

Articles from Computational Culture

Soft thought (in architecture and choreography)

2011-10-12 09:10:44 matthew

0. An aesthetic of code

This article is an introduction to and exploration of the concept of 'soft thought'. What we want to propose through the definition of this concept is an aesthetic of digital code that does not necessarily presuppose a relation with the generative aspects of coding, nor with its sensorial perception and evaluation. Numbers do not have to produce something, and do not need to be transduced into colours and sounds, in order to be considered as aesthetic objects. Starting from this assumption, our main aim will be to reconnect the numerical aesthetic of code with a more 'abstract' kind of feeling, the feeling of numbers indirectly felt as conceptual contagions', that are 'conceptually felt but not directly sensed. The following pages will be dedicated to the explication and exemplification of this particular mode of feeling, and to its possible definition as 'soft thought'.

The debate on the aesthetic of digital code has been predominantly focused, , on the non-representational and non-functional performativity of coding and its infinite possible infractions (errors, glitches and noise), emphasising that it is precisely these infractions that give code its real aesthetic value. An example of this 'post-digital' tendency towards error is the so called 'aesthetic of failure' proposed by, among others, sound designers and media artists such as Kim Cascone and Tony Scott, and conceptualized by theorists like Tony D. Sampson and Imam Moradi.¹ For these critics and practitioners, the accident shows how code can be productive of an aesthetic effect that results from uncertainty, random indeterminacy, or what goes against its own logic. The aesthetic of the digital accident indeed implies that codes are modes of thought, but only to the extent that they concretely do or realize things, even if in an imperfect or erroneous way. Codes are engines of production, of government and control, but also of confusion and chaos, as they exist not in isolation but bearing upon concrete structures (from data structures, to the physical effects of code on the material structures of reality). Glitch aesthetic in this sense relies, in order to emerge, on the actual production of a disruptive break in these very structures and functions of code-control.

It is important to highlight how this performative conception of coding implies that the code is not a pre-set form of instructions, but is rather continuously produced from within computational processes. Furthermore, the insistence on productivity, even in its disruptive and disrupted form, indicates an operative mode of thinking 'in' and 'through' matter, in the sense of presupposing a corollary of material realizations. In this sense, novelty in digitality is said to arise from the material operativity of coding, where coding is intended as a mode of thought deployed through technical applications and material errors, and where an abstract code is always in need of being concretely doing something, even simply of dysfunctionally disrupting itself. It is through this idea of 'doing by coding' that glitches or operational errors become

unexpected sources of novelty in the computational process, resulting in a particular form of code aesthetic. Even when the technology becomes very complex and sophisticated, the aesthetic (and philosophical) value of the code is merely considered as lying in the qualitative resonance of its effects, rather than in the operation of computing per se. Adopting the same 'qualitative' approach, a myriad parallel aesthetic currents in various fields have also been evaluating and reinforcing the resonance of code in its material effects, for example with architects focusing on the design of generative algorithms, and on the production of organic qualities and topological forms of space as their main perceptual effects. With their capacity to disrupt the 'cold' automated linearity of formal languages, these effects encourage us to perceive a dimension where algorithms have almost managed to 'come to life'. Among the many examples existing in this genre, we can arbitrarily mention here the 'narcissus' architectural installation in Frankfurt by SOFTlab, or the short digital films by FIELD.²

Another question often posed to the aesthetic of code, has been that addressing the sensorial alterations or affects produced by technology on the human body-subject. According to Mark Hansen, digitalization has an incredible potential to reveal the physical source and aim of art, by establishing new interactive relations between structural geometric systems and bodily phenomenology, and by exploring unthought and unexpected ways to physically perceive, experience, even imagine time and space.³ From this point of view, the main scope of every digital art 'application' becomes to extract or amplify the qualitative, organic sensations emerging from the aesthetic experience. As an example of this conception, some of the most recent experiments with Motion Capture in the field of performance art take the information gathered or captured about human movement as a starting point to shape the kind and scope of questions normally posed to technology. This sort of approach (adopted, for instance, by Chris Salter's interventions in digital performance art) applies the physical specificity of the body's experience to the design of 'more fluid' human-computer interaction environments.⁴ Here, the organic continuity and fluidity of the performed human movements directs the way in which technology is designed and experienced, while the technology itself is sensed as bouncing back and impacting on bodily movement and perception with its own sensations and affects.

