify a paradigmatic 'hylomorphic' production process such as concrete casting in rigid formwork could be seen as double impositions. They describe how form is to shape matter, and at the same time command the builder. We might then want to propose, as Protevi will, other

[17] Simondon, *L'individu*, p.48.
[18] John Protevi, *Political Physics*, p.4.

strategies of fabrication which would 'liberate' both matter and maker. Here for example are the architects Reiser + Umemoto, two of the most interesting contemporary theorist-practitioners, describing how hylomorphism structures both the object and practice of modernist architecture:

> It is interesting that the classical form/matter duality persists in the architecture of modernism both as a fundamental philosophical concept of design, per se, and in the way design arrives in the social field. For the same duality that stipulates a hard division between sovereign form and passive matter enforces a corresponding division of labour between conception and construction.[19]

For Reiser + Umemoto this parallel between the division of form and matter and conception and construction can be undone by enabling 'virtually every facet of the design process, including the spectrum of material properties and effects' to become 'actors in this parametric field.' Although they are careful not to make overblown claims for the social effects of such altered design processes they do mobilise the rhetoric of emancipation which we have already seen creeping into DeLanda's discourse:

> While the new models of production cannot make any undue claims for their socially liberating effects, they nevertheless have increased the degrees of freedom available to the designer and, by extension, to their productions.[20]

Simondon's argument does not take this direction. He does not propose that technical operations which are represented in hylomorphic terms produce particular social relations or organisations of work and might therefore need to be challenged.[21] Instead, the argument which follows from the free man/slave passage is one about what can be expressed. If it is the case, he suggests, that the processes of form–taking are veiled in the hylomorphic schema, then they cannot be known by he who stands outside the workshop, and are not therefore 'in the order of the expressible' which can be communicated to the 'slave' who will carry out the procedure.[22] Only form and matter are visible and can be expressed. The parallel is that the worker who carries out the technical operation only sees it in terms of an imposition of form on matter as does the one who gives the command. For both the chains of processes involved remain veiled. Protevi goes on to suggest that we can challenge the dominance of the form-giving architect by valorising the work of the artisan, a proposal which often appears as an alternative to hylomorphism in particular in *A Thousand Plateaus* which has been extremely influential for architects as well as philosophers, and is the main text through which Simondon's work is usually encountered. He writes:

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[19] Reiser + Umemoto, *Atlas of Novel Tectonics*, New York: Princeton Architectural Press, 2006, p.146.
[20] Ibid., p.148.
[21] In *Du Mode* Simondon does, in a rather different way, suggest that the hylomorphic schema might itself arise out of a particular relationship between worker and work, which he argues is changing with contemporary technological developments and I will discuss this towards the end of this chapter.
[22] Simondon, *L'individu*, p.49.

> Hylomorphism is a transcendental illusion: the architect arrogating to himself, to his vision of form and his directions for its imposition in formless chaotic matter, all credit for the production which actually occurs through artisanal work with the implicit forms of matter.[23]

In artisanal production, the argument goes, form is not imposed from outside, but follows the 'implicit forms of matter' which for Deleuze and Guattari are 'left by the wayside' in the hylomorphic model which 'assumes a fixed form and a matter deemed homogeneous.'[24] These 'things', they write, include:

> An entire energetic materiality in movement, carrying *singularities* or *haecceties* that are already like implicit forms that are topological, rather than geometrical, and that combine with processes of deformation: for example, the variable undulations and torsions of the fibers guiding the operation of the wood.[25]

To take account of these implicit forms, is, they suggest, 'A question of surrendering to the wood, then following where it leads by connecting operations to a materiality, instead of imposing a form upon a matter.'[26] The artisan is the figure who surrenders to the wood and follows where it leads:

> We will therefore define the artisan as one who is determined in such a way as to follow a flow of matter, a *machinic phylum*. The artisan is *the itinerant*, *the ambulant*. To follow the flow of matter is to itinerate, to ambulate. It is intuition in action.[27]

Deleuze and Guattari's figure of the artisan is not the same as the figure of the artisan who is traditional to architectural discourse and 'follows the dictates of his soul',[28] for their artisan follows the 'machinic phylum' which includes the availability of materials and resources and even the markets themselves, as well as the variegations and intensities of the materials they work. However, in proposing another kind of relationship to matter than that of either 'slave' or 'architect' both Protevi and Deleuze and Guattari appear to imply that the conditions of production need to change if we are to take the challenge to hylomorphism seriously.

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[23] Protevi, *Political Physics*, p. 122.
[24] Deleuze and Guattari, *A Thousand Plateaus*, p.408. Their arguments in this section of the book are made with explicit reference to Simondon's work.
[25] Ibid. Note that Deleuze and Guattari use the example of wood to support their discussion of the machinic phylum, rather than Simondon's main example of clay which he demonstrates also has singularities and haecceities.
[26] Ibid.
[27] Ibid., p.409.
[28] The idea of the artisanal has a powerful legacy for architects. According to Ruskin, writing in *The Stones of Venice*, we can identify two modes of building. Classical building was 'servile' – the slave carried out the orders of the master – while gothic building was 'Christian' (sometimes described as 'democratic'), where the 'system, in confessing the imperfections of the human soul and bestowing "dignity upon the acknowledgement of unworthiness" gave scope for the workman to do as best he could, *following the dictates of his soul*.' Mark Swenarton, *Artisans and Architects: The Ruskinian tradition in architectural thought*, Basingstoke: Macmillan, 1989, p.24, quoting Ruskin. My emphasis. See also John Ruskin, *Stones of Venice*, Jan Morris (ed.), London: Faber, 1991, pp.120-123.

Although Simondon does make an argument in *Du mode* to which neither Protevi nor Deleuze and Guattari refer, that the relationship of the worker to the technical object needs to change, he does not propose a turn to artisanal work as a solution.[29] For Simondon, to put it most simply, the hylomorphic schema gives form-taking the *appearance* of the imposition of form on matter.[30] Even the most paradigmatic instances of hylomorphic production, such as the moulding of a clay brick or the casting of a concrete wall, can be shown to take place through chains of operations and energetic exchanges. Part of the strength of his choosing clay as an example (and not wood or metal which Deleuze and Guattari make use of) is that it is a material which appears to be without variegation and 'implicit forms'. By examining the chains of process involved in a brick taking-form (and using the 'allagmatic' method that is applicable to all instances of individuation, not just technical operations or those which seem to exemplify hylomorphism) Simondon reveals that even the imposition of form on clay is a hylomorphic illusion; it is just that the chains of processes through which the brick takes form have been unseen or 'veiled' in the terms of the hylomorphic schema. He shows us that clay is no more an example of homogeneous matter than a gnarled and knotted piece of timber. Thus for Simondon, it is not a case of exchanging one material for another, or one form of production for another. It is not a case of liberating material from the imposition of form, and allowing it to 'have its say', because there was no imposition in the first place to be replaced by some other better process. Rather it is a case of reconceptualising form-taking in more adequate terms and understanding what the implications of such a rethinking might be.

3. Hylomorphism and process in Simondon's *L'individu*

> The hylomorphic schema corresponds to the knowledge of a man who stays outside the workshop and only considers what goes in and what comes out.
>
> Gilbert Simondon[31]

In a short catalogue essay which Roland Barthes wrote for an exhibition about plastic, he describes a plastic forming machine on display which transformed this green 'matter' into dressing room tidies. The machine demonstrates, he writes:

> '…the transmutation of matter. An ideally-shaped machine, tabulated and oblong (a shape well suited to suggest the secret of an itinerary) effortlessly draws, out of a heap of greenish crystals,

[29] This argument will be discussed in detail in Chapter Nine.
[30] As Pascal Chabot has commented, for Simondon 'Hylomorphism is a mentality, a way of seeing. Concrete experiences do not confirm it.' Pascal Chabot, *La Philosophie de Simondon*, Paris: Vrin, 2003, p.78.
[31] Simondon, *L'individu*, p.40.

> shiny and fluted dressing-room tidies. At one end raw, telluric matter, at the other, the finished, human object; and between these two extremes, nothing; nothing but a transit.'[32]

Barthes uses the terms of hylomorphism to convey this striking image. Plastic is imagined as 'raw, telluric matter' which undergoes an invisible and 'effortless' transmutation into a formed object. For Barthes plastic is a material with specific properties – in particular, paradoxically, its lack of identity which leads it to mimic the properties of other materials and its fluidity which suggests 'the very idea of its infinite transformation.' In addition, at least in the case of this machine which covers its mechanisms, plastic appears to be transformed into objects as if by magic. A particular process – that of forming a plastic material – appears as if its transmutation is 'nothing but a transit'. We cannot access or envisage the processes of fabrication. Barthes' image of the hidden processes of form-taking recalls Simondon's description of the hylomorphic schema in terms of a man standing outside the workshop seeing only 'what goes in and what comes out.' It seems, as Simondon will also suggest, that there may be some processes of fabrication such as moulding and casting which lend themselves to representation in the terms of the hylomorphic schema. In Barthes' example, the machine casing covers over the plastic-forming processes. If we were to remove it the processes would be visible, at least those at a scale we can see. For Simondon, however, the veiling is more a conceptual one about what we choose to know – it is how we narrate the technical operation which is at stake. He goes as far as to call this a 'veiling' suggesting that the chains of processes are actively hidden and kept out of sight:

> The hylomorphic schema only retains the extremities of the two half chains which the technical operation elaborates; the schematism of the operation itself is veiled, unknown.[33]

For Simondon it is this veiling of the operations of form-taking which is the central problem of the hylomorphic schema. As Adrian Mackenzie has summarized:

> The basic problem with the hylomorphic scheme is that it only retains the two extreme starting points – a geometrical ideal and formless raw material – of a convergent series of transformations, and ignores the complicated mediations and interactions which culminate in matter taking-form.[34]

As Simondon will make explicit in 'Allagmatique' his emphasis on process or 'operation' (the term he prefers to use) is part of his 'allagmatic' method and theory. Simondon's broad philosophical aim is nothing less than to give an alternative 'theory of operations' which is symmetrical to the 'theory of structures' which most sciences and philosophies concern themselves with. Allagmatic theory can, claims Simondon, reveal

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[32] Roland Barthes, 'Plastic' in *Mythologies*, trans. Annette Lavers, London: Vintage, 2000, p.97.
[33] Simondon, *L'individu*, p.40.
[34] Mackenzie, *Transductions,* p.48.

operations such as energetic transformations and changes of state which would otherwise go undiscovered and un-theorised.[35] *L'individu* makes central the processes through which the individual comes into being and provides an alternative theory of individuation to hylomorphism.

For Simondon there are a number of problems with the hylomorphic schema in addition to those set out so far. First, the hylomorphic schema locates the principle of individuation in terms prior to the individuation:

> A term itself is already an individual, or at least something capable of being individualised, something that can be the cause of an absolutely specific existence (haecceity), something that can lead to a proliferation of many new haecceities. Anything that contributes to establishing relations already belongs to the same mode of existence as the individual, whether it be an atom, which is an indivisible and eternal particle, or prime matter, or a form.[36]

This is a logical problem because another individual has to be posited to account for the individuation. In addition this account of individuation fails to take up the possibility that the individuation itself could furnish its own principle. It assumes that the principle of individuation must lie outside the individuation. As Simondon explains:

> The principle of individuation, then, is not grasped at the point where individuation itself occurs as a process, but in that which the operation requires before it can exist, that is, a matter and a form. Here the principle is thought to be contained either in the matter or the form, because the actual process of individuation is not thought to be capable of furnishing the principle itself, but simply of putting it into effect.[37]

He proposes that we take neither matter nor form as furnishing the principle of individuation but look instead to 'the genesis itself as it is in operation' as 'the veritable principle of individuation':

> The veritable principle of individuation is the genesis itself as it is in operation, that's to say the system in the course of becoming, during which energy is actualized. The true principle of individuation cannot be found in that which exists before the individuation takes place, nor in what remains after the individuation is accomplished; it is the energetic system which is individuating in as much as it realizes in itself this internal resonance of matter taking form, and is a mediation between

[35] Simondon, *L'individuation à la lumière*, p.559.
[36] Simondon, 'The Genesis of the Individual,' p.298.
[37] Ibid., p.299.

> orders of magnitude. The principle of individuation is the unique manner which the internal resonance establishes itself from *this* matter in the taking of *this* form.[38]

In order to explore the individuation of '*this* matter in the taking of *this* form' Simondon devotes his first chapter in *L'individu* - 'Form and Matter' - to his long and involved re-description of the moulding of a brick. He chooses the moulding of wet clay because it seems so perfectly to exemplify the hylomorphic schema, and shows that even this example of form-taking (like the more conducive example of the growth of the crystal in a supersaturated solution which will be the central example in the following chapter 'Form and Energy') can be rewritten in the terms of a dynamic individuating system. In painstaking detail, he relates the transformations, mediations and interactions – which culminate in the forming of a wet brick. These processes range from the macro scale of the clay's extraction from the ground and its industrial preparations in the brickworks to the micro scale of its colloidal structure and its energetic molecular dynamism during moulding. To a lesser extent, Simondon also explores the preparation and wetting of the wooden mould.

Simondon's meticulous attention to the processes involved in this clay/mould system is by no means informed by any conceptual interest in the question of materials which is central to this enquiry. But one outcome of his analysis is that wet clay – a paradigmatic example of a plastic material that can be infinitely available to any form - can no longer be seen as mere hylomorphic matter in any of the ways that have been discussed in this chapter. In his re-description of form-taking clay is not passive, inert or homogeneous. At the micro level its specific molecular structures and dynamic properties are what make it able to interact with the mould in such a way that it can take form at all. At the macro level these capacities are shown themselves to be prepared through a complex chain of specific processes which make it possible for form-taking to occur in its encounter with the mould that is itself prepared. First then, for this enquiry, Simondon's exposition of the clay-mould system reveals both the particularity of a material within a specific process, that is in stark contrast to the hylomorphic concept of matter, and suggests a means by which it can be retrieved and rendered visible via the examination of these processes.

Second, Simondon's re-description of form-taking is analogous to the kinds of descriptions in the specification which were identified in Chapter Three as process-based clauses. The similarity is most striking in the specification of processes similar to the moulding of a clay brick such as the forming of concrete in rigid formwork. Within the framework Simondon sets out, in which hylomorphism covers over the processes of form-taking so that they are excluded from 'the order of the expressible' leaving only form and matter visible, process-based clauses provides expressions of those processes. They describe form-taking, not in the terms of form and matter, nor just as orders imposed by an architect or specifier, but in terms of the chains of processes that Simondon is so keen to expose.

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[38] Simondon, *L'individu*, p.43.

In her commentary on Simondon's work Muriel Combes extends his notion of the veiling of operations to the technologies whose working operations we cannot understand and are shrouded in what she, as in common in many discussions of technology, refers to as a 'black box.'[39] In early specifications where it was enough to specify only what the builder is to make, and in more recent documents which attempt to specify only 'work in place' and reduce or even eradicate descriptions of construction methods, we might say that the processes of building are black-boxed. The process-based clause opens up the black box, at least in so far as the architect, specifier or researcher is concerned. In the next chapter I examine the process-based clause in the light of Simondon's account of form-taking in terms of operations, and make use of two specifications for concrete casting in rigid formwork, a process of construction that is particularly apt because like Aristotle's bronze sphere and Simondon's clay brick it also appears to be a paradigmatic realisation of the hylomorphic schema.

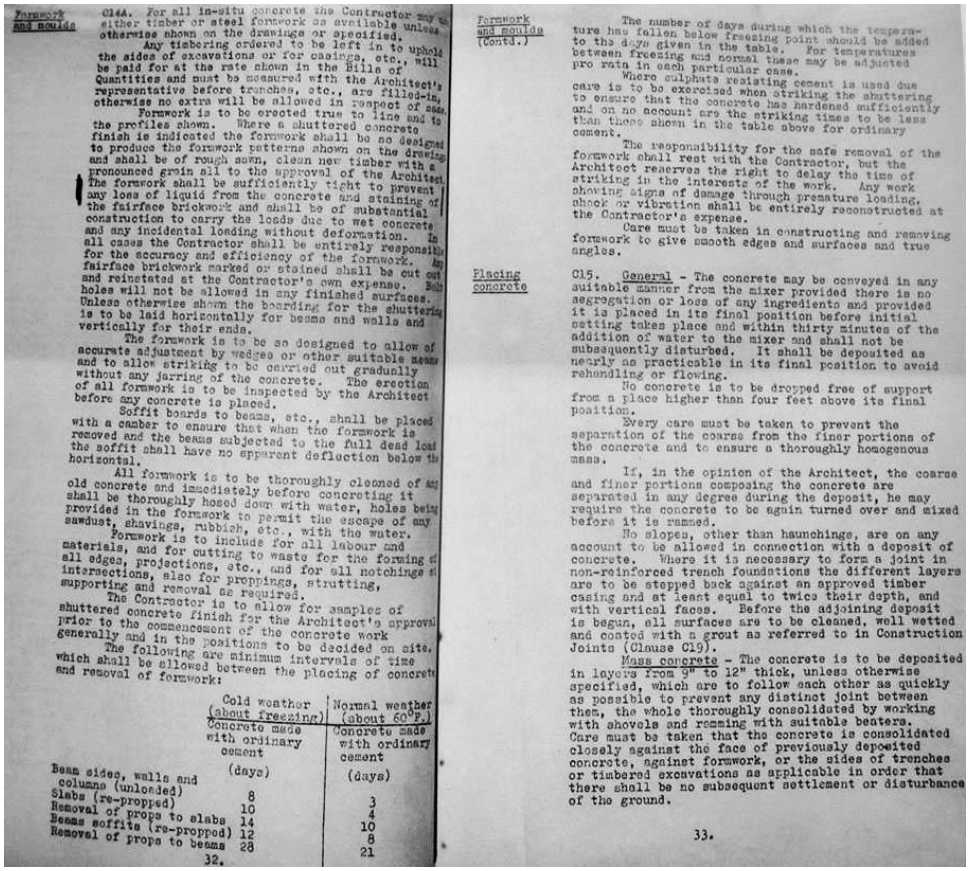
Third, in ways which were not apparent to me when I first began to explore the process-based clause in relation to Simondon's account, his attempt to bring the processes of individuation into visibility and thus rethink individuation itself will provide the basis of my own attempt to formulate concepts of materials without recourse to the concept of matter, via the forms of clause in the architectural specification. This may appear counter-intuitive in the case of the performance clause which, emphatically, describes materials with no reference to the processes involved in their making, but the relevance of Simondon's theory of operations will unfold gradually in the following chapters, as it did during the process of this research, through the encounter with specifications, other documents and the specifics of the forms of clause. Because, unlike Simondon who relies on his own rewriting of the clay/mould system, I draw on found examples from technical practice, the historical and industrial contexts which shape their appearance have to be taken into account, and this in turn introduces some additional considerations to the arguments Simondon puts forward in *L'individu*.

[39] Muriel Combes, 'Tentative D'ouverture D'une Boite Noire Ce Que Renferme la «Question de la Technique»' in Jean-Marie Vaysse (ed.), *Technique, Monde, Individuation: Heidegger, Simondon, Deleuze*, Hilldesheim: Georg Olms Verlag, 2006, p.87.

Chapter Five: Going Into the Mould: Operations in process-based clauses for concrete casting

> To know the veritable hylomorphic relation, it is not even enough to go into the workshop and work with the artisan: one would have to go into the mould itself to follow the operation of form-taking at the different scales of physical reality.
>
> Gilbert Simondon[1]

The Specification for the Elfrida Rathbone School (1961) produced by the LCC is an enormous document. 161 closely typed pages describing every aspect of the building process – from washing out buckets to the preparation of material samples for approval - in extraordinary detail (Fig. 5.1).[2] It represents a peak of process-based specification with clauses written in longhand and reading like prose. The section for the 'Concretor' runs to 15 pages and around 10,000 words despite the fact that the school was built almost entirely in brick, with only the top sections of the walls to the two raised halls cast in reinforced concrete.



Formwork and moulds

C14A. For all in-situ concrete the Contractor may use either timber or steel formwork as available unless otherwise shown on the drawings or specified.

Any timbering ordered to be left in to uphold the sides of excavations or for casings, etc., will be paid for at the rate shown in the Bills of Quantities and must be measured with the Architect's representative before trenches, etc., are filled-in, otherwise no extra will be allowed in respect of same.

Formwork is to be erected true to line and to the profiles shown. Where a shuttered concrete finish is indicated the formwork shall be so designed to produce the formwork patterns shown on the drawings and shall be of rough sawn, clean new timber with a pronounced grain all to the approval of the Architect. The formwork shall be sufficiently tight to prevent any loss of liquid from the concrete and staining of the fairface brickwork and shall be of substantial construction to carry the loads due to wet concrete and any incidental loading without deformation. In all cases the Contractor shall be entirely responsible for the accuracy and efficiency of the formwork. Any fairface brickwork marked or stained shall be cut out and reinstated at the Contractor's own expense. Bolt holes will not be allowed in any finished surfaces. Unless otherwise shown the boarding for the shuttering is to be laid horizontally for beams and walls and vertically for their ends.

The formwork is to be so designed to allow of accurate adjustment by wedges or other suitable means and to allow striking to be carried out gradually without any jarring of the concrete. The erection of all formwork is to be inspected by the Architect before any concrete is placed.

Soffit boards to beams, etc., shall be placed with a camber to ensure that when the formwork is removed and the beams subjected to the full dead load the soffit shall have no apparent deflection below the horizontal.

All formwork is to be thoroughly cleaned of any old concrete and immediately before concreting it shall be thoroughly hosed down with water, holes being provided in the formwork to permit the escape of any sawdust, shavings, rubbish, etc., with the water.

Formwork is to include for all labour and materials, and for cutting to waste for the forming of all edges, projections, etc., and for all notchings at intersections, also for proppings, strutting, supporting and removal as required.

The Contractor is to allow for samples of shuttered concrete finish for the Architect's approval prior to the commencement of the concrete work generally and in the positions to be decided on site.

The following are minimum intervals of time which shall be allowed between the placing of concrete and removal of formwork:

	Cold weather (about freezing) Concrete made with ordinary cement (days)	Normal weather (about 60°F.) Concrete made with ordinary cement (days)
Beam sides, walls and columns (unlonded)	8	3
Slabs (re-propped)	10	4
Removal of props to slabs	14	10
Beams soffits (re-propped)	12	8
Removal of props to beams	28	21

32.

Formwork and moulds (Contd.)

The number of days during which the temperature has fallen below freezing point should be added to the days given in the table. For temperatures between freezing and normal these may be adjusted pro rata in each particular case.

Where sulphate resisting cement is used due care is to be exercised when striking the shuttering to ensure that the concrete has hardened sufficiently and on no account are the striking times to be less than those shown in the table above for ordinary cement.

The responsibility for the safe removal of the formwork shall rest with the Contractor, but the Architect reserves the right to delay the time of striking in the interests of the work. Any work showing signs of damage through premature loading, shock or vibration shall be entirely reconstructed at the Contractor's expense.

Care must be taken in constructing and removing formwork to give smooth edges and surfaces and true angles.

Placing concrete

C15. General - The concrete may be conveyed in any suitable manner from the mixer provided there is no segregation or loss of any ingredients and provided it is placed in its final position before initial setting takes place and within thirty minutes of the addition of water to the mixer and shall not be subsequently disturbed. It shall be deposited as nearly as practicable in its final position to avoid rehandling or flowing.

No concrete is to be dropped free of support from a place higher than four feet above its final position.

Every care must be taken to prevent the separation of the coarse from the finer portions of the concrete and to ensure a thoroughly homogenous mass.

If, in the opinion of the Architect, the coarse and finer portions composing the concrete are separated in any degree during the deposit, he may require the concrete to be again turned over and mixed before it is rammed.

No slopes, other than haunchings, are on any account to be allowed in connection with a deposit of concrete. Where it is necessary to form a joint in non-reinforced trench foundations the different layers are to be stepped back against an approved timber casing and at least equal to twice their depth, and with vertical faces. Before the adjoining deposit is begun, all surfaces are to be cleaned, well wetted and coated with a grout as referred to in Construction Joints (Clause C19).

Mass concrete - The concrete is to be deposited in layers from 9" to 12" thick, unless otherwise specified, which are to follow each other as quickly as possible to prevent any distinct joint between them, the whole thoroughly consolidated by working with shovels and ramming with suitable beaters. Care must be taken that the concrete is consolidated closely against the face of previously deposited concrete, against formwork, or the sides of trenches or timbered excavations as applicable in order that there shall be no subsequent settlement or disturbance of the ground.

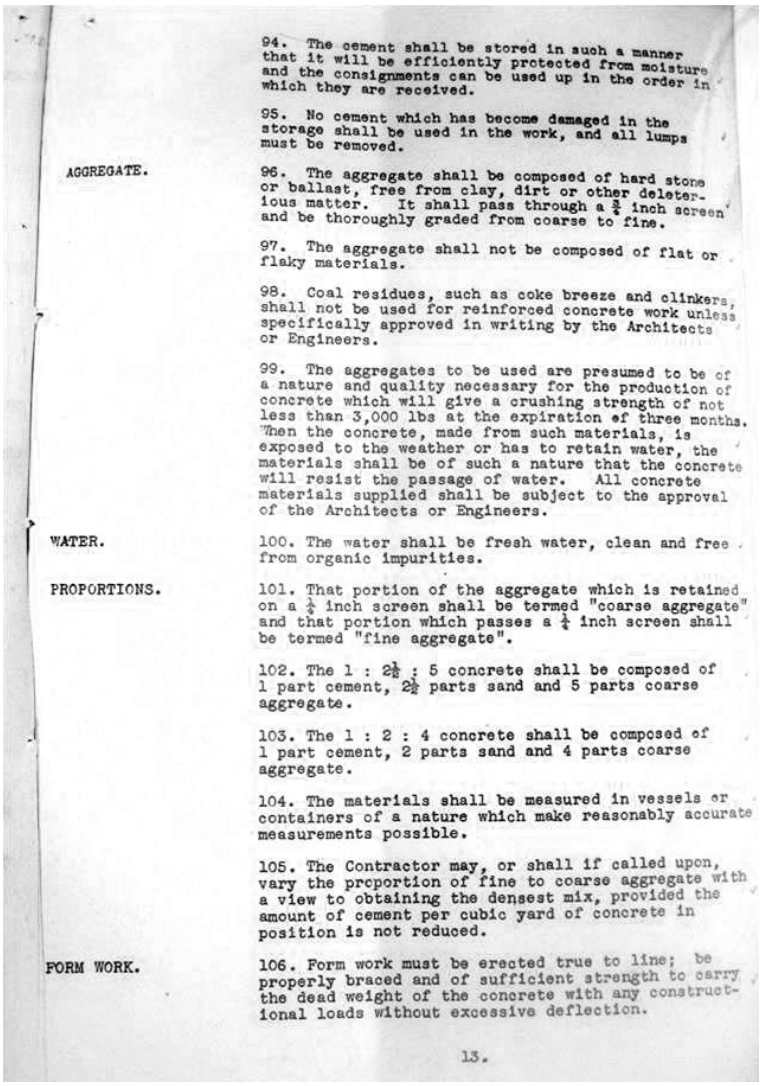
33.

5.1 Specification for the Works, Elfrida Rathbone School for the Educationally Subnormal, (1961)

[1] Simondon, *L'individu*, p. 40.

[2] According to Eric Classey who worked at the LCC designing schools during this period it was probably put together by a London County Council architect whose sole role was to produce the department's specifications. Interview Nov 2004.

On the one hand, this excessive use of the process-based clause can be seen as an extension of the need to control the quality and methods of workmanship when gross tendering took off in the early part of the 19th century and the use of the process-based clause became common. Similarly, the move towards reducing the use of the process-based clause which was initiated in the 1960s and has led to its near eradication in some forms of contemporary specification, was in part a response to documents such as those produced by the LCC and the great restrictions they placed on the contractor in carrying out work in ways which were most efficient and economical for them.



94. The cement shall be stored in such a manner that it will be efficiently protected from moisture and the consignments can be used up in the order in which they are received.

95. No cement which has become damaged in the storage shall be used in the work, and all lumps must be removed.

AGGREGATE.

96. The aggregate shall be composed of hard stone or ballast, free from clay, dirt or other deleterious matter. It shall pass through a ¾ inch screen and be thoroughly graded from coarse to fine.

97. The aggregate shall not be composed of flat or flaky materials.

98. Coal residues, such as coke breeze and clinkers, shall not be used for reinforced concrete work unless specifically approved in writing by the Architects or Engineers.

99. The aggregates to be used are presumed to be of a nature and quality necessary for the production of concrete which will give a crushing strength of not less than 3,000 lbs at the expiration of three months. When the concrete, made from such materials, is exposed to the weather or has to retain water, the materials shall be of such a nature that the concrete will resist the passage of water. All concrete materials supplied shall be subject to the approval of the Architects or Engineers.

WATER.

100. The water shall be fresh water, clean and free from organic impurities.

PROPORTIONS.

101. That portion of the aggregate which is retained on a ¼ inch screen shall be termed "coarse aggregate" and that portion which passes a ¼ inch screen shall be termed "fine aggregate".

102. The 1 : 2½ : 5 concrete shall be composed of 1 part cement, 2½ parts sand and 5 parts coarse aggregate.

103. The 1 : 2 : 4 concrete shall be composed of 1 part cement, 2 parts sand and 4 parts coarse aggregate.

104. The materials shall be measured in vessels or containers of a nature which make reasonably accurate measurements possible.

105. The Contractor may, or shall if called upon, vary the proportion of fine to coarse aggregate with a view to obtaining the densest mix, provided the amount of cement per cubic yard of concrete in position is not reduced.

FORM WORK.

106. Form work must be erected true to line; be properly braced and of sufficient strength to carry the dead weight of the concrete with any constructional loads without excessive deflection.

13.

5.2 Specification of Works, House at Farnham Common (1934)

On the other hand, the process-based clause offers some opportunities. The specification Val Harding wrote for his own house at Farnham Common (1934) built with the latest techniques of cast reinforced concrete is rich with the vivid detail of the building, preparation and striking of formwork, and the mixing, pouring, setting and finishing of the concrete (Fig. 5.2). These clauses may guide a builder through an unfamiliar process of construction and allow the architect or specifier to think through the operations of fabrication which remain

outside their scope of work when clauses describe only 'work in place'. In Harding's case the intensity of detail and language suggests that this was an opportunity he relished, a means perhaps of crossing the distance between the drawn and written representations of the imagined building-to-be and the material reality of the building itself. In both of these specifications the level of detail in their descriptions of concrete casting provides a parallel to Simondon's long and intricate unravelling of the processes involved in forming a wet clay brick in a wooden mould. They provide a resource for 'going into the mould itself' to explore the complex chains of processes at work in what appears to be another paradigmatic instance of hylomorphic production – the shaping of concrete in rigid formwork.

Concrete cast in situ, which required two unique categories in Table 2/3, is a particularly interesting example in two ways. Like the bronze Aristotle uses to stand in for matter in his account of substance, concrete is yielding and malleable. At least in its liquid state it is without a form of its own and can be formed into any shape. It appears to conform to the dream of hylomorphic matter or what Liam Ross has called 'grey gloop' in his discussion of Zaha Hadid's approach to materials in their form-driven architecture.[3] Increasingly new materials are being produced (such as zp®150 - the 'plaster' produced by Z Corporation for use in their 3D printers[4]) and traditional materials are being reconstituted (such as MDF) that reproduce this dream in as much as they are homogeneous, mouldable and can take any form. Like precast concrete which sits in a different category to in situ concrete in Table 2/3, these materials are produced and formed prior to their arrival on site and we have no access to the processes which render them matter-like.

The process-based clauses for in situ concrete make these processes available. We can see the extent of the operations which make concrete and formwork ready for casting and the degree to which a further set of operations edits some of the specificities of this particular material as it forms, in order perhaps to make the finished cast appear to have taken place as nothing more than a 'transmutation of matter'. Despite appearances, this is, as Simondon puts it in relation to the moulding of clay, no simple union between 'abstract matter' (the clay as 'indefinite plasticity') and 'abstract form' (the mould as 'this notion of the parallelepiped'). Instead there is a 'technical operation' which includes both the operations of form-taking itself and the preparations of material and mould for their encounter:

> The clay, conceived as supporting an indefinite plasticity, is the abstract matter. The right-angled parallelepiped, conceived as a brick form, is an abstract form. The concrete brick does not result from the union of the clay's plasticity and the parallelepiped. So that there can be *a* parallelepipedic brick, a really existing individual, it is necessary that an effective technical *operation* institutes a

[3] Liam Ross, 'An excess of unthinking material', unpublished paper available at http://tectonics2007.com/index.php?option=com_contents&task=view&id=Itemid=70 accessed 17.06.09.
[4] zp®150 is described on the manufacturers' website as a 'high performance composite' which 'delivers the best of everything'. See www.zcorp.com/en/Products/3D-Printers/Material-Options/spage.aspx accessed 02.05.2010.

> mediation between a given clay mass and this notion of the parallelepiped. However, the technical operation of molding does not itself suffice. Moreover, it does not institute a direct mediation between a given mass of clay and the abstract form of the parallelepiped; the mediation is prepared by two chains of preliminary operations which make matter and form converge toward a common operation. To give a form to clay is not to impose the parallelepiped form on rough clay: it is to pack prepared clay in a manufactured mold.[5]

Here Simondon makes an important distinction between these two kinds of operation. There are the operations of the mediation between clay and mould, and the 'preliminary operations' which make a common operation between them possible. Simondon seems to suggest that it is these preliminary operations – the preparations and manufacturing prior to form-taking - which should alert us to the fact that the form-taking of the brick is not reducible to the imposition of form on matter.

In this chapter examples from the process-based clauses for concrete casting in rigid formwork will support many of the arguments Simondon makes in his 'Form and Matter' chapter but I also hope to show that they extend them. First, they reveal that the hylomorphic schema is not only a conceptual apparatus, it is also physically reproduced and naturalised in this particular method of construction. Second, the clauses also specify non-physical processes, such as checks by architects and external authorities, which Simondon does not refer to in his account, but might also be included within his category of preparations. Thus, by considering 'real' descriptions of moulding, drawn from building practice, what emerges is not only an alternative to the hylomoprhic schema, but also a model for understanding materials through operations and preparations which might incorporate the specific industrial, regulatory and physical contexts of their role in building.

1. Processes of concrete casting in rigid formwork

> Instead, we would try to grasp the entire unfolding of ontogenesis in all its variety, and *to understand the individual from the perspective of the process of individuation rather than the process of individuation by means of the individual*.
>
> Gilbert Simondon[6]

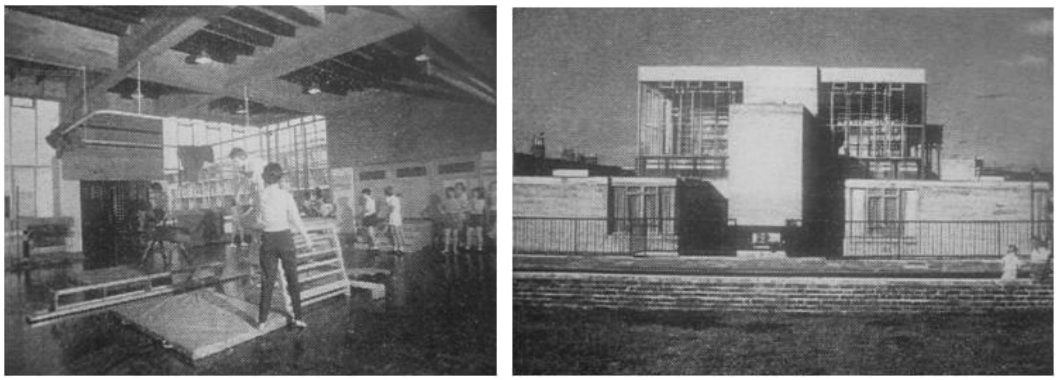
In the rhetoric of architectural styles the two specifications I have chosen to explore in detail describe two rather polarized approaches to working with concrete. At one end of the spectrum, in the quite typical

[5] Simondon, *L'individu* p.28-9. As translated in 'The Physico-biological Genesis of the Individual'.
[6] Ibid., p.4. As translated in 'The Genesis of the Individual', p.300.

modernist house that Harding designed with Tecton (1934-35), is the smooth white concrete of modernism.[7] In line with the then new vocabulary of the International Style, windows are large and steel framed, roofs are flat and used as terraces and the concrete wraps seamlessly around to provide a continuous enclosure punctured with openings (Fig. 5.3).

5.3 Valentine Harding, House at Farnham Common (1934-5), garden view

At the other end of the spectrum, in the concrete walls to the raised assembly hall at the Elfrida Rathbone School (1961) is the raw *béton brut* of brutalism.[8] Here the concrete is left exposed and reveals the marks of the timber shuttering used in its production.



5.4 John Bancroft for LCC Architects, Elfrida Rathbone School for the Educationally Subnormal (1961)

Within these two specifications, process-based clauses describe the detailed ways in which concrete and formwork are prepared prior to casting for the series of operations which will occur during their encounter.

[7] For details of this building see Jeremy Gould, *Modern Houses in Britain 1919-1939*, London: Society of Architectural Historians of Great Britain, 1977 and *Architectural Review*, October 1935, pp.123-126. It has recently been restored.
[8] The Elfrida Rathbone School for the Educationally Subnormal is in South London and still used, although the boardmarked concrete is now covered with a thick layer of purple paint. It was designed in 1961 and built in 1963/4, by John Bancroft at the LCC, who went on to design the better known Pimlico School. For more details see John Bancroft, 'Health, Power and Pleasure' in *RIBA Journal*, April 1973, pp.192-3.

Some of these processes, as well as a number of finishing processes after casting, seem to be designed precisely to edit out visible traces of the specific material operations of formation, even where boardmarks are marked in the finished surface of concrete. These processes seem designed to ensure that concrete appears as 'abstract matter' and formwork as 'abstract form' in a realisation of the hylomorphic schema.

The specification for Valentine Harding's house shows the degree of care involved in ensuring that the cast walls conform as closely as possible to the perfect lines of the rigid formwork. The weight of wet concrete as it sets is immense and unrestrained it could cause the formwork to bow or splay. But it is clear from the clauses of the specification that the forces of the concrete must be resisted, there must be no interaction between container and contained in the encounter between the two:

> FORMWORK
>
> 106. Form work must be erected true to line; be properly braced and of sufficient strength to carry the dead weight of the concrete with any constructional loads *without excessive deflection.*[9]

In order to produce the desired concrete surface the shuttering must be 'perfectly smooth' and the formed concrete must itself be sanded once the shuttering is struck:

> EXTERNAL FINISH
>
> 111. The shuttering for the external surfaces of all walls, reveals, copings, soffits and fascias must be perfectly smooth. As soon as the shuttering is struck and while the concrete is still green the above mentioned surfaces must be rubbed down with a wood float and sanded till perfectly smooth. On no account must a cement grout be used.[10]

The concrete is to remain 'pure' (any irregularities are to be polished out rather than filled with another material) but it is not intended to show any of the natural variegation that might occur as it sets. The aggregate of the polished concrete will not be visible, nor will any differentiation caused by gravity in relation to the position formwork (whether for example the wet concrete pushes down on the formwork when it forms a soffit, or vertically against it in a wall). In this sense, then, both formwork and concrete are to be treated so that the concrete appears as amorphous matter which can be formed perfectly into the orthogonal shapes

[9] Specification for a House at Farnham Common (1934), my emphasis.
[10] Ibid.

described by the architect's modernist concept.[11] Through the rigid formwork, form shapes matter which must submit entirely to its orders. Any straying from the predetermined form will be scraped away and eradicated. The extra work of polishing, sanding and bracing ensures that the casting will appear to have occurred according to the hylomorphic schema. While the same effect might have been achieved by rendering over brickwork (as indeed it was in Le Corbusier's Villa Savoye, modernsim's most famous white villa) Val Harding's house exemplifies the dominance of matter by form.

