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Michael O'Hara

Technological University Dublin, michael.ohara@tudublin.ie

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Traversing states: a reflection on digital technology and Simondon's critique of hylomorphism

Michael O'Hara

GradCAM, Technological University Dublin, Dublin, Ireland

ABSTRACT

In this article, I examine Simondon's concept of the technical object reflecting on its analogous relationship to digital technology. Intrinsic to such an analysis is Simondon's distinction between the abstract and concrete and his specific critique of the hylomorphic model. In a deeply rich example, Simondon, contra Aristotle, mobilises the process of mould-making as an exemplar of the modulated ensemble of forces that prefigure any formations of matter through form. I analyse Simondon's paradigmatic criticism while at the same time carving out the potential intersections that emerge through the kinaesthetic awareness of the body. By doing so I highlight the implicit relational formation that occurs through the process of object making that is at odds with ontologies that underpin digital technology. Finally, I analyse how the transformation of object making realised through digital fabrication radically transforms our relationship to objects claiming that such technology remains beholden to hylomorphic schemata.

This article examines Simondon's concept of the technical object and his associated critique of traditional accounts of object relations. In the first section, I focus on Simondon's account of the transition between the abstract and concrete, applying such a genetic analysis to digital technology, specifically computer code. In subsequent sections, I examine Simondon's criticism of information, underlining the implicit epistemologies that underpin cybernetics while focusing on hylomorphic examples furnished by Simondon. Through such examples I attempt to re-introduce the role the body plays in the production of technical objects, suggesting that it complicates such hylomorphic models. Mindful of this analysis of the body, the final section interrogates the design and modes of digital production through Simondon's philosophy.

Abstract and concrete transitions

Simondon, in Chapter 1 of *On the Mode of Existence of Technical Objects* [MEOT] (2017), distinguishes between the abstract and concrete, proposing that artisanal/hand-made objects correspond to the abstract stage of technical evolution while the concrete stage of technical objects is defined through industrial production. The abstract stage of the

technical object is conceived as a closed system comprised of an assemblage of parts that remain divisible and less integrated while the process of technical concretisation integrates parts into wholes. Concretisation marks the progress of a technical object from abstract structures to new regimes of functioning instantiated through operation. Citing the example of the engine, Simondon marks the evolution of the technical object through processes of concretisation, where integrated parts, or what he terms as technical elements, reach a degree of harmony and synchronicity, so that the engine has a coherence and unity within itself (Simondon 2017: 25–40).

Concretisation is not a linear process born of abstraction but one implicated by reciprocal causal relations that are manifest in the development of the technical object in its operation – how the engine works in reality. For Simondon, operation or *allagmatics* denotes the reciprocity between operation and structure and the process of individuation generated through relations. This axiomatic principle is realised in his concept of transduction, which is a process of phase shifts in information, the operation of a system as it moves between states. Simondon furnishes the changing state of a crystal as a paradigmatic example. As Muriel Combes states:

Transduction expresses the processual sense of individuation; this is why it holds for any domain, and the determination of domains (matter, life, mind, society) relies on diverse regimes of individuation (physical, biological, psychic, collective). (Combes 2013: 7)

Through such transformation, the technical object moves beyond the abstract, generating forces that ‘produce effects that are independent of the fabricating intention’ (Simondon 2017: 39). He gives the example of the cylinder head and the reciprocating function of cooling fins. When these different technical elements converge (the fins are cut as part of the head instead of a separate component) there is a convergence of function. The resulting convergence marks the very process of concretisation. Through its operation the technical object evolves through a set of phase shifts that are ‘essential, discontinuous improvements, as a result of which the internal schema of the technical object is modified in leaps and bounds and not according to a continuous line’ (Simondon 2017: 43). Although technical objects tend toward the concrete, they remain imbued with residual aspects of abstraction. Additionally, the concrete technical object is charged with its function but remains open – it is never fully known or concrete allowing it to shed its artificial character. In this sense it approaches the ‘mode of existence of natural objects’ (Simondon 2017: 49) which are, according to Simondon, concrete right from the start.

This movement between the abstract and concrete becomes a key feature in thinking the algorithm and its formation in code. It is the openness of the concrete technical object, which I suggest is analogous to the algorithm and its implementation in computer programming languages. Algorithms are often considered to exist primarily at the level of abstraction, as quasi-mathematical entities. It is only when the algorithm is parsed in a programming language that it moves toward the concrete domain, finally realised and implemented in hardware. I propose that algorithms are a nexus of the abstract and concrete, and following Timothy Colburn are a set of relations materialised in a computational process:

It is concrete because it can be described as the passing of electrons in circuits measured in microns, effecting changes in the state of semiconducting memory elements. On the other hand, the description of these state changes is a program that, as an expression in a

formal language, is an abstraction of a process the programmer hopes is a correct model of the solution of a problem in the real world. (Colburn 2000: 190)