Looking for the glitch in the functionality of the algorithmic system, or waiting for new qualities and affects to be generated by it, have so far been the two interwoven, polarizing tendencies of contemporary digital aesthetics. But most of these experiments and critical debates seem to overlook a fundamental aspect, that is the autonomy of code, 'code in itself', thus discarding all real engagement with its specific aesthetics. What is left behind here is the very possibility for digital algorithms to be seen as what they primarily are, i.e. mechanisms for the processing and calculation of quantities of data, rather than instruments for the production of qualities/effects. It is mainly to this quantifying capacity that we ascribe the aesthetic value of software, a value that we want to associate not to sensorial perception but to something that we define as 'thought': a thinking not relatable to any subjective or conscious reflection but to the automated, abstract dimension of

numbers. The definition of 'soft thought' we are proposing here thus indicates nothing more than that numerical and logical mode of thinking which is proper of software itself.

We have already briefly described this mode of thought as a feeling or, more precisely an abstract 'conceptual feeling'. Following Alfred N. Whitehead's vocabulary, a feeling must be intended here as nothing else than a 'prehension' or, in other words, a registering, a capture, the way in which one actual entity enters, transformed, the world of another. It is important to note the non-anthropomorphic and non-organic nature of prehensions as the immanent ground of all perceptions (physical prehensions) and thoughts (conceptual prehensions): the stone prehends the water it falls into, an addend prehends another in every mathematical addition. In Whitehead's philosophical system, feelings (or prehensions) can in fact be distinguished as 'physical' and 'conceptual'. Whereas a physical feeling involves the simple capture of what concretely 'is' and 'becomes' in the world, a conceptual feeling is a 'pure mental operation', the feeling "of what is not and may be, ... of some possibility as to how actualities may be definite."⁵ This potential of what 'may be' definite in the actual world is described by Whitehead as an 'eternal object', or an idea. A conceptual feeling is, in this sense, the abstract, non-subjective and non-conscious, non-corporeal and non-physical, feeling of an idea. If, as argued by Whitehead, these conceptual feelings bear "no reference to particular actualities, or to any particular actual world," the mathematical thinking of non-actualised data implied by computer software can thus easily be intended as a form of 'pure' conceptual feeling. This means that soft thought does not just rely on the performativity of the act of coding or on its physical application (in the same way in which, for Whitehead, every conceptual feeling corresponds but differentiates itself from a physical feeling). Rather, and more importantly, what is at stake is the algorithmic prehension of numerical data as abstract ideas, as 'what is not and may be', what has not been actualized (yet) but is nevertheless real.

We should at this point reiterate that the definition of soft thought we are adopting here does not lead to the conception of algorithms as a form of 'cognition' whereby software (or thought) necessarily depends on the physical machines or bodies on which it runs. According to Andy Clark's theory of 'extended functionalism', digital algorithms partake of the extended, software-like nature of the mind, where thought is a syntax that can be programmed and can run on any human or digital object.⁶ In this theory, digital machines are considered as mere extensions or functional activators of the software of the mind, with thought mainly framed into a closed syntactic form that can be endlessly reconfigured through various organic and inorganic extensions. From this standpoint, whilst we do share with the 'extended mind' hypothesis the idea that thought is not limited to the biological skin, we reject the syntax model of thought and the connectionist ontology on which it is grounded. Why should digital algorithmic processing be just another instance of a universal and predetermined grammar of thought? And if cognition is like the software of sequential or parallel connections bearing upon any sort of machine, organic or inorganic, all intended as extended prostheses of the brain, can there ever be new modes of thought that can escape this 'mind' model? The point here is certainly not to reject the software model in toto, but to unlock the potentialities of thought beyond

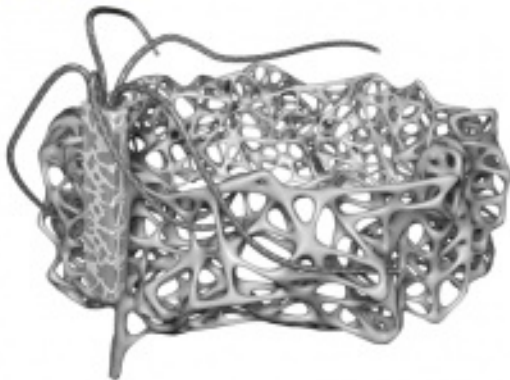
the limits of an enclosed grammar and of the bodily extensions by which this grammar is operated.