At the Elfrida Rathbone School the formwork must also be specified, but this time it is to be roughly sawn and carefully designed to reproduce the patterns of timber grain that are shown on the drawings:

> C14A FORMWORK AND MOULDS
>
> Formwork is to be erected true to line and to the profiles shown. Where a shuttered concreted finish is indicated the formwork shall be so designed to produce the formwork patterns shown on the drawing and shall be of rough sawn, clean new timber with a pronounced grain all to the approval of the Architect… Boltholes will not be allowed in any finished surfaces.[12]

Although this aspect of the fabrication is registered in these concrete walls, the specifier edits others from the finished product. He insists that the grain of the shuttering is inscribed into the finished wall but traces of the boltholes must disappear. He is also concerned that the aggregate does not interfere with the fine tracery of timber and that only the finest mix is used for the outer layer:

> C10. MIXING
>
> Where concrete is required for exposed finished shuttered work, the first mix of each day shall consist of sand and cement without the coarse aggregate as specified and shall be spread lightly upon the bottom of the formwork in order to avoid the first mix showing excessive aggregate.[13]

By specifying the finest mix at the surface of the wall the specifier ensures that only the timber shuttering will determine the appearance of the concrete. Despite the architectural rhetoric which understands this as an 'honest' treatment of concrete because it reveals the process of production, we see that the fabrication is in fact closely controlled so that only some aspects are registered.

[11]There are two curved walls in the Harding house but they are constructed from blockwork – not concrete – and rendered with a thick plaster.
[12] Specification for the Elfrida Rathbone School (1961).
[13] Ibid.

The specification for the Elfrida Rathbone school devotes much attention to ensuring that the concrete shows no variation. For example:

> C6. The contractor will reserve sufficient sand and gravel with Messrs. Eastwoods to complete the whole of the exposed shuttered concrete works without *undue variation of colour*.
>
> C14. Where concrete beams, slabs, etc. are shown on the drawings be a shuttered concrete finish, the Contractor's attention is drawn to the very high standard of accuracy, consistency and finish of concrete that will be required. The greatest care will be called for in formwork, mixing and placing of concrete, positioning of construction joints, removal of shuttering, etc. and the Contractor will be deemed to have allowed for this in his tender. *No rubbing down or making good will be allowed after removal of the shuttering to any of these surfaces. The resulting concrete surface is to be free of any honeycombing, cavities, pitting and any imperfections not the result of the texture of the concrete.*[14]

Here the possibility that differences in the sands used to produce the concrete might be visible through some colour variation in the finished building is curtailed. Concrete's tendency to pit and fissure, due to water rising to the surface during setting or to inevitable irregularities in the sizes aggregate is not considered an acceptable outcome of the casting process. Variation is considered to be 'imperfection' and the concrete is intended to appear homogeneous. The material specificity of concrete – both of its material parts and of the complex temporal processes of its setting – are denied here. Thus a great deal of care is taken to ensure that the concrete appears to be a homogeneous inert matter which merely receives the imprint of the timber shuttering.

At the detailed level of these processes of fabrication the concrete at the Elfrida Rathbone School might not be so very different to the smooth concrete of the Val Harding house. In the conventions of architectural history, timber grained concrete tends to be seen as an expression of the material which is neutralised in the amorphous matter of modernism. As Alison Smithson, herself a leading proponent of brutalism, puts it, modernist buildings were 'not built of real materials at all but some sort of processed material such as Kraft cheese: we turned back to wood and concrete, glass and steel, all the materials which you can really get hold of.'[15] The process-based clauses show the extent to which, in both kinds of fabrication, the concrete's own qualities and specific processes of setting are in fact restrained and edited out. At the Elfrida Rathbone school the processes of concrete fabrication are not really revealed, rather the processes of fabrication

[14] Ibid., my emphasis.
[15] Interview with Alison Smithson, *Zodiac* 4, 1959, p.64, cited in Andrew Higgott, *Mediating Modernism: Architectural Cultures in Britain*, London: Routledge, 2007, p.92.

enable the formwork to give the concrete form at two scales. As in the Val Harding house, the concrete takes its overall form at the macro scale from the formwork, but in addition, at the micro scale, it must take on the form of another material, the timber, which provides the limit condition to its own internal processes of slumping, and heating, and setting and drying. The concrete is mimetic as Barthes has described plastic, and it is able to imitate timber because of the fineness of its specific plastic properties. Despite the differences in the appearances of these two forms of concrete (and the rhetoric of styles surrounding them) they are both treated as matter - neutral, without identity, waiting to be given form.

2. Operations: the 'matterisation' of a dynamic system

> Simondon exposes the technological insufficiency of the matter-form model, in that it assumes a fixed form and a matter deemed homogeneous… Simondon demonstrates that the *hylomorphic* model leaves many things, active and affective, by the wayside.
>
> Deleuze and Guattari[16]

In the specifications for the Val Harding house and the Elfrida Rathbone school we have seen that behind the apparent simplicity of concrete taking the form of the shuttering it is poured into, lies a series of preparations and adjustments which counter unwanted forces, irregularities and outcomes of the casting process. Some of these processes seem designed to ensure that concrete casting appears as a realisation of the hylomorphic schema. Formwork is to remain rigid and unchanged by the heavy liquid mass in order that it can impose a pre-determined form on concrete. The results of the active processes which take place when concrete changes state from liquid to solid are carefully ironed out so that all that appears is the imprint of the formwork on the concrete. Concrete is carefully prepared, mixed, vibrated and 'finished' so that it appears as homogeneous matter. The descriptions of these processes show us that the setting of concrete in rigid formwork is a dynamic process which is restrained and edited through a series of carefully orchestrated techniques. The clauses give a picture of an energetic concrete/formwork system which is very similar to Simondon's re-description of the clay/mould system. In addition, they reveal the minutiae of processes which are designed to make an active energetic and variegated material appear in the finished product as if it is inert homogenous matter. Where Simondon goes only as far as showing that clay is prepared in such a way that it can take form when it comes in contact with the mould, the process-based clauses for concrete casting reveal that concrete and formwork are treated in ways which will give concrete the appearance of hylomorphic matter – concrete is not just rendered plastic, it is, to coin a term, 'matterised'.

[16] Deleuze and Guattari, *A Thousand Plateaus*, p.408.

For Simondon the dynamic processes which occur during moulding are the event of individuation through which the individual is produced. Processes from the more evidently energetic systems he explores in his next chapter 'Form and Energy' such as the transfer of potential energy to kinetic energy in a pendulum or the formation of crystals in solution, provide Simondon with a set of analytic tools which he makes use of in order to describe the process of moulding clay in energetic terms.[17] Simondon is keen to show that individuation, whether of a clay brick or crystal or micro organism does not occur because of external forces (such as the imposition of form or the introduction of a seed crystal into a solution) but because there is potential energy within a system that can, through a change of state, result in the process of individuation:

> The principle of individuation of brick is not the clay, nor the mold: this heap of clay and this mold will leave other bricks than this one, each one having its own haecceity, but it is the operation by which the clay, at a given time, in an energy system which included the finest details of the mold as the smallest components of this wet dirt took form, under such pressure, thus left again, thus diffused, thus self-actualized: a moment ago when the energy was thoroughly transmitted in all directions from each molecule to all the others, of the clay to the walls and the walls to the clay: the principle of individuation is the operation that carries out an energy exchange between the matter and the form, until the unity leads to a state of equilibrium.[18]

Individuation occurs as an actualisation of energy which in the case of clay takes place at the molecular level in the process of moulding. Simondon concentrates on the way in which potential energy, from the kneading and pushing of the clay into the mould, is released during the moulding and it is this energy and movement of the clay at the colloidal level which enables the slightly elastic walls of the mould to limit the expansion of the dough 'point by point' and hold it in a parallelepiped form:

> So that the clay fills the mold, it is not enough that it is plastic: it is necessary that it transmits the pressure that the workman presses on it, and that each point of its mass is a center of forces; clay is pushed in the mold which it fills; it propagates with it in its mass the energy of the workman. During the time of the filling, a potential energy actualizes itself. It is necessary that the energy which pushes the clay exists, in the system mold-hand-clay, in potential form, so that the clay fills all empty space, being developed in any direction, arrested only by the edges of the mold. The walls of the mold intervene then not simply as the materialized geometrical structures, but point by point as fixed places which do not let the expanding clay advance and oppose to the pressure only a developed

[17] This appears to be a strategy of Simondon's in *L'individu*. Each case study opens up processes and concepts which are then mobilised for the preceding study, so the growth of the crystal provides concepts with which to analyse the moulding of clay, and in turn the reproduction of organisms provides concepts for his analysis of the crystal and so on.
[18] Simondon, *L'individu*, pp.43-44. As translated in 'The Physico-biological Genesis of the Individual'.

> equal force in the contrary direction (principle of reaction), without carrying out any work, since they are not displaced.[19]

Simondon emphasises that the mould does not do any extra work, but acts instead as a limit to clay's energetic transformations. The forming of the wet brick is recast as a series of operations rather than as the imposition of form on matter in an instant. Clay is shown to be no 'abstract matter' subject to the imposition of 'abstract form' but an active energetic part of the clay/mould system with its specific colloidal properties.

In the process-based clauses for concrete casting we have also seen that concrete appears active and energetic. For example, in the Val Harding specification, measures to brace the timber formwork are taken in order to avoid any deformation by the liquid mass of the concrete – its potential energy – as it is poured in. The capacity of the concrete to actively affect the formwork is countered and restrained. In the Elfrida Rathbone specification we read that after shuttering 'the resulting concrete surface is to be free of any honeycombing, cavities, pitting and any imperfections not the result of the texture of the concrete.'[20] This is a peculiar clause because honeycombing, cavities and pitting are all the result of the dynamic processes which occur when concrete sets and in this sense might more properly be understood to be part of the texture of the concrete rather than a corruption of it. They arise when larger aggregate moves to the surface during setting, or the moisture in the concrete mix sweats out as the concrete heats up and goes off. Clause C10 (see p.95) specifies that a finer mix of concrete is spread onto the surface of the formwork before pouring to avoid just such 'imperfections'.

Many of these techniques seem designed to counter the concrete's dynamic operations and to limit and erase its contribution to the casting process. Not all forms of concrete casting go to these lengths to veil concrete's internal processes. At the micro scale it is unusual but perfectly possible to keep the natural inconsistencies of concrete as part of the finished product, and according to Pascal Chabot, Simondon mentions one such example in one of his lectures on 'Invention and Imagination'.[21] At Le Corbusier's monastery building La Tourette, the grain and boardmarks of the shuttering are left visible in the concrete - the aspect which Simondon is said to have admired (Fig. 5.5). But as Elisabeth Shotton explains, the more unusual aspects of the concrete's surface, the scars of pre-stressing which appear all over it and the pitting and roughness of the casting which give the material some of its power, are in part a result of money-saving measures taken by the contractors Sud Est Travaux who took over the work midway through construction.[22]

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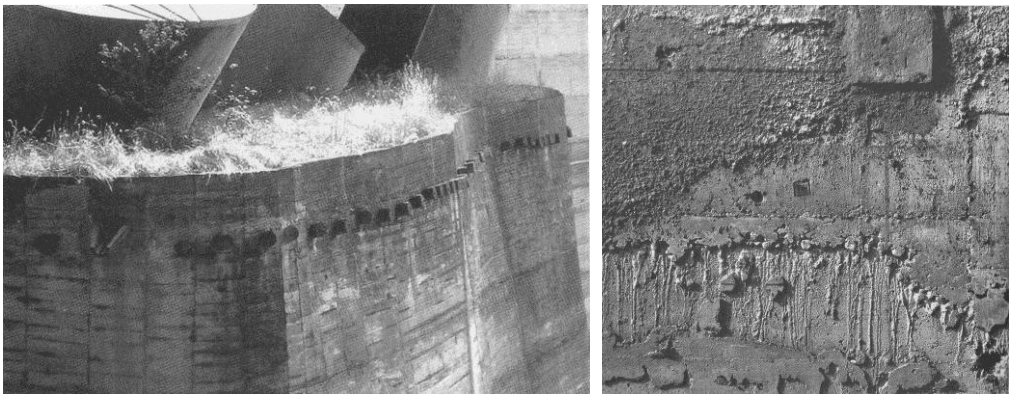
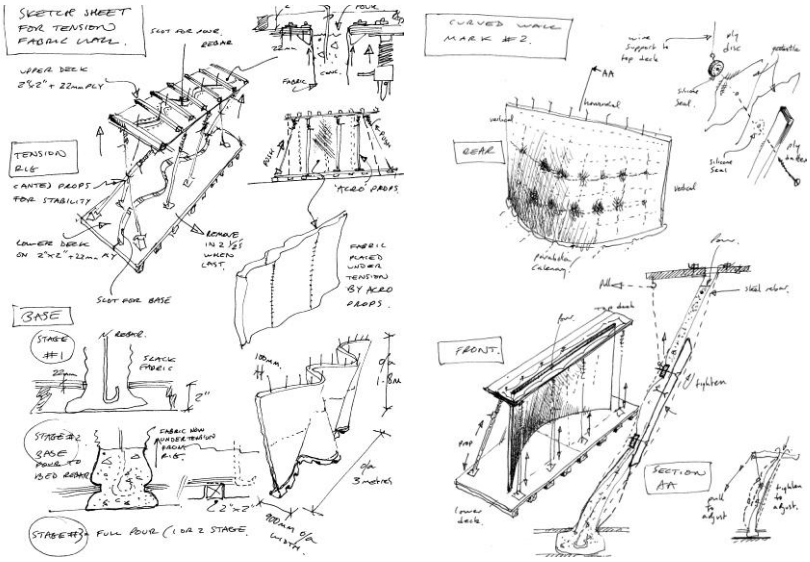
[19] Ibid., pp.33-34, as translated in 'The Physico-biological Genesis of the Individual'.
[20] Specification for the Elfrida Rathbone School (1961), C14.
[21] Chabot describes Simondon's 'technoaesthetic' and gives Corbusier, Xénakis and Léger as the artists whose work 'neither baroque nor over-ornate' he appreciated. For example 'Corbusier showed the grooves, the metal rods in the concrete, p.139. Chabot, *La Philosophie de Simondon*. See also *L'invention dans les techniques: cours et conferences*, Jean-Yves Chateau (ed.), Paris: Éditions du Seuil, 2005.
[22] Elisabeth Shotton, 'Material Imprecision' in Katie Lloyd Thomas (ed.), *Material Matters*, p.100.



5.5 Le Corbusier, La Tourette (1953-57) Details of the concrete finish

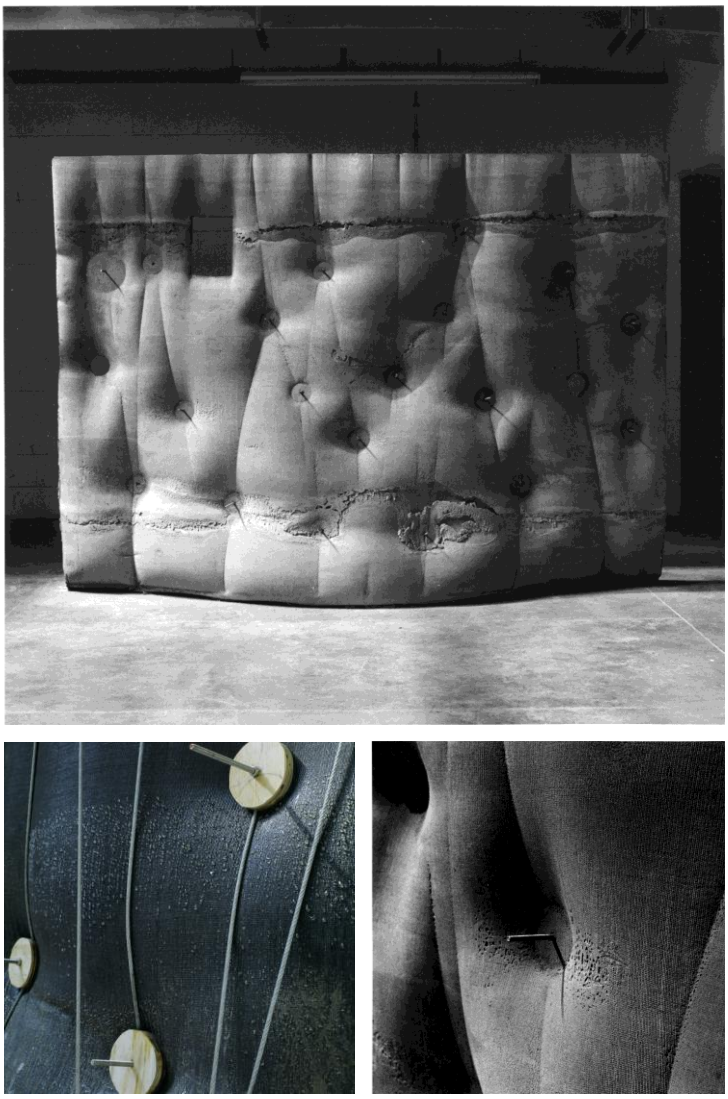
At the macro scale a rare and extraordinary technique known as 'fabric formwork' uses canvas as a mould which permits the deflection caused by the mass of concrete, and thus allows both concrete and formwork to be shaped by the other in their encounter, and to find a form which has not necessarily been predetermined (see particularly the work of Mark West and CAST in Manitoba, but also Miguel Fisac in Spain[23]). In 'Wall One', an experimental casting made by Alan Chandler and Remo Pedreschi with students at the University of East London, the rigid formwork we have seen in the examples of conventional casting was replaced by a flexible 'jig' which held a fabric bag in place and could be tensioned and adjusted as the concrete was poured into it (Fig. 5.6). Here the fabric only became tense (and able to act as formwork) when it was filled with liquid concrete and form arose out the interaction between the concrete's weight and tendency to sink and spread, and the partial restraint of bag and jig.



5.6 Alan Chandler, fabrication sketches for Wall One (2004)

[23] For the work of Mark West see his 'A Brief Description of Fabric-Formed Concrete' www.umanitoba.ca/faculties/architecture/cast/pdf_downloads/1_pr.pdf accessed 24 April 2007 and Alan Chandler, (ed.) *Fabric Formwork*, London: RIBA Publications, 2007. For the work of Miguel Fisac see Fransisco Soler, *Miguel Fisac: Architect*, Madrid: Ediciones Pronaos, 1998.

The fissures between pours were left as horizontal scars, and variation in colour between the different mixes was not avoided. Different sizes of aggregate sometimes allow the fine weave of the fabric to mark form the concrete and sometimes produces pitting and cavities. Where tightening rods pulled the two sides of the bag together in tension (like upholstery buttons) moisture sweating out of the concrete collected and became a micro formwork of tiny bubbles leaving their own mark in the surface.



5.7 Wall One (2004), Details of the concrete finish and fabric-formwork 'sweating.' Photographs: Dirk Lellau

The kinds of variegations and energetic potentials which determine the outcome of this casting process are not simply qualities or properties for that would be to locate them only in the substance of the material, but to use Simondon's term, 'implicit forms'.[24] They are, according to him, more obvious in materials which were

[24] In explaining this distinction, Simondon gives the example of the 'porosity' of timber which is not in fact a general property of the wood, but a result of timber's implicit forms – the tiny modifications brought about by the pores as they open or close, and of the manner of cutting across or with the grain. See Simondon, *L'individu*, p.56.

once living – leather, bone, bark – or in particular, in a construction such as Ulysses' bed which made use of a still living olive tree but they are no less present in matter-like materials such as clay and concrete. It is just that we need to look at a microscopic scale in order to see that clay is not 'indifferent' but dynamic in a specific way. Clay has colloidal properties which give it a viscosity in solution with water, thus allowing it change its form, molecule by molecule in communication with the walls of the mould, and at the same time to hold together. The mould does not impose form on it but 'modulates the ensemble of [molecular] threads already formed.'[25] Concrete and clay may appear to be instances of inert homogeneous hylomorphic matter, but it is only that their implicit forms are veiled.

The rig and fabric formwork in Wall One is set up so that the finished form is the outcome of the singular interaction between the liquid concrete, the jig and the movements and decisions of the fabricators. The finished form arises out of this dynamic system, rather than a fully predetermined form and the concrete's implicit forms mark and bring about the form of the finished casting. But in the rigid formwork castings we have looked at the dynamism of the process is carefully regulated so that concrete only appears as an instance of matter, and the fabrication seems to have taken place according to the hylomorphic schema. There is a *second* veiling of process. Not only are the processes of construction usually out of sight of the architect, the specificity of concrete when it is poured and sets is obscured and restrained by the detailed techniques of fabrication.

Interestingly, Simondon differentiates between techniques which appear to conform to the hylomorphic schema and those which are not as easily conceived in its terms. For example, when 'a mechanical saw cuts wood *abstractly* according to a geometric plan' it ignores the grain and torsion of the fibres in order to separate the piece into two half trunks and fails to take implicit forms into account. Other techniques, such as splitting with a wedge, 'respect the continuity of the fibres, curving around a knot, following the heart of the tree, guided by the implicit form which the effort of the wedges reveals.'[26] Some processes, such as metalworking, use so many processes that there is no one moment which stands out as a point where matter takes form (here he does not consider the process of casting metal which is readily understood in hylomorphic terms):

> In this case, the taking of form is not accomplished in a single instant in a visible manner, but in a number of successive operations. One cannot strictly distinguish the taking of form from qualitative transformation; the forging and tempering of a piece of steel are the one anterior, the other posterior,

[25] Ibid., p.32.
[26] Ibid. p.52. In a poetic moment Simondon comments in a footnote on this passage that these are expressions of the singularity of the growth of the tree, themselves singularities of another order – the action of the wind or animals – that become information guiding a new operation.

> to that which we can call the actual taking of form; forging and tempering are nevertheless the constituting of objects.[27]

Famously, Deleuze and Guattari take up his notion of the metallurgical as that with the potential to challenge form-taking as a simple interaction between form and matter:

> [I]t is as if metal and metallurgy imposed upon and raised to consciousness something that is only hidden or buried in the other matters and operations. The difference is that elsewhere the operations occur between two thresholds, one of which constitutes the matter prepared for the operation, and the other the form to be incarnated (for example, the clay and the mold).[28]

They suggest that some materials and processes provoke us to find alternatives to the hylomorphic schema for explanations of the technical operation, while others, such as concrete casting allow us to remain satisfied that it is adequate. In Deleuze and Guattari's account it is not clear whether it is simply by chance that certain processes are more or less like the form/matter model. Simondon, however, is more explicit that some techniques applied to materials transform them into matter-like materials render them 'plastic by preparation':

> The dominance alone of the techniques applied to materials rendered plastic by preparation can ensure to the hylomorphic schema an appearance of explanatory universality, because this plasticity suspends the action of historical singularities provided through the material.[29]

Re-makings of materials as realisations of the schema may contribute to its apparent universality, precisely because they erase the 'historical singularities' or implicit forms given through the material. First, the appearance of matter 'rendered plastic by preparation' is distinguished from the material as a constellation of historical singularities. Second, these specific techniques produce a material which in turn lends force to the explanatory force of the hylomorphic schema. The material practices through which clay or concrete are 'matterised' reinforce or give validity to conceptual framework. Indeed, according to Dominique Lecourt, for Gaston Bachelard (who was the teacher of Georges Canguilhem - Simondon's thesis supervisor) it is one of the characteristics of the 'new' sciences (and particularly in relation to chemistry) of the mid 20th century that they are '"artificialist", that they contain as one of their essential components a technique for the production of phenomena,' that they in turn account for.[30] At least in so far as the 'objects of science' are concerned:

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[27] Ibid., p.59.
[28] Deleuze and Guattari, *A Thousand Plateaus*, p.410. This seems to be only partially true and depends on the precise metalworking method. Bronze casting is after all Aristotle's favoured example of matter formed.
[29] Simondon, *L'individu*, p. 59.
[30] Discussing Bachelard's *Le Rationalisme Appliqué*, Dominique Lecourt, *Marxism and Epistemology: Bachelard, Canguilhem and Foucault*, trans. Ben Brewster, London: NLB, 1975, p.137. Bachelard's epistemological project, and

> Far from being poor abstractions drawn from the wealth of the concrete, [they] are the theoretically normed and materially ordered products of a labour which endows them with all the wealth of determinations of the concept.[31]

The work of conceptualisation can be lent force by things and processes in themselves particularly where these are already informed by a conceptual apparatus.

The matterisation of concrete which we have seen in the process-based clauses of these two specifications is thus interesting in two ways. First we see precisely the kinds of implicit forms and forces which must be edited out or restrained (in fact they are rarely simply ignored – it is the efforts taken to curtail them which we read in the specification) in order that a material such as concrete is 'rendered plastic by preparation' and appears to be an instance of 'abstract matter'. Do these implicit forms and forces suggest a first alternative concept of materials that would engage with it as an active and dynamic system of implicit forms at the micro scale and also recognise its historical singularities, arising out of actions past but still available within the material as potential 'information' which could arise in 'new operations'? These are of course precisely the aspects of the clay which Simondon concentrates on in his account of brick formation, although it is not the matter/material distinction which is at stake for him, but the question of individuation.

Second, we have seen an example of some of the detailed processes through which a material such as concrete can be 'rendered plastic by preparation'. It may indeed be the case that this matterisation lends the hylomorphic schema a certain explanatory weight and also that it contributes to yet further 'forgetting of operation' (since in matterisation the dynamic operations of the material are rendered invisible, and the historical singularities disappear) but is there more at stake in this? The brick industry is an ancient one, but many more materials have now been 'rendered plastic by preparation'. Glass and reconstituted stone can be cast. The building board industry uses waste products from the timber industry – lightweight timber, fibres and chips – and may mix them with resins or glues and put them under pressure - to form boards of homogenous material which can used to replace timber or various wall finishes such as plaster.[32] MDF which was developed in the 1960s an 'all-over' material which eradicates the historical singularities of the timber from which it was made and can be cast into any form.[33] How are we to understand this industrial acceleration of matterisation? What may lie behind its prevalence?

Lecourt's reading of it in terms of dialectical materialism is extremely pertinent to Simondon's philosophy and to this project and I hope to explore it detail in further research.

[31] Ibid., p.138.

[32] Marion Bowles, *Innovations in Building Materials*, London: Duckworth, 1960, pp.343-350. Interestingly Bowles explains that the fibreboards industry developed in the UK in the interwar years because plasterers were in short supply and fibreboard could replace their work.

[33] For details of the history of MDF production see www.madehow.com/Volume-3/Fiberboard.html accessed 26.04.2010.

Although Simondon points out benefits of following the grain and direction of a piece of timber he recognises that it also risks a conflict with the intended explicit form which can be difficult for the worker. Materials carry implicit forms but they impose prior limits on the technical operation and not all tools work with them.[34] The lathe for example does not need to take the implicit forms of timber into account, and timber with a fine grain is most suited to it for it is 'almost homogeneous'. Cyril Stanley Smith has pointed out that while a craftsman can follow the 'material's local vagaries' with his tools 'the constant motion of a machine requires constant materials'.[35] Matterised materials may simply multiply the number of options for working them, reduce the number of tools needed and increase efficiency. DeLanda also refers to the increasing dependency within engineering on isotropic materials, whose properties are identical in all directions. First, he suggests (surprisingly giving credit to Deleuze for this argument) that where materials are close to homogeneous their 'singularities and affects will be so simple as to seem reducible to a linear law.'[36] He recognises that although naturally occurring materials such as metals contain impurities which make their behaviours less predictable, the industrial production of metals has led to their homogenisation over the last two hundred years, not only, he suggests because of reliability and quality control but also for social reasons:

> Both human workers and the materials they used needed to be disciplined and their behaviour made predictable. Only then the full efficiencies and economies of scale of mass-produced techniques could be realised.[37]

As J. E. Gordon points out, DeLanda continues, homogeneous materials such as mild steel also make the engineer's job easier:

> At a higher mental level, the design process becomes a good deal easier and more foolproof by the use of a ductile, isotropic, and practically uniform material with which there is already a great deal of accumulated experience. The design of many components, such as gear wheels, can be reduced to a routine that can be looked up in handbooks.[38]

DeLanda stresses the industrial context of the production of materials and, recognises, as we have seen in the examples of concrete casting that Simondon's 'abstract matter' is materially reproduced. Constant materials, to use Smith's wonderful term, are constructed 'abstract matter' produced in such a way that a body of knowledge can be built up about them which appears universal, and in such a way that they are suited to mass production. Without perhaps recognising that the homogeneity of material is itself a

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[34] Simondon, *L'individu*, p.53-4.
[35] Smith, *A Search for Structure*, p.313.
[36] DeLanda, 'Material Complexity', p.19.
[37] Ibid., p.20.
[38] Ibid.

production, Marx draws attention to the uniformity of silver and gold - the two materials used to make money, and makes an argument which relates to the symbolic potential of a material to embody 'abstract and therefore equal human labour':

> Only a material whose every sample possesses the same uniform quality can be an adequate form of appearance of value, that is a material embodiment of abstract and therefore equal human labour. On the other hand since the difference between the magnitudes of value is purely quantitative, the money commodity must be capable of purely quantitative differentiation, it must therefore be divisible at will, and it must also be possible to assemble it again from its component parts. Gold and sliver possess these properties *by nature.*[39]

For Marx it is necessary that the materials used to make money are regular so that they can be easily divided up and stand in for quantities. The same volume of material, for example, will have the same weight. It is also interesting to see that Marx emphasises uniformity as a requirement of the appearance of value. It is as if it is only by eradicating the historical singularities in the material itself and removing any traces of men's actual labour, that money can embody abstract labour. In Marx's interpretation there is more at stake in the use of a matterised material than the routinisation of material production and inventiveness which DeLanda describes. For Marx, matter appears to be a precondition of the possibility of abstract labour.

By 'going into the mould' we have seen some of the detailed techniques designed not just to make possible an encounter between liquid concrete and formwork but also to counter some of the effects of concrete's implicit forms as it sets. We have seen that a plastic material such as concrete which appears to be an instance of matter – like gold, silver, plastic, clay and mild steel etc – might in fact be understood as a particular kind of material different to other materials – one that is 'constant' or homogeneous. Not only might 'abstract matter' in its material form be understood as a set of rather specific kinds of material, these materials are also carefully produced to become homogeneous constant materials and it is these preparations which make them ready to take part in specific industrial and manufacturing processes.

'Matterisation' is not only a conceptual apparatus then, limited to the way we describe a process of production, but a material one, which exists in a particular historical, social and economic context. Simondon is almost entirely concerned with the *physical* processes which take place during individuation, and those which precede it and prepare the clay/mould system for its energetic exchanges. Next I will explore further his discussion of these preparations alongside examples of process-based clauses and suggest that his notion of preliminary operations might make space for the acknowledgement of the social and industrial factors which cannot be filtered out in a study of the architectural specification.

[39] Marx, *Capital*, p.184, my emphasis.

3. Preliminary operations: the preparations of a plastic material

Brickwork Foundations Top Of Plinth	The mortar to be made up in as small quantities as the nature of the business will admit and to be thoroughly beaten with stampers. All the lime shall be Sieve'd very fine and well chafed slaked under cover and mixed in such proportions as the surveyor shall approve.

Description of the several works in erecting a new chapel in St James Burial Ground (1791-92) [40]

From its earliest beginnings in the late 18th century to its most recent appearances the process-based clause is used to describe the preparations for mixes to be made up on site, from the mortars used in bricklaying to the concretes we saw in the Val Harding house and Elfrida Rathbone school. These include instructions about where in the Thames to collect a supply of sand, how to break up, grind and sieve materials, how to mix pastes, how to pour them, and notably, in the very early specification for the new chapel at St James' Burial Ground (1791-2), when to have them checked by an external authority. Simondon's 'Form and Matter' chapter is primarily concerned with the processes taking place during individuation, but he also describes a series of processes prior to individuation which make clay and mould ready for their encounter. In *L'individu* these 'preparations' appear only in relation to the example of the clay brick, and not in any of the other individuating systems Simondon explores, but they are important. First, Simondon is explicit that his account of preparations shows that clay and mould are no mere 'abstract matter' and 'abstract form' but are made ready in specific ways for their encounter. Second, at least in so far as technical systems are concerned, preparations establish the conditions which make it possible for any individuation to arise.

It is the preparations for casting that are more directly described in the process-based clauses we have looked at than the operations of individuation itself. Moreover these 'real' examples, drawn from the practice of specification and building show that these preparations are not confined to the physical operations which Simondon limits his own account to in the 'Form and Matter' chapter. Process-based clauses include processes which extend beyond the physical manipulations of the material and might be called 'extra-physical,' such as the surveyor's approval in the example above. Preparations are significant, first because they are the operations which establish the conditions for an individuation which is intended, as in the case of manufacture or production, and second, because it as preparations that we might include the extra-physical processes which are becoming more and more central to the production, specification and regulation of building materials.

[40] Description of the several works to be done in erecting a new chapel in St James Burial Ground (1791-2).

In the 'Form and Matter' chapter Simondon describes how both clay and mould undergo a series of 'preliminary operations which make matter and form converge toward a common operation.'[41] On the one hand, the form, he notes, must both be built and prepared in very specific ways:

> The mold, moreover, is not only built; it is also prepared: a defined coating, a dry powdering that will prevent wet clay from adhering to the walls at the time of the release from the mold, by disaggregating it or by forming cracks. To give a form, it is necessary to construct such a *defined* mold, prepared in *such a* fashion, with *such a* species of material.[42]

On the other the clay must also be subjected to a series of preparations before it encounters the mould in order for an encounter between the two to be effected at all:

> As for clay, it is also subjected to a preparation; as a raw material, it is what the shovel raises to the surface at the edge of the marsh, with roots of rush, and gravel grains. Dried, crushed, sifted, shaped, lengthily kneaded, it becomes this homogeneous and consistent dough having a rather great plasticity to be able to embrace the contours of the mold in which one presses it, and firm enough to preserve this contour during the time necessary for that plasticity to disappear.[43]

There is of course an intention to produce the brick which motivates these preparations and Simondon refers to it from time to time,[44] but his primary concern here is to demonstrate that there are chains of operations which necessarily precede the 'capture of form' which is the visible climax to these preparations during the moulding. Form-taking, contrary to the hylomorphic schema, is not brought about at the moment of moulding, but is already underway with the shovelling which begins at the edge of the marsh and with the craftsman's stirrings of the paste:

> The preparation of clay is the constituting of this state of equal distribution of the molecules, of this arrangement in chains; the setting into form is already commenced at the time when the craftsman stirs the paste before introducing it into the mould.[45]

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[41] Simondon, *L'individu*, p.29, as translated in 'The Physico-biological Genesis of the Individual.'
[42] Ibid., p.30.
[43] Ibid.
[44] For example, 'The haecceity of this brick as brick is not an absolute haecceity, it is not the haecceity of this object preexisting the fact that it is brick. It is the haecceity of the object as a brick: it comprises a reference to the intention of its use and, through it, to the intention to fabricate, therefore to the human gesture which constituted the two half-chains joined together in a system for the operation of the capture of form.' Ibid., p.46.
[45] Ibid., p.31.

We have seen preparations like these described in technical language of the process-based clause. Here for example is a clause for mortar in a Specification for building a workshop (circa 1833-43) from Mocatta's collection. The processes of sourcing sand, mixing it with lime, sieving and beating it are laid out in detail:

> One Bushel of well burnt unslacked lime made from Dorking of Mersham grey chalk or Halling Lime to Three Bushels of clean Thames sand to be taken from the river between Fulham and London Bridge. The lime and sand to be mixed together during the suspension of slacking by wetting the lime and then covering it with its due proportion of sand. The proportion of each to be duly measured. It is then to be passed thro' a fine screen of no less than 35 units at equal distance in breadth of every foot. It is then to be sufficiently beat or passed through a proper mill.[46]

These accounts are not limited to processes carried out by hand, similar processes are described again for the mechanical mixing of concrete in the specification for the Elfrida Rathbone school:

> Mixing C10.
>
> Concrete for reinforced concrete work must be mechanically mixed in non-continuous machines. The fine and coarse aggregate and the cement shall be mixed for at least three turns in a mechanical mixer having a drum rotating about a horizontal axis, after which the required amount of water shall be added gradually while the mixer is in motion and the concrete mixed for at least two minutes until of a unified colour and consistence …[47]

These examples show that a chain of very specific processes must be carried out in order to produce the specific plastic materials which will either fill the gaps between bricks and adhere them to each other in the case of mortar, or take form when they are poured into a rigid formwork box in the case of concrete. Formwork too must be carefully prepared; sanded smooth or chosen for its rough grain, braced, reinforced and so on. Concrete must undergo a whole series of operations which constitute it in such a way (consistency, regularity, enough water to be poured but not too much that it doesn't set) that it can take on the dimensions of the formwork, and a number of physical restraints must be in place to keep in check many of its own unwanted active properties (its weight, the micro-topography of its heating, setting and drying processes, its sensitivity to the materials it is made up of and so on). During these processes, to use Simondon's words, 'the setting into form is already commenced' at least to the extent that what is prepared are the material's implicit forms.

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[46] 'Clauses to be introduced into a Specification of Works to be done in Building a Workshop', in Mocatta, *Specifications*, (circa 1833-43).

[47] Specification for the Elfrida Rathbone School (1961).

In addition, as we might expect in examples drawn from practice, there are also numerous references in these clauses to the industrial and regulatory framework which also constitute these processes in addition to the physical preparations of the material, just as we saw in the example of the clause for mortar at St James's Burial Ground. In the clauses for casting concrete there are references to the contractor, the builder, the architect, to building standards and to procedures of measurement and control which also play a part in the concrete's preparations. For example, in the specification for the Elfrida Rathbone School (1961) we read how bags of cement are to be checked upon arrival on site:

> Cement C2.
>
> Bags of cement which arrive on site must have their weight checked, each quality of cement is to be tested on site, and the contractor must keep enough cement on site to satisfy the architect and send him manufacturer's advice note after each delivery.[48]

And furthermore, how samples of each batch of cement are to be subject to quality control at the Council's testing station:

> Cement tests C4
>
> Cement will be tested at the Council's testing station. Samples to be taken from each delivery of cement as directed and conveyed by the Contractor to the County Hall… for testing. Tins for this purpose will be provided by the Council. Written notification of approval must be obtained.[49]

Even the workman's lunch break is incorporated into a clause concerning the care to be taking with cleaning out the mixer:

> Mixing C10
>
> On the cessation of work, including short stoppages for meals, or on any change of type of cement used in the mix, the mixers and all handling plant shall be washed out with clean water.

[48] Ibid.
[49] Ibid.

Preparations must also include the protection of concrete from the weather:

> Protection of concrete C22.
>
> Protect all concrete work from damage by traffic, sun's rays, drying winds, frosts running or surface water and heavy rains by covering with planks, sacking or sawdust, for a period of at least seven days after it has been laid. In hot weather the cover is to be kept well wetted.[50]

These practice-based examples make it clear that the processes which prepare for the individuation of a piece of cast concrete must also include forces outside the physical and molecular. Where Simondon concentrates on a chain of physical preparations to the clay and the mould in his process-based re-description, the clauses of the specification include a much wider range of processes in describing the preparations of concrete on site.