I suggest the algorithm can be considered as traversing states, or in Simondonian terms existing in a metastable state, charged with potentials that are carried through from stages of abstraction in code through to implementation in hardware. Metastability defines an equilibrium that retains sources of tension and momentum – a process of structuration which remains provisional allowing the system to evolve and change over time. The algorithm exists in a metastable state while programming languages are in effect the concrete implementation in a formal language of an abstract concept. Programming languages represent the collation of technical elements in the form of compilers, access rights and layout rules that are not algorithmic but procedural aspects of the program that are responsible for the implementation of such algorithms. Compilers are designed to convert and implement high level language statements into machine readable form that must be broken down character by character into short words, symbols and numbers into sets of machine code instructions that activate physical circuits. This points to the multi-layered and hierarchical privileging existing within programming languages and its perceived separation from hardware.¹ When speaking of implementation, I mean – what a piece of code does when executed or run. In computational terms, this is akin to the process of concretisation of a system.

Consistent with Simondon, programming languages remain indebted to residual aspects of abstraction in the form of schemas and mathematical objects. Simondon notes that abstraction underpins the idealisation of scientific representation. The sign or symbolisation comes to represent a ‘pure schema of functioning’ that still allows type to be determined by the function of the technical object – ‘the pure technical schema defines a type of existence of the technical object, grasped in its ideal function’ (Simondon 2017: 45). Simondon asserts that symbolisation theoretically schematises the function of the technical object. Likewise, Raymond Turner in *Computational Artifacts* (2018) notes the ‘structural isomorphism’ between the schematic and the physical circuit. (Turner 2018: 39) This does not necessarily entail correct implementation demanding the physical circuit behave in accordance with the modes of abstraction inherent within the schema. This is the translation of form from virtual to actual through operation that determines correctness within the physical system.

But even when this is completed there is no mathematical guarantee of correctness. Unlike the correctness between the functional and structural specifications, this is an empirical notion of correctness that is to be tested by physical, not mathematical means. This is the abstract-concrete interface. The functional specification is a mathematical object ... In contrast, an electronic device is a concrete physical thing. (Turner 2018: 39)

For Simondon, such representation is an articulation of an abstract technical object that is primitive and ‘not a natural physical system, it is a physical translation of an intellectual system’ (Simondon 2017: 49). The movement toward concretisation is expressed through operation in physical instantiation, and as Turner notes, not by mathematical means.

¹This is an argument put forward by Fredrich Kittler in his seminal text ‘There is No Software’ (1995). Kittler places responsibility for such a privileging of software at the genesis of the Turing machine, the ancestor of the microprocessor; ‘... the physical Church-Turing hypothesis, by identifying physical hardware with the algorithms forged for its computation, has finally gotten rid of hardware itself’ (Kittler 1995: 151).

Furthermore, I argue programming languages continue to privilege a distinction between form and content, explicitly evidenced in the Object-Oriented Programming (OOP) paradigm. OOP was developed in the mid-1970s by computer scientist Alan Kay.² OOP is best understood as the process of breaking programs into distinct classes, modules and objects. Such classes are packaged as templates for the creation of an object which describe attributes and properties of those objects. The class represents a schema or defined idea of the object but not the object itself. It describes the conditions of the possibility of objects and their level of function. Therefore, classes and modules operate as the *morphe* (form) aspect of the language while the *hyle* (data) are the code that constitutes objects, bearing as we shall see, a striking resemblance to hylomorphic schema. Consequently, computational ontologies remain indebted to traditional epistemological and metaphysical assumptions aligned to various substance-based ontologies and theories of information, some emerging concurrently with Simondon's major works.

Information and its ontologies

Simondon articulates a distinction between natural and technical systems which amounts to a critique of cybernetics and its theory of information. Cybernetics is conceived by mathematician Norbert Wiener, as the 'view that the structure of the machine or of the organism is an index of the performance that may be expected from it' (Wiener 1989: 58). It is characterised as privileging the concept of feedback in a system, seeing it as not only an underlying principle inherent in machines but intrinsic to organic systems. For some working in cybernetics this becomes an analogical principle that morphs into an isomorphism between the machine and organism. Although Simondon is sympathetic to the inter-disciplinary nature of cybernetics and its ambition to examine the complexity of systems and their organisation, he rejects its tendency to formalise an explanatory system that can be mapped onto living organisms. This is the misuse of analogy between the living and the technical that focuses on external aspects of systems while ignoring the energetic forces operating between the technical object and its milieu.

