

TECHNOLOGICAL ESSAY

Mud and Modernity

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What is concrete? Loved and loathed in equal measure, this building material, as soon as we try to define it, to specify it, to describe it, becomes, well, not very concrete at all, but rather fluid and surprisingly abstract! Concrete is a material which has been going through an interesting intellectual and practical renaissance in recent years, in no small part driven by the convergence of several different kinds of technology-driven manufacturing changes - ranging from computer aided manufacturing of formworks, to photograph etching, to engineering software, to nano- and bio-chemistry to 3D printing - which have opened up new worlds of realizable, expressive and performance optimised form. The demands posed by anthropogenic climate change, energy use, resource scarcity, and the environmental question more generally, have equally transformed the technologies and industries that are now feeding into developments in this material. On its own though, that is not enough to understand the revival in interest. In this paper I will argue that there are indeed profound relationships between capital, modernity and concrete. However, I will suggest that in order to really start to grasp these relations, we will need to explore some ways of thinking about concrete that have not been developed so far within the recent literature on the material. Notably I will develop an ecological approach to thinking about what concrete is, and in so doing redefine this material as a particular form of mud, or mudcrete: a material which is deployed by both human and non-human builders. I will note the ecological energetics and extended materialities of mudcrete, and will reflect upon the conceptual 'forms' or 'patterns' of this matter as a particular modality of the production of nature. Mudcretes always internalise in particularly interesting ways I argue, their external relations, the extended networks of materials, skills, labours and energies that go into their production. Mudcretes frequently stage fascinating bio-semiotic performances, whichever species or processes are dominant. But when the mudcretes in question are the product of human labour, they always act as social media.

Keywords: mud; concrete; modernism; Gaudi; Soleri; CAD/CAM; Cheval; Rodia; Wright

Introduction

What is concrete? Loved and loathed in equal measure, this building material, as soon as we try to define it, to specify it, to describe it, becomes, well, not very concrete at all, but rather fluid and surprisingly abstract! Concrete is a material which has been going through an interesting intellectual and practical renaissance in recent years, in no small part driven by the convergence of several different kinds of technology-driven manufacturing changes – ranging from computer aided manufacturing of formworks, to photograph etching, to engineering software, to nano- and bio-chemistry to 3D printing – which are opening up new worlds of realizable, expressive and performance optimised form (**Figs. 1 and 2**).

The demands posed by anthropogenic climate change, energy use, resource scarcity, and the environmental question more generally, have equally transformed the technologies and industries that are now feeding into developments in this material. On its own though, that is not enough to understand the revival in interest. Historians such as Adrian Forty [1], Jean-Louis Cohen [2], Mark Wigley [3], Sanford Kwinter [4], Antoine Picon [5], Katie Lloyd-Thomas [6] and Owen Hatherley [7] have all written about concrete in recent years. These thinkers have in different ways all seemed animated by a suspicion that, somehow, if they were only

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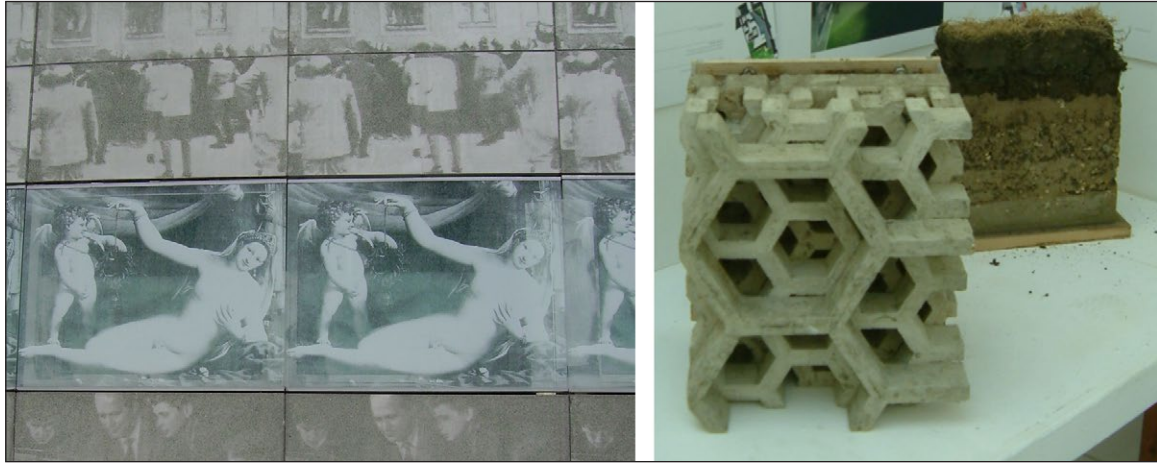


Figure 1: (Left) Photographically etched concrete façade panels. Eberswalde Library. Herzog and de Meuron. Built 1999. Image source: https://upload.wikimedia.org/wikipedia/commons/7/77/FH-Eberswalde_Bibliothek_Fenster.jpg; (Right) Concrete and mud experiments. Here Andy Ensor experiments with graduated mixes of conventional concrete and organic mud, testing the point at which concrete can support plant life. Polytechnic Studio, University of Westminster, UK, 2004 (Photograph by Jon Goodbun).



Figure 2: (Left) Concrete cushion fabric formwork experiment. University of Greenwich, UK (Photograph by Jon Goodbun/Cordula Weisser); (Right) Concrete tiles produced through adjustable analogue/digital formwork. Lorin Arnold. Polytechnic Studio, University of Westminster, UK. 2004 (Photograph by Lorin Arnold).

able to fully grasp this material, then they will come to understand something profound about modernity itself.

But as Forty has pointed out, the kind of language that I have used in the paragraphs above – suggestive of innovation, newness and potential – is the same language that has been used to describe concrete for the best part of two centuries. It seems that ‘the new’ – such an important concept within the self-mythology of modernism – found one of its most significant reifications in modern concrete. There are many reasons for this, but surely primary is the mode of production within which modern concrete grew as a technology and material: industrial capitalism. The flowing matter of concrete, which solidifies into fixed assets, is analogous – as Lloyd-Thomas has rightly observed – at some level of the collective imagination, to capital itself, and Karl Marx’s reflections upon the cultural use of metals as coinage might be re-projected through concrete [8]: “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.”