In a section from *A user's guide to Capitalism and Schizophrenia*, Brian Massumi sets out a range of forces which converge in the 'wood-tool encounter' when a woodworker make a table. This framework is rather different from Simondon's particularly in as much as it describes it in terms of a network of forces – 'the real monism of matter' – which Simondon rejects, but it is interesting for the breadth of the forces he includes. They include 'a boss, a body, hands, technique, intentions, the handle of the tool' and 'a piece of wood, a customer order, rain, trucks delivery' as well as processes such as 'planing,' 'the evolution of the tree's species; the natural conditions governing its individual growth, the cultural actions that brought that particular wood to the workshop for that particular purpose' and the 'particular institutionalization of craftsmanship formalizing knowledge accumulated over centuries by countless people.'[51] Unlike Simondon who asks again and again how it is possible for terms which have previously been incompatible to 'converge in a common operation' Massumi does not provide a detailed account of *how* these different forces are able to interact with each other, but the accumulation of factors he gathers, including the natural, cultural, technical, economic and institutional, better reflect the range of preparations to be found in the clauses of the specification than Simondon's near exclusive attention to the physical.

Throughout *L'individu* Simondon tends to restrict the processes he describes to physical operations: the changes of energy state in a pendulum, the growth of a crystal in a saturated solution or the reproduction of a colony of simple living organisms. By staying with physical processes he is better able to demonstrate that individuation can account for the genesis of both living and non-living individuals (without recourse to some

[50] Specification for the Elfrida Rathbone School (1961).
[51] Brian Massumi, *A User's Guide to Capitalism and Schizophrenia*, Cambridge, Massachusetts: MIT Press, 1992, pp.15, 10, 11.

kind of vital substance, force or spirit).[52] To some extent, the clay/mould system is rewritten in terms of molecular propagation so that it will resonate with the description of crystal formation which is introduced in 'Form and Energy', the chapter which follows 'Form and Matter'. By showing how extensively the clay has been worked from extraction through to moulding Simondon establishes the build-up of potential energy in the clay that is like the potential for formation in the crystal solution. Furthermore the preparations are shown to be specific to the particular form-taking they make ready. The crystal solution will only give rise to crystals of particular geometries, their particular form is already given, to some extent, by the prepared conditions: 'the setting into form is already commenced at the time when the craftsman stirs the paste before introducing it into the mold.'[53]

What will become clearer in the 'Form and Energy' chapter and in some of the more explicit passages of *Du Mode* (and in the concluding chapters of this investigation) is that these two kinds of operation correspond to what Simondon understands as two phases of being – the metastable or preindividual stage and the individuation itself. Metastability is a phase in which there are no changes of step, when disparate aspects of a system have the potential to come into communication but remain incompatible, as when the seed crystal has not yet been introduced into a crystal solution and crystallisation is potential but not yet actualised. In the case of the clay/mould system it too has the potential to enter into communication through individuation, but here this potential is described as having been intentionally prepared through the chains of preliminary operations. At least in the technical system preliminary operations are the processes which establish the given condition of metastability out of which individuation arises.

In the main, the process-based clause specifies materials in terms of the physical operations of making: chains of processes which are, according to Simondon's allagmatic theory, veiled by the hylomorphic schema, and also bring to light the implicit forms of materials - even those which seem most matter-like. Many of the processes described are preparations rather than the operations of individuation itself and they prepare the material for a *possible* mobilisation rather than directly producing the individuation itself. Amongst these preparations are some 'extra-physical' operations concerning checks, regulations, work routines and so on. By replacing Simondon's re-description of form-taking with found descriptions we catch sight of another set of preparations which also prepare the encounter of mould and material.

We might recall here that the clauses of the specification are statements in Foucault's sense. They participate in the constitution of the processes and works they describe and cannot be separated out from the discourses

[52] Even in *L'individu* there are exceptions to the focus on purely physical operations. The process of thought is, for example, described as individuation. In *Du Mode* Simondon is explicit that the work of production can make a relationship between man and nature that shapes the collective or 'transindividual', and in *L'individuation psychique et collective* individuation becomes what founds the possibility of collectivity itself.
[53] Simondon, *L'individu*, p.31.

and practices in which they are embedded. Simondon's account of form-taking limits itself the physical operations of individuation, and the ways in which physical mediations might arise. But need it exclude other kinds of preparations? Might Simondon's account of the coming into 'a common operation' be extended beyond the physical to understand the mediations between the diversity of forces in a description of technical production such as Massumi's?

In Chapter Six we turn to the performance clause in which materials are specified entirely in terms of how they are to perform in the future building. In this form of clause there is no concern with the physical processes of construction or with how a material is to be made up or handled on site. This is not to say, however, that preliminary operations are not necessary or relevant to performance specification. In fact, as we will see, the extent and complexity of these preparations increases enormously, and many more of these operations are 'extra-physical'. It is just that in the case of performance specification, these preparations take place off-site and there is no need for them to be described in the specification.

Chapter Six: 'Grounded in Such Usefulness': Material as equipment in the performance clause

> The form, on the contrary, determines the arrangement of the matter. Even more, it prescribes in each case the kind and selection of the matter – impermeable for a jug, sufficiently hard for an ax, firm yet flexible for shoes. The interfusion of form and matter prevailing here is, moreover, controlled beforehand by the purposes served by jug, ax, shoes.
>
> Martin Heidegger[1]

For Simondon, it is the operations of form-taking which are veiled in the hylomorphic schema. Heidegger has also described the terms of the schema as insufficient. In 'The Origin of the Work of Art' he argues that matter and form cannot be the 'original determinations' of a piece of equipment that is made 'for something' and grounded in usefulness. In particular, it is 'both the formative act *and the choice of material*' which are 'grounded in such usefulness.'[2]

Like Simondon, Heidegger makes an argument about the shortcomings of the hylomorphic schema by identifying it with a particular kind of production. While Simondon suggests that the processes involved in form-taking need not be known by a worker who is in control of the production of the technical object himself, Heidegger suggests the hylomorphic schema is an account of form-making which is derived from the specific relationship of the artist to the artwork. In the production of the artwork, he writes, 'matter is the substrate and field for the artist's formative action.'[3] But in the case of 'equipment', things such as jugs, axes and shoes, which are made for service, matter and form are no longer sufficient terms:

> Both the formative act and the choice of material – a choice given with the act – and therewith the dominance of the conjunction of matter and form, are all grounded in such usefulness. A being that falls under that usefulness is always the product of a process of making. It is made as a piece of equipment *for something*... Matter and form are in no case original determinations of the thingness of the mere thing.[4]

In the case of equipment the 'choice of the material' is 'grounded in such usefulness' and the selection of materials is 'controlled beforehand by the purposes served'. For Heidegger the form/matter model fails to include the 'usefulness' in which the making of things other than artworks is grounded.

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[1] Martin Heidegger, 'The Origin of the Work of Art' in *Poetry, Language, Thought*, trans. Albert Hofstadter, New York: Harper & Row Publishers, 1971, p.28.
[2] Ibid.
[3] Ibid., p.27.
[4] Ibid., p.28.

While the process-based makes no reference to the purposes that will be served by the material or element it describes, the performance clause is, as Chandler has put it, 'based on terms which describe what the material, construction detail or component is expected to do and how it must behave during and after placement.'[5] Of course materials are always specified in building because of their capacity to do something, whether it is simply to hold up a beam, keep the weather out or to look like marble, just as they are always prepared for fabrication and put together on site. What is notable about the performance specification is that it describes materials in these terms, both drawing the researcher's attention to this aspect of materials, and giving new significance to the performance of materials (and no longer to processes of production) in industrial practice. The uses of the material – whether structural, thermal, acoustic and so on – are usually given only within these limited parameters (and sometimes more explicitly), but in order to select appropriate values there must be an idea of the role the material is to play or the function of the environment it will be involved in providing. In this sense, that it is '*for* something' that is already known and determining the material's specification, the performance clause describes the material as equipment in Heidegger's terms.

In technical literature the performance clause tends to be discussed in terms of the contractual flexibility it provides, but within contemporary architectural practice and theory there is also more general interest in 'performativity' encompassing a wide range of meanings . In his introduction to the edited collection of essays *Performative Architecture,* Branko Kolarevic identifies 'increasing emphasis on building *performance*' as spanning a broad range of concerns: 'multiple realms from, spatial, social and cultural to purely technical (structural, thermal, acoustical, etc.)'[6] He suggests that new digital technologies used by designers to simulate the performance of buildings are largely responsible for the shift towards performativity. Certainly he is right that new computational technologies make it possible to calculate aspects of the building's performance and incorporate it into the design process, but the requirement to predetermine performance would seem to arise from a much wider combination of factors from environmentalism to new building standards to market forces. Furthermore, as the book's subtitle '*Beyond Instrumentality*' suggests, performance-led architecture needs to be understood in relation to function but it is not equivalent to the deterministic functionalism of high modernism. According to Kolarevic performance-led architecture can also be distinguished from 'form-making', it 'places broadly-defined performance above, or on a par with, form-making.'[7]

David Leatherbarrow's essay in the same collection argues that 'the actuality of building consists largely in its acts, its *performances*.'[8] The building, he suggests should not be considered as a static object but as a

[5] Chandler, *Building Technology 2; Performance*, p. 183.
[6] Branko Kolarevic, (ed.), *Performative Architecture: Beyond Instrumentality*, New York: Spon Press, 2005, p.3.
[7] Ibid.
[8] David Leatherbarrow, 'Architecture's Unscripted Performance', in Kolarevic (ed.), *Performative Architecture,* p.7.

constellation of actions. He extends this idea of action to materials themselves, in common with the new materialist architects and theorists we have already encountered such as Reiser + Umemoto and DeLanda. What is interesting in Leatherbarrow's discussion is that he doesn't limit this idea to the kinds of form-finding material processes that architects such as Nox are engaged with, but extends it to the activity of building elements - from columns to cladding – and their engagement in the 'performance' of maintaining an apparently static equilibrium in the finished building:

> There is another site of architectural action in which performance is less obvious but no less determining: those parts of the building that give it its apparently static equilibrium, its structural, thermal, material stability. When discussing these elements (columns and beams, retaining walls and foundations, but also cladding and roofing systems), it is common to talk of their 'behavior' – not only talk of it but to anticipate it, even predict it.[9]

This is of course, precisely the kind of reconceptualising of the material elements of building that the use of the performance clause brings about at the technical level. Here however Leatherbarrow identifies only one aspect of the building's performance that appears in the performance clauses – its 'structural, thermal, material stability'.

While the majority of performance clauses are indeed concerned with specifying materials and components in terms of the climatic and structural integrity of the building, a second set of criteria can also be identified. These clauses anticipate particular activities and uses of the building and specify material behaviours which will provide the appropriate environment (acoustic, thermal, degree of security and so on) for them. They are particularly interesting because they are concerned with the social program of the building and its spaces, and relate to the ways the building is intended to be used. They show that it is not just the material's role in the building as a discrete object, but also its relationship to an occupant, that is taken into account in its selection.

In this chapter I suggest that the performance specification involves a conceptualisation of materials that exceeds hylomorphic matter in a second way, in as much as they are described as equipmental and in terms of their specific uses. For Heidegger there must a plan for specific use - not just use in general - if something is to be constituted as equipment. Furthermore, the prescription of specific use is part of the making ready or preparation of the equipment. For Simondon, use is precisely what must be ignored in order to understand how a technical object evolves by adaption to itself. In the case of the performance clause, however, the way use becomes constitutive of the material goes beyond the ascription of functions, and this is more striking in the case of performance-engineered materials that I look at in Chapter Seven. They are designed at the

[9] Ibid., p.13.

outset for specific uses - use is inscribed into them. It may be, then, that the performance clause requires us to think use and material together. This is something Latour attempts in his accounts of the delegation of goals to nonhuman actors. For Latour, the 'pre-inscription' of goals does not ascribe uses to things or fully determine them, because there is always a detour via the material which may also produce the possibility of new goals. Similarly the performance specification of materials is never completely determining. Instead the questions we might ask are how it is made possible and how it alters the constitution of a material and the possibilities of its effects.

1. Heidegger's account of specific use

> *A ready-made piece of equipment* is subject to some implicit or explicit *prescription* with respect to its possible use. The prescription is not given by the readiness of the equipment, but is always derived from the plan which has already determined the production of the equipment and its specific equipmental character.
>
> Martin Heidegger[10]

For Heidegger the 'purposes served' by equipment are forgotten, not only in the hylomorphic account of production, but also, necessarily, in equipment itself, where material is 'used up' and 'disappears into usefulness'. As soon as equipment is put into service or 'ready', material is merely ready to hand and unavailable to understanding:

> The production of equipment is finished when a material has been so formed as to be ready for use. For equipment to be ready means that it is dismissed beyond itself, to be used up in serviceability.[11]

For Heidegger, the material's qualities and properties are 'used up' and forgotten, which arises, as in Simondon's 'forgetting of operation', out of a particular way of relating to the object, as user for Heidegger, rather than as fabricator as for Simondon.[12]

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[10] Martin Heidegger, *The Fundamental Concepts of Metaphysics: World, Finitude, Solitude*, trans. William McNeill and Nicholas Walker, Bloomington: Indiana University Press, 1995, p.228.
Here prescription is a direct translation of the noun 'vorschrift' which comes from the verb 'vorschreiben' meaning to prescribe. As in English, the root for this term is to write, but 'schrift' is not an equivalent to 'script' in the sense we use in the theatre. We might also note that in 'The Origin of the Work of Art' a different term is used 'vorzeichnen' for prescribe whose root is 'to draw'. 'vorschreiben' has a more legal sense than 'vorzeichnen' which may explain the difference in Heidegger's terminology, or perhaps the drawing-based term seems more appropriate in an essay about artworks. It may also be that there is no equivalent noun to 'vorschrift' which can be made from 'vorzeichnen'. With thanks to Gerald Niederle for his help with the original terminology.
[11] Heidegger, 'The Origin of the Work of Art', p.64.
[12] The 'forgetting of operation' is a term Muriel Combes uses in *Simondon. Individu et collectivité*, Paris: PUF, 1999, p.17, cited in Toscano, *The Theatre of Production*, p.43. 'Veiling' is used by Simondon, and it is not clear to what extent it carries the active sense of concealment and unconcealment which are so important with respect to truth for Heidegger

In the process-based clause, as when materials are named or given through their appearance, use remains outside the description of the material. The performance clause might be seen then as drawing attention to the behaviours and capacities of materials to act, which become ready to hand or 'used up' or once building materials have been mobilised as equipment. In the extract cited at the start of this chapter Heidegger does not name 'the kind and selection' of materials for the 'jug, ax' and 'shoes', only the way they must perform to serve the purposes of the equipment - 'impermeable for a jug, sufficiently hard for an ax, firm yet flexible for shoes'. Similarly the performance clause may well not name a material, and instead makes central the purpose it is to serve as we will see in the long performance specification for curtain walling for a supermarket by Chetwoods® (2005).[13] Typically the functions that a material is to perform are given in terms of the forces it is to withstand or as a property of the material or system itself, but in some cases the functions that a material is to perform are described explicitly within the clause itself in a manner which most directly relates to the prescription of specific use. In performance clauses, even when use is not given directly, the prescription of use, which in Heidegger 's discussion is necessarily 'used up' once a material is in service, is rendered visible and remains as evidence of the way the material was made ready.

Heidegger's discussion of the prescription of specific use and its centrality in the making ready of equipment appears in his earlier 1929/30 lectures, published as *The Fundamental Concepts of Metaphysics*.[14] Here it is the distinction between equipment and bodily organs, rather than the artwork, that concerns him as he sets out to explore the 'range of different kinds of beings: purely material things, equipment, instrument, apparatus, device, machine, organ, organism, animality,' and asks 'how are all these to be distinguished from each other?'[15] He distinguishes between the serviceability of equipment and the 'capacity for...' of bodily organs[16] in order to make a distinction between inanimate objects and humans without recourse to their genesis or to some kind of vital spirit. He is keen to avoid, as he puts it 'the most common way of characterizing the living being' which is 'to define it in terms of the organic as opposed to the inorganic.'[17] In this respect his approach recalls Simondon's, who is also keen to avoid any creationism or vitalism in his account of individuation. Equipment, suggests Heidegger, can be distinguished from organs not because of its physical structure nor its non-organic nature, but because it has been made 'for' serving in a particular way and that serviceability already arises out of anticipating the purpose it is intended to serve:

(see the later section of 'The Origin of the Work of Art') and for Nietzsche (see 'On the Uses and Disadvantages of History for Life' in Friedrich Nietzsche, *Untimely Meditations*, trans. R.J. Hollingdale, Cambridge: Cambridge University Press, 1997.

[13] Specification: Project Title: Sainsbury's Maidenhead. For Construction (2005), architect - Chetwoods®.

[14] A much earlier draft of The Origin of the Work of Art from 1935 has recently been published, suggesting there may be more continuity between these two texts. In this version Heidegger also associates hylomorphism with the artwork but does not discuss the question of use. Martin Heidegger, 'The Origin of the Work of Art: First Version', trans. Jerome Veith, in Günther Figal (ed.), *The Heidegger Reader*, Bloomington: Indiana University Press, 2009.

[15] Heidegger, *Fundamental Concepts,* p.213.

[16] Ibid., pp.228-9.

[17] Ibid., p.218. It is also important for Simondon that it should be possible to make distinctions between living and non-living beings without recourse to their essential vitality.

> Now in the production of equipment the plan is determined in advance by the serviceability of the equipment. This serviceability is regulated by anticipating what purpose the piece of equipment or indeed the machine are to serve. All equipment is what it is and the way it is only within a particular context. This context is determined by a totality of involvements in each case. Even behind the simple context of hammer and nail there lies a context of involvements which is taken into account in any plan and which is first inaugurated by way of a certain planning… It is not the complexity of the structure [machine] which is decisive for the machine-like character of a piece of equipment, but rather the autonomous functioning of a structure designed for specific dynamic operations.[18]

Thus it is certain kind of planning 'in advance' for the serviceability of the equipment which is decisive. Presumably this planning for serviceability distinguishes equipment from artworks, but it must in turn be specific to the 'particular range or possibility' for which it is intended. Equipment is not just planned for serviceability in general, bur for a specific kind of serviceability. In the specific case of a pen, for example:

> Being a pen means being for writing in a particular way. The pen has been made or produced as this particular piece of equipment with this in view. The pen is finished and ready only when it has acquired this particular serviceability, this particular range or possibility, in the course of its production.[19]

Heidegger recognises that equipment may only 'offer the *possibility* of serving for' what has been prescribed. Prescription is a condition of being equipment – a specific use must have been intended in the plan, but it is not necessary that the specific use is in fact fully determining:

> Such readiness can also imply the process of making something ready in and through production and preparation, a preparation or making-ready which procures and produces the ready-made product as something independently present at hand and present to hand for use. Equipment offers the possibility of serving for…, it always has a particular readiness for… which is grounded in the way it has been made ready.[20]

Here Heidegger leaves two blank spaces (....) in his sentence that can be filled in by some specific use or another. In doing so he tries to demonstrate this notion of prescription in the text – it must be there but the

[18] Ibid., p.215.
[19] Ibid., p.219.
[20] Ibid.

specifics of its content are irrelevant.[21] Heidegger gives an account of what must ground something being a piece of equipment. First, it must be made for service and with service in mind, and second, it must be prescribed for a specific use, although that specific use need not predetermine in any way how the piece of equipment is used or what it is like (its 'readiness'), but he has no interest in the specific uses themselves, or how one might be different to another.

2. Specific uses in the performance clause

If at the general level, the performance clause can be seen as a description that involves a conceptualisation of material as equipment, both in so far as it gives a specific use and introduces this prescription as part of the plan or making ready of the material, it also provides a set of examples of what those specific uses are in relation to building materials. The possibility that materials can be described in this way in specification is set up by a range of industrial and economic factors including the means to quantify and test the functions of materials, the standardisation of material production that ensures each sample is equivalent to the next, and the contractual context. In Chapter Three we saw how, for example, in the 1960s it was not yet possible to specify the 'non-slipness' of floor finishes in performance terms, but now tests and values have been developed which procure this function for performance specification.

In this section and in the following chapters, I look mostly at the performance specification of glass, because it is so often specified in these terms and because it is frequently used in the construction of a range of 'barriers' – curtain walling, roofs, internal screens and doors – which involve a full range of performance requirements. In addition, the number of functions which can be specified for glass continues to multiply, in part due to the fact that it is performance-engineered through the build up of films and deposits designed to achieve particular functions. According to the website of glass manufacturers Pilkingtons these performances include solar control, thermal insulation, fire protection, noise control, safety, security[22] along with other developments in smart materials where glass may have lighting or heating elements embedded within it. Where these materials are performance-engineered the performance clause is describing functions which the glass has been specifically designed to achieve.

In traditional specifications glass was specified without any references to its use. For example, in the specification for the Bristol Asylum for the Blind and adjoining chapel published in 1835, a clause from the 'Glazier' section reads as follows:

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[21] Of course the blanks in Heidegger's sentence also recall the blanks of the clauses of the specification. It is not the specifics of what the clauses prescribe which is significant but the way in which they do it – the forms of prescription (for use, or through process and so on) that are taken.

[22] See www.pilkington.com/europe/uk+and+ireland/english/products/bp/bybenefit/default.htm, accessed 26.04.2010.

> The windows on basement floor, to the men's work-room, and basket-shop, to be glazed with good thirds. The chapel and vestry windows, and the whole of remaining windows of house, to be glazed with the best seconds, free from colour and air bubbles... the whole of the windows throughout the buildings to be left perfectly clean and whole at the finish of the works.[23]

What is reflected here is the contemporaneous practice of grading and valuing glass according to its lack of discoloration and evenness and a reminder to the contractor to leave the glass clean at completion. Although the evenness and cleanliness of the glass might contribute to its capacity to transmit light, the specification describes the glass as a particular material to a standard common to the building industry, rather than through what it should achieve. There is no reference to the structural integrity of the glass, its resistance to weather or the transmission of sound, or even to its daylighting role in a space to be used primarily by blind men for work and prayer.

In the following specification, using the NBS format, for the Pottersfield Park pavilion (2006) a performance-engineered glass is specified ('with an interlayer of polyvinylbutyral (PVB), not less than 0.375mm thick, or methylmethylacrylate resin') but its composition is named outright.[24] The glass is not specified in performance terms and there is no reference to what the inclusion of the interlayer is intended to achieve (in laminated glass it is probably there in order to prevent the glass breaking into shards on impact and causing possible injury):

> 07 Glass:
> - See clause L40/02.
> - All glass to be double glazed and both panes laminated.
> - Glass to be free from scratches, bubbles, cracks, rippling, dimples and other blemishes / defects.
> - Heat toughened glass must be subjected to a heat soaking regime (8hrs) to minimise the risk from nickel sulfide inclusions. All panes must be heat soaked. Provide certified evidence of treatment and all panes to be permanently marked accordingly.
>
> 08 Laminated glass:
> - See clause L40/02.
> - Clear float glass with an interlayer of polyvinylbutyral (PVB), not less than 0.375mm thick, or methyl methacrylate resin.
> - Final selection of glass and glass thicknesses to be approved by CA, prior to ordering materials.
> - Seal edges of laminated glass with materials compatible with the interlayer. Any delamination will be rejected.
> - Edges of laminated glass to be finished with no lipping between panes.
> - Notwithstanding any other requirement the lower pane of all horizontal / slope glazing is to be laminated.

[23] Specification of the work, and particulars of the materials to be used in the erection of an asylum for the blind, Bristol (1835), architects - Rickman and Hussey in, a bound collection entitled *Specifications*, RIBA library, EW 2772.
[24] Specification for Parkside and Blossom Square Kiosks, Potters' Fields Park (2006), L40.

Although the laminated glass could be specified in performance terms and might well be in a different contractual contexts, here it is named. The list of defects to be avoided in the clauses for ordinary glass recalls the Bristol Asylum specification, and a process-based clause relating to the manufacture of the glass (heat soaking) has even crept into the specification. A performance specification for glass describes it in very different ways. Below is another section also using the NBS template, as used in a specification for curtain walling in a new supermarket by Chetwoods®. The values have been taken out (but were mostly 'to be confirmed by the engineer') but what is immediately clear is that the whole description is configured around the functional criteria the glazed walling is to achieve and its specific uses:

H11 CURTAIN WALLING

To be read with Preliminaries/General conditions.

DESIGN/PERFORMANCE REQUIREMENTS

305 GENERALLY:
- Comply with CWCT 'Standard for curtain walling', Section 2 - Performance Criteria unless specified or agreed otherwise.
- Project performance requirements specified in this subsection are to be read in conjunction with CWCT performance criteria.

311 INTEGRITY: Determine the sizes and thicknesses of glass panes and panel/facings, the sizes, types and locations of framing, fixings and supports, to ensure that the curtain walling will resist all wind loads, dead loads and design live loads, and accommodate all deflections and movements without damage.
- Design wind pressure: _____ Pascals.
- Permanent imposed loads: _____
- Temporary imposed loads: _____

312 INTEGRITY: Determine the sizes and thicknesses of glass panes and panels/facings, the sizes, types and locations of framing, fixings and supports, to ensure that the curtain walling will resist all wind loads, dead loads and design live loads, and accommodate all deflections and movements without damage.
- Calculate design wind pressure in accordance with BS 6399-2, Standard Method:
  Basic wind speed (V_b): _____
  Altitude factor (S_a): _____
  Direction factor (S_d): _____
  Seasonal factor (S_s): 1.
  Probability factor (S_p): 1.
  Terrain and building factor (S_b): _____
  Size effect factor (C_a): 1.
  External pressure coefficients (C_{pe}): _____
  Internal pressure coefficients (C_{pi}): _____
- Permanent imposed loads: _____
- Temporary imposed loads: _____

313 INTEGRITY: Determine the sizes and thicknesses of glass panes and panels/facings, the sizes, types and locations of framing, fixings and supports, to ensure that the curtain walling will resist all wind loads, dead loads and design live loads, and accommodate all deflections and movements without damage.
- Calculate design wind pressure in accordance with BS6399-2.
- Permanent imposed loads: _____
- Temporary imposed loads: _____

320 DEFLECTION UNDER DEAD LOADS of framing members parallel to the curtain walling plane must not:

- Reduce glass bite to less than 75% of the design dimension.
- Reduce edge clearance to less than 3 mm between members and immediately adjacent glazing units, panel/facing units or other fixed units.
- Reduce clearance to less than 2 mm between members and movable components such as doors and windows.

330 GENERAL MOVEMENT: The curtain walling must accommodate anticipated building movements as follows:

_____

340 AIR PERMEABILITY: Permissible air leakage rates of 1.5m³/hr/m^2 for fixed lights and 2.0 m³/hr/lin.m for opening lights must not be exceeded when the curtain walling is subjected to a peak positive test pressure of _____ Pascals.

350 WATER PENETRATION onto internal surfaces or into cavities not designed to be wetted must not occur when the curtain walling is subjected to a peak positive test pressure of _____ Pascals.

360 WIND RESISTANCE – SERVICEABILITY: Glazed units in framing member tests must have all edges supported.

370 THERMAL PROPERTIES: The average thermal transmittance (U-value) of the curtain walling, calculated using the elemental area method, must be not more than _____ W/m²K.

380 SOLAR AND LIGHT CONTROL: Glass panes or units in curtain walling must have:
- Total solar energy transmission of not more than _____ % of normal incident solar radiation.
- Total light transmission of not less than _____ %.

385 THERMAL STRESS IN GLAZING: Glass must have an adequate resistance to thermal stress generated by orientation, shading, solar control and construction.

390 CONDENSATION: The psychrometric conditions under which condensation must not form on the building interior surfaces of framing members or any part of infill panels/facings are:
- External: Summer: _____ °C maximum at _____% RH.
  Winter: _____ °C minimum at _____ % RH.
- Internal: Summer: _____ °C at _____ % RH.
  Winter: _____ °C at _____ % RH.

410 ACOUSTIC PROPERTIES: The following minimum sound reduction indices to BS EN ISO 140-3 must be achieved:
- Between internal and external surfaces of curtain walling: _____
- Between adjoining floors abutting curtain walling: _____
- Between adjoining rooms on the same floor abutting curtain walling: _____

420 FIRE RESISTANCE OF CURTAIN WALLING: To BS 476-22 and not less than _____[25]

What is most immediately apparent is that the titles of each clause do not refer to a type of material or component and then give a brand name or method of fabricating it. Instead they are a list of the functions the glass or glazing system as a whole is required to achieve: 'integrity', 'deflection under dead loads', 'air permeability', 'water penetration', 'acoustic properties' and so on. Within the body of each clause we see that in most cases these requirements are given in terms of the forces the glazing is to withstand: the 'basic wind speed' and 'permanent imposed loads' in which it must maintain structural integrity, or the temperature and relative humidity in winter and summer in which condensation must not form or air and water pressure in 'peak positive pressure tests'. In fewer cases the performance requirement is given as a property of the material or system itself: 'average thermal transmittance' or 'fire resistance'. In these examples use is not

[25] Specification for Sainsbury's, Maidenhead (2005), H10.

described directly within the text of the clause but it is clear that the values relate directly to the specific ways the materials are to be put to service. Nevertheless there are a couple of examples here where the functions that a material is to perform are described explicitly within the clause itself. The detailed design of the glazing is 'to ensure that the curtain walling will resist all wind loads, dead loads and design live loads, and accommodate all deflections and movements without damage,' and, 'The curtain walling must accommodate anticipated building movements as follows:' Here it is not only the functional requirements of the system that are listed, the purpose for which they are being selected is also part of the clause.

The function of materials and building systems determines the organisation of performance specification and is what is given, albeit in this range of ways, in the contents of the clauses. In this specification we might also identify rather different categories of specific use from the structural integrity of the glazing and its capacity to bear its self-load and other loads, including climatic loads such as wind, to its capacity to negotiate light, sound and heat in the production of an appropriate environment for its occupants. In the NBS the performance clause appears throughout the document, amongst other forms of clause and with no particular attention given to the kinds of uses it describes. But in technical literature and within the industry, different types of performance clause are divided into broader categories which suggest important distinctions between uses. Schumann Smith, for example, attempt to bring all performance clauses into a single section[26] and also list them under separate categories of requirement type: 'General', 'Structural Performance', 'Environmental Performance', 'Acoustic', 'Fire' and 'Durability'.[27]

In the technical literature about specification, other typologies are recognised although the terminology used and the distinctions made vary between commentators. For example, in *Material Architecture: Emergent materials* John Fernandez suggests there are two basic types of performance requirement:

> Essentially the vast majority of performance requirements can be divided between load transfer and barrier system requirements.[28]

'Load transfer requirements' relate to the structural integrity of the materials and components. They include the compressive and tensile strength of materials, and degrees of tolerance and flexibility. In the Specification for a supermarket (2005) these would include glass' capacity to carry its self-load, its dead load

[26] In the NBS performance clauses are peppered throughout the work sections. Schumann Smith endeavour to pull different types of clause together and each work section is divided into two type of clause; 'Performance Requirements' and 'Systems, Materials and Fabrication' in which systems and materials are described 'as is'.
[27] Specification,The H...y Building (2006), prepared by Schumann Smith for ...Architects. Section H11. A condition of using this specification for this research is that neither building nor architects are identified.
[28] John Fernandez, *Material Architecture: Emergent materials for innovative buildings and ecological construction*, London: Architectural Press 2006, p.80.

and design-live load (and would be more prominent in a set of clauses for a structural element). In the Schumann Smith Specification for The H...y Building (2006) most of these clauses are included in a specific category 'Structural Performance'. In some of these clauses the loads the material or component are those of the building's inhabitants, as for example in the clause below setting out the strength of doors: [29]

H11.1411 Strength of Doors

a) Ensure that the doors, including ironmongery, meet the 'heavy duty' category as defined in DD 171 or an equivalent international standard. At the same time doors shall comply with and not compromise the other stated performance criteria for the works.

b) Provide evidence to demonstrate that the doors, including ironmongery, have been tested to meet the minimum acceptance criteria given in DD 171 for the following:

i) Slamming shut impact.

ii) Slamming open impact.

iii) Heavy body impact.

iv) Hard body impact.

v) Torsion.

vi) Download deformation.

vii) Closure against obstruction.

viii) Resistance to jarring and vibration.

ix) Abusive forces on door handles.

'Barrier system requirements' include weatherproofing and resistance to other kinds of impacts, or the constructional integrity of materials and systems. In specifications for curtain walling most clauses relate to barrier system requirements since it is primarily acting as a barrier and must withstand likely levels of moisture, wind and high and low temperatures to maintain its constructional integrity. The Specification for The H...y Building (2006) also groups these clauses together in one section 'Environmental Performance' (which includes, for example, 'H11.1412 Moisture Movement' and 'H11.1418 Weather and Water Penetration Resistance).

It is within 'barrier requirements' that we might also identify a further category of performance requirement concerning the comfort and security of the building's inhabitants, such as acoustic, thermal and lighting control, which are intended to orchestrate their environment. In the Specification for a supermarket (2005) these would include clause 370 'thermal properties' which concerns the extent to which the glazing system will maintain an internal temperature and clause 410 'acoustic properties' which is to do with the sound reduction to the internal spaces. In the Specification for The H...y Building (2006) some of these requirements are included within 'Environmental Performance' ('H11.1413 Thermal Performance Requirements') but also within separate sections such as 'Acoustic Performance Requirements'. The majority of performance requirements Fernandez identifies concern the involvements between different materials in maintaining the internal equilibrium of the building and in relation to its environment. They fall mostly within the kind of behaviours Leatherbarrow included in his description of 'architectural action' and do indeed

[29] Specification for the H...y Building (2006), H11.

suggest a more dynamic understanding of the building than is conventional. But many of the specific uses prescribed in performance clauses exceed the structural and constructional stability of the building, and this third type of clause, which prescribes how materials are to perform to provide the acoustic, thermal and visual environment of the user, is particularly interesting and significant. These clauses are concerned more with the effect of the materials on the experience of the inhabitant than the integrity of the building and to some extent, as we will see in Chapter Seven, they anticipate the behaviours of the inhabitants too – the degree of heat conservation specified for a space might be affected by whether the inhabitants are anticipated to be sitting (and not contributing much heat themselves) or doing something more strenuous. Although performance clauses always describe materials through physical properties of materials, the specific uses to which these refer show that the 'serviceability' of the building is prescribed in ways which extend to social parameters. We might suggest that these kinds of clauses contribute a 'socialisation' of materials that was not possible in the same way before their implementation.

By way of example we can consider the internal glass dome at Foster + Partners' Reichstag in Berlin (1992-99) which separates the sightseeing public from the German parliament in session below (Fig. 6.1). In the rhetoric of twentieth century modernism glass is intended to represent the transparency of democratic politics, a concern Bernhard Schultz claims has 'dominated discussions about parliamentary buildings in Germany for decades'.[30] But if we consider the glass screen at the Reichstag in terms of its performance[31] – another set of uses have been prescribed which are in conflict with the intended 'openness' of its visual transparency.

6.1 Foster + Partners, Reichstag, Berlin (1992-99) Double glass screen between public gallery and parliament

[30] Bernhard Schultz, *The Reichstag*, Munich: Prestel Verlag, 2000, p.92. Other examples of the use of glass in German parliamentary buildings include Saxony's new regional parliamentary building in Dresden designed by Peter Kulka, ca 2002, the Bundestag building in Bonn designed by Gunther Behnisch in 1983. Peter Buchanan traces this motif back to Hannes Meyer and Hans Wittwer's entry for the 1927 League of Nations competition. Meyer's design report apparently stated there would be 'no back corridors for backstairs diplomacy, but open glazed rooms for public negotiation by honest men.' Peter Buchanan, 'When Democracy Builds' in Norman Foster, *Rebuilding the Reichstag*, Woodstock, NY: Overlook Press, 2000, p.169.

[31] Despite my best efforts, I have not been able to see the specification for this screen. Fosters refused access to it and approaches to other practices for specifications for similar glazed screens to the debating chambers of other parliamentary buildings have been no more successful. My analysis is based on general technical literature.

First, the glass has been engineered to provide a very high level of security and withstand attack (from bombs, bullets etc.). In this case, the degree of threat must itself be taken into account in order for the performance criteria to be known, and depends on the much wider political context. Facade engineer Sergio de Gaetano points out that this 'threat assessment' is 'the starting point of any bomb blast evaluation' and depends on a building's geographic location, its use as well as 'the political stability and history of terrorism in the city and in the country'.[32]

Principles Of Enhanced Façades To Bomb Blast Loads

The starting point of any bomb blast evaluation is the understanding of the threat assessment: it is a risk analysis of the likelihood of an attack on a building which has to identify the possible consequences inducted by the detonation of an explosive.
This assessment is function of several factors and the threat varies according to the following factors:

- the political stability and history of terrorism in the city and in the country;
- the value of the building, its function and the nature of business;
- the vulnerability and the accessibility of the area;
- the building location and the closeness to possible targets.

At Richard Rogers and Partners' Welsh Assembly Building (2003) another glass screen gives visual access to the debating chamber (Fig. 6.2). According to the specifier for the project there was a tension between the desire for visual transparency and the requirement for its security function. Midway during the detail design phase the September 11th attack on the World Trade Centre took place and the subsequent rise in the security requirement made a full redesign was necessary.[33]

6.2 Richard Rogers and Partners, Welsh Assembly Building, Cardiff (2003)

[32] Sergio de Gaetano, 'Design for Glazing Protection against Terrorist Attacks.' Paper given July 2005 at Glass Perrfomance Days. http://www.glassfiles.com/library/article.php?id=958&search=Gaetano&page=1 accessed 27.07.09.
[33] Telephone conversation with Welsh Assembly specification writer, Geoff Taylor of Schumann Smith, May 2008.

Second, the Reichstag glass screen has been designed to achieve acoustic separation that prevents participation in the debates below (Fig. 6.3). As Hisham Elkadi has observed, 'Visitors to the Reichstag... cannot listen or be listened to and are denied any real interaction.. in contrast to.. the public gallery in the House of Commons in London.'[34]

6.3 Foster + Partners, Reichstag, Berlin (1992-99) View from press gallery to parliament

At the visual level the glass suggests openness and accessibility, but at the level of what the glass *does* it hinders access and defends against it as a threat. The material's performance might not be visible but it can be experienced by the occupants, and here the performance criteria here are not merely 'technical' nor are they neutral. They drive aspects of the design which have significant effects on the experience and possibilities of the space.

Even in an ordinary office building these kinds of performance criteria can in fact be seen to extend the specific uses of materials beyond the integrity of the building or the simple notion of a worker's 'comfort'. As Emily Thompson has shown in her wonderful book *The Soundscape of Modernity* , the standard expectations of the acoustic environment in the office workspace were radically transformed in the United States in the early twentieth century. Thompson tracks the ways in which the changing soundscape of the city, and emerging discourses and practices of 'noise pollution' and 'noise control' (Fig. 6.4) brought about innovations in acoustic insulation which were widespread by the 1930s (Fig. 6.5). These new materials not only reduced sound transmission from the outside, they also reduced reverberation and defined a new soundscape which Thompson suggests was particularly conducive to the productivity of workers:

> [Reverberation] also impeded the performance of work by amplifying and sustaining the cacophony of sounds that sapped workers' energy and productivity. The modern sound that resulted from the

[34] Hisham Elkadi, *Cultures of Glass Architecture*, Aldershot: Ashgate, 2006, p.48. He notes it applies to many other buildings including office blocks which open their ground floors to the gaze but 'exclude people.'

use of new acoustical materials was thus stripped not only of reverberation but also of these inefficiencies. It both constituted and signified the efficiency of the spaces in which it was heard.[35]

In turn, these new noise environments became the norm for workplaces, and influenced expectations about the degree of soundproofing which was appropriate for other kinds of building including private residences. When acoustic performance is specified, then, it prescribes particular sound environments for particular social purposes and may make some kinds of activity impossible or unlikely. These requirements or specific uses are not established in reference to the practicalities of building, but arise out of and have effects on the broader historical and social context.