For Simondon, the traditional philosophical (and cybernetic) view concentrates on analogical relations of structure and form. He proposes an analogy of operation or allagmatics, that reveals the energy operating between structures. Simondon is drawing out a position that is demonstrably at odds with the philosophical tradition, not only in his conception of the technical object, but with the deeper ontological question of being itself. He rejects substance-based ontologies that conceive the individual as an expression of a pre-existing form or essence. In atomistic understandings, the principle of individuation is already given as individual atoms that merge into more complex systems. Simondon posits the complex idea of individuation as becoming that is fluid and non-linear, determining the individual as neither fixed nor stable.

Simondon also refutes the Aristotelian notions of hylomorphism which sees individuals as compounds consisting of matter and form. For Aristotle, matter (*hyle*) characterises the material from which an object is generated while the form determines what the object is. For Aristotle, form does not merely denote the mere shape of an object but characterises its

²Examples include Kay's Smalltalk and more contemporary examples such as C++, Pearl and Java.

essence – for example the essence of an oak tree residing in an acorn.³ This has its origins in Aristotle's four modes of causation – material, formal, efficient and final. An object's final cause, its function determines what a thing is for and in the *Physics* this represents not only the functional telos of technical artefacts but can be seen in the telos of the natural world.⁴

In *MEOT*, Simondon critiques the hylemorphic schema through the activity of the craftsperson.⁵ He offers the example of the making of the mould so it is 'capable of receiving information' (Simondon 2017: 249) The clay/*hyle* is pressed into the mould/*morphe*, taking form according to the mould. This is the classic Aristotelian account of the emergence of the object – form imposing order on matter. However, for Simondon, it is neither the mould/*morphe* nor the craftsperson that is responsible for the articulation of form but the 'mediation that fulfils itself on its own once the conditions have been created' (Simondon 2017: 249). Internal resonance is instigated through such processes, mediated by the craftsperson but not realised through them. Internal resonance designates the self-adaptation of the technical object as it reaches a degree of harmony and synchronicity with its milieu.

In *L'individu et sa genèse physico-biologique*, [IG] (1964), Simondon's questioning of the technical nature of mould-making (and importantly the body) appears more circumspect. Again, he focuses upon the practice of mould-making but here the mediation of the craftsperson is distinguished from the hylomorphic model. Simondon claims that the matter is agential, open to actualisation, revealing the internal resonances of energy that are latent within the clay substrate. In concordance with Simondon, I contend that in practice the material one casts with is intrinsic to the type of mould used.⁶ The performance of the mould – its ability to 'enclose' – is determined as much by the material being cast. In the case of the clay brick, one cannot use a silicon (water resistant) mould to cast bricks. Silicon rubber prevents the necessary absorption of water from the clay slip and the necessary transmission of potential energy. If the water is retained within the clay, the form can never take shape – the clay remains between states. The intimate relationship between clay slip and plaster mould is critical to the rendering of form. Plaster absorbs the water from clay through a transductive process that is the becoming of form itself. Transduction marks the regulative function of the mould and the localised indeterminacy of the clay material. However, transduction is also active within the mould itself, as the mould must possess the potential energy that provides the conditions of its operation. The cast is never fully constituted through the mould as it exists in a metastable state – suspended between energy and structure. The coming into being of the object is made possible by degrees of potentiality of not just the mould but the molecular changes and modulation occurring through the crystal structures of kaolinite, one of the important minerals in clay. Its crystal-like structures are linked with hydrogen bonds that amplify

³For as the bronze is to the statue, the wood to the bed, or the matter and the formless before receiving form to anything which has form, so is the underlying nature to substance, i.e. the 'this' or existent.' (Aristotle 1984: 722–723) Aristotle first introduces his notion of matter and form in the first book of the *Physics* but it becomes a conceptual cornerstone in his broader philosophical works.

⁴See Aristotle 1984: *Physics*, Book II, 8, 750–754).

⁵We highlight Simondon's example of mould-making as it furnishes a description of a technology developed in antiquity representing the first instantiation of a reproductive process of object making *en masse*.

⁶The author speaks here from personal experience as a trained and practicing mould-maker. There is great insight to Simondon's description of the process.

the physical and energetic changes in the clay, enabling the brick to take shape in the mould.

This returns us to Simondon's theory of allagmatics which contrasts with the notion of information articulated in cybernetics. He conceives information in a more primary sense, information that is not merely quantifiable. As Simon Mills argues, for Simondon

his notion of information shifts his theorization away from the sender-receiver model which cyberneticians such as Wiener found so useful in developing analogies between animals and machines. Instead his notion of information as ontogenetic, that is, as the becoming which is being, still enables systems to condition themselves but via processes of structuration and resonance. (Mills 2016: 47)

Simondon's commitment to a philosophy of becoming or ontogenesis conceives of a system rich in potential striving forward toward new structurations. Such a genesis prefigures the object and technical reality denoting the pre-individual fund, the very condition of being itself. The pre-individual expresses the metastable equilibrium of being that is full of potential individuations. Information understood as individuated and discrete cannot account for processes of individuation. In the case above, the molecular changes of the kalonite are a singularity that as information enable communication with hydrogen bonds which excite transformations of the clay in the mould. This metastable state 'dephases' to a different level or mode of individuation as the clay tends towards new structurations. I suggest that the mediation of the craftsperson, which Simondon describes, is not riveted to a hylomorphic account; and argue that the body, in a phenomenological sense, although implicated in the hylomorphic model, escapes its explanatory bonds. I briefly turn to Edmund Husserl's account of hylomorphism and concept of the body to show how such an account returns us Simondon's distinction between the abstract and concrete.

