

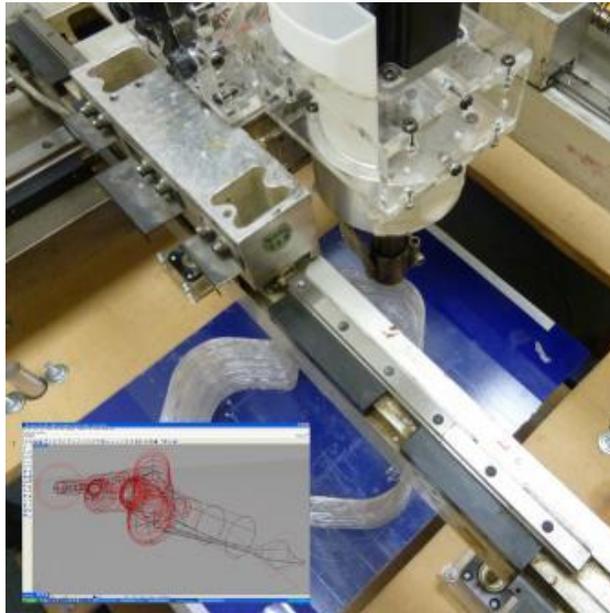
Digitaterial Gestures – Action-Driven Stererolithography.

James Charlton

Attempting to reconcile a digital sensibility with sculptural materiality steeped in the modernist legacy of “truth to materials,” we can conceive of a form that is generated outward from its central core. Reflecting on the theoretical implications of the generative process this paper explores the nature of digital materiality as a heterotopian space comprising of and uniting artist, material and process.



1. FORMø/12, James Charlton, thermoplastic extrusion, Copyright James Charlton.



2. FORMø: 3D Printer and Generative Software, Olaf Diegel, photographic documentation, Copyright Olaf Diegel.



3. *FORMø: Process Documentation*, James Charlton, stills from video, Copyright James Charlton.

Through what passes as a high-speed network in New Zealand I SHIFT/CLICK/ZOOM through the Quick Time Virtual Reality (QTVR) of Brancusi's studio in the Centre Pompidou. [1] Here, in this carefully manicured space, I can indulge my voyeuristic urges – rummage around the private inner sanctum of the artist's 'creative' process, lingering on every (contrived) residue, every 'casually' placed prop that poses as a creative artifact.

It is at the tool bench the artist's presence is most visceral: hand-worn tools and other signifiers of the making process litter the bench. Every 'discarded' shaving is given new import by the museum handrail that even in this virtual space asserts credibility. Here, surely, is the authentic act – the point of closest communion not simply between artist and audience but between artist and product.

It is in seeking this point of contact between the maker and the made, the making and the maker that the project FORMø will be discussed.

FORMø is an interdisciplinary collaboration between artist James Charlton and engineers Olaf Deigle, Sarat Singamneni and B. Huang. Working within the Creative Industries Research Institute (CIRI) at Auckland University of Technology, the project received Smash Palace funding under the partnership program between the Ministry of Research Science and Technology and Creative New Zealand. [2] The fund supports collaborative projects between teams comprised of loosely defined New Zealand scientists and artists. The emphasis of the fund is on the cross-disciplinary sharing of knowledge and exploration of methodology rather than applied outcome.

The project developed out of the dialogue between Design Engineer Olaf Diegle and Artist James Charlton in 2008 around the use of rapid prototyping technologies in creative practice. From this exchange Charlton produced a number of works that laid the foundation for this project, for instance *16:sec*, in which sixteen seconds of video was used to generate a series of rapid prototyped forms.

In Charlton's writing about this work, we find the concerns that have driven the conceptual direction of *Digital Gestures: 16:sec* "explores the construction and perception of time-based events by examining the ability of static objects to encapsulate temporal information. It aims to question our relationship with physical objects and the static concreteness that we assume of them, [...]" [3]

The relationship between Diegle and Charlton at this stage was not fully collaborative in nature. Diegle's expertise in rapid prototyping was being applied by Charlton in order to realize his ideas. What developed from that dialogue was an exchange of ideas about form, materiality and time in the context of fused deposition modeling and the authored gesture.