6.4 Noise Pollution assessment in New York

6.5 Advertisement for new acoustic materials

What is particularly interesting in the kinds of performance-led specifications which give the contractor responsibility for the detailed design is that these occupant-based specifications are the ones which still remain the main task for the architect. The following 'performance matrix' has been developed by the in-house specification team at Allies and Morrison, a large scale and well respected commercial practice who specialise in high quality office buildings with glass systems engineered facades, where the system design is

[35] Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933*, Cambridge, Massachusetts: The MIT Press, 2002, p.171.

contracted out to specialist facade engineers and fabricators. The matrix brings together all the performance clauses for glass rain screen cladding to avoid repeating the list in different locations throughout the specification, each time such a system is specified for walls, doors or windows.[36] Along the top axis are glass rain screen cladding 'systems' 'S1' 'S2' and so on, used in different parts of the building, for example to the reception area, to an office, a storage area, for glass doors etc. Some values will be null values; for example there is no need to worry about sound reduction to a storage area, and air leakage requirement is not an issue if the system is a door.

What is noticeable about this the performance criteria listed in this table, however, is that none of them relate to the structural or constructional integrity of the rain screen cladding system. This has all been given over to the facade engineers. All that remains for the architect, who knows how the parts of the building are intended to be used, is to specify the environmental performance: based on what kinds of accidents (whether impacts from 'hard bodies' such as stones, to 'soft bodies' such as footballs) might occur in each part of the building, what activities will take place in particular spaces, what items of value will be stored where and so on.

Clause no.	**Performance criteria**	**S1**	**S2**
	Test impact Hard body Requirement Soft body requirement		
	Air leakage requirement		
	Water penetration requirement		
	Minimum light transmission % Maximum G value %		
	Thermal transmission Vision W/m^2K Thermal transmission Opaque W/m^2K		
	External sound reduction dB R_{TRA}		
	Flanking sound reduction Vertical		
	Flanking sound reduction Horizontal		
	Security requirement		

The specific uses prescribed here concern how the fabric of the building is to behave to suit or even circumscribe the intended activities of inhabitants (mostly humans but not in all cases if this was a cow shed, a shark tank at an aquarium, a kidney bean warehouse, a bank safe and so on). These requirements are carefully specified and planned, and may also be the subject of building regulations yet they are rarely considered as one of the ways that space is controlled despite the fact that they may have significant impact.

[36] The table was part of a specification in production for a group of office buildings in Coventry (2007) by architects Allies and Morrison, who omitted the values from this table before releasing this information to me for legal reasons.

By examining the specific uses which inform performance specification and are sometimes made explicit in the document itself, another layer of 'functional requirement' in addition to the integrity of the building has emerged which concerns the social context in which they are intended to perform and a range of expectations, beliefs and regulations about the behaviour of occupants. Performance specification introduces a wider range of specific uses than can be explained by reconceiving the building in terms of a dynamic structural equilibrium. If it supports to some extent an equipmental conceptualisation of building materials, that is (in Heidegger's argument) excluded from the concept of hylomorphic matter in a very different way to Simondon's process, then this would need to be located as emerging in a specific industrial and historical context, not in the general terms of Heidegger's ontology. However Heidegger's account of the prescription of specific use is illuminating because it is necessarily a preparatory process which might for us recall Simondon's preliminary operations.

3. Performance specification as the inscription of goals

> The speed bump is ultimately not made of matter; it is full of engineers and chancellors and lawmakers, comingling their will and their story lines with those of gravel, concrete and paint, and standard calculations. The mediation, the technical translation that I am trying to understand resides in the blind spot in which society and matter exchange properties.
>
> Bruno Latour[37]

For Heidegger the prescription of specific use is a necessary preparation for a piece of equipment in addition to the processes of production which make it ready. It is not in the least clear what actual preparations Heidegger might mean by this although he mentions production a number of times (we can assume that naming or simply procuring would be sufficient). The point seems to be that being ready for service must involve some kind of 'preparation' – at least to the extent that equipment cannot be prior to the plan for its use. Preparations, whether they are the physical processes of production or the prescription or procurement of something for a specific use, make something ready for use and ground the possibility of its being equipment.

The notion of preparations plays a similar role for both Simondon and Heidegger. For Simondon, preparations are what distinguishes the technical system from the other individuating systems he explores in *L'individu* including living systems, while for Heidegger, 'making ready' for service distinguishes equipment from bodily organs (and perhaps from artworks although this conclusion would involve a reading between Heidegger's two texts which he does not make). The technical system and a piece of equipment are not equivalent terms

[37] Latour, *Pandora's Hope*, p.190.

for Simondon and Heidegger, nevertheless they both refer to something which is made according to some kind of plan, which entails some preparation or making ready. However, Simondon's 'Form and Matter' chapter makes no mention of the uses the clay brick might be put to, nor to the properties of the clay beyond its capacity to be involved in the dynamic processes of brick formation. This is no accidental omission. In *Du Mode* Simondon tries to establish a framework in which the technical being can be understood as part of culture, particularly in its more evolved and extensive mode as technical ensemble. In order to do this it is important, he writes, to understand the technical object 'as the end product of an evolution' and not as something which can 'be considered a mere utensil.'[38]

Although, as Muriel Combes explains in relation to the question of technique in Simondon and in Heidegger's work, both philosophers reject a means-based or instrumental understanding of technology they do so in very different ways.[39] For Simondon, to define technical objects in terms of their practical uses is to miss the modifications which take place during the course of their genesis. The specificity of an object's practical ends that it is designed to meet is, he writes, 'illusory, for no fixed structure corresponds to its defined use.'[40] He continues:

> Steam-engines, petrol-engines, turbines and engines powered by springs or weights are all engines; yet, for all that, there is a more apt analogy between a spring-engine and a bow or cross-bow than between the former and a steam engine; a clock with weights has an engine analogous to a windlass, while an electric clock is analogous to a house-bell or buzzer. Usage brings together heterogeneous structures and functions in genres and species which get their meaning from the relationships between their particular functions and another function, that of the human being in action.[41]

Simondon wants rather to understand the specificity of any given technical object (which he, like Heidegger, distinguishes from the aesthetic object) through its genesis which will also enable him to explore how it 'evolves by convergence and by adaption to itself.'[42] So Simondon excludes the question of use from his enquiry in order to give an account of genesis in which the phases of the object's evolution, and not just the object's use or the designer's intention, is understood as contributing to the evolution itself in a feedback process he calls 'internal resonance.' His aim is to set up a model which can go beyond an account of the

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[38] Simondon, *Du Mode*, p.15.
[39] Combes 'Tentative D'Ouverture D'une Boite Noire', p.75. Combes uses the term 'technique' to mark the shared concerns of Simondon and Heidegger, a move which is more easily made in French than in English - 'The question concerning technology' is translated as 'La Question de la technique' in French, and Simondon's technical objects are 'objects techniques'.
[40] Simondon, *Du Mode,* p.19, as translated in *On the Mode of Existence of Technical Objects*, p.11.
[41] Ibid.
[42] Stiegler builds on this notion of technical evolution in *Technics and Time, Vol I*.

isolated technical object and better describe the complex technical ensembles which are for him changing our relation to technology:

> The thought that recognises the nature of technical reality is that which, going beyond separate objects or utensils to use Heidegger's term, discovers the essence and magnitude of technical organisation, beyond separate objects and specialist professions.[43]

Simondon rejects Heidegger's discussion of equipment, for it grounds the ontological status of equipment in its usefulness, or in its relation to man, and does not move beyond a tool or object-based understanding of the individuality of the technical object. Certainly it is true to say that Heidegger's category of equipment makes no distinction between one material form and another, that it has no concern whatsoever with the specifics of material processes, and that they need play no part in the prescription of specific use. But in relation to the performance specification, specific use seems to both have taken on a role which is defining, even constitutive. In the performance clause use no longer seems to belong to a different realm to the material - 'that of the human being in action.' Instead it seems to have become internal to the material.

Bruno Latour's work on the inscription of goals may offer one way to think through this particular relation of use and material which for Heidegger and Simondon are mutually exclusive. Latour makes specific use (or 'goal' to use his term) and specific material co-productive in his account of technical objects. In this way (and despite his explicit position on Heidegger) he attempts to retain a notion of specific use as constitutive and at the same time include the possibility that the material contributes to its displacement and definition. Latour's way of collapsing the distinction between human and nonhuman in his account of the technical object is to recognise that both act:

> You discriminate between the human and the inhuman. I do not hold this bias but see only actors – some human, some nonhuman, some skilled, some unskilled – that exchange their properties.[44]

In the case of designed objects or systems it is in part the goals and functions which they are intended to fulfil that contribute to their status as actors and give them an equivalence in this respect to human actors:

> We must learn to attribute – redistribute – actions to many more agents than are acceptable in either the materialist or the sociological account. Agents can be human or (like the gun) nonhuman, and each can have goals (or functions as the engineers prefer to say).[45]

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[43] Simondon, *Du Mode*, p.222.
[44] Bruno Latour, 'Mixing Humans and Nonhumans Together' in William Braham and Jonathan Hale (eds.), *Rethinking Technology: A Reader in Architectural Theory*, London: Routledge, 2007, p.315.
[45] Latour, *Pandora's Hope*, p.180.

According to Latour simple distinctions between human and nonhuman make it impossible to understand some of the more significant phenomena of our time – the hole in the ozone layer or the Monsanto chemical industry. If we ascribe functions to nonhumans as well as humans, we can understand the ways that hybrids, or actor-networks might act collectively towards goals. 'Boeing 747s do not fly' he writes, 'airlines fly.'[46] Latour is careful to distinguish his own position from the position in 'social construction of technology' (SCOT) theory which tended to assume that it was possible to understand nonhuman actors entirely in terms of social relations with no account of material action.[47] He also distinguishes his position from a materialist position, which he claims is idealist in so far as it recognises only material forces. He characterises these two positions when he asks whether it is guns or citizens who kill. The materialist account might be represented, he suggests, by the slogan 'Guns kill people':

> The gun acts by virtue of *material* components irreducible to the social qualities of the gunman. On account of the gun the law-abiding citizen, a good guy, becomes dangerous.[48]

The sociological account sees only the human actor: 'Guns don't kill people; *people* kill people.'[49] But for Latour the gun cannot be simply a mediator of human will and therefore the sociological account is also problematic, because it suggests that:

> The gun does nothing in itself or by virtue of its material components. The gun is a tool, a medium, a neutral carrier of human will. If the gunman is a good guy, the gun will be used wisely and will kill only when appropriate. If the gunman is a crook or a lunatic, then, with *no change in the gun itself*, a killing that would in any case occur will be (simply) carried out more efficiently.[50]

Latour posits a third actor who is responsible for the killing, a hybrid 'citizen-gun' or 'gun-citizen'.[51] He also shows that in this case, what may be produced by this new hybrid is a new goal that belongs neither to gun or citizen on their own. Much of Latour's work is taken up with examining how designers and engineers go about delegating goals or functions to nonhumans and collective hybrids – for example in *Aramis or the Love of Technology* where he explores the design of a Personal Rapid Transit System[52] or in his delightful account of the design of a speed bump on his university campus in *Pandora's Hope*. Here he notes that a prescription or program of action 'make drivers slow down on campus' is not directly realised through the

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[46] Ibid., p.197.
[47] Adrian Mackenzie's otherwise excellent article 'Problematising the Technological: The Object as Event?' discusses some relationships and differences between the work of Latour and Simondon,but tends to conflate Latour with SCOT theorists and overlook the distinction Latour himself makes in this respect.
[48] Latour, *Pandora's Hope*, p.176.
[49] Ibid.
[50] Ibid., p.177.
[51] Ibid., p.179.
[52] Bruno Latour, *Aramis or the Love of Technology*, Cambridge, Massachusetts: Harvard University Press, 1996.

imposition of 'will on shapeless matter' when it is translated into concrete. Instead 'nonhumans also act, displace goals, and contribute to their definition':

> Instead of signs and warnings, the campus engineers have used concrete and pavement. In this context the notion of detour, of translation, should be modified to absorb, not only (as with previous examples) a shift in the definition of goals and functions, but also *a change in the very matter of expression.* The engineers' program of action, 'make drivers slow down on campus,' is now articulated with concrete. What would the right word be to account for this articulation? I could have said 'objectified' or 'reified' of 'realised' or materialised' or 'engraved' but these words imply an all powerful human agent imposing his will on shapeless matter, while nonhumans also act, displace goals, and contribute to their definition... I want to propose yet another term, *delegation*.[53]

Because of this contribution of the material, it is not possible either to think of the speed bump as simple mediator or conduit for the goal, or in the hylomorphic terms of the imposition of will. For Latour the material intervenes in unforeseen ways, independent of the engineers and designers' intentions and provides its own impetus to the development of further objects and systems. In this way Latour acknowledges both the goals or 'specific uses' that Heidegger sets out and 'the essence and the range of technical organisation' so important to Simondon's account of technical systems.

Despite Latour's claims that he understands human and nonhuman actors as equivalent, the examples of delegation he gives such as sleeping policemen, door closers or 'grooms', or flag-waving dummies at the side of a road are limited to the ways that nonhumans stand in for human actions and not vice-versa. This might be attributed to his strategy to persuade sociologists to pay attention to nonhumans, but in his terms it makes it easier to understand certain sorts of goals than others. Where performance clauses are related to the occupant's experience – such as prescriptions for specific acoustic or thermal performance – Latour's humanising of material objects elucidates the kinds of roles they may be playing. But where performance specifications are only concerned with the material's contribution to the structural integrity of a building they relate to other materials and their performances, rather than to the translation of a human action to a material register and it is more difficult to see how through them, we might be '"allowed", "permitted", "enabled", "authorised", to do things.'[54]

While Simondon only concentrated on the physical preparations which were involved in making clay and mould ready for individuation, and Heidegger's notion of prescription and preparation in the making ready of

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[53] Latour, *Pandora's Hope*, p.187.
[54] Bruno Latour, 'Which politics for which artifacts?' in *Domus*, June 2004, www.bruno-latour.fr/presse/presse_art/GB-06%20DOMUS%2006-04.html accessesd 09.01.2009.

equipment overlooked entirely the specifics of those differences, Latour's discussion of delegation both extends those preparations, offers detailed studies of specific examples and tries to establish a precise vocabulary for the various operations involved. 'Inscription' is Latour's term for the way in which goals or 'scripts' are translated into more permanent (and usually material) form:

> I will call the translation of any script from one repertoire to a more durable one *transcription* or *inscription* or *encoding*. This definition does not imply that the direction always goes from soft bodies to hard machines, but simply that it goes from provisional, less reliable one to a longer-lasting, more faithful one.[55]

The speed bump is a typical example since it replaces a policeman standing at the side of the road imploring drivers to slow down. But we might also consider the glass at the Reichstag as inscribed. In this case, through specific techniques of materials manufacture glass has been inscribed with a security function that might otherwise have been performed by security guards. But this inscription can only occur in the context of other work which sets the conditions that enable it to be effective. For this Latour has a second term - 'pre-inscription' - which refers to:

> All the work that has to be done upstream of the scene and all the things assimilated by an actor (human or nonhuman) before coming to the scene as a user or an author [by which he means designer or engineer][56]

The performance clause reveals modest examples of delegation and inscription, barely perceptible, but because they surround us and our activities and construct them they are persistent and influential. But in drawing our attention to the processes of inscription, Latour also reminds us that these delegations are the outcomes of institutionalised practices, and occur in specific ways, with particular kinds of translations and detours to be observed. Performance specifying is a relatively recent practice in the United Kingdom, which relates to the rise of performance-led design or what Bernadette Bensaude-Vincent and Isabelle Stengers have called 'materials on demand'. The performance clause is also evidence of a very particular kind of pre-inscription which requires a whole range of tests, systems of quantification and equivalence, and changes in design and contractual management to take place. It is to this context I turn in Chapter Seven.

[55] Latour, 'Mixing Humans and Nonhumans Together', p.319.
[56] Ibid. p.320.

Chapter Seven: Informing Materials: The pre-inscription of materials 'for a given service'

> Specification by performance is a dynamic concept. Its evolution is dependent on knowledge gained from research, technological experience including that drawn from other industries and countries. It is influenced by changes in resources, the social and economic environment within which building operates and the pattern of design-production responsibilities.
>
> G.A. Atkinson[1]

Although it is easily overlooked today when the use of performance specification is accelerating, it was clear in the debates of the late 1960s and early 1970s that performance specification is only possible within a context of specific systems of knowledge and industrial and legal practices. This context is, in part, one of testing, quantification and quality control (ensuring that all samples of a manufactured material will perform in the same way). It is also, as Bernadette Bensaude-Vincent and Isabelle Stengers suggest with respect to the history of chemistry, another applied industrial discipline, a context in which changes are occurring in the way materials are produced:

> In the 1970s... there arose a new orientation toward research on specific characteristics and specific materials. Plastic materials were diversified, geared to specifically targeted performance, and designed as a function of the final product. This new trend manifested itself not only in plastics but in materials as a whole. After having achieved mass production and standardisation, chemistry was put to work on a made-to-order civilisation.[2]

New building materials such as performance-engineered glass are not just *specified* in relation to their use, they are also 'geared to specifically targeted performance, and designed as a function of the final product.' This chapter explores the kinds of pre-inscription involved in performance specification and in performance-engineered materials. The preliminary operations which prepare a material that is selected or designed for specific use include and depend upon significant changes in the building industry – in the ways that contracts are managed, in the introduction of standardisation at the level of national building codes, and at the level of techniques of material production. Scientific methods must be applied in building, particularly in the testing of material properties and of the environmental factors they will either withstand or control. These processes represent an increasing socialisation of materials, both in the sense that their qualities and uses are regulated by institutional and national norms, and in the sense that their quantification in relation to environmental

[1] Atkinson, 'Performance Specification', p.115.
[2] Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry*, Cambridge Massachusetts: Harvard University Press, 1996, p.206.

factors enables them to play an explicitly codified and defined role in shaping the environments of inhabitants according to expected behaviours and social norms. They make possible, to use Latour's terms, the 'delegation' of social goals or actions to nonhumans which will in turn anticipate particular behaviours from those who use the spaces they construct. Furthermore the processes of testing and quantification which make possible the specification of a material 'for a given service' are 'extra-physical'. It is not just that in observing them we extend Simondon's category of preliminary operations to include social and epistemological preparations. In the industrial context of performance specification, the ways in which forces other than the physical can prepare a material must also be understood to have multiplied.

A number of commentators considering new materials 'geared to specifically targeted performance' in other applied disciplines have suggested that this represents a significant shift in the constitution of the material and emphasised the primacy of end use. Most strikingly, Bensaude-Vincent and Stengers claim, making reference to the hylomorphic concept of matter, that these materials, 'are made to solve specific problems, and *for this reason they embody a different notion of matter*.'[3] Andrew Barry takes up their brief discussion to explore new pharmaceuticals and emphasises that these new drugs are increasingly 'informed' – through industrial, legislative and knowledge practices with some similarities to those which ground performance specification.[4] For Simondon the cybernetic notion of information runs the risk of repeating the hylomorphic structure in so far as it is understood, like form, as an organising principle. Instead he understands information as the condition of compatibility between magnitudes of different orders which makes individuation possible. The kinds of formative forces which Barry and I explore are not information in Simondon's use of the term. I argue instead that they are better thought of as preliminary operations, and internal to Simondon's 'complete system' of individuation that is discrete and includes all the conditions for genesis within it, and that they also prepare 'disparate realities' and their compatibility for resolution in individuation. The performance-specified material might then be seen to be a 'system of material' which makes possible the emergence a compatibility between a materials and specific use. This would be a very different system to one which prepares a material for shaping or moulding. In this way we might understand the performance-led system of materials to be a radically 'different notion' not of matter, but of material.

1. Testing the material and quantifying the goals

In 1972 Atkinson made a number of recommendations for changes that would need to take place in the building industry in order for performance specification to become more common. These included the

[3] Bensaude-Vincent and Stengers, *A History of Chemistry*, p.206, my emphasis.
[4] Andrew Barry, 'Pharmaceutical Matters: The Invention of Informed Materials' in Mariam Fraser, Sarah Kember, Ceila Lury (eds.), *Inventive Life: Approaches to New Vitalism*, London: SAGE, 2006.

encouragement of 'standardisation and variety reduction' and of 'scientific methods of building,' as well as the necessity to:

> Strengthen, and where necessary, reform the institutional machinery for identifying needs for standardisation, agreeing and adopting standard codes of practice, design data, test methods, etc. for assessing and approving products and techniques and for quality control. [5]

Some sectors of industry had already begun to utilise performance criteria, for example in the case of building standards discussed by Atkinson, or in the production of materials for large-scale building projects or certain mass-produced products and components. The LCC, for example, who built the Elfrida Rathbone School, were a large enough organisation to have their own testing station at County Hall, to which, as we saw in Chapter Five, bags of cement were to be taken for quality control.[6] But as commentators in this period such as Tony Allot recognised, performance specification would not be possible for most building projects at the time, specifically those which were small scale building contracts and fully specified by the designer without access to materials science and testing facilities:

> The nearly pure performance specification can be appropriate, for example, where there is a large order, where design and development time can be allowed, where manufacturers or contractors have sufficient expertise, and where suitable tests exist: but the vast majority of designer specified building work is tendered for and built under conditions which make the pure performance approach difficult. Most projects are 'one off, not very large, needed quickly, built by small contractors, supervised by non-scientific staff, and do not always justify full testing procedures.[7]

It is still the case that where performance specification is more prevalent and consistently used – in the documents produced by Schumann Smith or the in-house specifications of Allies and Morrison for example – these specifications tend to be for large-scale projects in which systems are often designed, engineered and produced for a particular building or development. Nevertheless, precisely because the 'reforms' to 'the institutional machinery' advocated by Atkinson have occurred, much of the testing and building science which Allot recognized as necessary to performance specification is now carried out by external bodies, and a small practice or contract need not have its own expertise. Many materials, components and systems are now routinely tested by manufacturers, their performance capacities are given as data with them which comply with standardised criteria. This means that in the contemporary NBS, the master specification used for the

[5] Atkinson, 'Performance Specification', p.116.
[6] Specification for the Elfrida Rathbone School (1961), 'Cement tests C4'.
[7] Allot, 'NBS: a progress report', p.82.

majority of projects, the performance clause is used frequently, but only in relation to certain materials, components and systems in specific contexts.

Although specifiers such as Schumann Smith aspire to produce specifications which would be entirely performance-specified, not all materials used in building can be support the necessary degree of testing, quantification and quality control. If testing a sample to assure the performance of any other sample of a given material, there must be consistency between all samples. In some cases it might appear that, as Marx put it in relation to gold and silver, they 'possess these properties by nature' but equivalence, or 'constancy' is always a result of the preparations of a material. What is notable is first that performance specification demands this constancy of materials and second that materials are increasingly being produced so that they are homogeneous. The following two clauses from the NBS are both for stone walling to be used in identical situations, but one specifies natural stone which is quarried and the other cast or reconstituted stone which is made up of cement, sand and finely crushed natural stone.[8] In F21 the natural stone is specified through its source and geological description, while in F22 cast stone is, to some extent, performance specified[9]:

F21	**NATURAL STONE ASHLAR WALLING/ DRESSINGS**
	To be read with Preliminaries/ General conditions.
	TYPES OF WALLING/ DRESSINGS
110	ASHLAR _____ .
-	Stone:
-	Name (traditional): _____ .
-	Petrological family: _____ .
-	Colour: _____ .
-	Origin: _____
-	Finish: _____ .
-	Supplier: _____ .
-	Quality: Free from vents, cracks, fissures, discolouration, or other defects adversely affecting strength, durability or appearance. Before delivery to site, season thoroughly, dress and work in accordance with shop drawings prepared by supplier.
-	Mortar: As section Z21.
-	Mix: _____ .
-	Sand: _____ .
-	Other requirements: _____ .
-	Bond: _____ .
-	Joints: Flush.
-	Width: _____ mm.
-	Pointing: _____ .
-	Features: _____ . […]

[8] 'About Cast Stone' unpaginated webpage http://www.continentalcaststone.com/aboutcaststone.html accessed 10.06.2009.
[9] NBS: Standard Version (Update 38) (2004), F21, F22.

F22 CAST STONE ASHLAR WALLING/ DRESSINGS

To be read with Preliminaries/ General conditions.

TYPES OF WALLING/ DRESSINGS

110 CAST STONE _____ .
- Cast Stone Units:
- Manufacturer: _____ .
- Product Reference: _____ .
- Absorption: As clause _____ .
- Compressive strength: To BS 1217.
- Cube strength:
  - Average (minimum): _____ .
  - Single (minimum): Not less than _____ .
- Finish: _____ .
- Colour: _____ .
- Mortar: As section Z21.
- Mix: _____ .
- Sand: _____ .
- Bond: _____ .
- Joints: Flush.
- Width: _____ .
- Pointing: _____ .
- Other requirements: _____ .

Cast stone is a material with little structural strength used in the main to resemble natural stone, so apart from the fact that it is less badly affected by frost than natural stone, its visual characteristics are most important. Here, therefore only some of the clauses for the cast stone – those relating to strength and absorption – are performance specified. But these quantities can only be given because cast stone has already been processed in such a way that it is rendered homogeneous.

We also see a marked contrast in the degree to which testing is specified for natural and cast stone. Natural stone is specified in the NBS without any reference to performance criteria or testing. In the following clauses no requirements are given for its structural or weather resistant performance and the only samples requested are in order to check the consistency of the stone's appearance:

F21 NATURAL STONE ASHLAR WALLING/ DRESSINGS

To be read with Preliminaries/ General conditions.

GENERAL/ PRODUCTION

220 ADVANCE PROCUREMENT
- General: As Preliminaries section A56.
- Ordering: Take responsibility for this stone by an order to supplier covering price, supply and delivery to suit progress of work.

240 STONE SAMPLES
- Timing: Before placing orders.
- Submit: Samples of dressed stone which represent the range of variation in appearance.[10]

[10] Ibid., F21.

To specify the cast stone, however, a long list of tests and criteria are given. These include (220 Control Samples) the production of a control sample block and written approval of it, various tests for strength and absorption with lab reports to show that the sample mix meets BS 1217, and a quality control clause as follows:

230 QUALITY ASSURANCE
- Records: Maintain complete correlated records for each mix type, including:
  - Composition of facing mixes, any backing mixes including admixtures and reinforcement.
  - Batch identification numbers related to those of components and test samples.
  - Laboratory test reports, including cube identification numbers.
  - Dates for casting and delivery to site.
  - Any other pertinent data, e.g. identification of approved control samples.[11]

So although these two types of stone are to be used in exactly the same way in the building the cast stone must be submitted to a large number of tests, records and reports and meet a range of criteria. It is not just that its properties are quantified, they are documented and authorised according to national standards. The natural stone does not undergo any of these 'preliminary operations.' This comparison shows us that, to some extent, testing is not meaningful for every kind of material, particularly if it is naturally occurring and variegated. As Atkinson noted, 'variety reduction' would need to be encouraged.

It is also the case, however that, the way in which a material is to be used is influential, both with respect to its location in the building and to the contractual arrangement involved. In the same version of the NBS as above the clause for natural stone cladding, a product which is machine cut in much thinner pieces, also requires some tests to demonstrate performance in relation to moisture and strength:

H51 NATURAL STONE SLAB CLADDING/LINING/FEATURES

To be read with Preliminaries/General Conditions.

DESIGN/PERFORMANCE REQUIREMENTS

325 PRELIMINARY TEST INFORMATION
- Stone type: _____.
  - Petrographic examination to BS EN 12407.
  - Water absorption coefficient by capillarity to BS EN 1925: _____$g/m^2s^{0,5}$.
  - Apparent density to BS EN 1936: _____ Kg/m^3.
  - Real density to BS EN 1936: _____ Kg/m^3.
  - Open porosity to BS EN 1936: _____ %.
  - Total porosity to BS EN 1936: _____ %.
  - Flexural strength to BS EN 12372: _____ Mpa.

326 ADDITIONAL PRELIMINARY TEST INFORMATION
- Stone type: _____.
  - Test and result: _____.[12]

[11] Ibid., F21 and F22.
[12] Ibid., H51.

However, in an equivalent clause in Schumann Smith's performance- driven specification, although this time for stone flooring, the amount of tests required have almost doubled. The first list (a) describes the values that must be quantified in those tests and the second (b) gives the ranges into which those values must fall within for compliance in this particular case:

Stone Properties

H51.1402 Strength and Physical Properties

a) Provide information and values for the natural stone flooring for review by the architect for the following test criteria:

i) Dimensions
ii) Flatness of Surface
iii) Freeze/thaw resistance
iv) Flexural Strength (breaking load)
v) Abrasion Resistance
vi) Water Absorption
vii) Petrographic Description
viii) Ultimate Compressive Strength
ix) Density and Porosity
x) Breaking Load at Dowel Points

b) Provide information and values for the natural stone to the Architect to review to confirm the following criteria:

i) Petrographic description: No deleterious constituents
ii) Density: 2160 Kg/m^3 minimum
iii) Flexural strength under concentrated load shall be 3.4 Mpa minimum (wet). Note: tests shall be performed at proposed project thickness.
iv) Abrasion resistance: provide values for assessment
v) Water Absorption: 7.5%
vi) Compressive Strength: 28 Mpa minimum
vii) Surface finish: Smooth honed to match accepted samples
viii) Staining potential: non susceptible
ix) Coefficient of thermal expansion. Provide values for assessment
x) Saturation co-efficient: 0.85 maximum[13]

We see the acceleration in the requirement for testing that is taking place, and that although in part, the degree to which a material must be tested and authorised depends on the way that material has been produced and the degree it has been standardised, it is also highly dependent on the contractual context. While the NBS is designed to give architects and contractors a reasonable degree of protection against

[13] Specification for the H...y Building (2006). It is interesting to see that here a concern with the appearance has crept into a list which otherwise concerns the structural and constructional integrity of the stone. 'Flatness of surface' to be 'smooth honed surface finish' are not really performance criteria, but what Schumann Smith call 'design intent' and prefer to list separately. The inclusion of 'design intent' is new. Specifications have tended to be omit this kind of information, since to a great extent it is already contained in the drawings. It appears where architects no longer have control over the detail design and must find ways to let contractors know what the detail should look like without doing the work of designing them.

litigation, Schumann Smith's specifications are geared to big budget projects, particularly those that will involve specialist contractors in the design of construction systems. The emphasis on extremely precise performance specification is intended to avoid any litigation and particularly the costs that can be incurred by claims surveyors working for contractors where very large sums of money are involved. These tests and specifications are not only to ensure that the materials do not fail, they are also there to provide legal cover and ensure internal consistency of the document itself.[14] It is first then in this sense that the preliminary operations involved in performance specification cannot be separated from the social and economic climate which gives rise to their deployment.

P. J. Sereda's article 'Performance of Building Materials' (written in Canada some years before performance specification became mainstream in the UK) makes clear that the prediction of performance depends on more than the properties of the material to be used. The context in which a material is to be used, will also bring it into contact with specific environmental conditions which must themselves be quantified and tested:

> Exact prediction of performance requires a complete understanding of material properties, the processes involved in the interaction of the material with its environment, and the environmental factors to which it will be subjected. The only complete test of performance is trial by use. Prediction will always be limited by lack of complete knowledge; trial by use will be limited by time and inability to extrapolate to new conditions. Test methods can be used to supplement knowledge and experience in predicting performance.
>
> Some test methods depend on empirically derived relations between observed behaviour and some easily measured physical property; others subject the material to environmental conditions simulating those to be expected in practice.[15]

Sereda is mostly concerned with the durability of materials, and the environmental factors he discusses tend to be climatic. He makes the intriguing point that environmental factors also bring about changes to materials – there is physical transformation in these interactions – for example when a brick expands due to frost, so that its facing might crumble.[16] Generally, the necessary knowledge for performance specification is acquired

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[14] Tony Brett explained that claims surveyors working on behalf of the contractor can make claims simply because there is an error in the specification document, even if that error has not itself brought about any actual problems in building. A justifiable claim could for example be made simply because two different values were given in different citations of a clause in separate parts of a specification – even if this did not in fact go on to cause an error on site. Conversation with Tony Brett of Schumann Smith, 01.11.07.

[15] P.J. Sereda, 'Performance of Building Materials', in *Canadian Building Digest 115,* July 1969. http://irc.nrc-cnrc.gc.ca/pubs/cbd/cbd115_e.html accessed 10.06.2009.

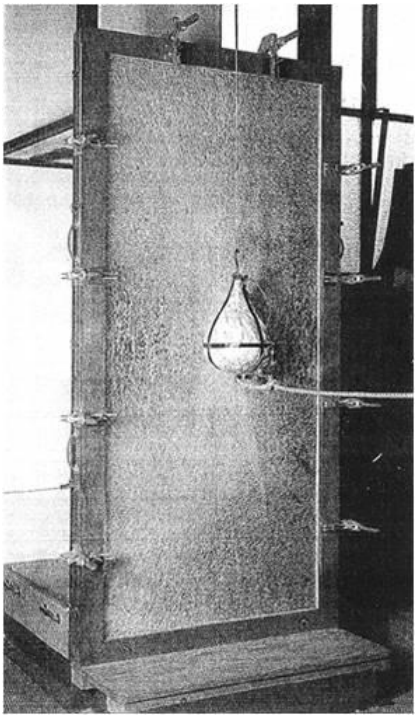
[16] According to http://www.continentalcaststone.com/aboutcaststone.html the performance criteria for a frost-proof brick involves freezing it and allowing it to defrost a hundred times. This suggests that Simondon's clay brick will in fact continue to individuate even after it is moulded – it will just be that these are other systems: the clay/heat system for example, or a clay/frost system and so on.

through tests of different sorts including some that will simulate the conditions that the material is to withstand rather than directly carry them out.

At the simple level of the kinds of forces a material must withstand and the ways that they too must be quantified we might recall the Allies and Morrison performance matrix which required that glass needs to be specified to withstand certain test impacts:

Performance criteria
Test impact
Hard body requirement
Soft body requirement

This requirement (the need for which depends of course on assumptions about the social and physical environment of the building) must be supported by relevant tests for different kinds of 'bodies' (from 'soft' footballs to 'hard' stones). In some cases the impacts of these bodies at different sizes and speeds can be directly tested, but in others such as the need to test for the impact of human body (a 'semi hard' body) these tests are simulated. Shown is a rig which uses a head-shaped leather punch bag filled with lead shot to test the impact of the human body on a plane of glass (Fig. 7.1).[17]



7.1 Test rig, Pilkingtons Glass Ltd.

[17] See Figure 16.3 Test rig, Pilkington Glass Ltd., St Helens, UK in David Button and Brian Pye (eds.), *Glass in Building: A Guide to Modern Architectural Glass Performance*, Oxford: Butterworth Architecture, 1993, p.258.

Although Sereda concentrates on the 'natural' forces of the weather, many of the forces a building is designed to withstand are themselves produced by other technical objects and systems, and these include weapons of attack. The requirement to take these forces into account is also mitigated by the security climate at the time the building is specified as when the specification for the glass internal walls in the Welsh Assembly Building had to change so substantially after September 11th that a redesign was necessary. These forces must themselves be quantified, as we see in the following table from Pilkingtons which gives the thickness required for laminated glass in relation to specific guns[18]:

Composite structure required for different levels of attack

	Parabellum 9mm	Magnum revolver 44	Nato rifle 7.62mm	Shotgun 12 bore
Laminated glass (mm)	20-40	40-60	50-80	30-50
Glass/polycarbonate composite (mm)	15-25	25-30	30-50	-

Testing is related to a specific technical object, but the job of the glass specifier is to select the correct thickness based on the perceived likelihood of each of these specific attacks (or on the thickness they can afford!). The specification of the glass does not only depend on a stand-alone property of the gun. The capacity specified is to withstand a particular named act within a specifically defined social milieu. In Latour's example of the National Rifle Association's defence that it is the gun holder who shoots not the gun he extends his argument that both humans and nonhumans are agents to suggest more provocatively that they can then also both have goals.[19] In this sense the 'goal' of these Pilkington security glasses, is shown to be to withstand attack from specific gun shots, and it is this goal which is materially inscribed through the thickness of the laminate or composite used. Thus a goal (to protect people from gunfire) is carried into the material register, which could be achieved in other non-physical ways - for example by legislating against gun ownership.

To specify the environment of the future inhabitant in performance terms a range of factors about the inhabitants of the space also need to be taken into account and quantified. For example, the thermal capacities of glass or a glazing build up are specified to ensure that a certain level of thermal comfort is achieved. This must go hand in hand with the quantification of all the factors that will contribute to the thermal environment, and include for example the metabolic heat generated by various activities (unsurprisingly the guidance works with the bodily surface area of 'a typical man')[20]:

[18] See Figure 18.4, ibid., p.276.
[19] 'Agents can be human or (like the gun) nonhuman, and each can have **goals (or functions**, as engineers like to say)' See Latour, '*Pandora's Hope,* p.180.
[20] See Figure 7.2, Button and Pye (eds.), *Glass in Building*, p.122.

Activities	W/m^2
Reading	55
Typing	65
Walking	100
Lifting	120

To some extent, the specifier must also assume the activities that will occur, as part of her selection of the material. Additionally these figures need to be moderated by the degree of insulation of clothing that the reader or typist or walker is expected to be wearing, given in 'clo', 'a relative value, with 1.00 being the measure for normal indoor clothing *for a man*:'[21]

Clothing	Clo
Underwear, socks, shoes	0.70
Underwear, shirt, trousers, jacket, socks, shoes	1.00
Underwear, shirt, trousers, jacket, heavy quilted jacket and overalls, socks, shoes	1.85

In designing and selecting a type of glass the performance engineer or specifier works with values based on assumptions about social behaviours and uses of spaces. Clearly the choices they make cannot fully determine behaviours, but Madeleine Akrich has suggested that when these assumptions are part of the design of an object they 'prescribe' them back to humans, and Latour has proposed (giving objects language in his typically anthropocentric fashion) that to some extent this might be considered as 'the moral and ethical dimension of mechanisms':

> I will call, after Madeleine Akrich , the behaviour imposed back onto the human by nonhuman delegates *prescription*. How can these prescriptions be brought out? By replacing them by strings of sentences (usually in the imperative) that are uttered (silently and continuously) by the mechanisms for the benefit of those who are mechanized: do this, do that, behave this way, don't go that way... As Akrich notes, prescription is the moral and ethical dimension of mechanisms.[22]

It is true to say that expectations about use influence the selection of the glass in very precisely calculated and articulated ways and that the materials are in Akrich's sense 'prescriptive' in as much as they are guided by these assumptions. But unlike the examples Latour and Akrich examine, in the case of building materials there is no one human action or goal which is being replaced. The social shaping of the environment via the performance-specified material is partial and more general, but it may also be more concealed and as such more naturalised. For Akrich the translation of social relations into technical objects conceals the social processes through which they are built up:

[21] Fig.7.3, ibid.
[22] Latour, 'Mixing Humans and Nonhumans Together,' p.313.

> It makes sense to say that technical objects have political strength. They may change social relations, but they also stabilise, naturalise, depoliticise, and translate these into other media. After the event, the processes involved in building up technical objects are concealed. The causal links they established are naturalised. There was, or so it seems, never any possibility that it could have been otherwise.[23]

We might then recognise that the testing and quantification of some of the goals or specific uses which enable glass to be performance-specified are concerned with putting the material to social use, and that these criteria become embedded into the selection process. In a particularly revealing passage Pilkingtons promote the performance-tested and designed glass they produce by explaining that a good level of thermal comfort can attract employees:

> Demands for improved comfort by the building occupants will increase in industrialised counties during the 1990's for several reasons. First, the older working population will have higher comfort expectations. Second, competition for employees will generate incentives by employers; a healthy comfortable working environment will be just such an incentive in the United States where the number of young adults will fall by 40% creating a shortage of entry level employees.[24]

In this appeal to the corporate client they make a direct link between the material and a good workforce. Such a link can only be demonstrable because a relation has already been made, through testing and quantification, between the comfort of inhabitants and the physical properties of the materials they manufacture.