The enactive body

In *Ideas I* (1983), Husserl first introduces the term *hyle* referring to the raw data of perception: the sensuous data such as colour-data, sound-data, touch-data, etc. For Husserl, hyletic data are primed and given sense through intentional consciousness in the original act of perception. 'Sensuous Data present themselves as stuffs for intensive formings, or sense-bestowings, belonging to different levels' (Husserl 1983: 204). Husserl's concept of hyletic data has been critiqued by many philosophers for appearing to essentialise and objectify sense data from a world of meaning. For Aron Gurwitsch, Husserl does not attend to the importance of the hyletic data noting there is a problem of what he terms the mediation of such data through consciousness; 'What is immediately given, the phenomenological primal material, is given only as articulated and structured' (Gurwitsch 2009: 284). The fact that *hyle* is given to reflection is a conceit that undermines the givenness of sensuous data. Intentionality bestows sense on that which has no sense and cannot be bestowed on that which already has sense or intention. This marks the 'problem of givenness' of the data in the first place, something which Simondon critiques as a substance already individuated.

However, I wish to separate Husserl's hylomorphic account from the more forceful Aristotelian account that Simondon disagrees with. In contrast to Aristotelean

hylomorphism, the later Husserl stresses a passively pregiven perceptual realm that sub-tends any intentional act. According to Kenneth Williford, the *hyle* represent a shift in Husserl's late thinking, the 'hyletic data come to us in the context of a pregiven order and are, as it were, primed for intentional animation' (Williford 2013: 510).⁷ On this view, the hyletic data become a bi-directional link between consciousness and the life-world (*Lebenswelt*) which exist in advance of us, with affective capacities to shape consciousness itself.

Furthermore, I argue for the importance the body plays in Husserl's account, returning us to the role of the craftsperson and the embodied act of mould-making. The lived/motile body (*lieb*) is the source of kinaesthesia, generating a different account of hyletic data, one constitutive of the lived body of the perceiver and object perceived. As he states in *Ideas II* (1989), 'a human being's total consciousness is in a certain sense, by means of its hyletic substrate, bound to the lived body' (Husserl 1989: 160). For Husserl, hyletic data are only given through the kinaesthetic experience of a lived body and such experience is a form of bodily self-awareness that is integral to the perception of any object and is composed of an outer horizon of cultural predicates.⁸

Such ideas have been integrated into contemporary theories of embodiment, such as enactive accounts proposed by Evan Thompson (2007) and Lambros Malafouris (2013) among others. Enactivism focuses upon the rich dynamical relations that occur amongst the brain, body and environment that also reject the hylomorphic model.⁹ As Thompson articulates in *Mind in Life* (2007), the enactive approach proposes:

that subjectivity and consciousness have to be explicated in relation to the autonomy and intentionality of life, in a full sense of "life" that encompasses [...] the organism, one's subjectively lived body, and the life-world. (Thompson 2007: 15)

Enactivism gives a more relational account of agency by proposing a dynamic and materially engaged account of action – *we think with and through things in action*. I propose that enactivism, building upon Husserl's concept of the 'I can' (which perceives objects in the environment in terms of what we can do with them), echoes Simondon's account of material engagement as outlined above.

This idea of material engagement is particularly evidenced in the work of Malafouris and his contention of the energetic transactions that occur through the engagement with materials and the kinaesthetic gestures of the body. In *How Things Shape the Mind*, Malafouris (2013) coins the term 'Material Engagement Theory' to describe the interdependent relationship between the maker and the object. He mobilises the example of the potter on the wheel and the processes that emerge from such interaction. According to Malafouris, a dynamic coupling occurs between the potter and the clay as the object emerges through the pressing, pulling and constricting of the clay. The metastable nature of the process is not merely underwritten by the potter's skill but the attunement of

⁷See Husserl, *Experience and Judgment*: 'This implies that the sensuous data brought into prominence by abstraction are themselves already unities of identity which appear in a multiform manner and which, as unities, can then themselves become thematic objects [...]' (Husserl 1973: 73).

⁸Although mobilising Heidegger and Merleau-Ponty, Hubert Dreyfus' arguments against Artificial Intelligence reflect a similar argument. In *What Computers Still Can't Do* Dreyfus (1992) argues for the organised, embodied human practices that shape our very experience of objects. Although beyond the scope of this paper, his argument can be applied to the ontology that informs Object Orientated Programming languages (OOP) as discussed above.