From this point of convergence, FORMØ proposed to realize a system through which the performative gestures of the artist are translated into concrete form by integrating motion capture technology with real time 3D printing.

The approach was to develop a concept machine made by modifying an X-Y axis system from an electronic pick-and-place machine that allowed for a print area of approximately 600mm cubed. The completed platform provides an X-Y axis that moves the print head along the vector print path and a Z axis which moves the build platform down by a unit of measure. The motor control system consists of four stepper motors (one for each axis, and one for the extrusion head), a Xylotec XS-3525/8S-4 Stepper Motor Driver Board, and an Olimex LPC-H2148 Microcontroller Board allowing for simple control of the 3D printer through a PC-based CNC machine control program called Mach 3 CNC. A custom-made thermoplastic extrusion head allows for granules, powder, or plastic to be extruded. (This system served the development phases of the project; it has subsequently been replaced by a Mitsubishi MoveMaster-EX five-axis robotic arm. This system is still under development at the time of writing.)

Initially, print data was generated using an OptiTrak V100:R2 six-camera motion capture system and Arena motion capture software. Even in this simple six-camera set-up the limitations of software designed specifically for animation purposes became evident and the motion capture equipment was quickly left behind in favour of a customized motion detection software system.

Experiments using color tracking proved much less cumbersome and more manageable but still required controlled lighting and trackable color markers that worked as an interface barrier separating the artist's hand from the digital expression of form, and theatricalizing the work. By switching to a Kinect depth map camera system and defining the sample space depth, accurate motion capture of hand gestures provides clean data for the printer.

The Kinect was hacked using MAX/MSP to extrapolate data for XYZ and direction for two hands to send to the Rhino plug-in Grasshopper for real-time form visualization and compilation. The flexibility of this approach using graphic programming interfaces to process the raw data enabled the team to experiment with and conceive of algorithmic methods of generating forms from the spatial data.

Put simply, instead of thinking that a hand moving in space would correspond to a similar movement by the printer, multiple points on the body could be combined to determine the position of the deposition head.

Through this train of thought, it became clear that the project was not thinking simply about virtual drawing in space but was attempting to understand how the artist's actions could interact with digital material. The notion of digital material is perhaps paradoxical. [4] Perhaps there is not even such a thing, or if there is it refers to things arising from a digital process – an image, a document or a 3D-print. As I attempt to explore this notion of digital materiality it will become clearer that what I am really speaking to is the non-material being of the media without manifestation – media as a concept in relationship to process.

This paper seeks to frame the project in these terms – as an attempt to reconcile spaces within a heterogeneous space that might constitute a new understanding of the materiality of the digital.

Collapsed Spaces.

Unlike the rarified and idealized modernist studio where singularity of discipline, intent and technique assume one source (the artist), FORMØ operates across spatial, modal, disciplinary and temporal sites.

In practical terms, there exist two primary sites: the site of production and the site of reproduction – in this case the artist and the 3D printer. Initially the challenge at this practical level seemed simply to eliminate the latency between these sites, bringing them together as one event. This might be thought of in traditional terms as seeking the same immediacy that the sculptor's hand has on a lump of clay or the painter's brush on a canvas, but is also evident in contemporary digital media practices such as video production, where the artist's gaze carves its way through time, or in some forms of installation and performance work. (I don't want to labor historical metaphors here but it is useful to ground the ideas in physicality of media when trying to understand the materiality of the digital.)

I am then suggesting that in direct manipulation of media – the visceral effect of the artist's body on materials – a synthesis of space is achieved by collapsing the spaces of the body and the spaces of the material into a heterotopia - a place "outside of all places," and removed from that which constructs it. [5]

Returning to Brancusi's studio for a moment we see that there are present at least three utopias – the artist's hand (as distinct from the artist's consciousness), the material studio (in this case both tools, materials and finished works) and the museum (acknowledged in the introduction by the handrail).