In this paper I will argue that there are indeed profound relationships between capital, modernity and concrete. However, I will suggest that in order to really start to grasp these relations, we will need to explore some ways of thinking about concrete that have not been developed so far within the recent literature

on the material. Notably I will sketch an ecological approach to thinking about what concrete is, and in so doing redefine this material as a particular form of mud, or mudcrete: a material which is deployed by both human and non-human builders. I will note the ecological energetics and extended materialities of mudcrete, and will reflect upon the conceptual ‘forms’ or ‘patterns’ of this matter as a particular modality of the production of nature. Mudcretes always internalise in particularly interesting ways I argue, their external relations, the extended networks of materials, skills, labours and energies that go into their production. Mudcretes frequently stage fascinating bio-semiotic performances, whichever species or processes are dominant. But when the mudcretes in question are the product of human labour, they *always* act as social media.

The Mental Ecologies of Mudcrete

‘any encounter with a piece of concrete, anywhere in the world, at once launches us into a dialogue about what “nature” is.’

Adrian Forty [1, p. 43]

Mud is a primitive, telluric, perhaps scatological substance. As children we might play with our hands in the dirt making sandcastles, whilst developing the neurologically networked micro-territories of our imaginations. But before that even, we pass through a stage of fascination with our own body’s expelling of waste as a very particular form of mud. Whenever we work the land as individuals or societies we are metabolising mud in some way, and whenever we bury our dead in the ground we are doing the same. Indeed, as Adolf Loos [9] famously noted, the making of a mound of earth and stones in the woods for this purpose is one of the foundation myths of the art of architecture.

The important ur-ness of mud has not changed with the modernity of concrete – in fact if anything it may have paradoxically intensified. One of the first observations that Adrian Forty made when he turned to consider modern concrete was that ‘concrete, let us be clear, is not a material, it is a *process*.’ [10]. Yet of course, this statement is true of all materials to various extents, so why make this statement about concrete in particular? (A statement, it should be noted, which caused some excitement in architectural academia when Forty first made it.) The answer, I think, to state it once again, is because the concrete that Forty studies is really a modern form of mud, and mud is arguably the most important and paradigmatic embodiment of an archetypal cultural conception of ‘base matter’. More than as base matter, it can also teach us something about pattern. Remembering the deep etymological pairing of matter and patter (mater and pater), muds embody, reveal and articulate through the use of formworks, or other forming processes, relations between and aspects of, one of the most long-standing of human cognitive dualisms: form and substance, mind and matter... or of that dualism’s immanent dissolution or transcendence in the *inform* and the emergent. And of course, Forty is right, concrete really is a process at a molecular level. It has a metabolism, a lifecycle. The crystals need a considerable time – many years – to fully develop and reach maximum strength.

Today the most common form of cement used in concrete is Portland Cement – a product patented in 1824 by Joseph Aspdin. However, cements do in fact exist naturally, and have been produced in geological situations that bring together limestone and oil shale under conditions where they can spontaneously combust. Such deposits have been found and used in Israel for example. However, the process of burning limestone (known as lime-burning, or calcination) to produce cementitious materials, has itself been used by humans for at least 3,000 years, and the product is known by common names such as lime, quicklime, or burnt-lime.

The Egyptians used lime mortars when building the pyramids, and the Romans burnt mixtures of pozzolana (volcanic ash from Vesuvius) and lime to produce concrete structures such as the roof of the Pantheon. The only thing that is really modern about modern concrete is the steel that reinforces many (properly named ‘ferro-concrete’) structures. Even the use of tensile reinforcement has a history as long as the cement that binds it. Although Joseph Monier received a patent in 1849 for the idea of combining the tensile strength of steel with the compressional strength of concrete, additives such as straw and hair have been added to concretes since Babylonian times, and indeed iron and bronze straps and chains have been used in concrete and stone structures for at least a thousand years.

Modern concrete then is just one particular ‘mix’ within a field of material-processes I’m here calling mudcrete. Whilst this term is already used to describe the addition of cement to marine muds in some construction, I am taking the term to describe a broader material family. My initial attempt to draw an outline around mudcrete would define the broad genus as a process which has a wet phase, takes on form

through a number of processes, and then solidifies, composed of a mix of aggregates, with a binding and/or fixing agent, mixed with water or other liquid to produce a wet, adhesive firm mouldable slurry, which hardens to have stone-like qualities. Examples in use today in construction in the UK include, in addition to modern concrete, terrazzo, adobe, rammed earth, ceramics, mosaics and baked clays. Elsewhere in the world are numerous vernacular members of this family of materials. As material processes they internalise, and make manifest, complex ecologies and relational social space-times. This is the case for human muds, but it is just as valid a way to understand a whole range of other structures built by non-human agents: termites produce mudcretes, as do many other insects: wasps build nests out of muds for example. And many birds and some fish and other marine creatures similarly build using mudcretes of various kinds, some occupying time-frames and spatialities almost impossible for us to imagine, for indeed, mudcrete could even describe the terraforming activities of Gaia, should we choose to give that name to the emergent mega-scale complex nest of systems at play on this planet. In almost all cases, these materials share an ability to hold detail, and to take on form. In almost all human mudcretes, the inherent properties of the material encourage the surface to become a highly worked store of labour, value and meaning, as it is often articulated into pattern forms or painted – it becomes media.

There are a range of constitutions, of component sizes and relative scales that the wet slurry typically might take. At one end of the range the slurry tends towards homogeneity. Adobe mud building would often be at this end of the range, as would the mixes produced by say wasps in their nest structures). In the middle of the range the slurry is made up of fine particulates (the cementitious component of the mix) within which larger scale aggregates are suspended. The 'classic' modern concrete mix of a ballast composed of sand and pebbles (typically themselves embodying vast energies of erosion from rivers, seas, winds, glaciers and the like), combined with Portland cement and water, describes well the mid range mudcrete. At the other end of the scale the mix is most non-homogeneous. A brick wall would fit this description for example. Here the aggregate – the bricks – are very large compared to the cementitious mix that bind them together into a wall, but in the new outline that I am attempting to define mudcretes by, the brick wall as a totality would be included. Rendered brick and block walls would likewise be included in their totality... thereby incorporating say Villa Savoye as not just being *about* the potential of modern concrete in its white rendered facades, but also being a mudcrete structure itself.