On the other hand, whilst the hypothesis of the 'extended mind' relegates thought to syntax and to the connectionist framework of a *partes extra partes* extended body, Varela and Thompson's theory of 'embodied cognition' rejects the assumption that digital algorithms are cognitive extensions at all.⁷ Instead, they argue, thought is always already part of an affective environment of material, physical relations which primarily constitute and depend on lived experience. This means that thought is an analogue process defined by relational qualities that cannot be reproduced by binary codes. In short, cognition is not equivalent to a software program, but instead emerges out of a situated relation in the concrete world. Whilst seemingly in opposition, what these two cognitive approaches would possibly agree on is that the aesthetic of software is not to be found in digital algorithms *per se*, but in the body, object, or hardware which sustains software as a mode of thought. In other words, for both extended functionalism and embodied cognition, digital algorithms could only ever acquire an aesthetic value (for them corresponding to aesthesis, as 'sensing' or 'perceiving') if and when they bear upon a material body. Both approaches assume in fact that a physical body adds feeling to an otherwise mathematical, non-physical, and consequently non-aesthetic, thought. This approach overlooks the possibility of engaging with the aesthetic proper of digital algorithms in code, without conceiving of them as simple representations of an analog experience. For us, instead, the aesthetic of soft thought precisely implies that digital algorithms are autonomous, conceptual modes of thinking, a thinking that is always already a mode of feeling ordered in binary codes, and is not to be confused with sensing or perceiving. Numerical processing is always a feeling, a simultaneously physical and conceptual mode of feeling data, physical in the actual operations of the hardware-software machine, conceptual in the grasp of numbers as virtualities or potentials.

The aesthetic conception offered in this article will therefore aim at including numbers and quantities, instructions and programming, or those ideas that Whitehead would call 'eternal mathematical objects', pure potentials for actualisation.⁸ In this sense, the main question for us becomes: how can numbers and quantities be an aesthetic mode of thought, without having to be primarily transduced into qualities? These numerical data, we will also argue, do not simply represent a closed, computable and determined world but also constitute a virtual, incomputable dimension, with digital algorithms becoming the actual hosts of random incalculable quantities. Instead of claiming that incomputability amounts to a surplus of information that digital systems cannot contain, we are instead interested in exploring how this incomputability always infects (and to some extent constitutes) the order of all data. In other words, the aspect of soft thought that we would like to investigate here lies in this double articulation of digital processing, whereby the actual order of the digital system is infected with the virtuality of incomputable information. A final, important point will thus be to conceptualize such incomputability as the potentiality or abstractness of all algorithmic code, that which distinguishes it from its material level and makes it into an aesthetic object in itself.

1. Model and metamodel

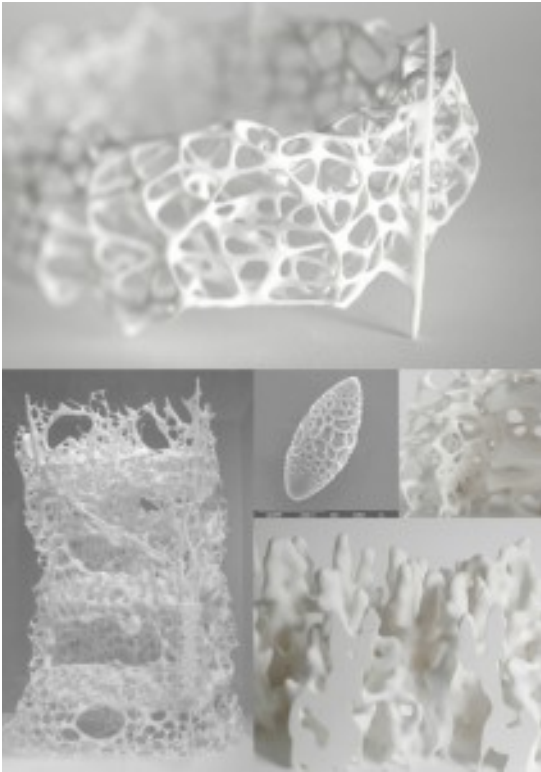
R&Sie(n)'s architectural project I've heard about it... (A fat, flat, growing urban experiment) (2005-6) is the computation of a urban space that does not yet exist, a software experiment drawing upon the dynamics of the auto-regulation of urban relations.⁹ Far from just designing the model or prototype of an actual city, this project is what Felix Guattari would define as a 'metamodel': the mathematical prehension of a urban system that is simply relatable to the order of data structures, to the abstract dimension of numbers and their autonomous connections and disconnections, and which is neither driven by a pre-established logic nor by an external set of concrete influences. I've heard about it..., therefore, is the metamodel of a city whose data architectures do not model an existing urban space but simply construct its order. The project, in other words, has no references to predetermined ideas or to the concreteness of reality, but simply describes the conceptual prehension of an 'architecture of abstraction'.