⁹Enactivism emerged as an alternative to explanatory models of consciousness that are interwoven with early information theory, cognitive science and functionalism.

the body, the slake of clay, and an ensemble of conditions involved in the traversing of states. Malafouris articulates a notion of the *hylonoetic field* that argues against the hylomorphic ontology of imposing form. Instead he asserts that such a hylonoetic ontology is a 'thinking through and with matter' that involves a 'a great deal of approximation, anticipation, and guessing about how the material will behave' (Malafouris 2013: 236). The object that emerges is the result of the potentialities between individual and milieu that I claim remain proximate with our embodied being in the world and at odds with computational ontologies which I return to in the final section.

Simondon – potential adaptations

How do these rich accounts of the emergence of the clay object through the kinaesthetic gestures of the body compare to Simondon's analysis? I propose that Malafouris' notion of the hylonoetic field captures the mediation that Simondon describes in the process of mould-making. There is the emergence of the clay brick through the (bodily) engagement of the craftsperson. However, Simondon appears to read artisanal production as abstract, thereby associating it within the hylomorphic schema. In *MEOT*, Simondon frames the body through artisanal production and links toolmaking explicitly to the extension of the body and organ. In his example of mould-making the gestures and habits of the body are marked as motivating factors for the 'two technical half chains, the one starting from form and the one starting from matter' (Simondon 2017: 249) – i.e. the hylomorphic schema.

However, in *IG*, Simondon suggests the hand is occupied in the process of modulation and mediation of form.

the gesture of the workman who fills the mold and compresses the clay continues the former gesture of kneading, stretching, shaping: the mold plays the part of a fixed set of modelling hands, acting like arrested forming hands. (Simondon 1964: 31)

Recall here Malafouris' hand as it anticipates and approximates the behaviour of the material. Later Simondon speculates that 'individuated being is never individuated more perfectly than when it leaves the hands of the craftsman' (Simondon 1964: 35). Through his concept of individuation, the process of coming into being, he furnishes us with a rich account of enaction, one that is not circumscribed to a body that only adapts to an environment. For Simondon to think adaptation, one must go beyond the constraints of adaptation as understood in the biology of evolutionary and cybernetic theory. In *L'individuation à la lumière des notions de forme et d'information*, Simondon (2013) critiques the implicit hylomorphic model that is embedded within the biological account of adaptation. He contends that adaptation 'is understood as a reciprocal and complex influence on the basis of the hylomorphic schema' (Simondon 2013: 208).¹⁰ Adaptation closes down rather than opens up the potential of the living being. As Jean-Hugues Barthélémy describes:

he insists on the fact that the biologism of adaptation is "a biologism without ontogenesis," he does not berate it for forgetting the conditions of adaptation that would be less than

¹⁰est conçue comme une influence réciproque et complexe à base de schéma hylémorphique' (Simondon 2013: 208). I thank my colleague Jonathan Mitchell for his translation of this section of the book.

adaptation, but for reducing an activity of the living being that is more than adaptation to adaptation. (Barthélémy 2015: 28–29)

The living being is individuated through transductive processes which are not merely conditioned through adaptation to an environment. This rejection of adaptation coheres with his critique of cybernetics. Simondon argues that there must remain a clear distinction between form and information. For Simondon, living things need information while machines deal in forms.

The living transforms information into forms, the *a posteriori* into *a priori*; but this *a priori* is always oriented toward the reception of information to be interpreted. The machine on the contrary has been built according to a certain number of schemas, and it functions in a determinate way; its technicity, its functional concretisation at the level of the element are determinations of forms. (Simondon 2017: 150)

It is this privileging of form and its dominant role in the machinic which, as already suggested, persists in aspects of digital technology.

I foreground the role that action has in Simondon's account of individuation, mindful of the enactive paradigm of *thinking with and through things in action*. The body is implicated in such transductive processes, but it is a body that is emergent and individuated through an ensemble of forces and energetic transformations. Brian Massumi, following Simondon, gives us the means to think the body through such processes of transduction by delineating a body that is a 'thinking-feeling body [...] operating as a transducer' (Massumi 2002: 135). The body is not only individuated through transduction but is a 'transducer of the virtual' (Massumi 2002: 135).¹¹ The body that creates a mould, shapes the clay pot, is a body that is an assemblage of forces that are not merely adapting or producing, but transducing through a range of vital relations within the gesture of the body from cell activation, to the activity of the nervous system and brain, and a host of other collective modes of individuation.