Performance specification may not be able to determine behaviours, but by finding ways to test and quantify both materials and environmental factors it makes it possible to select materials for a specific use. While some of these uses will be concerned with structural and climatic factors, others, as we have seen, are more clearly social. Testing and regulation operate at the statutory level and in the cases of these inhabitant-based functions they enable social criteria to determine specification of materials. But in the case of performance-engineered materials which are 'designed for a given service' it becomes possible to inscribe goals concerning the social performance or regulation of the occupant's environment into the design of the material itself.

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[23] Madeleine Akrich, 'The De-scription of Technical Objects' in Wiebe Bijker and John Law (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical change*, Cambridge, Massachusetts: MIT Press, 1992, p.222.
[24] Button and Pye (eds.), *Glass in Building*, p.121.

2. Materials 'for a given service' in the expanded context of performance engineering

> [the materials engineer's] job is to find, invent, and (or) produce materials having the particular combination of properties (mechanical, magnetic, optical, electrical, and others, including economic) that is needed for a given service. The materials engineer's complex knowledge of what it is possible to achieve, involves him in the very center of discussion of most new projects, whether scientific, engineering, or social in nature.
>
> Cyril Stanley Smith[25]

In the table showing the kinds of glass that can withstand the impact of bullets from different guns two different kinds of glass were listed. The first was laminated glass which gains increasing strength the more layers are added. The second was a glass/polycarbonate composite which 'is especially designed to provide protection against different levels of ballistic threat, from 9mm handgun to NATO armor piercing rifle, at the minimum possible thickness.'[26] It layers glass with various plastics including polycarbonate, which has 250 times the impact strength of glass and also has a degree of flexibility that absorbs the bullet. This 'glass' is a composite performance-engineered material. The requirement to achieve certain strength, flexibility and to reduce spalling on impact determines its design and physical constitution.

Although as Michelle Addington and Daniel Schodek explain, the development and take-up of performance-engineered materials is slower in the building industry than in other industries, it also represents a significant shift from traditional materials towards those which are produced 'to meet a specifically defined need':

> For many centuries one had to accept and work with the properties of a standard material such as wood or stone, designing to accommodate the materials' limitations, whereas during the 20th century one could begin to select or engineer the properties of a high performance material to meet a specifically defined need.[27]

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[25] Smith, *A Search for Structure*, p.124.

[26] 'BCE provide professional consulting by security advisers to offer you the most suitable transparency according to your requirements and fulfil your security needs perfectly with all the transparency technology in hand, incorporated with the "state of the art" glass bending and composite laminating techniques.' 'We offer protection... from a plain street assault with a 9mm hand gun, to an all out attack up to 12.7mm machine gun. Whatever the threat level, we can produce the optimum composition to insure maximum security.' BCE internet promotional material at http://www.bceglass.com/armouredglass.asp accessed 11.06.09.

[27] Addington and Schrodek, *Smart Materials*, p.3.

The uses performance-engineered materials are to be put determine the precise physical configuration of the material. They are not confined to the capacity to withstand environmental impacts but also include those which will control the environment of a building's users. For example, in order to build up glass products which will provide different levels of comfort for inhabitants, Pilkingtons have developed a range of very thin films which can be applied in layers on to glass through a variety of techniques. In the following illustration they show us a build up of three different layers which are described, not in terms of what they are, but in terms of what they are for[28]:

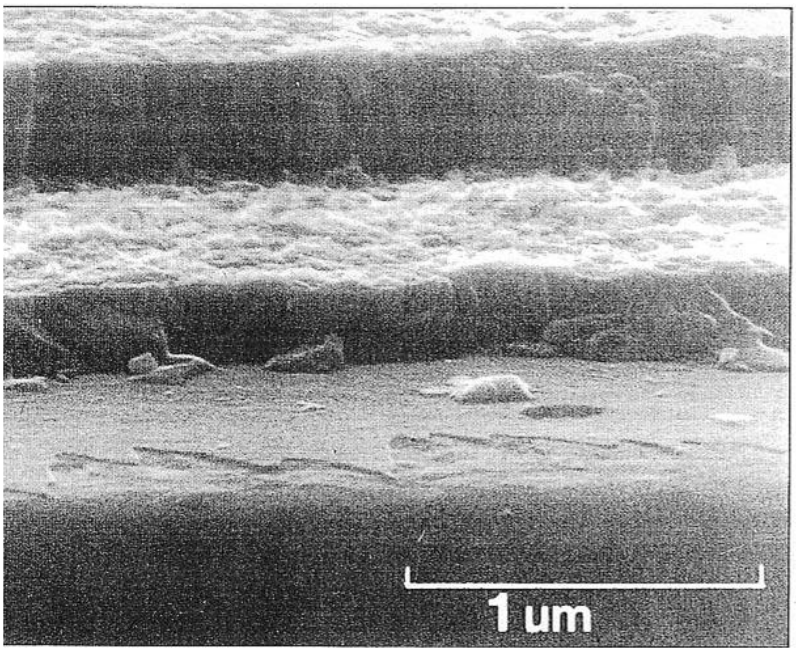

Figure 11.6
Three-layer coating on glass, Pilkington Technology Centre, Lathom, UK

The layers are
(1) thickness 200 Å, for adhesion;
(2) thickness 2250Å, for emissivity;
(3) thickness 2400Å, for reflectivity.

7.2 Three layer coating on glass, Pilkington Technology Centre

Here the purpose of these films is to limit heat transfer and orchestrate the role of the glass in the thermal environment of the space. The increasing emphasis on a material's performance is not only producing the new context of testing, material homogenisation and regulation explored in the previous section. It is also producing materials in which specific use is inscribed at a physical level.

It is notable that Addington and Schodek recognise the impact of these shifts on the industry – both at the level of what such materials can do and in the ways they are described, even conceived.[29] These shifts are yet more marked in the 'smart materials' which are the subject of their book, and are responsive and react dynamically to environmental changes. Commentators from other disciplines have also recognised the significance of the development of performance-engineered materials and in many cases they emphasise

[28] Fig. 11.6, Three-layer coating on glass, Pilkington Technology Centre, Lathom, UK, Button and Pye (eds.), *Glass in Building*, p.199.
[29] See Addington and Schodek, *Smart Materials*, p.29: 'In the traditional engineering approach the material is understood as an array of physical behaviours. Then in the traditional architectural and general design approach the materials is still conceived as a singular static thing, an artefact.'

their design for a specific use. Cyril Stanley Smith, for example, predicts that materials engineering 'for a given service' will not only put the engineer at the heart of 'most new projects' but that these will include projects that are 'social in nature' and involve the bringing together 'of fields that because of their special complexities have been unrelated: it would minimize the difference between the scientist and those who try to understand the human experience.'[30] In their *History of Chemistry* Bensuade-Vincent and Stengers use a range of terms to describe these new engineered materials – 'materials a la carte', 'materials on demand', 'made-to-order materials' and 'functional'. Like Smith, who proposes that materials engineering is a science of aggregates, rather than molecules or particle physics, they explain that these are usually composite materials and able, importantly, to perform in a number of ways or to integrate 'the maximum number of functions into a material.'[31]

What is particularly striking however is that they argue that because these new materials are 'made to solve specific problems' they embody 'a different notion of matter':

> Whether functional or structural, new materials are no longer intended to replace traditional materials. They are made to solve specific problems, *and for this reason they embody a different notion of matter.* Instead of imposing a shape on the mass of material, one develops an 'informed material' in the sense that the material structure becomes *richer and richer in information*.[32]

The traditional notion of matter implied here, where there is the imposition of 'a shape on the mass of material,' is hylomorphic matter, but unfortunately this idea is developed no further in their book. Nor is a source given for their notion of 'informed material,' although it appears tantalisingly in quotation marks. But in 'Pharmaceutical Matters; The Invention of Informed Materials,' Andrew Barry develops their notion of an 'informed material'. What puzzles Barry is that Bensaude-Vincent and Stengers describe the structure of the new materials designed for use as becoming 'richer and richer in information.' 'How' asks Barry, 'are we to make sense of the idea that materials can somehow become 'informed' or as they suggest, "richer and richer" in information?' Barry's article looks at new drugs emerging out of contemporary pharmaceutical research and development, and interestingly for my discussion he also emphasises the increasing range of factors which are involved in the production of these compounds:

> Pharmaceutical companies do not produce bare molecules – structures of carbon, hydrogen, oxygen and other elements – isolated from their environments. Rather they produce a multitude of informed molecules, including multiple information and material forms of the same molecule... The molecules

[30] Smith, *A Search for Structure*, p.125.
[31] Bensaude-Vincent and Stengers, *A History of Chemistry*, p.205.
[32] Ibid., p.206, my emphasis.

> produced by a pharmaceutical company are already part of a rich informational material environment, even before they are consumed. This environment includes, for example, data about potency, metabolism and toxicity and information regarding the intellectual property rights associated with different molecules.[33]

For Barry, part of the interest of chemistry is precisely that 'it is an industrial, applied and empirical discipline,'[34] but because of this it is usually seen as 'a science lacking in theoretical interest' and 'merely a "service science".[35] In extending the kinds of 'information' which constitute a new drug compound Barry makes the very important point that it is not sufficient to limit discussions of materials to questions of the physical, nor as he points out earlier, to understand them only as inventions 'driven by social and economic forces.'[36] In its exploration of an applied science his argument moves beyond epistemological questions, to ask precisely how materials might be constituted by their industrial context, and what changes in that context might mean for materials. Barry develops his account of informed materials in relation to Alfred North Whitehead's philosophy (drawn mostly from a small section of *Process and Reality*) in which entities - even those as simply physical as molecules - always exist in a material and 'informational' environment, and must then be seen as comprising both 'information and material entities'. Any entity must always exist amongst other entities which inform and modify it. Barry also draws on Bensaude-Vincent and Stengers in so far as they insist that a problem with science is that it assumes that a molecule in the laboratory is the same entity as a molecule elsewhere:

> For chemists, the fact that molecules have changing properties depending on their associations is an everyday reality. The molecule that is isolated and purified in the laboratory will not have the same properties as it has in the field, the city street or the body. [37]

In *Science and the Modern World* Whitehead makes this point in a more general way:

> The atomic material entities which are considered in physical science are merely these individual enduring entities, conceived in abstraction from everything except what concerns their mutual interplay in determining each other's historical routes of life-history. Such entities are partially *formed* by the inheritance of aspects from their own past. But they are also partially formed by the aspects of other events *forming* their environments.[38]

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[33] Barry, 'Pharmaceutical Matters', p.59.
[34] Ibid., p.52.
[35] Ibid., p.51.
[36] Ibid., p.54.
[37] Ibid., p.57.
[38] Alfred North Whitehead, *Science and the Modern World*, New York: Mentor Books, 1964, p.100, my emphasis.

For Whitehead, where earlier science assumed that an object such as a stone was a fixed unchanging entity, 19th century science recognised that it was dynamic at a molecular level, and instead posited molecules as fixed unchanging entities. In doing so science refused to acknowledge that the molecule was in fact 'a historical event' having 'to do with all that there is, and in particular with all other events.'[39] Thus the study of any 'organism' would 'also include the aspects of the event in question as grasped in other events, whereby those other events receive a modification or partial determination.'[40] Bensaude-Vincent and Stengers take up this idea by considering the differences between molecules in the 'aseptic space of a laboratory' and the body in which pharmaceuticals must operate - 'the living labyrinth whose topology varies in time'.[41] Barry avoids the simple environmental emphasis of this example (which doesn't seem to do justice to Whitehead's notion) and multiplies the factors which might modify the molecule to include the 'economic, regulatory and legal.'[42] He explains that a new drug cannot simply work at the physical molecular level, it must succeed in an environment which includes regulation, publicity, effectiveness and so on. In this way, suggests Barry, these new materials are 'informed', they are increasingly 'rich in information.' Barry's concept of informed materials gets closer than Bensaude-Vincent and Stengers' example of the lab and the body to Whitehead's idea of entities folding into and informed by each other because he moves away from considering the environment as only external to molecule and therefore only affecting or modifying it. As he explains;

> This would acknowledge that material objects (such as molecules) exist in an informational and material environment, yet this environment cannot, as Whitehead argued, be considered as simply external to the object. An environment of information and material entities *enters into* the constitution of an entity such as a molecule.[43]

It is however difficult to see what Barry might mean by this 'entering into'. He is clear that the molecule does not embody information but he wants also to avoid an account of information acting from outside the molecule. It is also (as he himself points out) difficult to imagine how molecules can get 'richer and richer' in information since for Whitehead all entities are (and have always been) informed by all other entities. They are part of what Whitehead calls an 'extensive continuum':

> All actual entities are related according to the determinations of this continuum; and all possible actual entities in the future must exemplify these determinations in their relations with the already actual world.[44]

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[39] Ibid., p.97.
[40] Ibid., p.98.
[41] Bensaude-Vincent and Stengers, cited in Barry, 'Pharmaceutical Matters', p.57.
[42] Barry, 'Pharmaceutical Matters', p.57.
[43] Ibid., pp.58-9.
[44] Alfred North Whitehead, *Process and Reality*, New York: The Free Press, 1978, p.66.

Within such an extensive continuum molecules already inform each other and have always been constituted by their informational environment. In Whitehead's relational ontology all historical entities or events are in relation to each other. In his lecture on the 19th century in *Science and the Modern World* he writes, 'We must start with the event as the ultimate unit of natural occurrence. An event has to do with all that there is, and in particular with all other events.' [45] In this sense, there is no outside and no inside and historical entities are 'transformed through their changing associations.'[46] To recognise information, in Barry's sense, would be to recognise that these associations transform objects such as molecules and 'cannot be considered as simply external to the object.'[47] The problem Barry has with his concept of information is that Whitehead's concept of associations only really allows him only to say that all molecules are informed and take historical forms:

> They are part of increasingly dense, spatially extended and changing informational and material environments formed not just through laboratory syntheses and tests, but through virtual libraries, computational models and databases.[48]

In this sense there would be nothing particular about the fact that pharmaceutical compounds which are designed today 'are not simply bare molecules'. There is only an intensification of information in today's pharmaceutical materials, their molecules are saturated with information. This seems only to render the informational constitution of material more visible:

> In part the conduct of contemporary pharmaceutical R&D is of general interest precisely because it makes the informational content of invented materials more clearly visible.[49]

I think Barry is right to suggest that pharmaceutical compounds designed today for particular uses within a vast industrial and regulatory framework are 'enriched in new ways'[50] and that there is a shift in the kind of forces involved in their constitution. But it is hard to see how the general claim that molecules are informed helps to explain this as a new condition, or even one in which chemicals may be becoming 'richer and richer in information'. For Simondon, however, the forces which come into resolution during individuation are internal to the individuating system, and the milieu only arises when individuation is no longer in process and the individuating system has separated out into modes which no longer have the potential for further communication. Simondon's account might provide a way to understand the 'information' Barry describes with so much insight, as internal to an individuating system, and as a *new* material condition.

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[45] Whitehead, *Science and the Modern World*, p.97.
[46] Barry, 'Pharmaceutical Matters', p.57.
[47] Ibid., p.59.
[48] Ibid., p.65.
[49] Ibid., p. 52.
[50] Ibid., p.65.

3. Informed materials: the performance-led material as a 'complete system'

> Information, at least as Simondon understands it, occurs whenever a transductive event establishes an intermediate level at which disparate realities can be articulated together. Information in this sense does not arrive from outside a system and need not be a discrete event. It eventuates whenever the 'unresolved incompatibility of a system becomes an organizing dimension in the resolution' of that incompatibility.[51]
>
> Adrian Mackenzie

Barry credits Bensaude-Vincent and Stengers with a 'concept of informed materials' although they do not refer to or develop this concept outside the brief passage he cites. The concept of 'informed materials' is really his own invention that builds on a term they make use of. But in the quotation he cites, Barry omits the strongest claim they make in concerning informed materials that informed materials 'embody a different notion of matter.' We have seen that to account for this different concept of matter using Whitehead's discussion of the molecule we run up against similar difficulties to Barry. Conceiving of a molecule as a 'historical route of events' does not allow us to make claims that the concept itself is subject to historical change. Are Bensaude-Vincent and Stengers simply suggesting that because of informed materials the problems with the hylomorphic concept of material are more apparent and we need, say, to turn to a more adequate concept such as Whitehead's? Or, as it sounds, are they saying that functional materials require a different concept of material, to materials which are simply prepared for shaping? Might these new performance-led materials (and indeed materials such as glass which may only be new in the sense that they are produced within an industry which is performance-led) 'embody a different notion of matter'? Does it make any sense to think of them in terms of this kind of rupture?

Simondon's account of individuation might be a more productive context to think through this problem, despite the fact that he is not concerned with proposing a theory of matter or material. It should be said at the outset that although Simondon makes use of a concept of 'information' it is very different to the one we have been discussing in relation to Barry's work, and needs to be understood in the context of other notions he develops – particularly 'metastable equilibrium' and 'preindividual reality' or 'preindividual being'– which I will set out in this section. Although Simondon takes the term 'information' from cybernetics he goes to great lengths to distinguish his notion from what he sees as a prevalent misreading of it – that it arises from outside a system and has an organising force – in the same way that form can be misconceived if it is understood in the terms of the hylomorphic schema. Toscano summarises his approach as follows:

[51] Mackenzie, *Transductions*, p.49.

> Simondon's approach to information is twofold. On the one hand, he applies to information theory and cybernetics the same critical parameters that lay the groundwork for an operational ontology of individuation; on the other, he presents a reformed concept of information as the key to a philosophy that would finally give the preindividual its due. That the modern concept of information is here subjected to critique should come as no surprise. We could even say that in its most 'dogmatic' uses, whether in philosophy or science, it is the bearer of a grand synthesis of the three main principles of individuation that come under Simondon's attack: as unit-measure which atomistically composes organization and quantifies degrees of order, it mimics atomism; as an expression of the unilateral relation between model and copy, it reinstates the Platonic archetype; finally, as a source of organization which is separate from matter or 'substrate independent', it is the contemporary heir to Aristotelian hylemorphism. In order to counter the widespread tendency to consider information as the principle of individuation that can synthesize all others, Simondon is obliged to rescue it from hypostasis and track its specifically operational reality.[52]

Simondon's concept of information is introduced in the section on crystallisation in the 'Form and Energy' chapter which follows 'Form and Matter' where most references to information appear as footnotes, as a kind of supplementary text which relates concepts from further on in the text back to the clay/mould system. Simondon is particularly interested in the way that a crystal seed entering a supersaturated crystal solution begins the formation of the crystal. He describes the solution as in 'metastable equilibrium', a state which in scientific terms implies a system which is neither stable or unstable, but rather on the point of changing state if there is some kind of very slight interaction, such as when a sound or slight motion can bring about an avalanche. In the 'Form and Matter' chapter a footnote explains first that the seed in the case of the clay/mould system is the mould, and gives two further examples of natural systems which form due to a seed:

> The mediating singularity is the mould here; in other cases, in nature, it can be the stone which starts the dune, the gravel which is the germ of an island in a drifting river of alluvia: it is of the intermediate level between inter-elementary dimensions and infra-elementary dimensions.[53]

Simondon raises a number of issues in relation to the seed and the amorphous crystal solution. First, he notes a change of state from isotropic to geometric, which is not in any sense ordered by the seed crystal, only set in motion by it and depends on the potential energy already available in the metastable equilibrium:

> The initial structure of the seed can't entail positively the crystallisation of an amorphous body [corps] unless the latter is already in a metastable equilibrium: there must be a certain energy in the

[52] Toscano, *The Theatre of Production*, p.142.
[53] Simondon, *L'individu*, p.36. As translated in 'The Physico-biological Genesis of the Individual'.

> amorphous substance [substance] which receives the seed crystal, but as soon as the seed is present, it possesses the value of a principle. [54]

Although the seed has no ordering potential to organise the solution, it appears to have the value of a principle. Although it comes from outside it will be incorporated into the structure of the crystal once individuation commences, and is internal - not external - to it. We can't 'speak therefore of an energy exterior to the crystal, because this energy is carried by a substance which is incorporated by the crystal in its own growth.'[55] This is an important distinction between crystallisation and the clay/mould system where the mould – as seed or 'mediating singularity' - is not incorporated. The notion of incorporated seed will enable Simondon to build his account of the individuation of the vital organism, and to set up an alternative to the notion of the gene as a kind of informational blueprint for the genesis of an individual.[56] In each of these cases what is crucial for Simondon is that the seed is not an organising principle, and that it is internal to the individuation. It must also be the case that the seed has some kind of identity with the metastable equilibrium, just as the metastable equilibrium must be able to receive it:

> Furthermore, the interiority of the structure of the crystal germ isn't absolute, and doesn't govern in an autonomous manner the structuration of the amorphous mass; in order for this modulating action to exert itself, it is necessary that the structural germ brings a corresponding structure to the crystalline system in which the amorphous substance can crystallise; it is not necessary that the crystal germ is of the same chemical nature as the amorphous crystalline substance, but there must be identity of the two crystalline systems, in order for the harnessing of potential energy contained in the amorphous substance to be able to operate.[57]

For Simondon information is not the seed entering the solution but the compatibility between them. In the following this is described as 'a certain potential' of the metastable equilibrium for the seed to be 'meaningful' in as much as it can bring about release of the potential in individuation. In this sense information is a potential itself already within the system:

> Information must be understood in the real conditions of its genesis, which are the very conditions of individuation in which it plays a role. Information is a certain aspect of individuation; it demands that before it there is a certain potential, in order for it to be understood as having a direction (without

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[54] Ibid., p.106.
[55] Ibid., p.107.
[56] He also examines the way that individuation of the crystal only occurs at its surface, which he will distinguish from the living being where individuation also has an interior power.
[57] Ibid., pp.107-8.

> which it is not be information but only weak energy). The fact that information is genuinely information is identical to the fact that something individuates.[58]

The generation of the individual, then arises out of an active mediation (information) between seed and metastable equilibrium, or what are called throughout the book 'two realities of different orders of magnitude'.

> The initiative of the genesis of substance returns neither to the raw material as passive nor to the form as pure: it is the *complete system* that generates, and it generates because it is a system of actualization of potential energy, joining together in an active mediation two realities, of different orders of magnitude, in an intermediate order.[59]

Taken together this is the 'complete system' of genesis: metastable equilibrium, mediating singularity and information are all internal to it. This system is also what he calls being in which the individual is only one phase.[60] Preindividual being, when there is only potential for individuation is a metastable state in which there are no phases, and when individuation is over, when there is no longer potential for further growth of the crystal, there is only an individuated individual (for Simondon no longer strictly speaking an individual) and the milieu:

> There is a correlative to the individual, constituted at the same time as it through individuation: the milieu, which is being, deprived of that which has become the individual. Only the couple individual-milieu can allow us to go back to individuation. Individuation is that which makes the dephasing of being into individual and milieu appear, on the basis of pre-existing being capable of becoming individual and milieu.[61]

Thus the milieu only emerges when there is no longer the potential for further communication in the system. So to return to Barry's notion of the informed molecule or material, we see marked differences with Simondon's account of information. First, for Simondon it is the germ or 'mediating singularity' which enters into the metastable equilibrium, rather than information, and it is through its capacity to mediate the individuation that it acts as information. Second, the 'mediating singularity', the metastable equilibrium and their informational relation comprise a 'complete system' that appears to be bounded and discrete, rather than belonging to the 'extensive continuum' Whitehead envisages as the environment of entities. It is the potential

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[58] Ibid., p.288.
[59] Ibid., p. 43
[60] 'The preindividual being is *being without phases*, whereas being after individuation is a phased being... The individual is not considered as identical to being… the individual is *an individual of being*, *an individual grafted from being*, *not the first and elementary constituent of being*, it is a manner of being, or rather a moment of being.' Ibid., p.273.
[61] Ibid., p.282.

for compatibility or exchange which organises the system.[62] Third, the milieu only emerges when there is no possibility of further individuation or relation, and there is no potential in the system.

At this point it might seem that Barry's insight that these new 'materials à la carte' are 'richer and richer in information' and that there is a multiplication of the kinds of forces involved in the formation of performance-engineered pharmaceuticals gets lost. But what if we think of these forces as preparations? Rather than acting on the individual (or molecule) as information they are part of the preindividual reality out of which the individuation of these new materials is generated. As such, these additional forces – the testing, quantification, standardisation and specification or design for specific use – could be understood in Simondon's terms as part of a performance-based 'complete system', and would then be specific and internal to the system. This involves taking two steps which are not made by Simondon in his account of the technical system, the only system in *L'individu* where we find these preliminary operations described. The first is that I extend his account of preparations to include the extra-physical. The second is to assume that if both clay (which takes the part of metastable equilibrium) and mould (as mediating singularity) are understood by Simondon as prepared, then so too must the possibility of the informational relation which transforms potential to a change of state or formation.

Simondon constructs his argument in *L'individu* by introducing each individuating system, one after the other – technical system, physical system, vital system, and the psychic/collective individuation which will be more fully explored in his *L'individuation psychique et collective*[63] – and each example introduces new concepts and also leaves behind the last, which it becomes apparent, was already informed by the next. This method might itself be understood as transductive since in part it is out of the relations between the systems that operations and concepts emerge. But this procedure also means that he does not return to the preparations introduced in the first chapter 'Form and Matter', apart from in a few footnotes which seem to perform the function of relating back terms introduced later in the text. To read Simondon's preliminary operations, then, in terms of the later discussions, is to make assumptions that are outside his argument. It seems clear, however, that Simondon's description of the chains of preliminary operation which prepare clay and mould for their encounter concerns the making of an individuating system that is constructed rather than naturally occurring, which - as with the crystal solution - will harbour the potential for individuation and the capacity to receive or come into relation with the seed, which is in the case of the mould, itself prepared for this dynamic operation of form-taking:

> The technical operation prepares two half-chains of transformations that meet at a certain point, when the two created objects are compatible, are on the same scale; this comparison is not single

[62] Simondon explains this in his example of the pendulum, in which it is the exchange of potential to actual (kinetic) energy and the potential for transformational relations between these two states which establishes it as a system, not an arbitrary grouping of thought. See ibid., p.77.
[63] Simondon, *L'individuation psychique et collective*.

> and unconditional; it can be done through stages; what one considers as single formalization is often only the last episode of a series of transformations.[64]

These two orders are described as two different kinds of inter-elementary chains which meet at a certain point when they are compatible. And, interestingly, the mould is described as comprising sets which are allied with more social operations - working, workshop, press – while the clay is allied with more physical molecular operations:

> The mold, thus, is not only the mold, but the technical term of the inter-elementary chains, which comprise vast sets locking up the future individual (working, workshop, press, clay) and containing potential energy. The mold totalizes and accumulates these inter-elementary relations, as prepared clay totalizes and accumulates the molecular inter-elementary interactions of aluminium hydro-silicates. [65]

As we have seen, Simondon explicitly designates the mould as taking the role of the 'meditating singularity' or seed crystal, but here it is not weak force as in crystallisation, and it has been prepared by 'vast' sets. The orders of magnitude which become compatible in the clay/mould system are still different and asymmetrical, but they are not characterised with the same direct analogy to the scientific notion of the metastable system (such as the change of state from snowy mountainside to avalanche). And it is clear too, that although this example has aspects of self-organisation in the dynamic way the clay is described inside the mould, this individuation is prepared by operations which are institutional and social as well as physical. In his most explicit use of the term 'information' in the 'Form and Matter' chapter he seems to suggest that the action of singular information is masked by the preparation of the clay, which appears to be organised by form according to the hylomorphic schema rather than what we will discover in his later discussions is the mutual compatibility between the two that enables the release of potential energy:

> The dominance alone of the techniques applied to materials rendered plastic by preparation can ensure to the hylomorphic schema an appearance of explanatory universality, because this plasticity suspends the action of historical singularities provided through the material. But it is a question there of a limit-case which masks the action of singular information in the genesis of the individual.[66]

So although 'preparations' are unique to Simondon's discussion of the manufactured clay/mould system, the communication between two orders of magnitude they make possible, and the individuating actualisation of individuation is common to all his examples of individuating systems. It is as preparations, then, that I want to

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[64] Ibid., p.32. As translated in 'The Physico-biological Genesis of the Individual'.
[65] Ibid.. p.32, fn. As translated in 'The Physico-biological Genesis of the Individual'.
[66] Ibid., p.59.

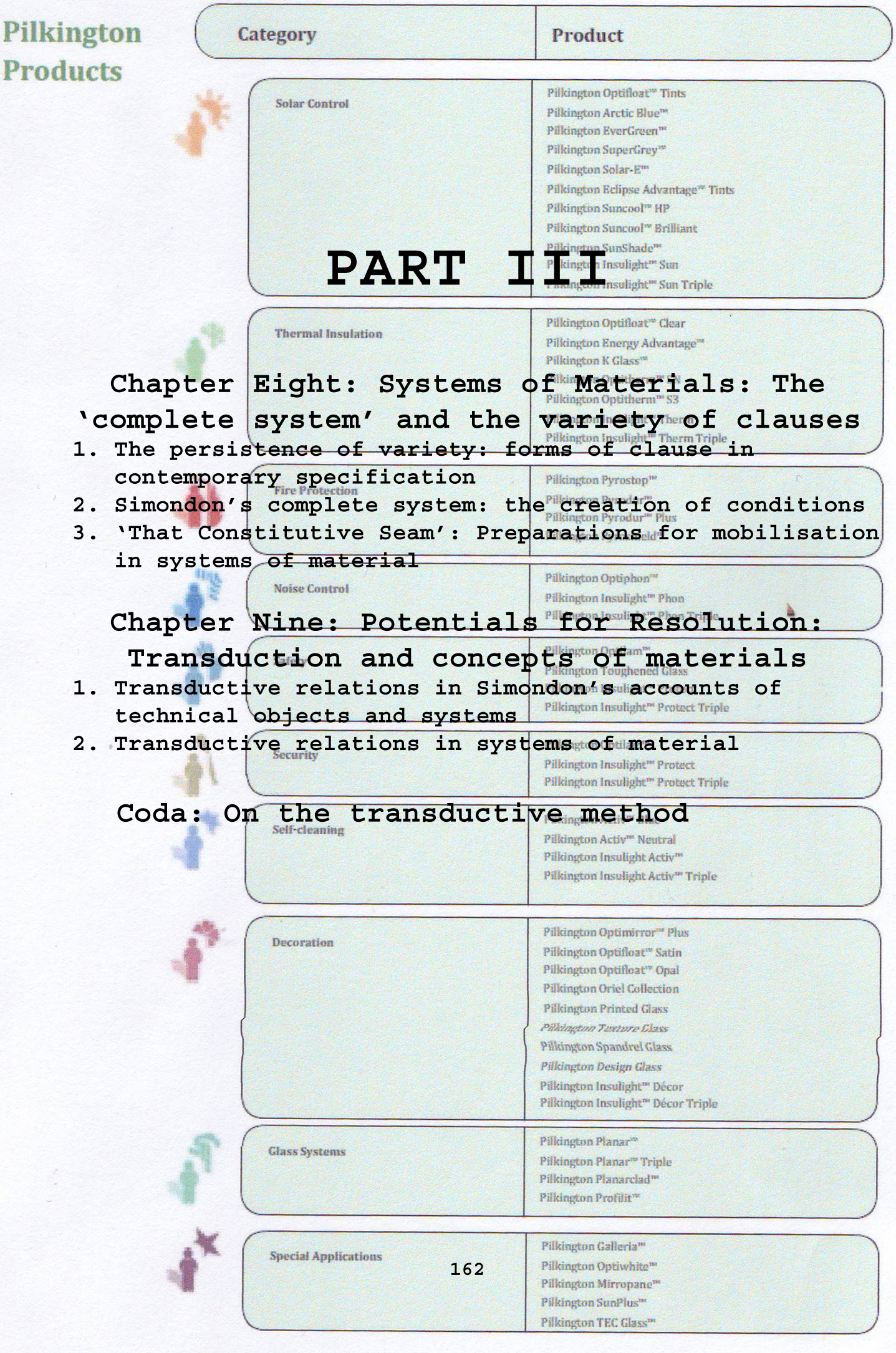
propose we think of the new kinds of operations which are involved in the formation of performance-specified and engineered materials, and in this account they become internal to the 'complete system' which constitutes such a material. Within Simondon's ontology it is perfectly possible for there to be discrete systems with the capacity for individuating and for new individuating systems to emerge – taut with different sets of potentials which are actualised through relations specific to the system. Furthermore he puts forward a more complex account of the whole [ensemble] which may be comprised of a number of subsets:

> One could say that information is at once interior and exterior; it expresses the limits of a subset; it is the mediation between each subset and the whole. It is the internal resonance of the whole in so far as it comprises subsets; it realises the individuation of the whole as a development of solutions between the subsets which constitute it: it is the internal resonance of the structures of the subsets inside the whole: this exchange is interior with respect to the whole, and exterior with respect to each of the subsets.[67]

This description is not tied to a specific example of an individuating system and it is not easy to imagine how it might operate, but it makes clear that although Simondon develops his argument out of examples in which there are only two orders of magnitude which are resolved in individuation (or at least only two which he concentrates on) he does not want to limit his notion of the 'complete system' to this apparently binary, if asymmetric, relation. His model is intended to allow for a number of subsets which could be in a system of exchange together.

In the case of the performance-specified material I want to propose that we are seeing a 'system of materials' that is discrete and different to other 'systems of materials' such as the apparently hylomorphic one, which comprises preliminary operations which are in the main physical, so that a mould or rigid formwork can limit the energetic processes of wet clay or setting concrete. As we have seen, the performance-specified material involves a more varied range of operations in its formation. Regimes of testing and standardisation make it possible for the quantification of both the properties of materials and values associated with the structural and social uses they are to be put to. They establish the possibility of exchange or relationship between materials and a given service. In performance-engineered materials these goals become internal to their physical arrangement. It might be, then, that the 'mediating singularity' in the case of a performance-specified material (if indeed we need to isolate only one of these 'solutions between the subsets') is its specific use – rather than the mould. And this could be a material constituted in a radically new way – within a new system of material. This would not constitute a 'new notion of matter' but rather a 'new notion of material' with profound implications both for the ways we build and the ways we traditionally conceive of materials.

[67] Ibid., p.290.



PART III

Chapter Eight: Systems of Materials: The 'complete system' and the variety of clauses

1. The persistence of variety: forms of clause in contemporary specification
2. Simondon's complete system: the creation of conditions
3. 'That Constitutive Seam': Preparations for mobilisation in systems of material

Chapter Nine: Potentials for Resolution: Transduction and concepts of materials

1. Transductive relations in Simondon's accounts of technical objects and systems
2. Transductive relations in systems of material

Coda: On the transductive method

Chapter Eight: Systems of Materials: The 'complete system' and the variety of clauses

> It is the *system* constituted by the mould and the pressed clay which is the condition of the taking of form; it is the clay which takes form according to the mould, not the worker who gives it form. The man who works prepares the mediation, but he doesn't accomplish it, it is the mediation which accomplishes itself by itself after the conditions have been created.
>
> Gilbert Simondon[1]

Simondon's technical system comprises *both* individuation itself and the creation of the conditions in which it arises. It is straightforward enough to consider the process-based clauses for concrete casting in terms of this system. They describe the work of preparing concrete and mould which creates the conditions in which the operations of individuation unfold. To understand the performance clause in these terms we have had to stretch Simondon's account: first to suggest that although performance specification doesn't describe process at all it necessarily makes specific use pre-inscriptive or preparatory. Second, we have extended Simondon's limited range of preliminary operations to include industrial, social and regulatory preparations such as testing, quantification and certification. Here I follow Latour and Barry in their refusal to separate the social and technical – a refusal that to some extent is already determined by the choice to look at building materials via the architectural specification.

In this concluding section I want to return to the variety of forms of clause and propose that they are evidence of a variety of technical systems or 'complete systems' in Simondon's sense, appearing here as 'systems of materials'. In a general sense the notion of a system shares much with an 'arrangement' - a term Barry uses as follows, in his book *Political Machines: Governing a Technological Society*:

> Instead of drawing a line between the social and the technical, one might instead analyse *arrangements*: of artefacts, practices and techniques, instruments, language and bodies.[2]

First, an arrangement is understood as a set of interactions between heterogeneous modalities – artefacts, practices, techniques, bodies and so on. If these interactions were more-or-less limited to the physical in the case of the process-based clause – formwork, wet concrete, energy and the occasional mention of a fabricator's lunch break – in the case of the performance clause they involved the full set of players which Barry mentions. Second, an arrangement carries the sense of having been arranged. The relations between an arrangement's terms are themselves constructed, they are not merely the result of an all-pervasive

[1] Simondon, *Du Mode*, p.243.

[2] Andrew Barry, *Political Machines; Governing a Technological Society*, London: Athlone, 2001, p.11.

interconnectedness. It is interesting to note, also, that in the case of the process-based clause, for example, the effects of the system of material do not extend to the end user of the building. They are limited to the material effects of the dynamic system within the mould, and in some rare cases to its effects on the fabricator (for example where they are asked to show judgement about the workability or stiffness of a mix), whereas in some forms of performance clause the effects on the end user become the central organising principle. Third, the arrangement is not an extensive continuum like Latour's network, but a particular and discrete configuration, of which there may be many, existing side by side.

Simondon's 'complete system' shares some similarities with this interpretation of an 'arrangement'. There can be more than one system (indeed *L'individu* can be read as the presentation of plural systems from wet bricks to single cell organisms to social beings such as ourselves), and at least in the case of the technical system there may be some intentionality in its arrangement, at least in so far as the conditions for individuation are created. But Simondon's technical system is also very specific. It is organised around individuation (and constituted then by a kind of interior tension or potential for compatibility rather than by external limits). It comprises two main phases – the metastable state which is prepared and rife with potential for resolution, and individuation itself in which the resolution between at least two previously incompatible orders of magnitude unfolds and 'accomplishes itself by itself.'

These specific aspects of Simondon's technical system are important because, first, they include preparations in the definition of the system. As de Beistegui has written, 'He prefers to speak of "systems" rather than "substances."'[3] It is not a case of positing a substance which can be prepared this way or that with different outcomes. Rather it is a case of those preparations altering altogether the system itself – such that in the case of building materials, a different form of description is required for each system of material (and not merely for each substance, or historical era, or contractual situation). It is the incorporation of preparations into the system of material and its relation to the variety of forms of clause that will be the main subject of this chapter. Second, in Simondon's technical system it is not the individual which is created, but the conditions for individuation or mediation. This is the most surprising and speculative result of pursuing his account of individuation in relation to building materials and the forms of clause. What is prepared is not the material itself, but the conditions for its possible mobilisation which we can think of in terms of a communication between orders of magnitude. The details and implications of this aspect of the system of material will be explored in Chapter Nine.

It should be said, however, that my insistence on the persistence of variety in the forms of clause is not the only direction we could take. For many commentators, both those engaged in the technical practices surrounding specification as well as those examining broader cultural, economic and architectural shifts in the

[3] de Beistegui, 'Science and Ontology; from Merleau-Ponty's "reduction" to Simondon's "transduction"', p.118.

current context of advanced capitalism, performance is becoming a dominant paradigm. Some observe the emergence and increasing dominance of what Jean-Francois Lyotard has called the 'performativity principle' (the imperative to be productive) across a number of practices and see it as nothing less than a new form of legitimating knowledge. In *Perform Or Else*, for example, Jon McKenzie identifies the rapid extension and expansion of 'performance concepts' across domains from techno-performance to performance studies 'an emergent stratum of power and knowledge,' that replaces discipline.[4] At least in so far as the specification of building materials is concerned, I reject this position. Before moving on to look at the system of material in more details I will show first that even in contemporary performance-led specification there is a proliferation of forms of clause, and that it is precisely because performance specification demands particular preparations and contractual situations, that to set it up as a dominant form is only to make marginal the great variety of systems of material that are in use (specified and un-specified) in building today.