This collapsed space of action and event (with implicit inclusion of author and outcome) is the space long identified in artistic practices. In its many interpretations we see investigations and experiments of Ruskin's "truth to materials," [6] in modernist sculptural work (most obviously the work of Henry Moore and minimalists Eva Hesse and Richard Serra) and in the emergence of performance works in the 1960s and 70s in which "sculpture is re-contextualised within an action." [7] More recently, the work and strategies of practitioners like Tino Sehgal have become exemplars of a type of practice that synthesizes production and product.

It is perhaps not surprising that digital art practice with its distributed nature, obsession with the screen and contestable authenticity is less concerned with materiality "as being 'hyper,' 'virtual,' and 'cyber' –

that is, outside of the known materiality, existing independently of the usual material constraints and determinants [...]” [8]

However, in technologies such as rapid prototyping we can see practices emerging that exploit the notion of the digital as a material with its own 'material truth.'

In the collapsed space of the computation process that developed in this project, the 'material truth' is one that originates not in the artist's body, the tools of production or the physical materials but a heterotopian space that is distinct from all three – the space of the digitaterial. (It's important here to distinguish the Digitaterial from digitality. Negroponte's (1995) treatment of digitality separates the world into "bits and atoms" whereas the notion of digitaterial space collapses the physical and the digital into a common space in which the digital has materiality.)

Rather than visualizing the outcomes that might be produced, what must be conceived of is what the process itself delivers. Rather than imposing subject matter for technology to execute, the relationship between the artistic gesture and technology should be seen as subject matter itself in a manner that is part of the continuum of "truth to materials" in sculptural practice.

Traditionally additive manufacturing processes estrange the act of production from the act of generation as files are worked on in isolation from the material reality of the 3D printer. In fact this has been the goal of these technologies – not only to allow predefined designs to be realized as proto-types, remote from the tooling and mass production, but to remove the designer from the constraints of the materials and the preconception of form.

As Ann-Sophie Lenmann puts it: “New media have led to the formation of new creative spaces; spaces that seem to have caused a dislocation of materiality of the traditional working space.” [9]

Here we might identify both the promise and failure of not only additive manufacturing but, perhaps, our general approach to the digital. In liberating the artist from the constraints of the physical we define a media whose intrinsic materiality strives to go unrecognized or to pass as the real rather than the imitation of the real. “[...T]he very process of making is rendered invisible by the medium itself.” [10]

The digitaterial space is then defined as being the heterotopian space comprising and uniting artist, material and process – a space in which materiality and form are defined from within.

Ironically enough we find this endlessly thrown up to us in demonstrations of the marvel of 3D printing where the very tired Klein bottle is once again the standard. This impossible form – without boundary and in which notions of left and right remain illusive – has become the Escher of rapid prototyping as it exemplifies the dilemma of digital materiality.

This is the space of the impossibly perfect contour, the surface model that denies its own existence, as opposed to the space that has no form other than that which it itself defines.

The point I am making here is simple enough: that the digital, freed from representation, is not without material qualities. In and of itself it has characteristics that are as compelling as the block of wood or lump of clay in Brancusi's studio.

Yet to sculpt them, to form them, is akin to modeling air. In the most literal sense this is the experience of making these forms.

One's hands become disembodied. No longer the property of the artist they defer to the material of the digital that, as it twists, bends and rotates appears more in control of the artist's body than s/he is.

No longer calling to another site, this collapsed digital material now looks within to the locally defined gestural source for its sense of material truth.

The artist's actions are thus sublimated into the digital, his/her body controlled by the material logic of the medium. Rather than manipulating it s/he is party to it both inside and outside.

Slices of Time.