I've heard about...(a flat, fat,
growing urban experiment),
R&Sie(n) / François Roche,
Stéphanie Lavaux, Jean Navarro
& Benoît Durandin

The notion of 'metamodel' was used by Guattari to defy the assumption that models are closed and pre-determined formal systems, simulation-based patterns of recognition, or cultural, aesthetic and political schemas governing society.¹⁰ A model is usually considered to be a formal structure, a blueprint or a set of instructions that need to be concretely realized in order to unfold their full potential. As opposed to this idea, a metamodel is not a blueprint. Instead, the philosopher searched for diagrammatic relations that could challenge the closed hierarchy between models and facts, between the formal and the practical. Whilst rejecting

the notion of model qua representation or of prototype to be applied to reality, Guattari's notion of metamodel fully embraces the reality of form and abstraction, and suggests that thought is as real as any other thing.



I've heard about... (a flat, fat,
growing urban experiment),
R&Sie(n)

The main example used by Guattari to clarify his concept of the metamodel draws from the virtual particles of contemporary theoretical physics, i.e. abstract entities that can only be theoretically thought and discovered through mathematics, rather than through empirical experimentation. Not being directly detectable in the actual world, the metamodelling of particle physics goes beyond already determined probabilities and describes how the abstract processing of rules “constructs its own cartographies, its own reference points, and thus its own analytic approach, its own analytic methodology,” at the same time incessantly re-singularizing its own configurations.¹¹ In this sense, it becomes clear how the notion of metamodelling was not developed to define a schema apt to social implementation. At the same time however, it may also be reductive to suggest that metamodelling always already results from physical systems, whereby the model emerges from practice. A metamodel, in fact, is a thought diagram whose signs and symbols show a propensity to prehend an abstract, ‘alien’ world. This means that modes of abstraction are not simply representations of reality, but are processual forms imbued with their own reality. For this reason, metamodels enjoy a form of temporality subtracted from linear causality and can enter infinite, indeterminate modes of arranging data. It is this very infinity of mathematical possibilities that constitutes their aesthetic potential. Describing the project I've heard about... as an example of metamodelling will thus help us to define the software programs used in digital architecture as soft modes of thought, numerical speculations whose

aesthetic side relies not on their visual, perceptible interface but primarily on the abstractness of their conceptual algorithmic processing (or prehension) of data.

It is crucial to remember that Guattari's concept of metamodelling challenges the priority of the empirical, by revealing how the code of mathematical signs has no physical objects as its referents, but constructs a reality that exceeds what is physically experienceable. In the same way, computer algorithms not only describe the use of mathematical models to compute bio-physical realities, but more importantly announce the speculative power of soft thought, with metamodelling ready to design spaces that are not yet and may never be lived. These algorithms re-introduce the reality of architectures of abstraction, of virtual architectures irreducible to the reality of the actual, a metamodelling of computational experiments that imply a metamorphosis of abstraction, of thought and reason in themselves. Here, software speculations are not simply models to be applied to physical constructions, but first of all they are aesthetic adventures of ideas, of mathematical eternal objects that can indeed follow (and transform) bio-physical structures, but without being engendered by them. In I've heard about..., this algorithmic architecture is but another instance of soft thought leading to new formalizations of spatio-temporal actualities.