1. The persistence of variety: forms of clause in contemporary specification

Both specification consultants Schumann Smith and the in-house specification team at Allies and Morrison aim to produce documents which avoid closed specification for those areas where the detailed design will be carried out by specialist sub-contractors. These specifications are performance-led. They are designed as improvements to the NBS (which is still used by at least half of the architectural practices in the UK[5]) in which performance clauses are the exception rather than the rule. 'As she stands,' Gelder says, the NBS 'does not support outline specifications or performance specifications very well.'[6] These new streamlined specifications are intended to be more up-to-date, more responsive to change and most importantly, more claim-proof than the NBS with its assortment of forms of clause and greater number of closed specifications. These factors might lead us to conclude that performance specification is on the ascendancy, soon to supersede other forms of clause, that the NBS will soon catch up with this more advanced version and that specification practice, as so many other contemporary practices and techniques is also governed by the 'performativity principle'.

In Lyotard's view 'the imperative for performance improvement and product realization' has been driven by the desire for increased profits.[7] According to Mckenzie who draws heavily on Lyotard's analysis in *Perform*

[4] Jon McKenzie, *Perform or Else: From Discipline to Performance*, London: Routledge, 2001, p.18.
[5] Email correspondence with John Gelder, NBS contents manager, 20.07.2009.
[6] Email correspondence with John Gelder, 30.07.2009.
[7] Jean-Francois Lyotard, *The Postmodern Condition: A Report on Knowledge*, trans. Geoff Bennington and Brian Massumi, Minneapolis: University of Minnesota Press, 1984, p.45.

or Else, but also makes the interesting move of relating changes in engineering or what he calls 'techno-performance' to shifts towards performativity in business management and performance studies[8]:

> Performance means effectiveness, and effectiveness that, in most cases, must be quantified for measurement and endlessly qualified for evaluation.[9]

No doubt these same factors influence the shift towards performance specification in building. But apart from telling us little about the effects of this shift (beyond the imperative to 'perform or else') and concentrating primarily on causes, both authors make rather grand claims for the power and centrality of the performance principle. For Lyotard it has come to legitimate knowledge in place of truth. For McKenzie it has even replaced discipline as the contemporary 'onto-historical formation of power and knowledge':

> Performance must be understood as an emergent stratum of power and knowledge... and will be to the twentieth and twenty-first centuries what discipline was to the eighteenth and nineteenth, that is, an onto-historical formation of power and knowledge.[10]

Apart from the fact that McKenzie finds little to suggest that performance in the different domains has much more in common than emergence at a similar historical moment (which he identifies particularly with cold war engineering projects in the US in the1950s[11]) and a general emphasis on efficacy, a first problem with McKenzie's study of techno-performance is that he tends to use examples which are already performance-engineered. His main case study is the Space Challenger - a highly engineered technology whose parts must subjected to endless tests and perform in highly predictable ways. But modern space transport is hardly a representative technology and it cannot simply be extended to other technical artefacts.[12] Of course if we look at examples like this we will see performance as central, as it is in high quality facade-engineered glass

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[8] The most important and interesting aspect of McKenzie's thesis is that he tracks the possible relationships between a concept of performance which is seen as 'liminal', 'marginal', 'on the edge' and 'a reflexive transgression of social structures' in performance studies but is concerned with efficiency, productivity and normativity in organisational performance management and technological performance, and raises some critical questions for the grip of 'performativity' in many areas of cultural studies.

[9] McKenzie, *Perform or Else*, p.97.

[10] Ibid., p.18.

[11] This claim is made a number of times throughout the book, see for example, ibid., p.12. Disappointingly the simultaneous emergence of these different domains remains one of his key arguments for their interrelatedness. In terms of performance specification, it might be noted that Atkinson notes (with McKenzie) that the performance specification of building materials also emerges in the US, but in the 1920s/30s - rather earlier than McKenzie's cluster of concepts and practices. Atkinson, 'Performance Specification', p.115.

[12] McKenzie supplies the following list of artefacts (including building materials) which have been advertised using performance technology: 'Air fresheners, roofing insulation, bicycles, carpets and rugs, powerboats, wallcoverings, drain panels, cleansing towels, car-stereo equipment, bakeware, aquarium filters, tires, fabric, window film, woodworking knives, automotive timing chains, foil containers, audio antennae, deep-fat fryers, embossing tools, mop handles, music synthesizers, casement windows, and eyeliners. The list is compiled from a selection of items which have some variant of the word 'performance' in their product names. McKenzie, *Perform or Else*, p.11 and expanded later in the book, pp.104-6.

rain screens. I will return to the question of exclusion in the second half of this section. A second problem, at least as it pertains to the specification of building materials is that even in the performance-led specifications of Allies and Morrison and Schumann Smith more forms of clause are in use than just the performance clause. Indeed both Tony Brett (of Schumann Smith) and Mark Taylor (of Allies and Morrison) explained that if used on its own performance specification leaves the document too open for a contractor to price. Rather than resort to straightforward traditional prescriptive specification to solve this problem they have devised new forms of clause to augment performance specification which nevertheless leave specification open.

Both Brett and Taylor see the existing range of forms of clause in the NBS as a problem they try to avoid in their specifications. Schumann Smith have compiled a database which gives different versions of clause for any given material or component in each of three categories: pure performance specification, 'descriptive' specification – performance augmented by what they call 'design' or 'visual' intent - as well as traditional prescriptive specification:

A	**GENERAL REQUIREMENTS**
A.1000	**FORMAT, DEFINITIONS AND USE OF THE SPECIFICATION**
A.1001	Specification Format
d)	The types of Specification are as follows:
i)	Prescriptive (P): The section is a detailed materials and workmanship Specification reflecting the Employer's Retained Architect's design solution. The contractor may be required to provide some fabrication details but design responsibility remains with the Employer's Retained Architect.
ii)	Descriptive (D): The section, when read with the Design Drawings, indicates the visual intent with which the Contractor must comply when undertaking the Detailed Design. The Contractor retains full responsibility for completing the Detailed Design and execution of the works and for meeting the specified performance criteria. [13]

They consider the selection of one of these types to be interchangeable. Each can be applied as easily to one material produced in specific conditions, as to another produced in entirely different circumstances. Any material can be represented in any of these three ways and selection just depends on the contractual situation. Where the architect has sufficient knowledge about a detail they prescribe it. Performance specification can be used when the detailed decisions are to be left to a specialist subcontractor, or descriptive specification can be selected if the architect wants to retain some control over the look of the detail. In practice, the forms are not interchangeable in this way. Some materials such as in situ concrete resist or demand certain forms of clause whatever the contractual situation. Natural stone, as in the indicative clause for Portland Stone below, is still specified through a list of properties, such as geographic source, which are not given for other materials. Other materials such as plasterboard may be specified without the

[13] Specification for the H...y Building, (2006).

detail of their properties, perhaps because this information is given in standards outside the specification.[14] While Schumann Smith organise these three forms of clause they use into separate categories in the document,[15] Taylor tries to streamline the categories yet further. For example, the performance matrix we saw in Chapter Six (see p.130) has been developed to gather together like information, reduce unnecessary repetitions and exclude extraneous information – such as specifications for acoustic performance in a storage area. So although they organise their forms of clause into separate categories, and avoid the use of some traditional forms such as process-based clauses, they still use a range of forms of clause and devise others. For example, where prescriptive clauses are used they are not to be taken as outright but rather to be 'deemed indicative' and as representing the architect's 'design intent only':

F10.1100	**SPECIFICATION AND SCOPE**
F10.1101	Descriptive Works...
...d)	Where a particular material, product or supplier is indicated in the Specification, such material, product or supplier shall be deemed indicative representing the Employer's Retained Architect's design intent only. The Contractor may complete the installation using that product, or such other confirmed as acceptable by the Employer's Retained Architect in writing, but shall remain fully responsible for the Detailed Design and Performance of the works. [16]

In some cases, where materials are given, they are explicitly named as indicative only as in the following clause for Portland Stone from a Schumann Smith Specification for the Q...t Building (2005) where Coombefield Whitbed is given as an 'indicative stone'. If the 'indicative stone' does not in fact conform to the other criteria given in the specification it is the contractor's responsibility to find another stone.

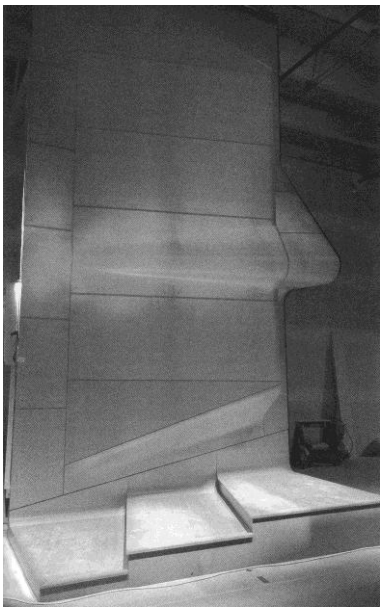
H51.2000 Systems/Materials and Fabrication
Eg. H51.2101 Portland Stone Type STN-02

a) Oolitic limestone to BS5628 Part 3
b) *Indicative stone:* Coombefield Whitbed
c) Quarry: Coombefield, Dorset
d) Colour: Buff white, to match and fit with accepted range samples
e) Texture: fine grained
f) Stone sizes. Large panel sizes up to 1500mm x 750mm as indicated on the Design Drawings *or as otherwise determined to meet the appearance and performance criteria*.
g) No saw mark shall be visible on the finished surface
h) Stone selection and testing to comply with the CWT 'Guide to the Selection and Testing of Stone Panels for External Use'[17]

[14] Brett at first explained this as a difference between natural and manufactured materials. Interview 01.11.07.
[15] Although in a more general sense all clauses in the specification are prescriptive, 'prescriptive' clauses here are those which direct the contractor towards a particular material or product, while 'descriptive' clause only give parameters and leave the selection open. As such the definitions almost reverse the philosophical distinction between the terms, where a prescriptive statement has the sense of 'ought' and a descriptive statement merely describes what is.
[16] Specification for the H...y Building, (2006).

In this indicative clause Coombefield Whitbed has a curious status. It is named, its geographic source is given, but it is put forward as a kind of idealised material to which the designer aspires, which can be used by the contractor if it satisfies the given criteria or substituted by another to satisfy the same criteria including appearance.

Another method is 'descriptive specification' developed by Schumann Smith and used when architects hand over the detailed design of a part of the building to a specialist subcontractor but still require some control over its visual appearance. It augments performance clauses with 'visual' or 'design intent', a new form of clause which ties the design drawings into the specification. Taylor explains that design intent is only relevant for the visible parts of the building, hidden structural steelwork would require only engineering input, whereas exposed steelwork would have 'architectural requirements' to specifiy visual intent. This is a peculiar division. It leaves the architect's role as designer of the visible. The architect designs the form and visual appearance of the building and gives the performance criteria, and the fabricator or engineer ensures that it conforms to these criteria within the parameters of visual intent. We might for example see the wood panelling which Diller & Scofidio + Renfro designed for the Alice Tully Hall at the Lincoln Center in New York as a case where the material is specified in relation to visual criteria but engineered to meet performance criteria (Fig. 8.1).[18]



8.1 Diller & Scofidio + Renfro, Alice Tully Hall, Lincoln Center, New York (2009) Mock up of 'wood' wall

The panelling had a complex undulating surface which needed to meet a range of visual and behavioural criteria along its length, described here by Ruben Suare, the lead architect at 3form who manufactured the composite wood and resin panels:

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[17] Specification for the Q...t Building (2005).

[18] Ruben Suare, 'Innovation Through Accountability in the Design and Manufacturing of Material Effects' in. Branko Kolarevic and Kevin Klinger (eds.), *Manufacturing Material Effects: Rethinking Design and Making in Architecture*, London: Routledge, 2008, p.57.

> One-inch thickness, a class-A fire rating, approval by MEA (Materials and Equipment Acceptance) to address toxicity requirements, formable to various complex geometries informed by acoustic requirements, no difference between solid and translucent panels when not lit, and capable of sequencing the wood throughout the concert hall.[19]

For the architects, wood was to look like book-matched timber panelling whatever way it functioned:

> There are intimacy issues, trying to get everything into the hall, and doing it all with one very strong and versatile element, and that is wood. Wood can be steps, wood can do all the sound shaping, and wood can produce the effect of the enveloping quality of light.[20]

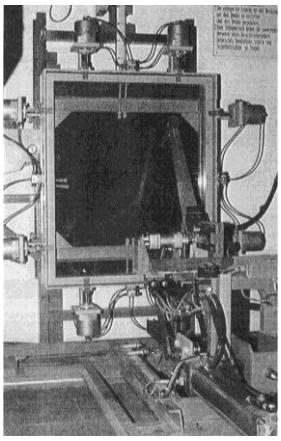
In terms of the material intentions for this choice of material, it is the look of the material that marks it out as 'wood' for the architects and must be consistent, while its properties can vary and are given in terms of performance criteria. In a sense, then, the traditional form/matter model is replaced here by visual intent/performance, in the same division that structures the Schumann Smith specifications.

What has become clear then, is that the rise of performance specification is in fact always supported by other new forms of clause alongside the use of some traditional ones, even within the most open specifications produced for contractual situations where the architect has little responsibility for the detailed design. It is also clear that performance specification is not only more appropriate in certain contractual arrangements, but also suits materials that have been designed and quantified in specific ways. Brett listed three key factors which lead to this kind of specification. Performance specification occurs where building is 'standards-led' and construction must be speedy, where construction is complex and specialist and the architect can identify only parameters but not a design solution, and where products and materials are being used that can be tested and manufactured so that each sample performs in the same way. The high quality facade-engineered modernist office blocks that Allies and Morrison build require design skills and construction expertise which exceed those of the architects. They use materials and systems which are highly engineered and produced on a large scale. Performance specification is limited to just some of the systems of materials which are used in building, and is still just one form of clause amongst a variety.

If even in these performance-led specifications we see the persistence of a variety of forms of clause, we might also ask to what extent we would simply fail to recognise a great range of systems of materials if we insisted that the performance clause is the dominant form about to make all others redundant. We have seen some of the regimes of materials engineering, testing and quantification which are needed to prepare a material for performance specification and that they range from the physical to the 'extra-physical'. Stone

[19] Ibid.
[20] Elizabeth Diller presenting the mock up, citied in Suare, 'Innovation Through Accountability', p.58.

needs to be reconstituted and rendered constant, glass needs to be tested for a great range of impacts from bullets to simulated human heads to the 'mechanical axe man' (Fig. 8.2) and floor finishes require the 'ramp test' amongst others to evaluate 'non-slipness.' Even when a material has been performance-engineered it may not necessarily be available for performance specification.



8.2 Mechanical Axe Man Test, Pilkingtons

In the following examples we see how the cleaning of a facade can move from being specified as a process (even in a Schumann Smith specification which goes to such efforts to eliminate the process-based clause wherever possible) to becoming internal to the material itself, and that even this degree of performance engineering needs another level of testing and quantification for self-cleaning to be performance specified. Below are some examples of the detailed descriptions from a Schumann Smith specification of the processes to be carried out in the removal of bird droppings from stone-clad facades:

C40.3102 Bird Guano Removal

a) Prior to cleaning any stone, all areas of bird dropping build-up (not to be confused with bird dropping staining which refers to light coloured staining on vertical surfaces) shall be removed with wooden or plastic scrapers. These areas shall then be cleaned with hot water and stiff bristle brushes...

C40.3104 Bird Staining Cleaning

Before cleaning the facades, all bird dropping staining on all facades shall be treated in the following manner:

a) Wash the surface thoroughly with high-pressure hot water
b) Thoroughly wash the entire area with pressurised water (450 psi)
c) Repeat the process as required to fully remove all stains.
d) Consult with the Employer's Retained Architect in connection with any stains not
e) removed by the specified treatment[21]

Despite the efficiencies of facade engineering and progressive specification the business of cleaning up after the birds still requires scrapers, stiff bristle brushes, hot water and elbow grease. It is still a straightforward

[21] Specification for the H...y Building (2006).

labour, a process that acts on the material and is unavailable to quantification. In the case of glass, the material is to be sufficiently hard so that it 'resists abrasion from agreed cleaning methods... without any noticeable change in surface appearance.' Cleaning is anticipated in the clause, but only in as much as it is not to affect the material, in particular, unsurprisingly in relation to the way it looks:

	Durability
H11.1424	Impact and Abrasion Resistance a) The works shall resist abrasion from agreed cleaning methods and maintenance systems without any noticeable change in surface appearance. Generally, surfaces shall be sufficiently hard (including glass coatings) to resist all reasonable impacts from hand-held objects in accordance with BS EN 358.[22]

In the case of glass facades however, Pilkington are marketing a performance-engineered product they call 'self-cleaning glass' (Fig. 8.3):

> Pilkington Activ™ Clear is the world's first true self-cleaning glass. Essentially it is the same as conventional glass, except for a unique dual action coating which works in two ways. First it uses UV rays to break down and loosen organic dirt (such as bird droppings) and then it uses rain to wash the dirt away.[23]

The glass works by using a microscopic photocatalytic layer which makes use of light to break down organic matter and another hydrophilic layer which prevents water from forming moisture so that it comes off in sheets taking the organic matter with it without leaving streaks.

8.3 Detail of self-cleaning glass

First it might be noted that the cleaning requirement has become internal to the material itself. As with other performance-engineered capacities, the requirement, which is as much to do with cultural values as it is with

[22] Ibid.
[23] www.Pilkingtonselfcleaningglass.co.uk/Pilkington-activ accessed 27.08.2009.

the long term durability or functioning of the building is now embedded in the material. Second, in their trade brochure for the product, Pilkington explain that there is only a BS EN number to cover the durability of Activ™ Clear but as yet there is none to cover 'self cleaning performance'.[24] So although this new material exists, and performs the task of self cleaning, it cannot yet be specified in performance terms. It is only when 'self cleaning performance' is quantified and tested that it will be possible to specify Activ™ Clear with a performance clause and at this point the material will be constituted in a new way, in relation to its capacity for autonomous cleaning. Rather than understand these as influencing factors, if they are understood as part of a system of material, they become internal to the conceptualisation of the material. The precise 'arrangement' of these factors, including the form of clause, is what constitutes the material, and only some arrangements can be performance specified.

At the other end of the spectrum are those uses of materials which simply do not fit any current specification practices. Even the NBS with its wide range of forms leaves some materials and methods of construction outside its scope. The NBS is carefully constructed to relate to industry norms and regulations. It must constantly be updated to include new materials and components arriving on the market.[25] New, unconventional or marginal applications of materials must be approved before they can be included in the NBS, and practitioners who make use of unusual or 'non-compliant' materials need to find other ways to specify them. These may be innovative uses of materials such as those not typically used in building or fabricated using experimental techniques, or salvaged materials which must be specified piece by piece for individual characteristics of each sample. In some cases these uses of materials will be excluded altogether from the specification, with no form of clause attached to their use, and alternative procedures must be developed to ensure the quality and control of materials which often alter the working relationships between builders, statutory control, contractors and architects. Nevertheless these should still be considered as systems of materials in so far as they are prepared and mobilised in building in specific ways even if they are not recognised formally in specification practice. Where unconventional construction is used it may mean that the specification is written from scratch without reference to a master specification as when Caroe and Partners Architects designed a 'primitive hut' to be built in a garden which used saplings stripped of their bark but otherwise untreated. The specification René Tobe produced on their behalf is refreshingly prescriptive and invents its own rather detailed descriptions:

> 4.3.2 Structure to be exposed columns and bracing members of solid timber saplings with bark stripped as shown on drawings. Vertical columns to be 8 no. 160mm diameter oak saplings with bark stripped columns. Diagonal and horizontal cross brace timbers to be 100mm diameter oak saplings with bark stripped brace timbers.[26]

[24] www.pilkington.co.uk/pdf/trade/Activ%20Technical%Update%20April%2009.pdf accessed 27.08.2009.
[25] In fact, manufacturers can ensure that their products are included in the NBS by paying for product placement there.
[26] Specification of MATERIALS and WORKMANSHIP For Greenhouse and Summerhouse at Richmond Terrace Gardens (2005), architects - Caroe & Partners, specification prepared by René Tobe.

At the Potters' Fields Park pavilion (2006) DSDHA described their innovative charring technique (Fig. 8.4) by adding their own clause into the main body of the NBS framework as follows (note that this is given as an 'indicative method'):

H21Timber Weatherboarding

01 Description:

- Work in this section, together with glazing, rigid sheet cladding, doors, etc. will be subject to Contractor design.
- Bespoke timber weatherboarding system with 'blackened charred' finish to be developed with Architect (see appendix A – indicative method)[27]

8.4 DSDHA Potters' Fields Park Pavillion, London (2008) Charring and finished surface

They included further details in Appendix A, where a series of process-based clauses describe the production of samples for approval by the architects in unusual detail:

01 Description of Tests:

- Provide *two* charred sample strips, prepared in a controlled environment of each ~~of the three timber types~~ in 1.2m lengths with the cross section as shown in diagram 1 below. These timber strips will be charred using ~~two different~~ the following method.
- Method 1
  Method 1 will use a high performance hand held propane gas burner with an output of 125 KW, see image 1 below. Each strip will be hand charred using this burner and will then be ~~sandblasted or dryiced~~ waterblasted to remove loose surface char. This will bring the surface to a 'clean to the touch' finish with the appearance of fire damaged timber. One sample is to be subjected to 'intense' waterblasting and the other to 'light' waterblasting in order to ascertain the appropriate aesthetic.[28]

Rather delightfully, a photograph of the recommended propane gas burner (Fig. 8.5) is included with this appendix.[29]

[27] Architectural Specification for Parkside and Blossom Square Kiosks, Potters' Fields Park (2006).
[28] Ibid.
[29] Ibid.

8.5 DSDHA Potter's Fields Park Pavillion, Image of high performanc burner appended to specification

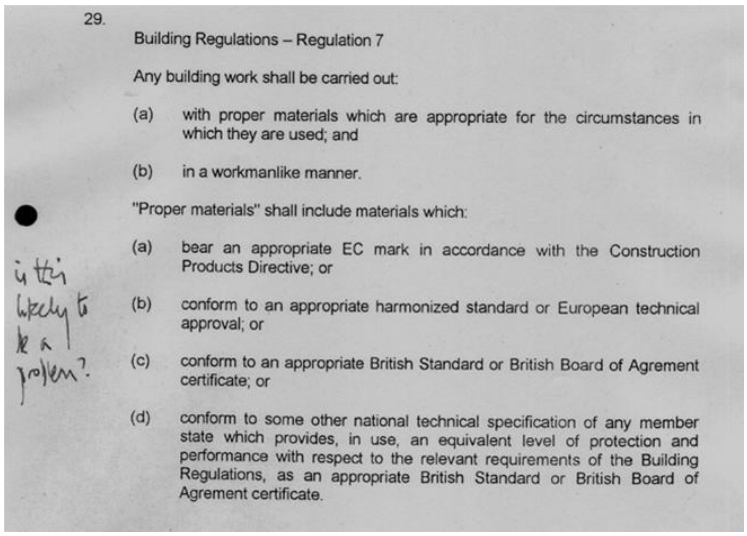
Here the architects avoid outright prescription by referring to their innovative method as 'indicative' within the main body of the edited NBS and by giving the process-based details of the method outside it in the kind of attentive language we might recall from Val Harding's specification for casting concrete walls. It is interesting to note also, that they refer to the achievement of an 'appropriate aesthetic' – which suggests the centrality of 'visual intent' without utilising the formal language and specification structure used by Schumann Smith.

DSDHA are able to adapt the NBS to specify their innovative material techniques but Cottrell & Vermeulen Architecture, a practice who integrate the use of salvaged materials into some of their building projects, prefer not to write specifications at all. Instead they work closely and usually with the same contractor, ensuring quality and workmanship through an ongoing relationship of trust, which makes the need for formal specifications redundant.[30] In this case material innovation is possible because of contractual arrangement that itself lies outside normative practice. The Stock Orchard Street 'straw bale house' designed by Sarah Wigglesworth Architects (SWA), used a range of materials and techniques, many of which were invented specially for the project such as cement-filled sandbags, an upholstered wall, thick gabion 'columns' and, of course, straw bales (Fig. 8.6).

8.6 Sarah Wigglesworth Architects, Stock Orchard Street house, London (2004) uses of materials

[30] Interview with Simon Tucker of Coterell Vermeulen, 02.04.07.

Many of these were outside those covered by the standard clauses of the NBS and what building regulations define as 'proper' materials (Fig 8.7)[31]:



29.

Building Regulations – Regulation 7

Any building work shall be carried out:

(a) with proper materials which are appropriate for the circumstances in which they are used; and

(b) in a workmanlike manner.

"Proper materials" shall include materials which:

(a) bear an appropriate EC mark in accordance with the Construction Products Directive; or

(b) conform to an appropriate harmonized standard or European technical approval; or

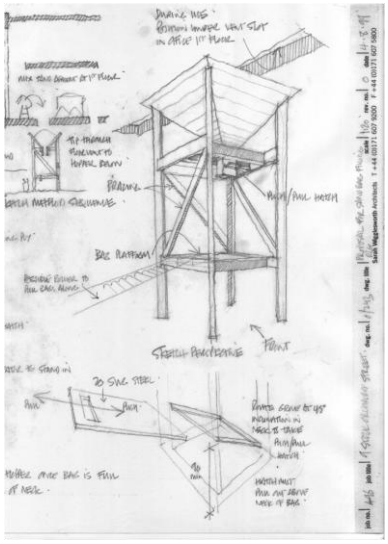
(c) conform to an appropriate British Standard or British Board of Agrement certificate; or

(d) conform to some other national technical specification of any member state which provides, in use, an equivalent level of protection and performance with respect to the relevant requirements of the Building Regulations, as an appropriate British Standard or British Board of Agrement certificate.

is this likely to be a problem?

8.7 Sarah Wigglesworth Architects, Stock Orchard Street house, Schedule attached to letter from L B of Islington

Notably, proper materials are determined by their conformity to national or European standards and should have been tested to demonstrate this. SWA produced very thorough detailed drawings but no specification was written as part of the construction documentation. In part this was because many of the techniques had to be worked out on site rather than prior to construction, which in turn demanded a different relationship with the contractor and builders. Details and costs could not be finalised before building and the builder was often involved in developing construction solutions. In the case, for example, of the building of the sandbag wall which faces the railway track running along one side of the building, the architects designed a complex rig which could be used to fill the bags with cement (Fig. 8.8).



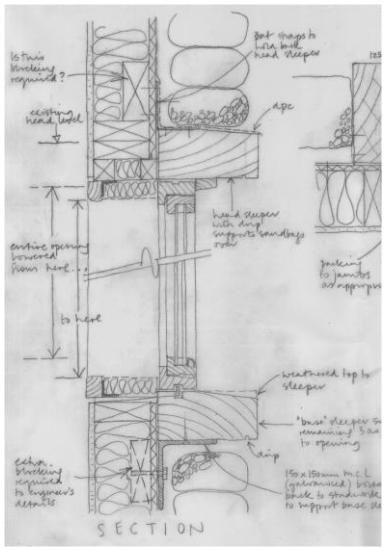
8.8 Sarah Wigglesworth Architects, Stock Orchard Street house, working drawing of sandbag-filling rig

[31] Schedule attached to letter from London Borough of Islington Control, in respect of 9 Stock Orchard Street, 1 July 1998. My emphasis.

In the event, the builders designed their own ad hoc system using items already on site such as plastic piping. According to Wigglesworth and Till this kind of inventive involvement in the building process gave builders a different relationship to it:

> In their making of the building, the builders have suspended their initial disbelief in the project and have claimed the various unknown technologies as their own.[32]

More significantly, perhaps, the fact that the sandbags could not be included as a 'proper' material in the terms of the building regulations meant that their performance was not officially considered as part of the functioning build-up of the wall (Fig. 8.9). Although the bags dampened sound and vibration from passing trains an inner wall built with conventional materials had to be demonstrated to perform this role. At least in terms of compliance with building regulations, the sandbags became 'extrafunctional'[33] and their status was relegated to that of mere decorative cladding.[34] The physical properties of the materials are thus deemed irrelevant, in as much as they become extraneous because of the mechanisms of statutory approval.



8.9 Stock Orchard Street house, detailed section through sandbag wall showing inner performing wall

Similarly, in the case of the well-known straw bale wall, only some of its functioning capacities were recognised as contributing to the approved performance of the wall. The Building Control officer decided

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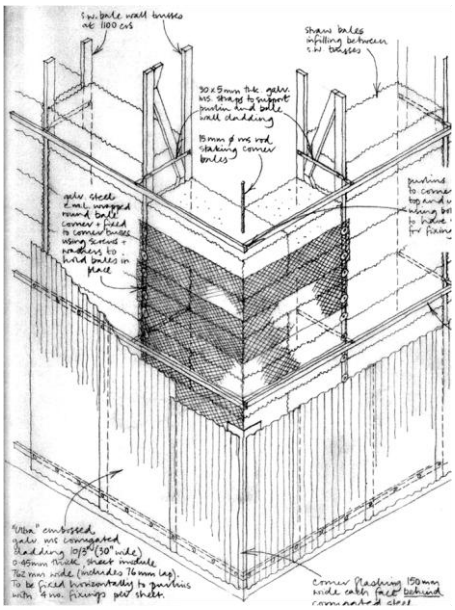
[32] Jeremy Till and Sarah Wigglesworth, 'The Future is Hairy', in Jonathan Hill (ed.), *Architecture: The Subject is Matter*, London: Routledge, 2001, p.16.

[33] 'Extrafunctional' is a term used by Elizabeth Grosz in her essay 'Architectures of Excess' in *Architecture from the Outside*, Cambridge, Massachusetts: MIT Press, 2001, p.163, first published in ed.Cynthia Davidson, *Anymore*, Cambridge MA: MIT Press, 2000. A more detailed account of the notion of excess in relation to the straw bale house is given in my 'The excessive materiality of Stock Orchard Street: towards a feminist material practice' in Sarah Wigglesworth (ed.), *Around and About Stock Orchard Street*, London: Routledge, forthcoming.

[34] This was also the case with the upholstered wall, an innovative, untested material which similarly performed an insulating role which could not be recognised in the terms of building control. Thus its functional 'excess' is produced by statutory frameworks, as opposed to its literal or physical role as part of the building's functioning structure.

there was not sufficient evidence to allow the bales to be used structurally, and to avoid their outright rejection the architects designed a vertical timber truss which took the official, demonstrable role of taking the loads (Fig.10):

> The argument is that the wind loads are transferred via the cladding ladders and therefore the bales do not enter into the structural argument because they are being treated as non-structural infill material. [35]



8.10 Stock Orchard Street house, axonometric section through straw bale wall showing structural 'ladders'

In this case then the bales become 'extra-structural' because of their statutory status rather than the physical capacities they in fact possess. But when it came to providing an agreement certificate to guarantee the viability of the straw bales as a building material, building control accepted a batch of alternative documentation compiled by the architects from straw bale builders' handbooks, internet sites and informal advice. In lieu of the usual statutory and industry authorised tests and standards, the voices of amateur fabricators entered the negotiations around the 'proper' material and all parties involved, including building control, drew on their experience and capacity for independent evaluation, rather than the simple regulatory mechanisms of inclusion and exclusion. At the Stock Orchard Street house, the degree to which the performativity of the sandbag wall or the straw bales is recognised is a result of the statutory mechanisms which can include or exclude performance as a relevant attribute of a given material, just as in the specifications produced by Schumann Smith and Allies and Morrison where the use of performance specification will depend on factors such as the architects' expertise with the material, its location in the building, the contractual arrangement it is part of, as well as the kind of material it is (natural, standardised, mass-produced, performance-engineered and so on).

[35] Notes of Meeting between Seyan/Andrews from London Borough of Islington Building Control and Sarah Wigglesworth and Jeremy Till, 24 June 1998.

Just as performance specification is part of a specific configuration or practices, techniques and material technologies, and other forms of clause are evidence of other systems, we can also identify systems of material which cannot be included within the master specifications that are currently available. If we look at these we see that different practices and techniques prepare these materials for their mobilisation in building, ranging from ad hoc or inventive specification practices to abandoning the use of specifications altogether. A cement-filled sandbag as used at the straw bale house, which has not been part of this regime of evaluation might have the physical capacity to insulate against sound and vibration but these capacities cannot be recognised with the regulatory framework. This amounts to saying that although two different forms of clause could be used to specify the same substance, their use would each constitute a different system of material, since their preparations and mobilisations are very different.

The different forms of clause in the specification are evidence at once of the very different ways a material may be mobilised in building and the different regimes of preparation which make that mobilisation possible. Where the process-based clause is used, the system of the material only includes its fabrication and the preparations described are mostly physical, to be carried out on site or, on occasion, in the factory. Where the performance clause is used the system of the material extends to the way it is intended to behave in the finished building and a much wider range of preliminary operations are required to make it possible to specify a material in this way. If the form of clause is an indicator of a specific system of material, it is also part of the preparations which make that material ready for its specific mobilisation in building and its use is dependent on those preparations. To insist that we recognize the variety of forms of clause and those outside specification practice is to acknowledge the plurality of systems of materials in building, and to pay attention to the very different techniques and materials that each is constituted through.

2. Simondon's complete system: the creation of conditions

> The initiative of the genesis of substance returns neither to the raw material as passive nor to the form as pure: it is the *complete system* that generates, and it generates because it is a system of actualization of potential energy, joining together in an active mediation two realities, of different orders of magnitude, in an intermediate order.
>
> Gilbert Simondon[36]

To propose a model of 'systems of material' within architectural theory, is to suggest that the preparations which make a material ready for its use in building – whether an impact test on glass using a leather punch

[36] Simondon, *L'individu*, p. 43.

bag in a Pilkington research centre or the sieving of aggregate into different sizes on site – are themselves understood as constitutive of the material. They alter the material (as it becomes individual, or mobilised for use in building) and as such demand serious exploration within architectural discourse, as well as within construction and technical accounts. As in Simondon's example of the clay brick, the operations described in the process-based clause are mostly physical, although in Chapter Five some exceptions involving weighing and testing concrete, and cleaning out the mixer during workers' lunch breaks raised the possibility that preliminary operations could encompass a wider set of processes than Simondon describes. The operations which give rise to the possibility of performance-based specification include many such 'extra-physical' processes, extending well beyond the physical processes of manufacture and construction.

In thinking of building materials in terms of Simondon's 'complete system' I want to suggest that different kinds of preparations might characterise different systems without proposing that they completely determine the systems or fully account for them. Rather, these preparations establish conditions or potentials out of which particular materials can come into being, understood not simply as physical substances but as materials which can be mobilised in specific ways in building. A piece of glass may be engineered in such a way that it is strong enough to withstand a bullet, but it is only when tests establishing this capacity have been carried out and incorporated into the approved documentation that it can be mobilised with this performance as a specific use. These preparations establish a potential for a mediation between glass and the effects of specific bullets as part of a system. What is particularly useful in Simondon's account of the system is first, that the conditions out of which mediation or individuation arises are just one phase of the system (and the only phase which Simondon suggests is created), second that these conditions are specific to each system and the potential individuations are limited by them, so there are multiple systems in which different kinds of individuation take place, and third, it is the potential for mediation between disparate orders which characterises a system as opposed to a 'set' of parts.

In Simondon's account of the technical system preliminary operations prepare the conditions in which individuation (or mediation) takes place. These conditions, rife with potential and usually described as the 'metastable' or 'preindividual' state, and are just one phase in Simondon's complete system, in which there is latent potential for individuation or the transductive communication between different orders of magnitude. As Muriel Combes explains:

> Before every individuation, being can be understood as a system that contains potential energy. Even though it exists *in actu* within the system, this energy is called potential because in order to structure itself, that is, to actualize itself according to certain structures, it needs a transformation of the system.

> Preindividual being and, in a general way, every system that finds itself in a metastable state, contains potentials which because they belong to heterogeneous dimensions of being are incompatible.[37]

In the case of the clay brick the potential for the dynamic rearrangement point by point throughout the mass that has been rendered plastic through its preparations is actualised 'according to certain structures' in the transformation of the system that is more commonly thought in hylomorphic terms. The system comprises all the phases of being in which becoming individual is only one:

> The being in which individuation comes to fruition is that in which a resolution appears by its division into stages, which implies becoming: becoming is not a framework in which the being exists: it is one of the dimensions of being, a mode of resolving an initial incompatibility that was rife with potentials.[38]

At least in the example of a technical system, individuation itself involves a transformation of the system in which the potential already present in the system is self-actualised, but the metastable state is described as created. However, in Simondon's 'Form and Energy' chapter attention turns to what he calls 'physical systems'. He explores a number of oscillating systems such as the pendulum where he is interested in the ongoing transformation of potential energy into kinetic energy and back to potential energy and so on. He argues that there is not some external relation which connects potential (stored up) and actual (released) energy, but that each is a different phase of the same system and that this change can only occur because there is a dissymmetry or tension in the system. A more striking change of phase is the formation of a crystal out of a crystal solution. The solution, he suggests, is the metastable state which already has the potential to change into its crystalline state.

> The [metastable] state contains forces of tension, a potential energy, which can be called the form of the system, for it is its dimensions, its topology, its internal isolations which maintain these forces of tension.[39]

Simondon is not concerned with the preliminary operations involved in preparing these physical systems, but he does suggest that the metastable states of pendulum and crystal solution might be called the 'forms of the system'. The form of the system differentiates one system of individuation (or being) from another. 'Its dimensions, its topology, its internal isolations' are specific to it in as much as the tensions each system harbours have the potential only for certain kinds of individuation, although these always exceed the preindividual (otherwise presumably the preindividual would be equivalent to the individual). As Toscano elucidates:

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[37] Combes cited in Toscano, *The Theatre of Production*, p.138.
[38] Simondon, *L'individu*, p.5. As translated in 'The Genesis of the Individual', p.301.
[39] Ibid., p.103. My translation.

> The field is both determinate (it is populated by disparations, real conditions of individuation that are neither arbitrary nor indifferent) and untotalizable (its dimensions are not parts of a whole but the tensions of a system that can only be retroactively individuated once these are resolved). A preindividual field is thus not to be considered as a creative reservoir or phenomena or an unlimited source of givenness but as a *real* condition of individuation. A preindividual field does not contain or anticipate the forms that any individuation may take, but it does oblige it to be the individuation of *this* field and not of preindividuality of 'being' as such. It would therefore be more accurate to speak in the plural of preindividual fields – determinable energetic and material conditions modultated by events of information... From this perspective, individuations always result from an event that resolves the determinable potentiality harboured by a given field.[40]

The preindividual field is not fully determining (although in the case of the technical operation at least, contra Toscano, there must be some anticipation about the forms that an individuation may take, and this is precisely what the preparations achieve) but as a '*real* condition of individuation' it is *limiting*, and limits the individuation to being the 'individuation of *this* field'. In this sense the system is a 'complete' system, in as much as it is *this* one and not another, and that these systems, each comprising different preindividual fields with different potentials, are plural.