Why draw this outline? What is at stake in this definition of mudcrete? I must start the answer to that by remembering what the foundational ecological theorist Gregory Bateson had to say about William Blake's dialectical reflection upon the human production of categories and concepts:

'There was a very angry artist once who scribbled all sorts of things down, and after he was dead they looked in his books and in one place they found he'd written "Wise men see outlines and therefore they draw them" but in another place he'd written "Mad men see outlines and therefore they draw them."' Gregory Bateson, [11]

Bateson and Blake are of course reminding us here of both the necessity of producing concepts and drawing outlines, in order that we might see things, but they are also warning us that there is a certain madness and paranoia implicit in any such activity. And maybe I'm being paranoid, but it seems clear to me that the definition of modern concrete as a distinct material actually obscures a much more complex political and social ecology. As already noted, Forty has argued that concrete is a process more than it is a material. In a similar vein, Mark Wigley has stated that "concrete no longer appears as a solid and inert fact but as an ever evolving set of relationships." [3, p. 6] I think that we can push this reading further and use the kind of outline of mudcrete suggested here to reflect upon the ecological webs within which such processes and relationships operate. It was Gregory Bateson again who realised that ecological thinking can do much more than account for the dynamics of complex living systems. It can be used to move beyond a number of dualisms that have been long dominant within western thought, notably the mental and the material, form and substance, abstract and concrete. Felix Guattari developed Bateson's work on ecological theory, and on schizophrenia, and with Giles Deleuze famously politicized both. In his work on assemblages and in his account of the three ecologies he found in Bateson's thought (the personal, the social/technological, and the environmental) [12], we find a new way of articulating the kinds of relational networks models suggested by Marx a century earlier: "... technology reveals the active relation of man to nature, the direct process of the production of his life, and thereby it also lays bare the

process of the production of the social relations of his life, and of the mental conceptions that flow from these relations." [8, p. 493]

If we ask what are the ecologies of mudcrete, what networks of relations are at play in the various forms of mudcrete, then it becomes clear that concrete internalises a series of very local and wholly global relations, spanning a range of scales and temporalities. Any piece of concrete can only be properly grasped as a network that extends from the most modern chemical research laboratories and patent offices, to boats dredging up the banks and estuaries of an ancient Thames-Rhine mega delta hidden beneath the North Sea for aggregates, and limestone kilns around the world burning the corpses of ancient marine creatures. Its political ecologies include modes of production that are exceptional social performances, such as the annual renovation of the adobe mosque in Djenné, Mali, and elsewhere other divisions of labour that couldn't be more modern. Its use is so large scale that it has become a primary constituent of the anthropocene rock which is re-surfacing the planet, while the more than one billion cubic meters of water tied up in the molecularly Scheerbartian crystalline architecture of modern concrete annually drains aquifers and water tables of entire regions, and the carbon dioxide already emitted into the Earth's atmosphere through cement production will reflect back solar radiation onto the increasingly concrete surface of the planet that would otherwise escape into space, with climatic consequences that will play out over the course of millennia to come.

Thus the eco-mental systems (to again borrow from Bateson) of mudcrete are always cracking through the stresses of their internal contradictions, even as they express or dominate the forces of the world around them. Rem Koolhaas wasn't wrong when he saw in concrete's schizoid ecology of mind an exemplary architectural expression of Salvador Dalí's Paranoid-Critical Method:

'First, the conjectural structure of shuttering is erected – the negative of the initial thesis . . . then a mouse-grey liquid is poured into the speculative counteroffers to give them a permanent life on earth, an undeniable reality, especially after the signs of the initial madness – the shuttering – have been removed, leaving only the fingerprints of the wood's grain, infinitely malleable at first, then suddenly hard as rock ... it is the architect's plastic.' [13]

The commodification of mud

For Marx, capital is a process, not an object. It is a particular historically determined process that money can be put through in order to create new value. However, concrete is not reducible to capital flows, nor is it in any simple way an analogue of it, as a form of fixed or of living labour. Nonetheless, the codes of the 'commodity form' have structured the development of modern concrete profoundly. For entrepreneurial chemists and materials scientists, but also architects and engineers since the nineteenth century, developments around this material have created ways to expand their practice beyond the constraints of the professions, by developing and sometimes patenting their particular material mixes and construction processes. Naturally, the success of defending these patents has relied upon proving the newness of the technique

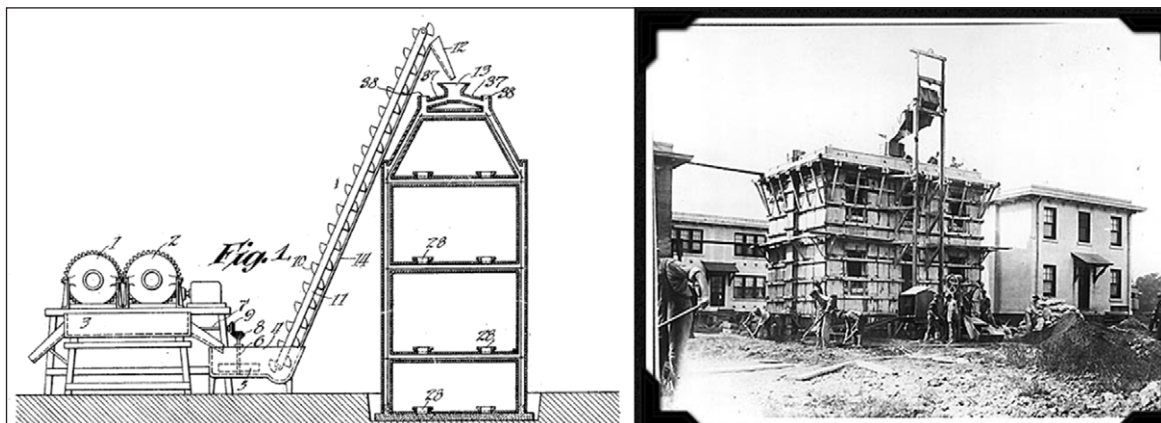


Figure 3: Thomas Edison. (Left) Patent application for single-pour concrete house; (Left) Photograph of concrete house being constructed in a single pour, 1919.