From this standpoint, I've heard about... is not a Platonic blueprint of a city ready to be implemented, executed or actualized. Understood as a metamodel, I've heard about... shows that the logic of algorithmic instructions is not the mere static embodiment of an instrumental rationality, but becomes dynamic as numbers automaticallyprehend themselves and the ideal, algorithmic city grows, extends and contracts beyond its initial conditions. The algorithms of this city are therefore not primary instructions but are continuously re-programmed through their own coral-like growth, whose perceivable shape is constituted by recycled, synthesized and polymerized materials. Rather than being conceivable as performative actants, or action-instructions, these growing algorithms do not just represent or simulate but make a city in themselves.

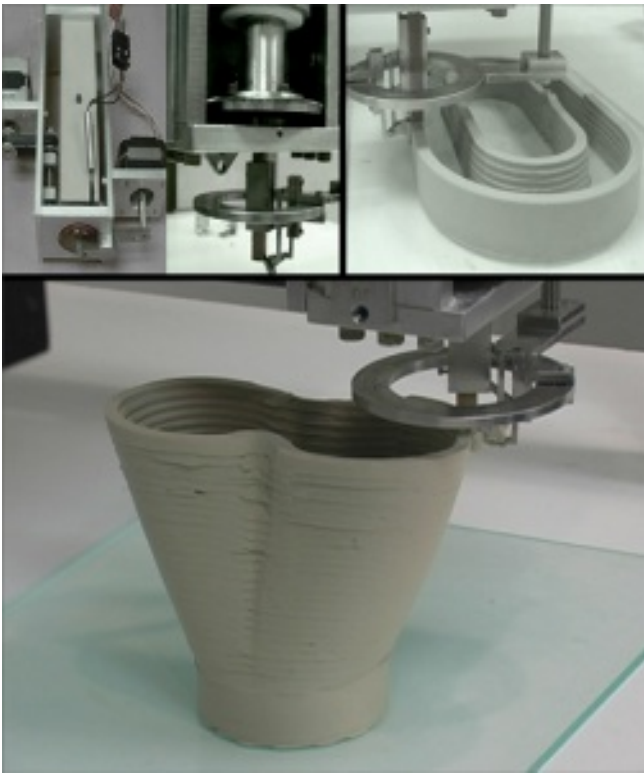
It should at this point be mentioned that the algorithms of I've heard about... have been designed to get access to and quantify a series of data, such as: 1. the external data of pre-existing urban morphology: structural limits, natural light, the dimension of habitable cells; 2. the internal data of the structure and of chemical elements: e.g. physiological empathy, endocrinal secretions, bodily emissions of the inhabitants; 3. the electronic processing of information and decision making. All these data are then constructed into growth scripts and neighborhood protocols. These (biotopes) 2.0 (as R&Sie(n) calls the protocols) therefore include the contingency of physical data within their algorithmic design. Conceptual prehensions, as Whitehead points out, are always accompanied by parallel physical prehensions. It is the perishing of physical data that drives algorithms to build multiple, heterogeneous and contradictory scenarios. In this sense, the relation with physical data structures makes finite algorithms become contingent, rather than infinitely regenerating, because it subjects them to the constraints of physical, chemical and electronic conditions. In other words, the architecture is programmed to be affected by the entropic deterioration and dissipation of material data.

It is therefore true to say that the performative and temporal qualities of algorithms are inevitably related to material data structures. On the other hand, however, the open relation between algorithms and data cannot be exclusively explained by this performative operability, as if algorithms were primarily 'doers' or actants. Of course algorithms are temporal engines for action and implementation but, we want to argue, this is only one side of the coin. On the other side, the reason why algorithms continue to animate software culture is because they are and remain not only activators and executors of physical realities, or models of the temporal evolution of these realities, but also because they are ideal, conceptual elaborations of pure potentials. What we propose here is, in other words, to consider algorithms as having not only a physical but also an abstract pole. It is important to warn readers that this 'extra', ideal layer of computation is not to be intended as a supracognitive, transcendent order or just another face of idealism rooted in human thought. To the contrary, what we mean by 'pure potentials' is that the formal logic of algorithms is always inherently incomplete and infected with uncertainties. In other words, this logic does not need to be extrinsically disrupted (as is the case with 'glitch art' or with the ingression of physical contingency in algorithmic structures), but is inherently exposed to that intrinsic incompleteness which it tries to order and organize. If data are understandable as indeterminate quantities, it is not simply because of the arbitrary appearance of contingencies and errors. A simple gesture of the external intervention of chance into a formalism could never suffice to explain how soft thought can become an instance of something that thinks, of something that shows the unpredictable indeterminateness of thought, and that is not merely reducible to the thought thing.¹²