In *Individuation psychique et collective* Simondon explains that simple hetereogeneity is not enough to establish metastability and gives the example of granite:

> Simple heterogeneity without potentials cannot promote becoming. Granite is made from heterogeneous elements like quartz, feldspar, or mica, and yet it is not metastable.[41]

No mediation can arise between granite's parts. For the clay brick, it is only as pressed clay and prepared mould that there is metastability, once the brick is formed it is simply an already individuated individual and a milieu, no longer strictly speaking a system or being. Without information, without the potential to become compatible, there are only parts of a set or 'ensemble' and not a system at all. In the same set of footnotes to Chapter 1 of *Individuation psychique et collective* Simondon gives the potential for mediation as:

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[40] Toscano, *The Theatre of Production*, p.155. In his review of *The Theatre of Production*, in *Parrhesia* No.7 2009, Eugene Thacker sees Toscano's presentation of Simondon's preindividual as problematic - 'In thinking the preindividual one ceaselessly toggles back and forth between poles, determinable but not determined, productive but not creative, univocal but not One,' p.90. Nevertheless, Toscano is right. Simondon's concept of the preindividual is not 'an unlimited source of giveness' and is partly determining despite the fact that many of his readers fail to take up this distinction – see for example, Harvey, Poppowski and Sullivan, 'Individuation and Feminism.'

[41] Simondon, *Individuation psychique et collective*, p.95, fn6. As translated in 'Individuation of Perceptive Units and Signification.'

> The essential distinction between a *set [ensemble]*, whose unity is merely structural, not energetic, and a system, a metastable unity made of a plurality of sets [ensembles] among which there exists a relation of analogy and an energetic potential. Sets [ensembles] do not possess information. Their becoming can only be that of a degradation or augmentation of entropy. On the contrary, the system can be maintained in its being of metastability due to the activity of information which characterizes its systemic state.[42]

Metastability is then, the particular state in which mediation between disparate orders can arise, and it is information and the potential for mediation which characterizes a system. In the technical system, where the metastable condition can be understood as prepared (unlike in the living systems Simondon studies later in *L'individu*), it is only the potential for mediation which is created. This potential and its specific but undetermined capacity for resolution in individuation (and for further individuations in some cases, particularly for living systems) constitutes the system.

So Simondon's systems are plural and there are many preindividual states, as opposed to preindividuality in general. Metastability is only the preindividual phase of Simondon's complete system and preliminary operations constitute metastable potential and not the individual itself. I will go on to explore the question of mediation and systems of materials in the next chapter but here I want to suggest that we understand the regimes of preparations we have looked at in relation to the process-based and performance clauses as constituting the preindividual field of any given system of material, and the forms of clause as evidence of those systems.

In suggesting this, the individuation of the material would be understood as its mobilisation rather than its production, and the preparations for its mobilisation (as well as its physical manufacture) would be understood as constitutive. This leads to two main points. First the variety of forms of clause in the specification that has been the main object of this study can be understood as evidence of a variety of systems of material. Second, by considering building materials in terms of Simondon's system, we cannot ignore the constitutive role of the conditions of production (what may be included in these conditions is itself specific to each system) in preparing the possibilities of any material's mobilisation. At least in the technical

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[42] Ibid., p.94, fn.1. As translated in 'Individuation of Perceptive Units and Signification.' It should be noted that Taylor Adkins' translation of the French 'ensemble' as 'set' is atypical. 'Ensemble' is more usually translated as 'ensemble' or 'whole' and is a term which will have particular significance in *Du Mode* where it will refer to a kind of technical object which comes to prominence in the 20th century. Technical 'elements' are stand-alone technical objects through which man works on nature. Technical 'individuals' are those which seem to replace the work of man, particularly the machines through which early industrialisation develops. Technical 'ensembles' are usually groupings of technical elements in which the development of the parts evolves together in specific relation to the ensemble they are part of and involve what Simondon calls an 'associated milieu'. The parts of a technical ensemble form a system, that is to say they are in an informational relation with each other which has contributed to their specific evolution. While for Simondon it is possible for a man either to control a technical ensemble or become a cog in its functioning, there is a third possibility, particular to technical ensembles, which is that man can regulate the ensemble, becoming part of a system which is, then constantly inventive. His choice of the term 'ensemble' in this case to mean a set of parts which are not in systemic relation to each other, is confusing, since in *Du Mode* it seems precisely to refer to an individuating technical system.

system, metastability can be created, so we might understand the emergence, say of performance-specified and engineered materials as the creation of a new system of materials with radically new possibilities and effects, not just for materials, but also for architecture and its users.

3. 'That constitutive seam': preparations for mobilisation in systems of material

Although the appearance of any one particular form of clause indicates a specific set of preliminary operations, or industrial and regulatory preparations, it is not the case that the forms of clause we have looked at each correspond to a certain system of material in a neat one-to-one mapping. We find many other kinds of processes of working with concrete described with this clause from pouring it to make a floor slab to breaking it up and sorting it to use as hardcore, as well as for other kinds of construction including bricklaying, paintwork and carpentry. Compare the following clause for a carpenter from the 1964 edition of *Specification* to those specifying the making of the rigid timber formwork for the Elfrida Rathbone School (1961):

beams and binders	...The timber is to be in one piece and in one length between supports. Joints between continuing lengths are to suitably scarfed or spliced and secured with bolts and plates or metal straps (or to detail). Joints into or over posts are to be of the most appropriate type, and must be accurately constructed, and reinforced with metal straps where necessary to prevent displacement (or to detail). Housings, mortise-and-tenon and other joint cuttings must be carefully executed, and performed in such a way that they do not impair the strength and stiffness of the beams or binders.[43]

Process-based clauses are not of course tied to the moulding of a material, they describe a full range of processes including, in some cases, the more 'artisanal' processes valorised by Deleuze and Guattari, DeLanda, Reiser + Umemoto and others, and the incorporation of clauses which recognise the fabricator's own skill and judgement.

The variety of forms of clause leads us instead to take seriously the constitutive role of preparations, not only in so far as any form can only be used where certain preparations have taken place, but that these forms are

[43] *Specification*, 1964, p.681.

always plural and correspond to different possibilities of the material. So quantification and testing might be some of the general preparations which make performance specification possible, but within this are more specific kinds of test (that have already measured the capacity of glass to withstand the impact of a bullet or a football or a falling body, but have not, for example been established to quantify the capacity to self-clean). In general, performance testing establishes the possibility for a material to be mobilised and conceived of in terms of its prescribed use, but the precise relationships which are made possible across the material are specific (between a material and a perceived terrorist threat, between a material and cleanliness). Thus the variety of forms of clause indicates a plurality of forms of system that must include their preparations, but within each category there will be very different systems of material.

A first implication of thinking of materials in terms of Simondon's complete system is that if forms of clause correspond to particular sets of preparations, which make ready any given preindividual field and in turn give rise only to certain systems of materials, then the forms of clause which are excluded from any form of specification practice, will also exclude certain systems of materials. We have seen how some construction techniques, such as concrete casting on site, can resist these exclusions (so that the process-based clause in this case persists) but it is also apparent that a performance-led form of specification, such as that of Schumann Smith or the in-house team at Allies and Morrison will tend to limit the materials that can be worked with to those which can be and are already being prepared in the ways which make performance specification possible. In many cases, preparations which might have been given in a process-based clause (for the contractor to carry out tests on site, or the architect to make checks) are moved into national regulatory frameworks (such as British Standards and other product certifications) so that these judgements become absolute and invisible. To consider materials in terms of systems which include their preparations is also to recognise that systems of materials which are outside what can be specified in any given form or clause are also prepared. It is just that an aspect of these preparations is their exclusion from entry into specification. Thus the sand bags used in the straw bale house belong to a system of materials, whose preparations include negotiations between architects and builders and the possibility of the invention of construction techniques, but cannot include the recognition of their capacity to insulate from sound and vibration. While the voices of amateur builders and their accumulated experience are included in the approval of the straw bales as durable building material, these preparations are not sufficient for the structural capacity of the bales to be considered as a functioning part of the building. Systems of materials may be excluded from specification, or from the realm of the 'proper' material, but they alert us to other kinds of preparations involved in the making ready of materials for building.

A second implication of thinking of materials in terms of Simondon's complete system is that the preindividual field, always prepared in the case of the technical operation, is a phase in the being of any material that cannot be separated out from it, and also, as we have seen limits the possibilities for its individuation and mobilisation. Because a system of materials comprises both the conditions of its production (understood in

the broadest sense where necessary as in the case of performance specified materials) and its mobilisation (and because, as we will see, the possibilities of individuation always exceed the preindividual) it goes beyond an understanding of materials as physical substances, commodities or nothing but the result of the mode of production.

To insist on this (that performance-specified glass is a different 'material,' in so far as it is mobilised in building, to glass that is physically the same but has been specified through a nominative clause, for example) is to trouble accounts in architectural theory which try to propose the material as a category which can somehow be lifted out of the industrial and regulatory conditions in which it is produced.[44] Peculiarly, this seems to happen in precisely those accounts which identify themselves as materialist. For a number of practitioner-theorists, who insist that the form/matter distinction is not viable, the 'material' is allowed to enter in to their form-making only in as much as it contributes to it and inflects form. For some this reflects a primary concern with form (and often with questions of bodily perception) while for others it is important to retain a working notion of the material that can distance it from the building materials that capitalism produces. But if we take seriously that materials in building, can only exist as a system of material, then that system must necessarily include preliminary operations which are embedded in the wider frameworks of industry and regulation.

In critical architecture which seeks to find a possible autonomy, at least since Eisenman defined formal manipulation as architecture's interiority,[45] materials have been hived off from architecture proper which is supposed to get on with 'the exposition of a set of formal relationships.'[46] In the design of House I Eisenman's primary concern is to reduce the 'existing meaning' of the materials he uses in order that they are not read symbolically but simply as a set of formal markers in space. He explains that he borrows the material palette of the International Style, both because its association with the style limits the formation of new materials and because planes of white or clear and grey glass are 'closer to an abstract plane', even 'neutral.' [47] Just as Eisenman attempts to make spaces which are not defined or identified through their function, he tries to use materials which will only contribute their capacity to support formal relationships. In this early work, the material is still identified primarily with a capacity to signify (its relationships to other kinds of manufacture and building, its historical and symbolic meanings, as well as its cultural value and so on).

When Frederic Jameson so astutely describes the impact of Frank Gehry's use of everyday construction or 'cheapskate' materials – corrugated aluminium, steel mesh, raw plywood, cinder block, telephone poles – in

[44] Glenn Adamson, writing in relation to craft has described this material realm as 'a base materialism that would drag the work into the realm of the ebb and flow of daily life'. Adamson, *Thinking Through Craft*, p.11.
[45] For Eisenman's use of this term and his explicit positioning in relation to architecture and ideology see for example his 'Introduction' to *Eisenman Inside Out*, pp.vii-xv.
[46] Ibid., 'Cardboard Architecture,' p.29.
[47] Eisenman explains that he uses white card for the design of House I because it is 'closer to an abstract plane than say a natural wood or a cut stone wall, and therefore reduces existing meaning.' Ibid., p.30.

his celebrated essay on Gehry's own house in Santa Monica (Fig. 8.11), he also proposes that this is to do with their meaning:

> Such materials clearly "connote"; they annul the projected syntheses of matter and form of the great modern buildings, and they also inscribe what are clearly economic or infrastructural themes in his work, reminding us of the cost of housing and building and, by extension, of the speculation in land values: *that constitutive seam* between the economic organisation of society and the aesthetic production of its (spatial) art, which architecture must live more dramatically than any of the other fine arts (save perhaps film), but whose scars it bears more visibly even than film itself, which must necessarily repress and conceal its economic determinations.[48]

Eisenman's material strategy can also be seen as an attempt to avoid the 'scars' of the economic organisation of society that the material necessarily bears (but these are not marks or signifiers, 'scars', they constitute the material) and to make form the theme of his architecture rather than economy or infrastructure which are, according to Jameson (in what is probably a very generous analysis!) the themes of Gehry's architecture.

8.11 Frank Gehry, Gehry House, Santa Monica, California (1978)

This is not a problem in itself – at least as far as I am concerned architectural design can be driven by any number of themes - but now that Eisenman's explicit privileging of formal manipulation has taken a material turn, particularly in parametric architectural design, a rather more peculiar set of discourses around the material and its production have emerged. Theorist-practitioners such as Reiser + Umemoto and Nox recognise that there can be no form/matter distinction, that form is always necessarily material and that material acts. In his book *Nox: Machining Architecture*, Lars Spuybroek describes a number of 'material machines' constructed by the practice to harness the materials' capacity to generate complex forms (Fig.

[48] Frederic Jameson, 'Architecture' in *Postmodernism or, The Cultural Logic of Late Capitalism*, London: Verso, 1991, p.113, my emphasis.

8.12). Like form-generating computer programs, they are self-organising and 'seek an order that is not transcendentally established but emerges from the bottom up.'[49]

8.12 Nox, Project for the World Trade Center, generating form with wet wool

As for Eisenman, architecture for Nox is primarily a formal discipline, but their use of alternative geometries is driven by a concern with constant variation (difference) and with the affect and movement of the perceiving body. Benjamin's essay 'Notes on the Surfacing of Walls: Nox, Kiesler, Semper' proposes that the work of Nox and of the early 20th century Austrian architect Friedrich Kiesler reveals Semper's concern with the textile wall as one of the interrelationship of geometry and matter. He notes that although Semper wanted to hold out for the possibility that architecture was more a material art than exegetic, he was critical of the '"materialists" for whom forms are determined soley by the structural and material conditions.'[50] According to Semper, Benjamin writes, the materialists' mistake came from conflating meaning and idea. They could not see that there could be other kinds of (material) ideas such as the 'wall effect' which 'is produced (effected) by the work of specific materials.'[51] The material is introduced as that which inflects geometry and produces a material idea rather than one which is purely ideal or symbolic and Benjamin has called it 'material possibility' elsewhere.[52] In this essay Benjamin uses the term 'material event' to denote 'the moment at which geometry, programme and the work of materials are interconnected.' He points out that this specific interconnection is always a singularity that 'resists any form of generality,' and suggests that it presents an alternative to criticality for the definition of architecture's autonomy.[53] It is 'because they [materials] are bound up with architectural effects,'[54] for Semper, that Benjamin denies there is essentialism in his work. But nevertheless he tends to emphasise materials' specific capacities for formal organisation – writing for example that

[49] Lars Spuybroek, *Nox: Machining Architecture*, London: Thames and Hudson, 2004, p.8.
[50] Andrew Benjamin, 'Notes on the Surfacing of Walls: Nox, Kiesler, Semper,' in Spuybroek, *Nox: Machining Architecture*, p.344.
[51] Ibid., p.346.
[52] See Benjamin, 'Plans to Matter'.
[53] Benjamin, 'Notes on the Surfacing of Walls', p.343.
[54] Benjamin, 'Plans to Matter', p.24.

'different textiles will have different geometrical implications'– rather than these effects.[55] As we have seen, Benjamin advocates a materialist history of architecture (and argues that an account of material possibility rather than materials allows for this) but his materialism takes no account of the kinds of industrial and regulatory conditions which produce the materials. The thought of the materially inflected but nevertheless purely 'architectural' effect must rely on an abstracted notion of the material (and in Benjamin's case that is primarily one of structural properties which inflect form). In this sense, it seems to me that far from inventing new kinds of materialist design processes for architecture, in which the imposition of ideal form on matter is replaced by the dynamic processes of form/matter as force, a kind of abstract material which is nothing but its potential to arrange itself formally has been proposed. In itself this might not be a problem but where it is described in terms of material effects we need to acknowledge that a wider set of influences than architecture's interiority will necessarily shape such potentials.

It is unusual to find architectural writers tracking the development of increasing interest in the material in architectural discourse and practice, and McAnulty's essay 'What's the Matter with the Material' is a rare exception. For him this interest represents a kind of backlash to 'the critical project' which 'floundered in discursive excess'. No wonder, he says, that design programs are hurrying to 'refashion themselves in material terms – material relations material operations, material constructs, material this, material that.'[56] The problem for McAnulty is that while the 'new model of material practice' envisaged by practitioners such as Stan Allen and Jesse Reiser moved away from what was predominantly the textual practice of critical architecture towards a practice 'which produces ideas and effects through the volatile medium of artifacts' it nevertheless retained an awareness of the material conditions of advanced capitalism. The material practices which followed, however, 'were simplified to be those dealing with real materials, real constraints and real problems,'[57] and 'so much of today's work that is celebrated for its material innovation does little to challenge the oft-repeated standards of an architectural practice firmly grounded in capitalist production.'[58]

If Benjamin is silent on the question of material production in his exquisite and measured accounts of a 'materialist' architecture of material possibility, McAnulty is explicit. Although McAnulty's characterisation of some of the buildings which arise from this trend as a 'new orthodoxy of simplified forms' is apt (even hilarious) his insistence that architects work with the effects of 'matter' – 'those time-bound sensations that we think of as uniquely architectural' (whatever that means)[59] - rather than with 'materials' (as those commodities constituted and used in the building industry) repeats the problem we already identified in Benjamin's argument. How, at least if we think of materials as systems as I am proposing, are we to separate the supposed architectural effects of 'matter' from the effects of materials as they are prepared and constituted in

[55] Benjamin, 'Notes on the Surfacing of Walls', p.343.
[56] McAnulty, 'What's the Matter with the Material', p.88.
[57] Ibid., p.89.
[58] Ibid.
[59] Ibid., p.90.

industrial production? How can we separate what McAnulty refers to as architecture's 'own peculiar material effects' that 'may be experienced pervasively as mood, atmosphere, or generalized 'vibe'[60] from the ways that these effects are currently being physically and immaterially organised through quantification and regulation into the materials with which we build?

To understand materials as systems in Simondon's sense obliges us to include the industrial, statutory, social and physical preparation of materials in our conception of them and to think of their effects as necessarily bound to the conditions which render them possible. Importantly, it allows for the possibility that quite new systems of materials can emerge which extend material (and architectural) possibilities from outside architecture's interior. Because for Simondon it is the potential for specific kinds of mediation which characterises any complete system, I want to suggest that the emergence of new systems of materials, such as performance materials, introduces the possibility of new relationships. This would be to agree with McAnulty that architecture's material effects 'resonate most noticeably when they project surprising new possibilities for material organization, or better yet *new forms of relation*,'[61] but to insist that these new possibilities also emerge in more radical, troubling and surprising ways from the industrial conditions which he, like others, wants to exclude from the sphere of properly architectural concerns. We should recognise the significance of developments and changes in this rich 'constitutive seam' in the shaping of systems of materials and their impact on architecture and its possibilities. They demand our attention, not their banishment to architecture's outside.

[60] Ibid., p.91.
[61] Ibid.

Chapter Nine: Potentials for Resolution: Transduction and concepts of materials

> Such an individuation is not to be thought of as the meeting of a previous form and matter existing as already constituted and separate terms, but a resolution taking place in the heart of a metastable system rich in potentials: *form, matter and energy pre-exist in the system*. Neither form nor matter are sufficient. The true principle of individuation is mediation, which generally presumes the existence of the original duality of the orders of magnitude and the initial absence of interactive communication between them, followed by a subsequent communication between orders of magnitude.
>
> Gilbert Simondon[1]

The prepared metastable field is only one phase of Simondon's technical system. Preliminary operations create the conditions for what is 'the true principle of individuation' - mediation. It is mediation, or the processes of individuation, which differentiates one system from another, not the conditions of individuation which are indeterminate. We have seen that if building materials are conceived as systems of materials their preparations are internal to them and cannot be separated out. If mediation, as a 'subsequent communication between orders of magnitude' is at 'the heart of a metastable system' and characterises each system, we have yet to ask what significance this may have for the variety of systems of materials which have been revealed through this study of the forms of clause in the specification. The suggestion in this concluding chapter will be that a system of material is organised around the material *relations* it makes possible, and that where new systems of material emerge, so too do 'new forms of relation' which themselves amount to new concepts.

For Simondon, as Toscano puts it, 'to relate – orders of magnitude, differences of potential, and so on – simply *is* to individuate.'[2] The potential for mediation is the tension in the metastable state, between two or more disparate orders, which is temporarily and partially resolved through individuation:

> Individuation must therefore be thought of as a partial and relative resolution manifested in a system that contains latent potentials and harbors a certain incompatiblity with itself, an incompatibility due at once to forces in tension as well as the impossibility of interaction between terms of extremely disparate dimensions.[3]

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[1] Simondon, *L'individu*, p.8. As translated in 'The Genesis of the Individual', p.304.
[2] Toscano, *The Theatre of Production*, p.139.
[3] Simondon, *L'individu*, p.4. As translated in 'The Genesis of the Individual', p.300.

Importantly, this mediation does not take place between two already constituted individuals (such as matter and form) but as the resolution of pre-existing tensions that are incompatible in the preindividual state:

> A relation does not spring up between two terms that are already separate individuals, rather it is an aspect of the *internal resonance of a system of individuation*. It forms part of a wider system.[4]

The relation cannot only be understood as a third term which emerges during individuation. Rather it forms 'part of a wider system' of individuation, or what we have called Simondon's complete system. In the physical systems he examines this involves a change of state: latent energies in a crystal solution become structure in the formation of the crystal, structure becomes energy in the case of an electronic signal. Simondon calls this 'transduction', a notion which, as Mackenzie explains, he draws from ideas which were emerging in the molecular biology of the 1950s[5] and from electronic engineering;

> In electrical and electronic engineering, transducers convert one form of energy into another. A microphone transduces speech into electrical currents. For the process of transduction to occur there must be some disparity, discontinuity or mismatch within a domain, two different forms or potentials whose disparity can be modulated. Transduction is a process whereby a disparity or difference is topologically and temporally restructured across some interface. It mediates different organizations of energy. The membranes of the microphone move in a magnetic field. A microphone couples soundwaves and electrical currents.[6]

In the case of the wet clay brick a dynamic chain of processes constitutes the communication between mould and clay that is also its individuation. The 'two realities, of different orders of magnitude' that are mediated are form and clay. In this case, where the system has been made ready in order that this particular mediation arises, we might say that it is not the clay brick (as individual) which is prepared but the potential for a relationship between the two realities (or individuation). In the technical operation the *conditions* for meditation are created, and not the resolution itself which Simondon understands as self-actualised. The preindividual and individuation are two phases of the system or being. The possibilities of individuation always exceed the metastable potentials they partially resolve. To cite Toscano:

> Both living beings and technical beings are caught up in individualizing processes inasmuch as they never fully exhaust the metastable potentials of which they represent a partial resolution. [7]

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[4] Ibid., p.11. As translated in 'The Genesis of the Individual' p.306.
[5] Mackenzie, *Transductions*, p.17.
[6] Ibid., p.25, fn.3.
[7] Toscano, 'Technical Culture and the Limits of Interaction', p.202.

For many of the individuating systems which Simondon discusses, such as feedback systems and the living being the partial nature of each resolution can be accounted for by the fact that the process of individuation is ongoing. Each individuation furnishes the metastable field for the next (as in the case of the crystal, once in the process of formation and before the solution is saturated, which acts as seed for each successive individuation). In the living being individuation is continuous and '*individuation is brought about by the individual itself*.'[8] But even in the technical system, where individuation is not propagated but results in an individuated individual (not strictly an individual at all) and a milieu, the resolution is partial, because it is only one of the albeit limited possibilities, of the potential of the metastable state. It is in this sense that Toscano can describe all individuations, not only those which propagate further individuation, as partial, 'non-arbitrary' and as *inventive*:

> It is a resolution, the invention of a compatibility between potentials of dimensions of being that are in excess of unity. In this respect, one of the key characteristics of the disparate or metastable character of preindividual being is the (non-arbitrary) multiplicity of solutions: each individuation constitutes an invention.[9]

In this sense then, while the metastable conditions can be created in the case of the technical system, the potential they harbour to give rise to resolutions always has the capacity to exceed the conditions – and to be inventive.

The first implication of taking transduction seriously in thinking about materials is that we can understand the preparations involved in different 'systems of material' as establishing the possibility of a range of relationships across materials, whether for a material such as liquid concrete to be available to a prescribed form-taking, or for a sample of performance-engineered glass to be mobilised as security glass to withstand bullets from a particular gun. The potential for these relationships is not equivalent to the physical properties of the material. It is given through the wider system of the material that makes its specific mobilisation in building a possibility. The range of relations we have seen here include relationships of materials to systems of classification and knowledge such as species and manufactured products, as well as techniques of testing and quantification which bridge the gap between physical substances and other technical objects or living beings. They include referential relationships to other instances of building, to the procedures of checking and controlling building and of craft, and of course to the possibility of making connections between substances and formal ideas. If any individuation is characterised, as Simondon argues, by the becoming compatible of different domains, then the particular potentials or different transductive relationships amount to different kinds of individuation. We might propose then, that these different relationships at once characterise different conceptions of materials (as that which enables a formal idea to become compatible with a

[8] Simondon, *L'individu*, p.9. As translated in 'The Genesis of the Individual', p.305.
[9] Toscano, *The Theatre of Production*, p.140.

substance, or as that which enables a specific use or effect to become compatible with it) and different potentials for mobilisation. To start then, from conceiving of materials through what relationships might be made possible through them (with all the implications for the kinds of preliminary operations which would prepare them – from the physical to the extra-physical – some of which have been examined here) and by recognising this variety as it is already mobilised within the existing building industry, would perhaps enable a more radical set of potentials for architectural practice which seeks to make more primary an engagement with the material. It might be possible, furthermore, to start from relationships in which form is not one of the domains and destabilise the form/materials model which might be seen still to persist in theoretical attempts to hive off aspects of the material to the extent that they inflect form, or in specification practices which introduce a visual intent/performance binary that retains the form/materials but in an altered configuration.

The second implication of taking transduction seriously is methodological. In his introduction to *L'individu* Simondon proposes that transduction is also a process of thought through which, as Mackenzie explains, heterogeneous realities are placed in contact and different orders or domains are mediated between.[10] For Simondon, this process enables the discovery of problematics and their resolutions from within the system of thought, and the containment of all their 'original terms' rather than losing them or reducing them:

> Transduction represents a discovery of dimensions that are made to communicate by the system for each of the terms such that the total reality of each of the areas' terms can find a place in the newly discovered structures without loss or reduction...There is no impoverishment in the information contained in the terms: transduction is characterized by the fact the result of this process is a concrete network including all the original terms. The resulting system is made up of all the concrete, and it comprehends all of the concrete.[11]

If a process is transductive it does not lose the terms which gave rise to its possibility (which are, at least for Simondon, always part of the complete system of any being). It is not a matter of moving on from a situation to derive an ideal principle which can be abstracted from the situation (although in some sense, it is unavoidable that the theory of individuation or transduction itself tends towards this) or of moving in the opposite direction. As in the example of the crystal it is neither a case of matter yielding to the geometrizing power of form nor of locating a pre-existing geometric identity within the solution.

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[10] 'Transduction refers not only to a process that occurs in physical, biological or technical ensembles as they individuate. It also occurs in and as thought. Thinking can be understood as an individuation of a thinking subject, not just something that someone who thinks does. To think transductively is to mediate between different orders, to place heterogeneous realities in contact, and to become something different.' Mackenzie, *Transductions*, p.18. Here Mackenzie emphasises the individuation of thinking subject – that to think transductively is 'to become something different.' I am not trying to follow this point through, nor am I convinced that it is Simondon's focus, for presumably the individual in this case is the thought itself.

[11] Simondon, *L'individu*, p.21. As translated in 'The Genesis of the Individual', p.315.

My own method, then, of relating the forms of clause in the architectural specification to the question of concepts of materials, might itself be understood as transductive. It is not supported by a particular research method, nor is it a logical process.[12]

Although it might be described in such terms - that a technical document should not be precluded from theoretical study, that the descriptions it contains can be argued to be conceptualisations, that the industrial context must be made primary, that the specification is complementary to the architectural drawing and so on - this choice to study the specification has not derived its validity from some other set of principles. The act of making it a vehicle through which to think about architectural materials brings a set of questions into being which are particular to this system. It would be impossible to avoid, say the context of the building industry and changes in production, or the question of the variety of forms of clause. The process, in as much as it sets up a system for the research, brings a set of questions into being which were not there previous to the attempt to follow it through. The value of this process lies in the potential it brings into visibility to yield its own dimensions and problematics, which in itself is part of the resolution:

> In the area of knowledge [transduction] maps out the actual course that invention follows, which is neither inductive nor deductive but rather transductive, meaning that it corresponds to a discovery of the dimensions according to which a problematic can be defined. It is the analogical process insofar as it is valid.[13]

If to some extent, this process limits the possibilities of the conclusions of this study because it cannot move out of the highly regulated normative context of specification, it might nevertheless provide a model for thinking about an applied discipline such as architecture which attempts to retain 'all the concrete' and 'comprehends all of the concrete,[14] rather than losing the concrete in the move towards abstractions. Here transduction allows us to consider systems of materials as different conceptions of the material that at the same time cannot be extracted from the conditions in which they are produced. To recognise this variety of concepts is at once to insist on the centrality of the material's preparations and their changing conditions but also, perhaps, to suggest that each system of material offers very different possibilities and starting points for designing with materials in ways which might recognise the range of relationships that are mediated beyond simply giving presence to a formal idea or conforming to 'visual intent.'

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[12] Ibid., p.20:. 'Clearly transduction cannot be presented as a logical procedure terminating in a conclusive proof... I see it as a mental procedure, or better the course taken by the mind on its journey of discovery. This course would be *to follow the being from the moment of its genesis, to see the genesis* of the thought through to its completion at the same time as the genesis of the object reaches its completion.' As translated in 'The Genesis of the Individual', p.314. Jacques Garelli explains that for Simondon transduction cannot be included within strictly logical procedures: 'The situation prevents the conceiving of transduction as a simple logical process, which would have the cognitive function of locating and classifying other strictly logical figures such as deduction or induction.' 'Transduction et information' in *Gilbert Simondon,* Paris: Albin Michel, 1994, p.56.

[13] Simondon, *L'individu*, p.19. As translated in 'The Genesis of the Individual', p.313.

[14] Ibid., p.21. As translated in 'The Genesis of the Individual', p.315.

More broadly, the transductive process, as an alternative to the imposition of frameworks from other disciplines such as philosophy or pure science, might enable the discovery of concepts of materials that are particular to applied disciplines such as engineering, chemistry and architecture, at once retaining disciplinary and practice-based specificity and recognising the potential for such practices to produce their own concepts. The potential of the transductive process is not restricted to the particular case of building materials that has been the subject of this research.

1. Transductive relations in Simondon's accounts of technical objects and systems

> This notion [transduction] can be used to understand all of the different areas of individuation; it applies to all the cases where an individuation occurs and reveals the genesis of a network of relations based on the being. The possibility of using an analogical transduction in order to understand a given area of reality shows that this area is really the place where an analogical structuration has occurred. Transduction corresponds to the presence of those relations created when the preindividual being becomes individuated.
>
> Gilbert Simondon[15]

As we have seen, it is the potential for mediation, or the presence of information that distinguishes a system from a set or ensemble. The orders of magnitude are also described as sub-sets ('sous-ensembles') within a complete system ('ensemble'). 'It is information...,' writes Simondon, '...that is the mediation between each sub-set and the system' and 'realises the individuation of the system as a development of solutions between the sub-sets which constitute it.'[16] The presence of information in the system makes it non-identical with itself, and gives it instead what Simondon calls a 'transductive unity.'[17] Transduction is 'individuation in progress,'[18] and it 'corresponds to the 'presence of those relations created when the preindividual being becomes individuated.'[19] Transduction is the process of propagation made possible by the specific information in a system, which in a physical system may 'occur at its simplest form of a progressive iteration' and is more complex in a living system.[20]

The kinds of potentials for mediation that are furnished by any given preindividual field are specific to it. As Toscano has written, 'From this perspective, individuations always result from an event that resolves the determinable potentiality harboured by a given field.' As we have seen the discussion in *L'individu* moves

[15] Ibid., p.19. As translated in 'The Genesis of the Individual', pp.313-4.
[16] Ibid., p.290.
[17] Simondon, *L'individu*, p.16. As translated in 'The Genesis of the Individual', p.311.
[18] Ibid., p.18, As translated in 'The Genesis of the Individual', p.313
[19] Ibid., p. 19. As translated in 'The Genesis of the Individual', p.314.
[20] Ibid., p.18. As translated in 'The Genesis of the Individual', p.313.

through a number of 'regimes' of individuation, starting with the technical system moving through to living beings. At the most general level Simondon proposes that there is a marked difference between the mediations of physical systems and of living systems. In physical systems individuation only occurs at the exterior – as in the growth of the crystal which occurs at the edge of emerging crystal where structure and solution meet. As Deleuze explains in his review of *L'individu*:

> The physical individual is content to receive information only once, and reiterates an initial singularity, whereas the living being successively receives many supplies of information, and adds up many singularities. Above all, physical individuation is made and prolonged at the limit of the body, crystal being an example, whereas a living being grows from both the inside and the outside, the entire contents of its inner space are in 'topological' contact with the contents of exterior space.[21]

In vital systems individuation is both exterior and interior (but not necessarily 'successive' as Deleuze claims):

> The living being can be considered to be a node of information that is being transmitted inside itself – it is a system within a system, containing *within itself* a mediation between two different orders of magnitude.[22]

Simondon gives a number of examples of mediations in a living being which are at once interior and exterior. The footnote to the sentence above refers to photosynthesis as the capacity of the living being 'to bring different orders or magnitude into relation which one another: that of the cosmic level (as in the luminous energy of the sun, for example) with that of the intermolecular level.[23] He also looks at the problem of affection and perception in terms of mediation that is both external and internal, and most significantly perhaps, at the resolution of psychic problems interior to the individual, as necessarily involving 'participation in a wider individuation, that of the collectivity,' which is for Simondon the basis of ethics and the possibility of action and the 'transindividual'. Thus the individuation of the living being is comprised of multiple resolutions and the preindividual being is 'correlative to a plurality of orders of magnitude.'[24]

At the more specific level, each of the various domains of individuation Simondon describes is characterised by particular kinds of tensions, orders of magnitude and potentials for mediation. In the physical systems these are largely concerned with allagmatic exchanges between structure and energy. In the case of the crystal there must be a 'reunion' between the metastable energetic condition of the solution, and the structural

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[21] Gilles Deleuze, 'Review of Gilbert Simondon's *L'individu et sa genèse physico-biologique (1966)*' trans. Ivan Ramirez, in *Pli*, vol. 12, 2001, p.47.
[22] Simondon, *L'individu*, p.10. As translated in 'The Genesis of the Individual', p.306.
[23] Ibid., fn.1. As translated in 'The Genesis of the Individual', p.318, fn.5. Also see fn.13 for a more direct description of photosynthesis as vital individuation.
[24] Ibid., p.12. As translated in 'The Genesis of the Individual', p.307.

condition of the crystal introduced into the solution. But Simondon engages less explicitly with the question of orders of magnitude in these systems than for living systems. In *L'individu* his concern is really to show that the transductive processes which characterise living beings also occur in technical and physical systems, albeit in limited, simplified and successive forms, and there is no need to identify a living substance or force in order to account for the difference between vital and physical beings.

In the case of the clay/mould system Simondon sees individuation as the dynamic energetic process which propagates through the mass of clay and is limited by the mould. The possibility of this process of form-taking is what has been prepared by the preliminary operations. Sand poured into the mould would just be a heap of sand. There would be no communication between the parts. They would not constitute a system. Simondon describes the mediation in two rather different ways. First it is described in the terms of hylomorphism as a mediation between the clay or 'abstract matter' and 'this notion of a parallelepiped' or 'abstract form':

> The clay, conceived as supporting an indefinite plasticity, is the abstract matter. The right-angled parallelepiped, conceived as a brick form, is an abstract form. The concrete brick does not result from the union of the clay's plasticity and the parallelepiped. So that there can be *a* parallelepipedic brick, a really existing individual, it is necessary that an effective technical *operation* institutes a mediation between a given clay mass and this notion of the parallelepiped.[25]

It is in this way that we tend to understand the mediation if the processes of individuation remain veiled. Second, Simondon recasts this mediation as a communication between 'an inter-elementary order, macro-physical, larger than the individual, and an intra-elementary order, micro-physical, smaller than the individual.' His definition of these orders is somewhat ambiguous.[26] Communication between clay molecules, as energetic exchanges, take place at the micro-physical scale, prepared through a series of processes from quarry to mould. At the macro-physical scale, he seems to be referring to the organisation of work which gives the mould potential energy that is set in motion during moulding:

> The mold, thus, is not only the mold, but the technical term of the inter-elementary chains, which comprise vast sets locking up the future individual (working, workshop, press, clay) and containing potential energy. The mold totalizes and accumulates these inter-elementary relations, as prepared

[25] Simondon, *L'individu* p.28-9. As translated in 'The Physico-biological Genesis of the Individual'.
[26] The term 'orders of magnitude' is Gaston Bachelard's. According to Lecourt, one of its roles was to articulate the difference between the used of any term shared by philosophy and science. For Bachelard (in Gaston Bachelard, *Le Rationalisme Appliqué*, Paris: PUF, 1949) 'one learns to think in accord with the order of magnitude of the phenomena studied', Lecourt, *Marxism and Epistemology*, p.38.

> clay totalizes and accumulates the molecular inter-elementary interactions of aluminium hydro-silicates.[27]

The energy exchange which unfolds during moulding is both micro-physical and macro-physical. Moulding and the preliminary operations which make it possible (which both involve labour) establish a communication between the energetic activity of molecules and organised work. To think of the mediation only in terms of 'abstract matter' and 'abstract form' and as no more than a conceptual relation, is to fail to see the potential energy accumulated in the system that is in fact set in motion in the process of moulding.