However, even this does not dissolve a tension in Simondon's definition of artisanal production which appears at odds with such modes of transduction. In *MEOT*, Simondon defines artisanal production as abstract in nature and subject to a made-to-measure schema which bears the hallmarks of gesture and bodily extension, an object that in fact lacks 'intrinsic measure' (Simondon 2017: 29). It is only in the industrial age that the object, no longer abstract, circumscribed by gesture, escapes the bonds of abstraction acquiring the 'power to shape a civilisation' (Simondon 2017: 29) as it becomes concrete. But are tools or hand-made objects not concrete? Have not such objects also begotten the power to shape civilisations?

For Simondon, technical objects are always embedded in technical ensembles that are both subject to and productive of social, political and economic forces. By bracketing tools and hand-made artefacts as abstract, Simondon appears to delimit their potential to generate similar productive forces. There are multiple instances throughout history where the development of a new tool engendered profound changes in the trajectory of civilisations, e.g. the development of the axe head, the stirrup or gunpowder; all of which developed through modes of artisanal production. As Katherine Hayles notes, tools share these

¹¹The virtual, following Deleuze, is that which is not actual or realised, existing in the realm of potentials. One of the aspects of Deleuze's idea of the virtual is its generative nature, to realise potentials that although not material are real. See Deleuze (1991, chapter 5) and Deleuze (1995, chapters 4 and 5).

productive characteristics that Simondon assigns to concrete objects and she disagrees with Simondon's reductive definition of tools by claiming 'tools as part of technics, and indeed an especially important category because of their capacity for catalysing exponential change' (Hayles 2012: 90). Hayles, mobilising research on compound tools, denotes how the development of tools such as the stone axe led to the rapid increase in the Broca area of the brain, enabling the subsequent expansion and development of language.¹²

Tool fabrication in this view resulted in cognitive changes that facilitated the capacity for language, which in turn further catalyzed the development of more (and more sophisticated) compound tools. (Hayles 2012: 91)

Hayles is keen to establish a theory of co-evolution of embodied human cognition and technics that continues with the development of digital technology. In concordance with Simondon, she reiterates that technical ensembles 'create technical individuals; they are also called into existence by technical individuals' (Hayles 2012: 89). Embodiment, for Hayles, relies on ideas outlined earlier through enactive models of cognition, but locates such models within the contemporary milieu of code, digital tools, objects, networks and environments. As I shall suggest there is a blurring of what an object is and can become through current digital fabrication technologies.

The digitalised object

The development of digital technologies has led to a complex infrastructure of tools and fabricating techniques that are responsible for the production of other tools and digital artefacts. Contemporary modes of production such as laser cutters and 3D printers further extend the understanding of the technical object. The digital object, as conceived by Yuk Hui (2016) in *On the Existence of Digital Objects*, gives us a new way to think about the materialisation of data. The genealogy that Hui traces draws out the explicit computational ontologies that are intrinsic to the processing of data and information. The distinction between form and content continues to reflect the hierarchical organisation encoded in digital objects. It articulates a set of relations that appear abstract and immaterial in nature but are, as indicated with the example of the algorithm, a set of materialised relations that subtend and mediate between form and content.

This technology epitomised through CNC machines, laser cutters and 3D printers push the transition of the digital object into the terrain of the materialised or what I call the 'digitalised object'. This digitalised object, a derivation of Hui's digital object, is a materialisation of data into the domain of the natural or real object. Such fabrication requires the translation of an object from the real world into discrete bits that become available for manipulation. It represents at a discrete level the transmission and transformation of ones and zeroes into physical layers on a 3D print bed or subtraction/carving of a physical material on a CNC machine or laser cutter.

Digitalised objects are often the culmination of industrial design concepts expressed in 3D form. The process of design relies on powerful CAD based software that operate in a

¹²Bernard Stiegler is another who articulates the crucial role that the development of the tool had on the emergence of the human. Stiegler, following Leroi-Gourhan, claims that 'the human invents himself in the technical by inventing the tool – by becoming exteriorised techno-logically.' (Stiegler 1998: 141)

reticular virtual space of geometry. The design of objects in virtual space is predicated on complex interaction of other digital objects at the interface level. Text buttons and icons solicit the user to draw lines, construct planes, extrude, pull and push digital material through virtual space. The object is exported out of the primary CAD programme and converted to G-Code, a basic scripted numeric control language that translates the integrity of the object across to the CNC/3D platform. This transitional space between the virtual and the real is the interoperable space between different language platforms, which implement the physical manifestation of the object in real space. It signifies the parsing of the algorithm, the transition of abstract code to the concretisation of a material object. Data is given as object to the user, an object is created by the user, the object is dematerialised or broken down to data, rematerialised as a physical object – object remains given as data.

Data → digital object → data → digitalised object

This digitalised object exists across different registers of digital space, realised through a transductive process as an artefact in real space yet like the algorithm traversing states. The digitalised object, as reticulated data, is repeatable as a print and communicable as a discrete file. Its reproduction in material form is infinitely realisable across time and space, and its (re)production is automated and animated through multiple robotic gestures and movements. The process of reproduction, the object infinitely repeatable in multiple forms, has passed from the technology of the mould-maker to the milieu of the digital.