The metamodel I've heard about... points to a mathematical mode of thought proper to machines. The urban space is in fact actually constructed by a secretion machine or VIAB (standing for 'viability') made of nanoreceptacles, psychochemical receptors of data secreted by human and nonhuman inhabitants, and of mutating algorithms. The very processing of the material deploys the machine as a thought-thing coinciding neither with a subject thinking nor with a thought object. The VIAB is not a subject that enacts thought in order to make sense of the world. It is instead an instance of thinking procedures that are machines in themselves. As Whitehead says (with specific reference to algebraic symbols), it is not human subjects that think through symbols, but the symbolic operations of algebra do the thinking for us.¹³ In some ways, these symbols are different to those of ordinary language, because the manipulation of the algebraic symbols does your reasoning for you, provided that you keep to the algebraic rules." See "Alfred N. Whitehead. Symbolism. Its Meaning and Effect. Barbour-Page Lectures, University of Virginia, 1927," URL <http://www.anthoniflood.com/whiteheadsymbolism.htm/> In the same way, the VIAB machine does not simply execute a task, but entertains its own algorithmic processing and in doing so it overcomes the centrality of thought as based in thinking things.¹⁴ Things (or machines) do not think but 'are' thought. They do not simply host thought or become implementations of a predeterminate cognitive structure. Rather, thought results from the modalities or the mannerism of the machine: what thought becomes is how the machine thinks.

From this standpoint, the VIAB machine cannot be said to be part of the environment of what Andy Clark calls an 'extended cognition'. This machine does not complement human thought and is not simply driven by universal codes running on any body. The machine is its own thought, without having a supplementary dimension that grounds its cognitive structure. From this standpoint, the thinking machine is not another instance of functionalism as it does not simply host a code that instructs it to work in a certain way. In the core of the VIAB, fuzzy algorithms are prehended by an insect-like robot, a pneumatic articulated machine (robotic muscle system) knitting space whilst registering the rules of algorithmic change and prehending biochemical data. By sieving and weaving, the machine creates a vertical structure, a three-string bunch (each 5 cm in diameter) wrapped around on itself, and uses a hybrid material (bio-cement) that agglutinates and coagulates chemically. The tank loads the file describing the 3D morphology, and with its terminal devices works like a 3D printer. This is not a swarm intelligence protocol, but rather a 'swarmoid', a protocol for a division of labor that is at once centralized and distributed, axiomatic and incomplete. In other words, this protocol's axiomatic is challenged by its execution and at the same time each execution cannot simply perform the code but rather needs to transform it.

This is how the VIAB deploys another mode of thought, which is aesthetic before being functional. It is aesthetic because, above all, it deploys a mode of feeling data, a physical and a mental mode of elaborating on the information retrieved from the program and the environment. As opposed to exclusively considering machine thought as an expression of a code that can run on it, machine thinking for us has also to account for the conceptual feeling that the VIAB machine itself has. This means that the algorithms operating in and through the machine will not just operate on and through blind matter. The conceptual mode of thinking here is intrinsic to the mode of the machine and cannot therefore be otherwise. This means that the thought of the actual machine is not simply an execution of instructions, but has become autonomous and develops its own algorithmic modalities, where the sequence of instructions changes according to the way the machine orders data. This means that the machine thinks beyond the formal level of instructions, and also beyond the empirical data it gathers from the environment. The closest thing to a VIAB machine perhaps is a small mud-working robot invented by Behrokh Khoshnevis, a 'contour crafter' working more or less like a 3-D printer.¹⁵ Contour crafting however is a job that termites have been doing for eons, building skyscrapers by spitting and smoothing mud.