Figure 4: Mud media. (Left) Wall in Mali (Photograph by Jon Goodbun); (Right) The surface of the material often acts as a primary site of social media in vernacular building (Photograph by Jon Goodbun).

in question. There were many successful such patents developed over the last two hundred years, some of which resulted in or supported large industrial corporations that continue to dominate the construction landscape, and indeed the constructed landscape, today (**Fig. 3**). On occasion, these privately patented construction processes were brought in close to the heart of architectural ideology. As Cohen reminds us, Le Corbusier's Dom-ino system was a patent before it was a 'project' [2, p. 24], and remains perhaps one of the most direct and extraordinary translations between capitalist business plan and utopian architectural ideology to be found anywhere.

The fact that these patents were privately owned, and that the culture that existed around these products was a form of false consciousness articulated through 'the new', meant that concrete has perpetually seemed like it has only recently been developed. Forty has described concrete's condition as "a field littered with truncated techniques", defining "a material without a history." [1, p. 35] Yet the constant ideological return to the 'newness' of concrete can I think be traced far beyond the effect of patented processes, and has in fact been used to reinforce deeper aims of capitalist modernisation and monopolisation to an extent not previously considered by most commentators.

The new concrete technologies sought to establish themselves within building production throughout the nineteenth century, as new demands were placed upon the building industry by capitalist development. The remains of the builders' guild networks were breaking down all over Europe, unable to meet the constructional, organisational and temporal demands of the growing industrial populations. For modern concrete to become the dominant material-process that it is today, the emerging industry needed to find ways to overcome its 'family history' – the inheritance of being a material that is traditionally under local ownership and control. Modern Concrete needed to become material without this social history. The easiest way to do that was to define itself as a completely new thing, rather than a new form of an old material-process. Of course, a perpetual association with newness resonated with the broader cultural ideology of modernity. Similarly, distancing this new material from the potentially dirty associations of general vernacular mud was also crucial given the other broad pre-occupations of modernist architectural culture during this period, such as hygiene, whiteness etc. Viewed in this way, the level of ideological complicity between modern architectural culture and the emerging concrete industry is extraordinary. Architects, theorists and historians have all happily spent the last hundred years restating the myth of the newness of this material, and have happily acted as the unwitting stooges of a particular set of capitalist interests (and in a certain sense, I can't help but continue that process here!). Whilst doing this, they have been largely unwittingly suppressing the social history of mudcrete. A social media, constructed out of a very wide range of materials, often commonly owned and constructed by the local community, was replaced with semi-mute expanses of one particular sub-family of patented mixes and processes, which of course were those most amenable to exploitation by the emerging industrialists (**Fig. 4**).

Having said that, Modern Concrete has of course been fantastically successful, facilitating processes of modernisation, and the construction of important buildings and infrastructure that would have been inconceivable without it. In certain instances, it has given a particular and profound architectural expression of modern social identities, such as in the particular conceptions of collectivism expressed through socialist East Germany's *Plattenbau* system, and arguably in brutalism more broadly. I don't have the space to discuss

those here, and in any case, they have been well covered in recent and historical modern historiography (and this paper does is conceived as having a dialectical relation to those histories). Nonetheless, the dominance of one mode of modern mudcrete has had other broader cultural effects. The success, real and ideological, of Modern Concrete has meant the suppression of the broader field of mud processes. The division of labour in the use of Modern Concrete typically operates in such a way as to allow little possibility for broader social engagement in production. It forms a finished surface which is almost impossible to add to, which both denies people the possibility, or even the idea, of decorating and participating in the production of their environments. In this sense the graffiti that concrete attracts the world over, is often perhaps the appropriate final stage of production for this material-process.

Another Modern Mud

However, despite the dominance of Modern Concrete, there has in fact been a consistent line of architectural research that sees in concrete the potential for a properly modern form of mud, often developed with radically different social building processes in mind. Forty again has noted that the majority of concrete construction today does not involve architects or engineers, but is often used in unexpected hybrid forms, integrated into more traditional ways of building and divisions of labour. Modern concrete's contemporary *other*, as Forty intriguingly reveals, is in fact the vast number of other-modern traditions of concrete, often more informal, that can be found in the developing world, where concrete has become one of the primary 'new technologies of poverty' [1, p. 41]. There, he finds fascinating hybrid processes of non-modern social forms based upon working with mud as a building material persisting even whilst transformed through the adoption of modern concrete processes. In for example the South American 'mutiroides' or self-build cooperatives, 'making concrete is integrated into domestic life' [1, p. 40] as women collectively manufacture their own precast concrete construction elements. Here also then, concrete accurately acts as an index of the process of capital in these regions, as 'like a photograph, a concrete structure is indexical – it carries within it direct evidence of the moment of its making' [1, p. 254]. These accounts of non-professional and non-western practices are incredibly revealing when set against more familiar ways of working with concrete.

It is not a coincidence that some of the most intensely communicative modern architectural objects around use 'handmade' mud as a media which can be shaped, coloured, and decorated with inserted objects. I am thinking for example of the work of architects such as Antonio Gaudi (**Fig. 5**), Frank Lloyd Wright, Paolo Soleri, and perhaps even more the kind of work often categorised as 'outsider architecture' – such as the Palais Ideal of Facteur Cheval, and the Watts Towers by Simon Rodia.