In *Shaping Things* Bruce Sterling (2005) conceives of the ‘whatness’ of such objects as the very transformation of the object into mutable data that is recycled into a variety of what he labels as ‘SPIMES’ – defined as virtual smart objects that can be physically incarnated and geo-located e.g. the Internet of Things (IOTs). Echoing Hui, the SPIME is a set of relations first and is only instantiated as an object when needed. ‘In an age of SPIMES, the object is no longer an object but an instantiation’ (Sterling 2005: 79). In Sterling’s account such technologies move the object beyond limited conceptualisations in time and space. Similarly, the emergence of a digitalised object, manufactured from a 3-D model, is a culmination of a set of relationships of data across a multitude of planes, from coded data, coded object to physical object. Echoing Simondon, Sterling claims that such models of objects are more open than real or natural objects. They can be deployed, developed and replicated by a variety of creative users such as designers, engineers, artists, etc.

In her more recent work Hayles, again citing the influence of Simondon, underlines the co-emergence of cognition and technics, noting how large-scale networks and algorithms perform complex decision making that is recursive and feed forward into human cognition as forms of non-conscious cognition. Digital technologies represent further externalisations of human cognitive processes. She notes that computational media are not merely another technology because they operate within ‘complex ecologies’ and have ‘stronger evolutionary potential’ than any other form of technology due to their networked structure and problem-solving capacities (Hayles 2017: 34). Although these assertions are consistent with Simondon’s allagmatics they highlight how such relations ‘feed forward’ into social and political discourse around technology.

This resonates with the ‘problem of the given’ that I outlined in Husserl’s work above. But here the problem of the given is manifest in the production of the hylomorphic schema in computational ontologies. It is these imperceptible aspects of computational

techniques of data processing and production that are reconfiguring the very nature of the sensory field. It requires a rethink of what is given in this manifold of data that prefigures and shapes our relations to objects. What are the implicit biases inherent within the givenness of such data and objects, and how are they shaped by forces of capital and culture? Simon Mills claims that although Simondon's account of the technical object offers a powerful account of technical evolution, it lacks a substantive account of the cultural and social forces that play a key role in such evolution. According to Mills this is evidenced in the development and deployment of software in financial markets and social media sites such as Twitter.

Simondon's reluctance to allow social aspects into his theory of concretization cannot be sustained when considering contemporary networked media technologies, other than at the cost of their being denied technological status. (Mills 2011: 225)

Mills argues that Simondon's insistence on the purity of mechanical evolution and dismissal of mechanical adornment is insufficient to interrogate the cultural phenomena that are programmed into software. Similarly, I claim that the emergence of the digitalised object relies on input from artists, designers and engineer and such 'fabricated intention' requires the translation of an object from the real world into discrete bits that then become available for manipulation. The givenness of data must be constructed and programmed in the digital domain and is not something emergent in a Simondonian (or enactive) sense but something that must be constituted upon differing relations of data and the ontologies that underpin computational systems.

As Hui notes, hylomorphism remains a dominant engineering principle in computer science, evidenced in the development of the semantic web through web-based languages and protocols such as HTML (Hyper Text Markup Language).

... the *concept of form* continues to serve as a technical tendency within computing, although it is now *standards* that have become universal. Forms are abstract schemes, and standards are concrete objects. (Hui 2016: 67)

However, the real world is non-computational and material objects require translation from the real world into discrete bits – to be objectified. As David Berry highlights, 'To mediate an object, a computational device requires that it be translated' (Berry 2011: 14). Such translation requires a trimming of the informational content in order that it can be encoded. Furthermore, the hidden, discrete nature of such 'programmed givenness' mediates the very representations we see on the screen. Computation through the 'givenness' of its data, is integrated into the associated milieu of the living being, that following Hayles, subtends and feeds-forward into human cognition. Or as Berry notes:

What is happening in the 'digital age' is that we increasingly find a computational dimension inserted into the 'given' [...] the ontology of the computational is increasingly hegemonic in forming the background presupposition for our understanding the world. (Berry 2011: 128)

The digitalised object highlights how the digital fabrication of objects passes through the ontological distinction between the analogue (bodily) flow of continuous experience to the discrete nature of digital recombination. It does this by seamlessly operating, in the Simondonian sense, as part of our technical milieu and by processing information beyond our cognitive abilities. How does the idea of the openness and autonomy of the

concrete object, apropos Simondon, cohere with the body, artisan making, and as we have seen, the algorithm and digital/digitalised objects? Do such objects approach the openness synonymous with the body of living beings? Such questions require a rethink of what is given in this manifold of data that prefigure and shape our experience and relations to objects. But as Simondon reveals, a phenomenological description of objects (not to mention technicity) can only get us so far, and it is only through conceiving of a more relational account of technics that we can reveal the inherent complexity of such digital technologies and our relationship to them.