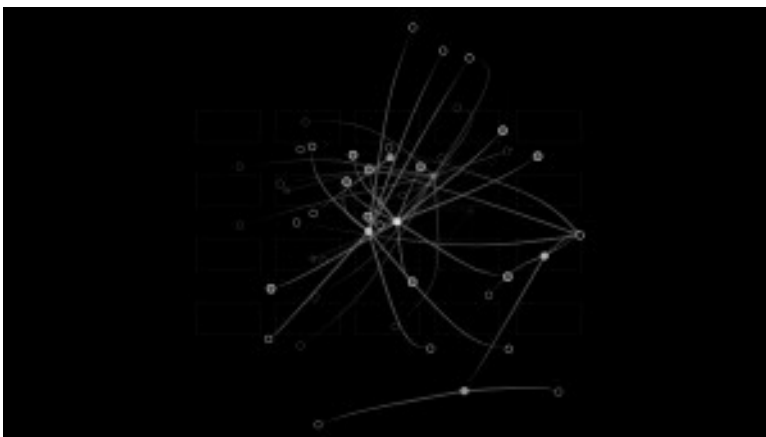
The VIAB is indeed a busy termite with a body full of wet cement and instructions. Its machinic parts are data and procedures, infinite and finite sets that cannot be synthesized into a coherent, fixed and finished whole. The actual VIAB therefore is not a mere implementation of generative algorithms. Since the model is always of a secondary order compared to the diagrammatic constellations of a metamodel, the VIAB machine is yet another instance of a body able to think beyond its physical constraints. But to understand how this machine could think beyond what it already is, one may need to turn to Whiteheads' notion of the 'eternal object'. This notion directly addresses the impalpable reality of ideas, which according to Whitehead are prehended by each and any actual entity. In particular, the notion of ideas offered here will also help us to distinguish this mode of machine-thought from the framework of extended cognition, according to which thought is always already an extension of what the mind and its subset of the operations of the brain do. In fact, extended cognition does not succeed in making or explaining such a difference and leaves us thinking that despite their 'alien' nature, machines are just another instance of a mindware operating a hardware. Instead, we want to probe the possibility and take seriously the challenge that Whitehead's philosophy poses: that actual entities (no matter how small and how inorganic) have their own physical and mental pole. Actual entities like the VIAB machine are not set to think but rather are their own thinking, whilst they physically and conceptually prehend things and ideas.

2. Choreographic calculations

"Synchronous Objects for One flat Thing, reproduced" is a choreographic website created by the William Forsythe Dance Company in collaboration with the Ohio State University's Department of Dance and its Advanced Computing Center for the Arts and Design (ACCAD). The main aim of the website is to visualize and re-animate the choreographic data of the performance One Flat Thing, reproduced 'in new ways'. Here, the conjunction of visualization and reanimation seems to coincide with the very process of thinking: how else, the project seems to ask, can the

movements of a dance be thought?

The online platform was realized with the aid of several mapping technologies; various image processing, computer vision, 3D computer graphics and interactive software were then deployed to explore the mapped data, and to systematically formalize the components of the choreographic system. The performance 'cueing' system, for instance, defined by Forsythe as 'an internal clock of aural or visual signals given and received by the dancers to trigger and organize the dance event', was mapped as a score of interconnected points in 3D space. This and many other abstract diagrams of dance information (about the cues, but also about the alignments, the directionalities of corresponding flows, the analogous shapes of body movements, the related timings) were translated into algorithms. On their turn, these algorithms were used to determine results and effects in other performative modalities (such as the modeling and milling of fabricated architectural objects by a machine instructed to 'follow the shape' of a particular motion). We can thus describe the Synchronous Objects project as another example of code aesthetics working according to the dynamics of soft thought, i.e. a level of conceptual prehension of numerical potentials going beyond the polarization between algorithms as sequential arrays of codes, and the visual effects generated by them. In this project, it is in fact possible to distinguish, along the lines of Whitehead's philosophy, two kinds of potentiality that invest the actual entities of the code: the abstract 'pure potential' of numbers as ideas, and a 'real potential', the potential of each actual occasion (or each Synchronous Object) to become the datum of another occasion, in the actual processing of the software. Let us start with a description of the latter.