The Catalan architect Antonio Gaudi is one of the key figures of the 'other' tradition in modern architecture, in many ways. Across all periods of his work there is sophisticated research into decorated 'mud' surfaces. He develops complex essays outlining a proto-surrealist modern language of communicative concrete, integrating existing local craft skills with new construction methods to produce combinations of stone, plaster and decorated mosaic surfaces, which are treated as a plastic continuum, connecting the individual body

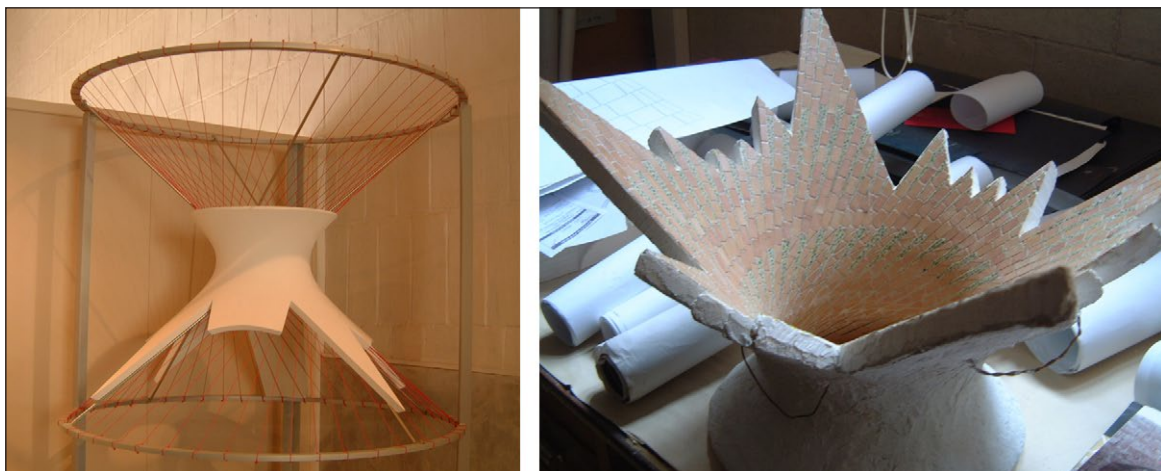


Figure 5: (Left) Gaudi's analogue computing models, and their scaled-up use on site, as seen in a site visit with Mark Burry (Photograph by Jon Goodbun); (Left) Further example of model after Gaudi (Photograph by Jon Goodbun).

with larger urban and landscape structures. Gaudi's development of the surface as a mosaic is particularly interesting, and creates a distinct expression of the wet mud stage of the process, during which it is possible to work and add to the material. The use of everyday object *trouvé* as surface aggregates, such as broken household ceramics in the benches in Parc Güell (and elsewhere), or broken and whole wine bottles on the roofscape of Casa Mila, prefigure by decades the Dadaist assemblages of Kurt Schwitters.

In the Sagrada Familia, Gaudi's work with modern mud continues to engage and develop the leading edge of building production to this day, in ways that presumably even he could not have completely anticipated. Gaudi started work on the Sagrada Familia and during his lifetime the lower sections of the church were completed, together with the towers of the apse. Work stopped and started sporadically throughout the twentieth century, hindered by a range of factors, not least the fact that Gaudi did not leave a set of typical drawings, but rather a selection of models – many of which were damaged or destroyed during the Spanish Civil War. For the last twenty years Mark Burry has been involved in helping to reconstruct Gaudi's plans for the cathedral, from the remains of the models, drawings and photographs that survived, working with a team of masons who are directly connected with the team that Gaudi originally put together.

Gaudi of course would have been well aware that the the building project would continue long after his death, and equally I think would have been well aware of the complex status of this building, as (in a sense) both the last medieval, and the first modern cathedral. Typically in a medieval cathedral, there was a very different division of labour to that found in modern construction, with building knowledge and design practice



Figure 6: (Left) Example of Soleri's earth-casting techniques at Cosanti and Arcosanti (Photograph by Jon Goodbun); (Right) View of Cosanti (Photograph by Jon Goodbun).



Figure 7: (Left) Earth-cast wall at Cosanti (Photograph by Jon Goodbun); (Right) On site with students in conservation with Paulo Soleri (Photograph by Jon Goodbun).

residing socially within the builders' guilds, rather than with an architect. In such a scenario the death of any individual would not in principle affect the project. It seems that Gaudi did not quite define the design knowledge for this building in ways that might have been expected of a modern architect (ie an extensive set of drawings), nor did he rely upon what was left of the guild system (which would have been misplaced and nostalgic). Instead it seems that he intuitively grasped that an equivalent of the shared social knowledge of the guilds, would in modernity be located in somewhere within mathematics, machines and 'computers'. He embedded his design legacy within such modern social knowledge, by developing a language for the higher parts of the church, which he knew he would never see built, out of the mathematics of ruled surfaces and their intersections, and other 'animated' mathematical entities.

Gaudi of course did not design with digital computers. He did however develop a series of analogue material computational devices to design the structures of his later work. These devices included tension-suspension models constructed out of strings weighted with sand bags, to produce catenary curves which could be inverted to describe compression structures. They also included string cylinders which could be twisted to describe ruled surfaces.

What had not been well appreciated until Burry's recent work uncovering Gaudi's use of mathematical entities called paramorphs, was that he embedded similar systems within the models to define the design of the decoration of these structures [14]. It seems that we should think of a series of movements up the cathedral, from figuration to abstraction, from medieval to modern, from Gaudi on-site, to Gaudi embedded in mathematical machines. Although much of the structure of the cathedral is stone construction, the language that unites the building is inseparable from Gaudi's modern mud research. Much of the stonework that Gaudi personally oversaw is worked in such a way as to appear fluid, whilst much of the more recent construction has continued to incorporate machines through the production of large scale cad-cam milled foam formwork for casting concrete elements. The strings of the original analogue computers have even manifested themselves directly as reinforcing rods!

The Italian architect Paolo Soleri, like Gaudi, developed a language of modern mud-concrete, which connects in one plastic surface, local decoration at the scale of the hand to infrastructural expression at the scale of the city (**Figs. 6 and 7**). For Soleri, modern concrete clearly remains a capitalist technology that can be socially seized, occupied and redirected towards a more progressive future. Soleri's research into the potential of modern concrete has always been a simultaneously social, technological and media study. It is clear from his drawings, models and built practice that for him concrete really is just mud, a fundamentally telluric material that is an expression of consciousness upon the surface of the planet. His development of the technique of 'earth casting' captures this notion perfectly. In this process for producing decorated shell