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Notes on contributor

Michael O'Hara is an artist, writer and lecturer in Fine Art at Technological University Dublin. He is also an Associate Researcher at GradCAM at TU Dublin with the Aesthetics Group and Digital Studies Seminar group. He has published work on subjects such as the philosophy of technology, the aesthetics of the post-digital, arts policy in Ireland and the aesthetics of football.

References

- Aristotle. 1984. *Physics*. In J. Branes (ed), *The Complete Works of Aristotle*. Translated by R. P. Hardie and R. K. Gaye. Princeton: Princeton University Press, 699-983.
- Barthélémy, J.-H. 2015. *Life and Technology: An Inquiry Into and Beyond Simondon*. Translated by Barnaby Norman. Lüneburg: Meson Press.
- Berry, D. M. 2011. *The Philosophy of Software: Code and Mediation in the Digital Age*. London: Palgrave Macmillan.
- Colburn, T. 2000. *Philosophy and Computer Science*. New York: M. E. Sharpe.
- Combes, M. 2013. *Gilbert Simondon and the Philosophy of the Transindividual*. Cambridge: MIT Press.
- Deleuze, G. 1991. *Bergsonism*. Translated by Hugh Tomlinson and Barbara Habberjam. New York: Zone Books.
- Deleuze, G.. 1995. *Difference & Repetition*. Translated by Paul Patton. New York: Columbia University Press.
- Dreyfus, H. 1992. *What Computers Still Can't Do*. New York: MIT Press
- Gurwitsch, A. 2009. "Phenomenology of thematics and of the pure ego: studies of the relation between gestalt theory and phenomenology." In *The Collected Works of Aron Gurwitsch*. Dordrecht: Springer.
- Hayles, N. K. 2012. *How We Think Digital Media and Contemporary Technogenesis*. Chicago and London: The University of Chicago Press.
- Hayles, N. K.. 2017. *Unthought*. Chicago and London: The University of Chicago Press.
- Hui, Y. 2016. *On the Existence of Digital Objects*. London: University of Minnesota Press.
- Husserl, E. 1973. *Experience and Judgement Investigations in a Genealogy of Logic*. London: Northwestern University Press.

- Husserl, E. 1989. *Ideas II*. Dordrecht: Kluwer Academic Publishers.
- Husserl, E. 1983. *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy – First Book: General Introduction to a Pure Phenomenology*. Translated by F. Kersten. Vol. 1. The Hague: Kluwer Academic Publishers.
- Kittler, F. 1995. 'There is No Software'. Available online at: <http://www.ctheory.net/articles.aspx?id=74>.
- Malafouris, L. 2013. *How Things Shape the Mind: A Theory of Material Engagement*. Cambridge: MIT Press.
- Massumi, B. 2002. *Parables for the Virtual. Movement, Affect, Sensation*. Durham/London: Duke University Press.
- Mills, S. 2011. 'Concrete Software: Simondon's Mechanology and the Techno-social'. *The Fibreculture Journal* (Open Humanities Press) 18, 206–231. Available online at <http://eighteen.fibreculturejournal.org/2011/10/09/fcj-127-concrete-software-simondon%e2%80%99s-mechanology-and-the-techno-social/> (accessed January 2019).
- Mills, S. 2016. *Gilbert Simondon: Information, Technology and Media*. London: Rowman and Littlefield International.
- Simondon, G. 2013. *L'individuation à la lumière des notions de forme set d'Information*. Grenoble: Editions Jérôme Millon.
- Simondon, G. 2017. *On the Mode of Existence of Technical Objects*. Translated by Cecile Malaspina and John Rogove. Minneapolis: Univocal.
- Simondon, G. 1964. Physico-biological genesis of the individual. *topologicalmedialab*. Taylor Adkins. Available online at: <http://topologicalmedialab.net/xinwei/classes/readings/Simondon/Physico-BiologicalGenesisIndiv.pdf>
- Sterling, B. 2005. *Shaping Things*. Cambridge: MIT Press.
- Stiegler, B. 1998. *Technics and Time, 1 The Fault of Epimetheus*. Stanford, CA: Stanford University Press.
- Thompson, E. 2007. *Mind and Life Biology, Phenomenology and the Sciences of the Mind*. Cambridge and London: Harvard University Press.
- Turner, R. 2018. *Computational Artifacts Towards a Philosophy of Computer Science*. Berlin: Springer.
- Wiener, N. 1989. *The Human Use of Human Beings*. London: Free Association Books.
- Williford, K. 2013. 'Husserl's Hyletic Data and Phenomenal Consciousness'. *Phenomenology and the Cognitive Sciences* (Springer) 12: 3, 501–519.