The sequential layering approach of conventional rapid prototyping systems imposes a structural logic on form that is alien to its own inherent structural logic. The computation of slices that provide the freedom to generate impossible Klein-like forms is one of the liberating attractions of 3D printing. Yet, even in structural terms it presents a weakness. Unlike a branch that's grain is indicative of its form, adding a strength to it that is an inseparable part of its materiality, the slice approach is externally defined.

Using the analogy to wood-grain we can conceive of a system in which the printer head follows the contour of a form, possessing its own material logic. However, this places further conceptual considerations before us.

Diegle's work on curved layer deposition follows this logic and looks to the form itself as the referent for its deposition structure. By analyzing the contour of a surface, layers can be deposited along the curvature of the shape, increasing the structural integrity of the build.

Instead of sequential layering's external slicing up of time, in curved layer deposition time exists relative to the form of the material. Form is not conceived of with a logic outside of its own generation; rather, the space and time of the form are "constructed locally." [11]

The imposition of an externally defined time based construction of form has the inevitable effect of producing a lag between generation and realization. Reducing or eliminating latency has been the ambition of many developments and experiments in digital media. Explorative investigation of direct manipulation such as those conducted by Willis et al, cite latency as a problem to be solved, as a temporary technical obstacle to achieving material immediacy. However, if time is seen as a material feature of the digital as discussed, then immediacy is inherently resolved. The goal of reducing latency in digital media processes is then a misguided attempt to make the digital 'real' – immediate in the here and now.

If, as suggested earlier, direct manipulation can be achieved by collapsing the space of the body and the space of the material, and that time is a dimension of the material instead of producer, then the imperative of reducing or eliminating latency between generation and deposition becomes obsolete. Instead of seeing latency as a technical/mechanical failing to be overcome, the gap between production and produced simply no longer exists.

The Workbench of the Digital.

Unlike Brancusi's studio the workbench of digital material is not a space cluttered with tools or littered with shavings any more than it is the SHIFT/CLICK/ZOOM of the mouse or the software interface. The digital workbench is the disembodied space map of my hands as they reach out and dissolve in the Kinect's vision.

Perhaps instead of obsessing about making the digital 'real' by seeking to impose ever-greater control over its ability to be 'real' (or, more accurately, to conform to existing notions of the material real) we can approach an understanding of digital materiality by collapsing into the space that is "absolutely different from" that which defines and generates it. [3] The digital material is that which is released from our grasp as we embrace it.

References and Notes:

1. Centre Pompidou, "360 Degrees Atelier Brancusi," Centre Pompidou's Official Website, <http://www.centrepompidou.fr/Pompidou/> (accessed January 15, 2011).
2. Ministry of Science and Innovation, "Science-Art Collaboration," MORST, <http://www.morst.govt.nz/> (accessed January 20, 2011).
3. James Charlton, *dForm* (Auckland: MIC, 2008).
4. Paul A. Taylor and Jan L. Harris, *Digital Matters* (New York: Routledge, 2005), 114.
5. Michel Foucault, "Des Espaces Autres," *Architecture, Movement, Continuité*, no. 5 (1984): 3.
6. John Ruskin, *The Seven Lamps of Architecture* (Orpington: George Allen, 1889).
7. Thomas McEvelley, *Sculpture in the Age of Doubt* (New York: Allworth Press, 1999).
8. Marianne van den Boomen et al., "Introduction: From the Virtual to Matters of Fact and Concern," in *Digital Material: Tracing New Media in Everyday Life and Technology*, eds. Marianne van den Boomen et al., 8 (Amsterdam: Amsterdam University Press, 2009).
9. Ann-Sophie Lehmann, "Hidden Practice: Artists' Working Spaces, Tools, and Materials in the Digital Domain," in *Digital Material: Tracing New Media in Everyday Life and Technology*, eds. Marianne van den Boomen et al., 270 (Amsterdam: Amsterdam University Press, 2009).
10. *Ibid.*, 279.
11. Bruno Latour, *Science in Action* (Cambridge: Harvard University Press, 1987), 253.