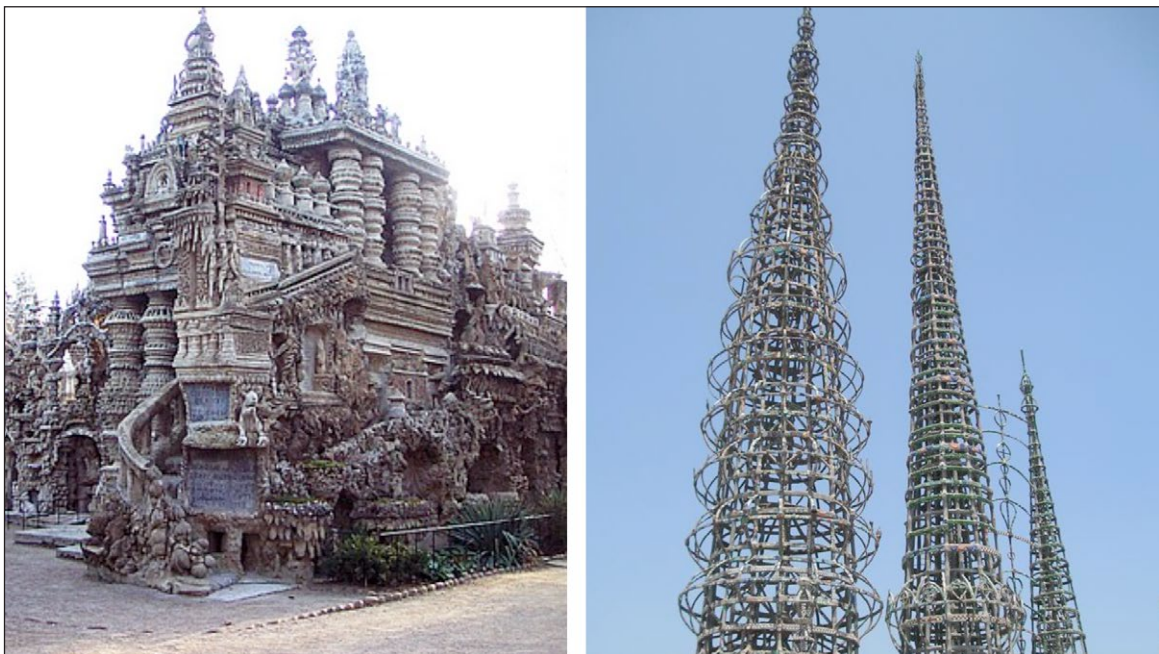


Figure 8: (Left) Palais Ideal by Facteur Cheval (Photograph by Jon Goodbun); (Right) Watts Towers, by Simon Rodia (Photograph by Jon Goodbun).

structures, the ground is built up into domed mound. The surface of the ground is then patterned and decorated, and often powdered dyes are spread on the ground. Concrete is then spread over the mound of earth, and once set, the earth under the now structural shell is removed, leaving a patterned, coloured surface which retains traces of earth and hand. Soleri prototyped these techniques at the Cosanti Foundation, and has deployed them further in the ongoing attempts to build a three dimensional city in the desert out of concrete, at Arcosanti – both in Arizona. In both of these projects the need for a new division of labour is built in, as the designing of the surface happens on site. Indeed, in both of these cases, structures were built exclusively by using the on-site labour of opt-in communities of inhabitant-builders.

For Soleri, it is the hands-on nature of the techniques that he has developed that gives concrete its radical potential, in that it is possible to work with it outside of mainstream construction interests. Interestingly, the qualities he sees in it are the opposite of what most people would correctly associate with most modern concrete processes, which as discussed already, tend to be anything but socially participatory. In visits to the Arcosanti site with students, I've had a number of discussions with Arcosantians, and with Soleri himself. It was clear that there are ongoing internal discussions about how to incorporate recent concrete technologies, and indeed how to incorporate things like insulation into the concrete! Equally it was clear that Soleri was resistant to any processes that make this material less accessible. His allegiance is to an idea about mud-crete. He has a big view of concrete, which spans the decorative to infrastructural, and it is for him I think, an analogue to the philosophical ambitions of Arcology itself: a structure that stretches from the human hand to the planet.

Empathising with Abstraction: a phenomenology of modern mud

Soleri is not alone in grasping the hands-on potential of concrete. Perhaps the clearest modern expressions of the kind of individually produced 'concrete' structures that Soleri wanted to see occupying the three dimensional frameworks of Arcosanti can be found in the kind of work often categorised as 'outsider architecture' – such as the Palais Ideal of Facteur Cheval, and the Watts Towers by Simon Rodia (**Fig. 8**). Both of these examples are of significant large structures built by individuals with no architectural or construction training. In both cases they use concrete as the basic material, and in both cases use it as a simultaneously structural and expressive medium, which is heavily worked by hand, patterned and which also acts as a fluid