Simondon's important concepts of invention and of mediation within individuating systems acquire more significance in relation to technical objects in *Du Mode* where he identifies three types – the technical 'element', the technical 'individual' and the technical 'ensemble'. It is a mistake, writes Simondon, to consider technical objects only in themselves. As technical beings their genesis must also always be considered as essential:

> These specific modalities should be distinguished from a static modality which could be established following the genesis of the object by taking into account characteristics of various kinds of objects. The precise goal in using the genetic method is to avoid the use of established ideas of classification which come into play once the genesis is complete and which divide the totality of objects into genus and species suitable for discussion. The past evolution of a technical being remains as an essential of this being in its technical form.[28]

In the early stages of the development of a technical object it is designed to carry out a specific task, and its physical arrangement is entirely constituted around the parameters of that task. Even if there are a number of parts (as in a complex pulley system or an early engine for example) each part simply represents a function that has been envisaged for it:

> The early engine is a logical assembly of elements defined by their total and single function. Each element can best accomplish its particular function if it is like a perfectly finished instrument that is completely oriented towards the accomplishment of that function.[29]

Simondon calls this kind of development 'abstract' because it is still a literal material manifestation of the set of functions that the designer imagines, it is 'a physical translation of an intellectual system.'[30] The technical object becomes 'concretised' when the parts of that object start to develop a logic which derives out of their

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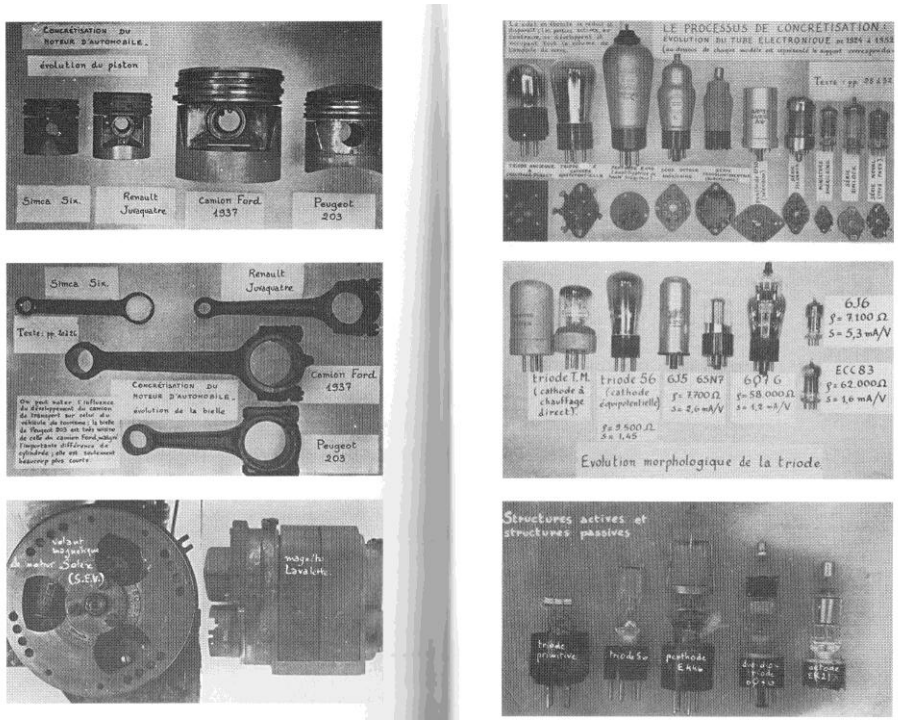
[27] Ibid., p.32, fn.2. As translated in 'The Physico-biological Genesis of the Individual'.
[28] Simondon, *Du Mode*, p.20, fn.1. As translated in *On the Mode of Existence of Technical Objects*.
[29] Ibid., p.21. As translated in *On the Mode of Existence of Technical Objects*.
[30] Ibid., p.46. As translated in *On the Mode of Existence of Technical Objects*.

relationhsips to each other. They may develop so that they carry out more than one function, or be adapted to improve the overall functioning of the object, in such a way that they are no longer interchangeable between objects (an amplifer is absorbed into overall design of a music player rather than plugged in as an attachment). Simondon is at pains to point out that these kinds of adaptations are not simply driven by economics or external demands, they are in a sense opportunities or problems that become apparent because of the physical reality of the object or set of parts. In relation to the arguments in *L'individu* we can see that concretisation is the point at which a techncial object becomes a system. At a bigger scale the wider envrionment (the Guimbal turbine, which converts tidal movement into energy is an example) and infrastructre (as when technical objects become standardised and compatible with each other) –'the associated milieu'– is also drawn into the system.

Some commentators, such as Paul Dumouchel, have been tempted to see Simondon's account of concretisation in terms of progress and the achivement of technical perfection. It is certainly the case that Simondon writes with such enthusiasm and sustained attention to the details of concretised technical objects (and illustrates them copiously with handwritten notes covering the photographs – see Fig 9.1) and with such disdain about the superfluous excesses that can still be seen in them,[31] that one might see something of this lying behind his interest, but progress is not his point.



9.1 Plate 3 'Concretisation of a petrol engine' and Plate 4 'Concretisation of an electron tube', Gilbert Simondon, *Du Mode d'existence des objets techniques* (1958, reprinted 1989)

[31] 'Each element can best accomplish its particular function if it is like a perfectly finished instrument that is completely oriented towards the accomplishment of that function.' Ibid.,p.20. As translated in *On the Mode of Existence of Technical Objects*.

For Simondon, concretisation radically transforms the status of technical objects in two important ways. First, it institutes a new kind of object that is neither purely natural nor purely human:

> The technical object, thought and constructed by man, isn't only restricted to creating a mediation between man and nature; it is a stable mixture of the human and the natural, it contains the human and the natural; it gives to its human content a structure similar to natural objects and allows the insertion of this human reality in the world of natural causes and effects.[32]

The concretised technical object no longer mimics known laws or logics, but institutes a new reality that can itself be studied and provide a source for new areas of knowledge as cybernetics had for Simondon and his contemporaries.[33] Second, the concretised technical object, particularly at the larger scales of technical ensembles in industry and information technology, has ramifications for man's relationship to nature in regard to work and the individuation of collectives. In Simondon's account, when a worker fabricates a technical object according to a pre-determined plan (and therefore abstractly) and as a 'bearer of tools' he is a 'technical being', in as much as his body, and the work of his body establishes a relationship between human and nature. In this kind of the work the 'technical operation' (the real processes through which the individuation of the object takes place) remains obscure and the work can achieve no more than a kind of replication or materialisation of the original plan.

The problem with the machine, as Simondon sees it, particularly in its early forms, was that it appeared to take over the role of the worker, and was understood as a 'technical individual' leaving the worker only as director of the machine or support or cog in its functioning. The concretised technical ensemble provides a possible alternative. First at the level of work, the operator's skill and intuition could be integrated into the system of the machine's functioning, so that its operation becomes a continuous invention between man and machine (and not just invention at the stage of its genesis).[34] Second, at the level of the relationship between

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[32] Ibid., p245. Also cited in Toscano, 'Technical Culture and the Limits of Interaction', pp.202-3.

[33] 'Because the mode of existence of the concrete technical object is analogous to that of a spontaneously produced natural object, we can legitimately consider them as natural objects; this means that we can submit them to inductive study. They are not longer merely applications of certain anterior scientific principles. In that they exist they prove the viability and the stability of a certain structure which has the same status as a natural structure, though it can be schematically different from all natural structures.' Ibid., p.47-48. Earlier Simondon suggests a correlation between the fabrication of simple machines and the laws of classical mechanics. Ibid., p.32. He also calls cybernetics 'the first inductive study of technical objects.' Ibid., p.48, Mellamphy trans. p.42) All translations from *On the Mode of Existence of Technical Objects*.

[34] Simondon also refers to the necessary 'alienation' in this kind of work. Toscano develops this in relation to the notion of labour in his essay 'Technical Culture and the Limits of Interaction'. He understands Simondon's characterisation of work in terms of alienated labour and suggests that his proposal that an 'inventive' relationship between machine regulator and the machine that the technical ensemble makes possible, is intended to overcome the problem of alienation. Although Simondon certainly believes that new possibilities emerge from technical ensembles for collectives and for workers, I am not convinced that traditional 'work' is problematised by him per se, since as far as he is concerned the worker as artisan, as 'bearer of tools' institutes a relation between human and nature, even if that relation goes no further than the individual worker and is not between human collective and nature.

man and nature, the concretised technical object has the advantage that it can stand alone from the one who creates or uses it, and it can be available for another:

> Through technical activity, man creates mediations, and these mediations are detachable from the individual who produces them and thinks them; the individual expresses himself in them, but he doesn't adhere to them; the machine possesses a sort of impersonality which makes it possible for it to become an instrument for another man; the human reality which crystallises in it is alienable precisely because it is detachable. Work adheres to the worker, and reciprocally, though the intermediary of work, the worker adheres to the nature on which he works.[35]

In the conclusion of *Du mode* Simondon returns once more to the hylomorphic schema. Here, he treats 'form' and 'intention' as interchangeable and describes how, in work, the material is modelled according to it as a pre-determination:

> Indeed, in work, the man coincides with a reality which isn't human, he folds himself into this reality, he slips in some way between the natural reality and the human intention; man, in work, models matter according to a form; he arrives with this form, which is an intention for a result; a predetermination of that which he must obtain as a result of the work according to pre-existing needs. This form-intention doesn't belong to the matter on which the work is carried out; it expresses a utility or a necessity for man, but it doesn't come from nature. The activity of work is that which makes a connection between natural matter and form, of human origin. The work is an activity which is able to make coincide, to render synergetic, two realities as heterogeneous as matter and form.[36]

Here, what I have called preparations, are re-described in terms of work, which is also what here veils the operations of individuation, because the worker 'must have his eyes fixed on these two terms which he must connect.' If the worker is servile 'the operation through which matter and form are brought to coincide' is rendered still more obscure. Nevertheless, because the worker still renders some kind of connection between the (natural) material and the (human) form, he or she remains a technical being, despite the fact that the operation remains closed and there is no invention. When the technical object (and operation) is concretised this relation is no longer instituted by the worker, but resides in the object. This at once represents a problem – the worker is no longer a technical being because the work is carried out by the machine which functions rather than works[37] – and an opportunity:

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[35] Simondon, *Du Mode*, p.245.
[36] Ibid., p.242.
[37] Simondon uses the term 'fonctionner,' to function or run, to distinguish the machine's activity from the worker's.

> Technical activity, in building the world of technical objects and in generalising the objective mediation between man and nature, ties man to nature according to a connection much richer and better defined than that of the specific reaction of collective work. A convertibility of the human into the natural and of the natural into the human is instituted through the technical schematism.[38]

'Technical activity' institutes new kinds of mediations between man and nature. Because it is no longer each individual, with their own body, who institutes the relation between human and nature, and because this relation now resides in a technical object and operation which need not adhere to an individual there is the possibility of a richer relation between man and nature. Furthermore, this 'technical activity' is 'the model of the collective relation... it is not the only mode and the only content of the collective, but it is of the collective and in certain cases, it is around technical activity that the collective group can be born.'[39] It is transindividual.

In *L'individu* the mediations which Simondon describes in relation to the technical operation are only at the level of the physical processes of preparation and the self-actualising operations of individuation itself. They play a role in the development of his argument but are not folded back into his account of collective or 'transindividual' individuation. In *Du mode* Simondon proposes that the technical object and technical activity also have the potential to contribute to collective individuation in so far as they can establish new relations between the collective and nature. As Paolo Virno has put it:

> Perhaps the central point [in *Du Mode*] is that technology is transindividual for Simondon. That is, it expresses what does not reach the point of individuation in the mind of the individual. The machine gives an external appearance to what is collective, to what is species-specific in human thought.[40]

Not only is transduction an aspect of the genesis of technical beings, the technical object and operation, at least in so far as it becomes a system as in concretisation, can itself become a 'node of information' which establishes new conditions for the individuation of the collective.

2. Transductive relations in systems of material

In Simondon's terms a system is distinguished from a set of parts by its potential for mediation between different orders of magnitude internal to it. This potential is unrealised in the system's metastable state, and actualised in individuation. This relation is not a concept that links pre-existing terms (such as form and matter in the hylomorphic schema) but a real process that remains veiled until we shift our attention away

[38] Ibid., p.245.
[39] Ibid., p.243.
[40] Paolo Virno, in 'Reading Gilbert Simondon: Transindivuality, technical activity and reification' an interview with Jun Fujita Hirose, trans. Matteo Mandarani, *Radical Philosophy*, No.136, March/April 2006, p.36.

from individuals or substances, towards the processes of individuation. Moreover these systems, and the potential for particular mediations, which organise their specificity, are multiple and discrete. By examining the process-based clauses for concrete casting we have been able to see some of the processes involved in preparing formwork and concrete for their encounter. These preliminary operations (as well as others that are not described in the clauses of specification) establish the potential for the parts to constitute an individuating system when the concrete is poured and the process of setting unfolds. In these examples we also saw that extra adjustments had to be introduced to manipulate and control the material excesses of the concrete; rubbing down surface imperfections, bracing against deflections, the avoidance of colour variegation between pours and so on). Like Simondon's account of the clay/mould system, these descriptions transfer attention from the individuated individual to the processes of individuation and enable us to see both the preliminary operations that make this process possible and the self-actualising processes of the individuation itself. The mediation has to be understood as a real process in itself which brings orders of magnitude that are not simply abstract form and abstract matter into communication. But in both of these examples the 'form-intention' (as Simondon calls it in *Du mode*) that is mobilised through these material processes is form as shape. Although form-taking is shown to be a dynamic chain of processes that includes the micro and macro preliminary operations and the operations of individuation, and not the simple imposition of form on matter, the mediation still takes place in the terms of a geometric form-intention and a physical substance. If, for example, Simondon had concentrated on the next step in brick-making – the firing of the wet brick – he would have been concerned with form-intentions other than shape such as durability and weather resistance.

What may be most significant then, about studying the performance clause in conjunction with the process-based clauses for concrete casting is that form-intentions other than the classic shape-form of hylomorphism come into play in the establishment of the conditions in which a material is individuated or mobilised.[41] At their most straightforward, performance clauses specify the structural integrity of a material itself or in relation with other materials. They also specify materials in relation to the environmental factors they are to withstand, including 'natural' factors such as wind, rain, gravity and sunlight as well as those which are manmade such as pollution or the impacts of bullets, footballs or maintenance activity. In these cases, the form-intention can be seen to extend to factors which are subject to local, historical and social change. The social aspects of the form-intention are still clearer when performance clauses specify aspects of the material which will relate to the experience of the inhabiting subject through prescribing behaviours such as acoustic and thermal separation. Performance specification (and the necessary tests, regulatory and manufacturing procedures which I have documented) is evidence that a broader set of factors become a system rather than a set of

[41] I use the term 'mobilisation' rather than 'individuation' here to distinguish between individuating processes which can be directly related to the production of a material as it is used in building, and extra-physical processes which prepare a material for a specific use in building. This involves an assumption that individuation might be understood, not just as the genesis of physical individual, but also as the processes by which a material becomes integrated in a specific way into the building. It is at this point, we might say, that a material is not just a reservoir of potential for use, but comes into a specific communication. To some extent this notion can be seen to go beyond Simondon's own accounts of individuation.

parts in the preparations and mobilisation of these materials. Performance specification requires that we think of the orders of magnitude that are mediated in each material system in terms other than shape-form and formable material or the energetic processes of work and physical material.

Within the variety of forms of clause that have been explored here we also see a variety of systems of material. I have made a distinction (also recognised in industry), for example, between performance clauses which specify structural performance, constructional integrity and those which directly related to the inhabitant which can be seen to derive from socially defined norms about work, privacy, comfort and so on and contribute to their material stabilisation to some extent. Only a small number of process-based clauses actually relate to processes which appear to reproduce the hylomorphic schema as closely as concrete casting in rigid formwork. Rather than track all of these alternatives (wood working, masonry, the application of finishes and so on) I have tended to highlight examples of process-based clauses which include extra-physical factors that exceed the physical factors which Simondon concentrates on in his account. One such example specifies the application of paint to a column at the Elfrida Rathbone School (1961):

26.13	…Each succeeding coat of priming and undercoating paint shall be sufficiently different in colour to be readily discernible…[42]

The specification of paintwork is usually concerned with appearance and maintenance. At the physical scale each layer applied to the last enables a transition form a specific material (wood, metal or plaster) to a more general finish (gloss, matt and so on). In rare cases, as we saw in the clauses specifying intumescent paint finishes, texture may be given and we could understand this as a description of form at the micro-level.[43] What is peculiar about Clause 26.13 is that each layer of paint is specified to be a different colour, even though they will be hidden (and only seen, perhaps, when one day a child rides their bicycle into the column and reveals the rainbow of colours beneath the surface). The different colours are there, presumably, to allow the architect to check that each layer – primer, undercoat, topcoat - has been applied as instructed. The clause (and in this case, unusually, the only preliminary operation is the clause itself) mobilises the paint as a checking device. The paint is prepared for the architects' visit, for an 'extra-physical' demand that is materialised in the fabrication and becomes a physical part of the column. What alters here is not so much the physical make up of the material, as the 'system of material' which makes possible the relationship between the paint and quality control. This work could also have been carried out by other means (by a social system of trust for example, or through surveillance CCTV). It need not have happened through the mobilisation of paint in this particular system of material.

[42] Specification for the Elfrida Rathbone School (1961).
[43] See for example the various textures for the final coat of intumescent paint that were cited in Chapter Three.

The specifications we have looked at yield other examples of systems of materials where mediations and orders of magnitude exceed those given in Simondon's re-desciption of the clay/mould system. We have seen numerous examples where materials are simply defined in terms of dimensions, such as this recommended specification for hardcore (1985):

> Make up to required levels under concrete beds and pavings with approved brick hardcore *broken to pass a 75mm gauge.*[44]

In others, such as the clause for putty below, materials are described in terms of their relation to other materials:

> Putty is to be linseed oil to BS544: 1969 *for glazing to wood* and approved best quality metal-glazing compound *for glazing to metal.*[45]

These systems of material are confined to the building itself. We have seen other examples, however, where materials are specified in terms of their source; whether that be the place they can be dug up: 'Three Bushels of clean Thames sand to be taken from the river between Fulham and London Bridge'[46] or the port they are traded at: 'The whole of the Fir Timber used in the building to be of yellow Crown Memel, Danzig, or Riga fir... the deal to be Christiania or deals equivalent in quality.'[47] This kind of information locates the material in a wider geographical and context. It is sometimes given today for materials such as some natural stone but is, for example, necessarily excluded from performance specification. In a rather delightful (and vague) description of the detailing of some timber stairs – 'Best stairs finished as Mr Turners is done'[48] – the reference is to another built example, a practice I am told was common in Roman specifications.[49] What is clear in these different examples of clause and the systems of materials they are evidence of, is that other factors than form-shape are defining.

The first point about this variety is pragmatic. Different forms of clause exclude and include certain aspects of the material. To omit some forms is to exclude certain aspects of the material from consideration (or at least to render these aspects invisible from the point of view of specification). For example, it is rare to see materials specified in relation to where they are from today, but this is just the kind of information that might be useful if we wanted to include the energy costs of transporting materials in the remit of specification. As

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[44] Bowyer, *Practical Specification Writing*, p.55 (my emphasis).
[45] Ibid., p.24 (my emphasis).
[46] Specification of Works to be done in Building a Workshop, in Mocatta, *Specifications* (1833-43).
[47] Specification for two houses on Marylebone Street, in Mocatta, *Specifications* (1833-43).
[48] Proposals by Benjamin Timbrell to Sir William Heathcote for Building a House in St James Square (1734-6), RIBA Archives HEW/1.
[49] Conversation with Fabio Barry, 3 June 2009.

such the emphasis on performance specification is at odds with the environmental demand to specify materials in terms of the embodied energy involved in their extraction, production and transportation. We might say that in performance specified materials, the production of a material is excluded from the system of materials as a relation.

In Chapter Eight we looked at uses of materials that can't yet be included in standard specifications. In the case of the straw bale house it was not just the properties of the straw bales or cement bags or the architect's intention which determined the ways they could be mobilised in building, but whether or not they had been approved for specific uses. Regulation, rather than physical behaviour, determined the kinds of relations that could be made through the material and the design outcome. Straw bales were only recognised in their insulating role and vertical trusses had to be introduced to do the official work of load-bearing. Cement-filled sandbags had to be treated as exterior decoration and a conventional inner wall met structural and performance criteria.[50] At the scale of building, the potentials for the mobilisation of these systems of 'improper' materials are limited to 'extra-functional' mediations, and at the scale of the organisation of work they set up conditions in which the normal professional hierarchies of communication and agreement are challenged. To recognise the variety of forms of clause might raise questions at the level of specification practice as to which mediations and possibilities are included and excluded and whether demands other than protection against litigation should be informing the selection of forms of clause.

The second point about the variety of clauses, systems and the mediations through or across the materials which they are organised around is conceptual. Not only do we need to reconceive the form/matter binary in terms of processes as Simondon has shown, we have to multiply the kinds of processes we consider in relation to the material. Shape is not the only form-intention which material systems are prepared for. New chains of preliminary operations can establish the conditions or potential for radically new kinds of mediation to be made through the material register, as is most strikingly the case in performance specification. We might imagine for example, the advent of an increased fear of terrorist attack in the west and a sheet of laminated glass as two ends of a chain. Some kind of equivalence must be prepared for them to come into communication which constitutes them as a system. These long chains of preliminary operations involve engineers, labs, new systems of measurement and quantification both of material properties and threat, and prepare the possibility of a mediation that is actualised in the mobilisation of the material. We might understand this system of terrorist-proof glass as equivalent to Simondon's concretised technical object, as a new mediation that is brought about through technical activity:

[50] We might also add that what might at first appear a cultural or expressive choice to use an excessive or decorative use of material – the straw bales are not structural, the cement bags are cladding – in terms of architectural categories, is in fact produced by the mechanisms of regulation – or at least that in this case there is a necessary relation between them.

> Through technical activity, man creates mediations, and these mediations are detachable from the individual who produces them and thinks them; the individual expresses himself in them, but he doesn't adhere to them.[51]

Importantly, for Simondon these new technical objects are detachable from 'the individual who... thinks them.' They are not simply 'abstract' - physical manifestations of an intention or idea. Technical activity 'gives to its human content a structure similar to natural objects and allows the insertion of this human reality in the world of natural causes and effects.'[52] It stabilises these new mediations which do not mimic existing logics but exceed those given either by the natural physical world or the conceptual horizons of abstract thought. In this sense, we might say that these new technical objects are also new material concepts, and that they can also, like the objects themselves, be plural. What I want to propose then is that the plurality of systems of materials, needs also to be seen as a plurality of material concepts, of which the 'performance concept' (which includes performance engineered materials who have been physically altered and performance specified materials which need not have been) is perhaps the most strikingly radical. It is in this sense that we might say performance-driven or 'functional materials' have instituted 'a new notion of matter', to remember Bensaude-Vincent and Stengers' phrase, but this is not new in the sense that it replaces other notions of 'matter' (of course it is more accurate in my terminology to use 'materials' here). Rather it adds a new material concept (that may dominate for a time but will always be subject to history) to what was already a plurality of concepts of material.

For Simondon, it is a mistake to consider relations merely as concepts that link individuals. They are themselves real processes. It may well be possible, for example, to conceive of a relation between a material and the inhabitant of a building, but a clause for the acoustic performance of glass (and the associated manufacturing and procedural processes) organises this relation as part of an actual material/social system. It is in this sense that new mediations or material concepts can be seen to arise out of industrial and regulatory practices surrounding the production of materials and also to have real effects for the work architects do with materials (and presumably for all of us who inhabit the built environment). We may remember here McAnulty's statement that architecture's material effects 'resonate most noticeably when they project surprising new possibilities for material organization, or better yet *new forms of relation*.'[53] It is not clear what he means by 'new forms of relation' but it is clear that for him, they are the production of 'architecture' and not also of the industrial regimes which produce the materials and regulatory conditions in which architecture must always be made. Similarly the 'material effects' with which Andrew Benjamin is concerned, are not only given by the architect or the structural properties of the materials selected for use.

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[51] Simondon, *Du Mode*, p.245.
[52] Ibid. Also cited in Toscano, 'Techncial Culture and the Limits of Interaction', pp.202-3.
[53] McAnulty, 'What's the Matter With Material?', p.91.

The possibilities for their mobilisation are, where performance engineering or specification is employed, already to some extent embedded into their physical or contractual constitution.

If new notions of material can be seen to arise out of industrial and regulatory practices involved in the production of materials that have real effects for the work architects do with materials, then a more radical critique of hylomorphism emerges than one which stays essentially within an ahistorical understanding of concepts of materials (as unaffected by the conditions of their production and mobilisation) and goes only as far as granting materials energetic activity or the capacity for self-organisation. While, as we have seen, in many cases systems of materials are confined to physical parameters – such as their capacities for energetic exchange and transformation – in others the conditions established for a material's mobilisation make social, cultural, statutory and economic factors a part of that system. And in some cases, the mediation which can arise out of these conditions as the individuation of a material mobilised in a specific way, is a communication with orders of magnitude that are social and physical. The conditions which enable a piece of glass to be mobilised to fulfil a social role (watch those MPs but don't hear their debates, see your public but don't listen to their protests) are established through a chain of processes which include extra-physical procedures, in the same way that clay is prepared for moulding through a series of physical preliminary operations.

The 'black box' is a recurring figure in *L'individu* and in *Du mode*. It is there when a worker shapes clay in a mould and need only see form and matter without understanding the dynamic process of taking-form, or when the workshop manager gives an instruction outside the workshop. It is there, we might say, when the energy of a pendulum switches form potential energy at the end of its swing to kinetic energy during it. It is there, more troublingly for Simondon, when a machine 'functions' and the operator is either outside the operation or becomes part of it, and in the conceptual model of the hylomorphic schema which sees only matter and form and not the processes of individuation. We might say too, that the material, at least as it is figured in architectural discourse and practice, is in another black box, that it too is, for the most part, understood as substance (or the potential for structure) and not as process. The specification has been a resource in this investigation for opening this black box. In some cases, as in the process-based clause, processes are immediately visible. They may be explicitly described or become apparent because of techniques which edit or control physical processes. In other cases, as in the clauses which give the port where a timber is traded, or the stretch of the Thames where sand is to be sourced or a named manufacturer, we see traces of different kinds of processes. This is not the case in the oldest specifications I have looked at. In these cases the processes of building and procuring materials were still organised through 'personal relations' as opposed to 'material relations' to use Amhoff's terms, and they are not part of the material mechanisms of contractual description.[54] More recently, and particularly in the case of performance specification and its associated forms, these processes are themselves black-boxed. They are codified and specified elsewhere, with

[54] Amhoff, *Adapting the architect's products to the capitalist building production*, p.3.

manufacturers or statutory authorities, and they have to be retrieved by looking for information outside the clauses of the specification.

These processes, I have argued, are what characterise particular systems of materials, and the potentials for mediation or individuation that are specific to each. To open these black boxes is simply to try to understand the specificity of each of these systems, to demonstrate their variety and show that this variety is a result of industrial, social and regulatory changes, that in turn produce new configurations of material systems and their potential mediations. For architects, access to these understandings is restricted in a number of ways. First architects are (usually) outside the workshop. In a sense this position is foundational to the profession in as much as it is built on a separation from the craft of building. Second, as industry and building regulations develop, these processes take place at ever further remove, represented by numbers and codes that few architects are familiar with, or embedded into the materials they specify (as, say, in the case of self-cleaning glass). Third, the conceptual models for thinking about materials – as matter in particular – tend to reinforce the black-boxing of the material. In form-led design, materials may be black-boxed altogether, whether understood as beneath architecture, or denigrated as the tainted products of profit-seeking industry but meanwhile left to do the dirty work of conforming to regulations that are outside the architect's control. In material-led design, materials may be celebrated for their visual effect or for their capacities to generate form, but the social and industrial forces which produce them (and their relational possibilities) are black-boxed as if these characteristics can exist outside and unaffected by them.

To make the specification a resource for this enquiry is a mixed blessing. On the one hand the variety of forms of clause and the processes they make visible have provided evidence for this proposition that there is a plurality of systems of materials, and for the various mediations they make possible and the variety of conceptualisations they demand. On the other hand the specification is entrenched in the very conditions of production and normativity of the building industry as it stands. It can only show us the limitations, restrictions and conventions through which building is controlled and regulated. To study the specification is, perhaps, to describe precisely the conditions which make architects content to leave materials in their black boxes and elaborate conceptual frameworks which substantiate this position.

In *Du mode*, however, Simondon invites us to see otherwise. While he is at once troubled by the new technical objects which seem at first to usurp the worker's role as 'mediation between man and nature' he also proposes that they tie 'man to nature according to a connection much richer and better defined.' At one level, in *Du mode* new technical objects (which I am suggesting are equivalent to some systems of materials) give to 'human content a structure similar to natural objects and allows the insertion of this human reality in the world of natural causes and effects.' That is to say they no longer mimic existing reality and logics, and may go beyond either. As such they provide new possibilities that are at once material *and* conceptual. To draw these out, then, is also to make it possible to utilise the potentials they may offer. At another level, in

the chapter on technical systems in *L'individu*, Simondon gives us an account of metastability which is both created and also necessarily inventive. To follow this through would be to say that while the potential for the mobilisation of any system of material (to act acoustically, to be shaped in a timber box etc.) is given by its preparations, its individuation is not fully determined. If we take seriously the processes through which systems of materials are differentiated from each other, and the specific mediations they make possible, we might also find inventive, speculative and critical ways to make use of them, which exceed the ways they are determined in normative specification practice. Not only would we recognise the variety of systems of materials and the processes which institute them in their specificity, we would have at our disposal a broader range of material concepts than visual intent or matter as that which is formed. These material concepts would be both more specific to architectural practice, and yield a far richer range of material mediations for architectural practice to deploy.

Coda: On the transductive method

> There can be a type of knowledge that is the most stable possible for this subjective condition or that objective condition. If an ulterior modification takes place in the subjective conditions (for example the discovery of new mathematical relations) or in the objective conditions, the old type of knowledge can become metastable through relation with a new type of knowledge.
>
> Gilbert Simondon[1]

In transduction all aspects of the individuating system – seed, solution and information - are part of the system, even when the potential for further individuation has been exhausted. The transductive relation is not merely a conceptual mediation, but a real process in itself. If this system characterises the model I have set out for thinking about building materials (at least as they appear in the architectural specification) it also suggests some kind of aspiration for an approach to materials, components, techniques and buildings in architecture. A transductive method sets itself apart from those which seek to apply abstractions or find concepts which might have universal explanatory force – whether, in the case of materials, to understand them as subsets of matter, and in architecture as a technical substrate for form, or as 'commodity', to be separated out from a critical architectural practice which seeks autonomy from the conditions of production. This research has sought to find conceptualisations of materials which are internal to the ways they come into being and are mobilised, and to include their ideological, physical and epistemological constructions.

Given the very particular emphasis on the role of preliminary operations in Simondon's thought, my version of a transductive method should also recognize that for productive encounters to take place between forms of clause and concepts of materials they have themselves been prepared. Thus much of the work of this research is the preparation for the encounter. Arguments from philosophy are intentionally selected and edited, even bent, and forms of clause are read in ways which exceed their role in what is a technical and contractual document. Some of this preparation is presented here, in the body of the text and its arguments, but other aspects ground it silently, in particular my encounter with the poetry of Francis Ponge which preoccupied me for some months before and during the period that the forms of clause in the specification became the focus of this study.[2]

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[1] Simondon, *L'individuation à la lumière*, p.83. This text is not included in the first edition of *L'individu*. Simondon's beautiful notion here seems to draw on Gaston Bachelard's earlier work where he sets out the ideological and symbolic forces which necessarily shape any encounter with substances, molecules and phenomena in the chemist's lab. For Bachelard, these concepts were then necessarily historical and contextual and equally, then, subject to change (in a localised sense, rather than in the sense of the epistemic shifts which Foucault describes).

[2] Some of this work is published in my 'Specifying materials: language, matter and the conspiracy of muteness' in *From* Models *to Drawings*, Marco Frascari, Jonathan Hale and Bradley Starkey (eds.), London: Routledge, 2007. When presented at the AHRA annual conference at the University of Nottingham, it enraged some listeners that I could compare the specification to poetry or even include it in a conference about architectural representation. Of course their

Ponge developed a method that he called 'adequation' in order to write 'on the side of things.' Of course, such a project is already flawed. There is no way to speak for things, nor is it obvious why it should be necessary or desirable to try to give things a voice. Ponge's method was to try and find what might be in common between the things he wanted to write about (or for) and the language he used in his writing. In the *Méthode*s he explains his 'Chosen genre' as 'definitions-description which are aesthetically and rhetorically equivalent.'[3] In some cases it was a quality that language and the subject of his poem shared. For example in 'Les Mures' – 'ripe blackberries' - he plays on the similarity of the inkiness of the printed text and the black juice of the fruits:

> In the typographical thickets that go into the making of a poem, along a road that leads neither beyond things nor to the mind, certain fruits are formed by an agglomeration of spheres, each filled with a drop of ink.[4]

In other cases, he worked with what, following Simondon, we might call operations. In writing about a mirror (or the impossibility of the pure copy or representation as the poem's title 'Fable' suggests) Ponge uses textual strategies of (impure) reflection, making symmetries between lines, spoken and written versions of a word or its capacity to be used as either signifier or sign within the text.[5] In his long poem 'Faune et Flora' Ponge finds a relationship between the voicelessness of words and letters in themselves and that of plants:

> They have no voices. They are all but paralyzed. They can only attract attention by their postures.
>
> For all their efforts to 'express' themselves, they merely repeat the same expression, the same leaf, a million times… they think they're breaking into a polyphonic canticle, bursting out of themselves.[6]

The text itself repeats lines and phrases, adequating the replication of the leaves. Ponge concentrates on what poem, plant and mirror do, finding ways of using language which could correspond to his object without necessary recourse to its appearance or form. In *Pré*, his poem about a meadow, he publishes every version of the poem that was written during the five years he worked on it (Fig. 9.2).[7] The build up of versions, each providing material for the next, is analogous to the way a meadow grows, each year's detritus becoming the source for the next.

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primary objection, that the specification is 'just a legal and technical document' could as easily be made about the architectural drawing.

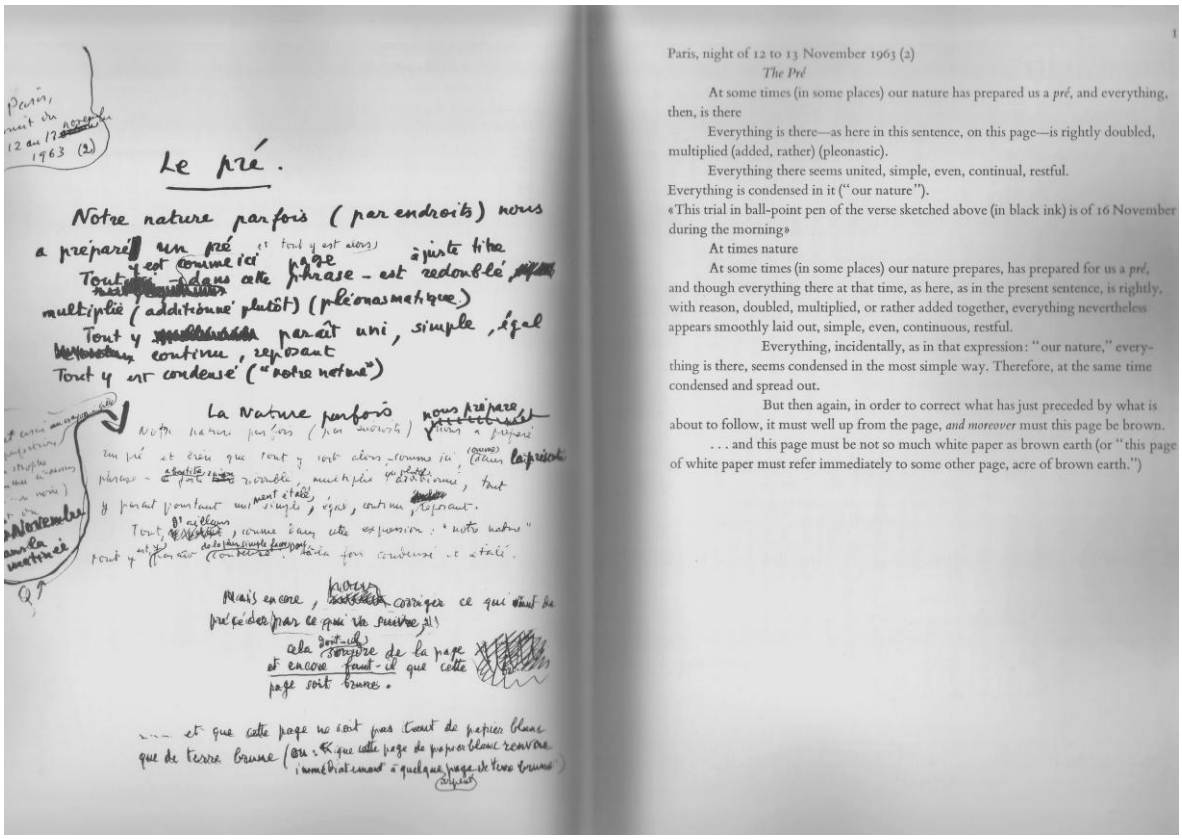
[3] Martin Sorrell, *Francis Ponge*, Boston: Twayne Publishers, 1981, p.63.

[4] Francis Ponge: *Selected Poems*, Margaret Guiton (ed.), London: Faber and Faber, 1998, p.15. Translation of this poem by C.K. Williams.

[5] 'Fable' is translated in Sorrell, *Francis Ponge*, p.118.

[6] Ponge, *Selected Poems*, p.71. Translation of this poem by Margaret Guiton.

[7] Franicis Ponge, *The Making of the* Pré *by Francis Ponge*, Trans. Lee Fahnestock, Columbia: University of Missouri Press, 1979.



Paris, night of 12 to 13 November 1963 (2)

The Pré

At some times (in some places) our nature has prepared us a *pré*, and everything, then, is there

Everything is there—as here in this sentence, on this page—is rightly doubled, multiplied (added, rather) (pleonastic).

Everything there seems united, simple, even, continual, restful.

Everything is condensed in it ("our nature").

«This trial in ball-point pen of the verse sketched above (in black ink) is of 16 November during the morning»

At times nature

At some times (in some places) our nature prepares, has prepared for us a *pré*, and though everything there at that time, as here, as in the present sentence, is rightly, with reason, doubled, multiplied, or rather added together, everything nevertheless appears smoothly laid out, simple, even, continuous, restful.

Everything, incidentally, as in that expression: "our nature," everything is there, seems condensed in the most simple way. Therefore, at the same time condensed and spread out.

But then again, in order to correct what has just preceded by what is about to follow, it must well up from the page, *and moreover* must this page be brown.

. . . and this page must be not so much white paper as brown earth (or "this page of white paper must refer immediately to some other page, acre of brown earth.")

9.2 Francis Ponge, *The Making of the* Pré, pp.118-119

What interested me about Ponge's work was that, unlike other writers and poets concerned with the materiality of language whose strategies tended to work with the materiality of language in general, he tried to find language and textual strategies which related to the specific materiality or operations of what he wrote about, and as a result there were differences between the forms of language he used in each poem. It was Ponge's strategy of adequation then, which made me alert to the potential of the architectural specification, and its variety of forms of clause which I half remembered from my days in architectural practice writing specifications (without the NBS) for tiny domestic extensions. Ponge's poetry and my particular preoccupations with the differences between architectural materials transformed the specification from nothing more than a mere technical prescription – as 'statement' in Foucault and Deleuze's terms[8] or 'the greatest *stifler* of the forces of language'[9] – to a what I hoped would be a generative field. We could say that the specification, or at least the variety of forms of clause in the specification, became metastable, a field in which individuation could occur, through being put into relation with Ponge's poetry.

[8] 'Any institution implies the existence of statements such as a constitution, a charter, contracts, registrations and enrolments. Conversely, statements refer back to an institutional milieu which is necessary for the formation both of the objects which arise in such examples of the statement and of the subject who speaks.' Gilles Deleuze, *Foucault*, trans. Seán Hand, London: Athlone Press, 1999, p.9.

[9] Jean-Jacques Lecercle, *Deleuze and Language*, Basingstoke: Palgrave Macmillan, 2002, p.167. Lecercle describes how, for Deleuze there would be nothing to be gained from reading most texts or utterances: 'It is clear that for him there is no democracy of corpuses. The detailed study of an everyday discussion or telephone conversation yields trivial and uninteresting results, for such every day exchanges are fully functional… and more often than not irenic…' p.199.

The main argument of this thesis is that materials in architecture should be understood in more ways than the concepts of matter or commodification allow, and to put forward a set of concepts of material that recognise the social and industrial contexts they arise out of and are developed to intervene in. The secondary argument is to show that concepts may not just be materially validated, reinforced or sometimes reproduced, but themselves arise out of material (physical and extra-physical) change. This is to argue for a complication of the role of nonhumans than Latour sets out, and to trouble his notion of delegation which, despite his explicit claims that humans and nonhumans are equivalent as actors, tends to describe a one way movement from humans to nonhumans. It is to propose that conceptualisation occurs transductively between them, in the very real ways that relations between them are changed in the ways that have been explored in detail here in relation to the process-based and performance clause.

To extrapolate this would be to propose that materials and buildings, and the ways they are prepared, can themselves alter concepts, or produce new concepts. We might not turn so readily to philosophy or science for the conceptual schemas we apply to architecture, but derive concepts from this applied practice, that is always necessarily historical and ideologically produced. This would be a method that would bring ideological and industry-based changes into view and take them seriously, and also, perhaps be generative in a manner which I hope to have shown.

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