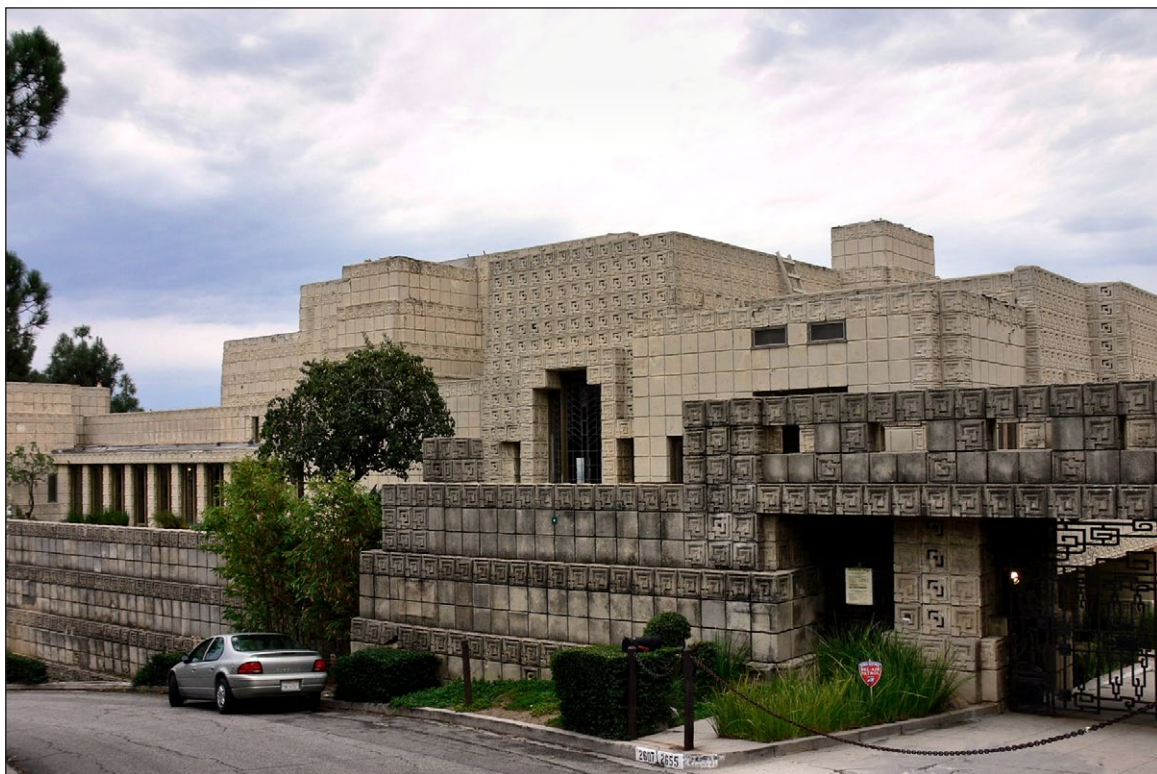


Figure 9: Frank Lloyd Wright, textile-block construction, Ennis house. Image source: https://en.wikipedia.org/wiki/Ennis_House#/media/File:Ennis_House_front_view_2005.jpg.

medium to hold other found everyday objects. In both cases the obvious modern precedent would have been the work of Gaudi, although both men were apparently unaware of his work. Other precedents would have been vernacular mudcrete structures around the world. Whilst structures such as the highly complex adobe Hindu temples in India were directly referenced by Cheval, there are no buildings anywhere that have quite the same structure as Rodia's work. In both cases, the fact that they were completely untrained, and were using concrete in ways that no mainstream commercial builders in their society were, suggests to me that making structures with mud like materials is in some way a critical modern expression of our extended ecology of mind.

Soleri's understanding of the social production of concrete-mud was no doubt in part instilled by the year he spent working with Frank Lloyd Wright at Taliesin West. Throughout his career Wright used concrete in innovative ways. Often these projects, such as Falling Water, and the NY Guggenheim, could be brilliant without being in any critical sense challenging to the 'logic of the new' of modern concrete. However, beyond these mainstream innovations, of particular interest to us students of the other history of concrete are a series of projects where Wright was properly working with concrete as a study in modern mud media, often in ways that challenged modern concrete's divisions of labour.

Wright started to experiment with mud media, in the form of concrete and plaster mouldings reminiscent of Native American art forms on the top of the internal columns of the 1904 Larkin Co Admin building in Buffalo, NY. His first project to experiment with custom cast concrete tiles and blocks was the 1914 Midway Gardens project in Chicago, whilst both mouldings and casts were used in the 1916–22 Imperial Hotel project in Japan. However, this line of research really started to get interesting in his development of decorated concrete blocks, first in a series of houses in California in the twenties (known as Textile Blocks), and again in the Usonian houses over a decade later (**Fig. 9**). For Wright, the textile block system represented a way of democratising building production. The idea was that anyone could make their own blocks, presumably with their own patterning (rather than his) if so desired, and build their own house. In the prototype houses that Wright built using this system, the textile blocks were produced onsite, often using Wright's students and apprentices, and on the whole they look stunning. They are not without problems however. The weaving system of steel bars which thread the blocks together (and give the structures their woven name) were nowhere near strong enough to withstand California's frequent earthquakes, and many have become seriously damaged. In addition, quality control problems from mass casting on site has meant that many blocks are starting to fail. In some cases, major problems have been caused by Wright's mistaken intuition that it would be a good idea to mix in some material from the ground of the sites, without checking exactly what it was. In the event, the soils contained large amounts of organic matter, and given the mixes used and other factors, has speeded the breakdown of some blocks. Nonetheless, even this 'mistake' tell us much about how Wright was conceiving of these casting processes as transmutations of telluric mud into construction media.

Newcretes

We have then I argue, even within modernity, a consistent tendency of producing popularly accessible mud based building materials and processes that allow us to shape, personalise, pattern and decorate – to express labour – to our structures and environments – even if the dominant expression of commodified modes of production has tended to work against this. Concrete and mud are amongst the most important and paradigmatic embodiments of cultural conception of base matter, with concrete taking, as it so often has, the role of a specific material which has the property of acting as an analogue for matter in general, while this field of material-processes have tended to facilitate a complex social division of labour in their production, often resulting in highly worked surfaces that become dadaist sites of popular media. Despite its role as an indexical ecology of adding labour to matter – a way of bringing forth of the human and of facilitating the potential for a carnival of both social and non-human labour that is latent within it – modern concrete has frequently minimised, for complex reasons, the amount of labour that actually goes into the surface. Even in the modern forms of mud, much of the 'surplus value' of the material tends to exist on the surface. Quite literally, the more labour that is invested in working the surface, the greater the communicative and social potential – the extent to which it becomes media – and generally the greater the production cost. Perhaps then, one of the primary reasons that there can be such a strong emotional response to concrete from the general public, is that people have an ecological understanding of the kind of material it is, and are either frustrated or exhilarated to see it presented as a form of bare-life.

Still, as stated at the beginning of this piece, concrete hasn't stopped renewing itself, and again an ecological conception of mudcrete can help us to see some interesting outlines emerging. Of course, the demands



Figure 10: Guan Lee, Clay Robotics at architecture research centre at Grymsdyke Farm, UK (Photograph by Guan Lee).



Figure 11: Yingchuang New Materials research. 3D-printed buildings using recycled materials. Image source: Yingchuang New Materials. Image source: http://static.dezeen.com/uploads/2014/04/3D-printed-buildings-China_dezeen_ss_6.jpg.

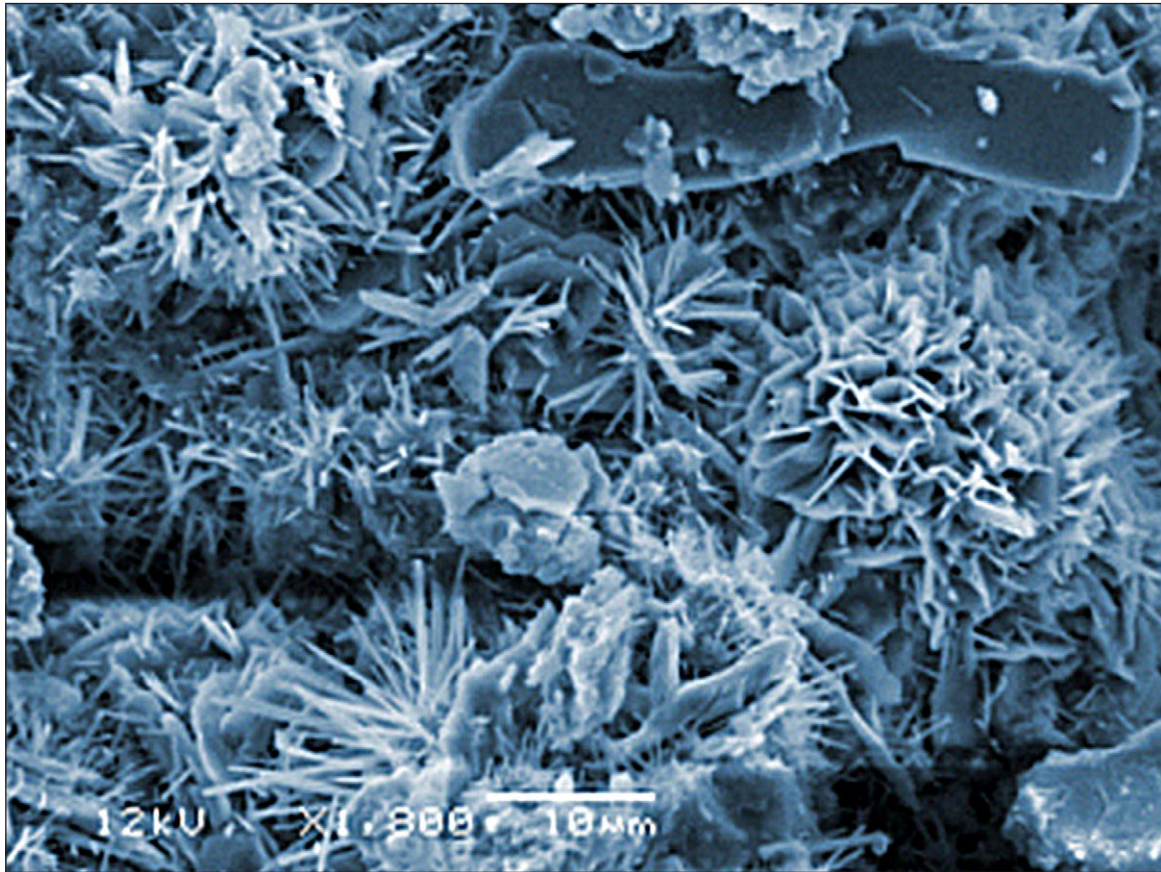


Figure 12: Microscopic image of mineral crystals developing in concrete. The crystals need a considerable time – many years – to fully develop and reach their maximum strength.

of anthropogenic climate change and a host of associated environmental questions have led to the development of all kinds of more sustainable concretes, such as incorporating the use of fly ash into cement mixtures [15], or the incorporation of organic materials such as hempcrete [16] or recycled waste [17] as aggregates, or ongoing modern developments of traditional methods such as rammed earth [18]. Perhaps most striking is that the use of formwork, such a key expression of the division of labour in the production of modern concrete structures, and such a clear expression of a certain kind of schizo-dualistic thinking more generally, is being slowly superseded. Early signs of this shift emerged with the explorations of fabric formwork by Alan Chandler and Remo Pedreschi [19], and Mark West [20] amongst others.

More recently immanent modes of formal and structural production have emerged in the nascent technologies of large scale 3D printing which move beyond the need for formwork, and resonate with some of the animal-made mud structures, as being developed by Massimo Moretti [21], Andrey Rudenko [22], Enrico Dini [23], the Yingchuang New Materials factory in China [24] and many others (Figs. 10 and 11). The research of Norman Foster's office into structures on Mars is exploring the accreted emergence of new non-Earth telluric mixtures, using techno-ecologies of labour that will need some theorizing in themselves [25]. The potential for self-assembling proto-biological muds are now being investigated, both in the laboratory and the field, by Rachel Armstrong [26] and Henk Jonkers [27] amongst others.

Ultimately, the aim of this research has been to critique and explore in some way the progressive potential of this family of material-processes, and to develop new practices and teaching methods with contemporary technology based upon this thinking. Moreover, if as Forty has noted, concrete's misplaced 'shame is that it is so dependent upon labour and upon such a variety of trades' [1, p. 34] then the re-examination of the nature of its value seems long overdue. There is furthermore, much that is at stake in the claim that we need a more ecological understanding of what concrete is. Ecology is increasingly providing a new paradigmatic model in contemporary theory, one which allows us to see and think through relations that are multi-scalar, multi-actor and spatio-temporally extended, suggesting a new way of performing our material bio-politics. It has often been assumed that ecological thought is inherently embedded within strategies of political resistance, yet it is increasingly clear that capitalism itself is also adopting ecological strategies, as it extends its reach both around the planet, and into the molecular and bio-political worlds. It might well be the case that

an ecological materialism is necessary to grasp capital's role in the production of nature today. With those thoughts in mind we must conclude that mudcrete today is undergoing a new phase of technical development, with new divisions of labour, and a new phase of theoretical reflection, allowing us to revisit some old standing abstract philosophical dualisms which had become all too concrete. Yet as Forty again notes, 'with concrete. . . there still remains the opportunity for the architect to be his or her own alchemist, and to create an entirely new substance' [1, p. 40]. Indeed, it is perhaps at these alchemical scales that we can ultimately find both new modern ecologies of mudcrete, and new explorations of Bruno Taut and Paul Scheerbart's dream of a modern crystalline architecture (**Fig. 12**) [28].

Competing Interests

The author declares that they have no competing interests.

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