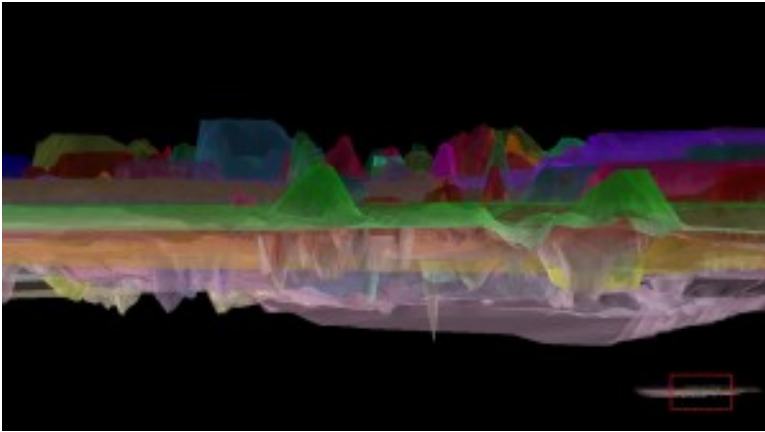
From an empirical point of view, extensive subdivisions (quantities, measures and their related algorithms) and perspectival relations (points and lines) constitute, in the website, a dimension of 'real' potential of the actual entities (movements) that are part of the One Flat Thing, reproduced dance. The presentational immediacy of computer graphics illustrates each of these mapped and quantified subdivisions of the dance as a visible slice of space-time, a 'duration' that is objectified (or made into a perceivable object). Through the presentation of multiple objects, the website not only describes a way to precisely quantify and clearly illustrate the divided choreographic structures of the performance, but it also implies the repurposing of this information about its concrete, physical and material possibilities in other fields. If the actual synchronous objects atomize the performance continuum (into as many

annotated regions, quanta of visualization, threads, choreographic wholes and parts), these atoms also exhibit a mathematical relationality which corresponds to the automated dimension of software, and at the same time transforms them into real movement potentials, potentials of the movement to acquire infinite visible forms.

Adopting Nigel Thrift's terminology, we can define this potential of algorithmic objectification of a dance as obeying the "new calculative background that is coming into existence" in our times, "a background that will both guide and constitute what counts as 'thinking'."¹⁶ Differently from the theory of extended cognition, what Thrift seems to suggest is that the contemporary version of thought (what 'counts' as thought) is a form of mindware or the softwarization of the mind that needs to be addressed as a form of 'qualculation', the latter being defined by the emerging of repetitive patterns, a background of continuous and ubiquitous calculations that characterizes the social and material environment today. Significantly for our choreographic example, these calculations end up producing new perceptions of space and time, or a new 'sensorium'. Calculation (or 'qualculation'), in short, is the way in which thought results from those material habituations (the repetitive algorithms) of matter, repetitive habits that allow all bodies to find their way or become oriented in space-time. Instead of an extended software thought running on material bodies, here we have a form of thought emerging from the iterative patterns and calculations of matter itself, suggesting a productive and constructivist notion of thought that does not describe but produces nature as it builds a constrained, ordered, objectified world. From this point of view, the linear causality of sequential algorithms shows that thinking is the same as tracing a grid in space-time. As already illustrated with the example of the VIAB machine and its material processing of data, actual occasions always include a physical dimension or 'pole' that is, in this case, identifiable with the linear sequencing of space and time operated by the choreographic software. This capacity for ordering allows for what would be defined, in Thrift's words, as the construction of a new spatial awareness, a possibility for the body to re-orient itself and therefore develop new thinking modalities. It is by materially changing this level of 'bodily thinking' that choreographic software thus realizes its material 'pole' as an actual occasion of movement experience.

In the same way, we could say that the dance, *One Flat Thing*, reproduced of the website is not to be thought as a simple reproduction, or simulation, but as a calculated nexus of events, or what Whitehead would define as an objectified set of data, a series of 'units of historic fact' (such as the points mapped in the scores), or 'pulsations' (0s and 1s) transmitted from occasion to occasion. The data is calculated by weaving a relation between what has been in the past, but also what might have been, and what might be in the future: a dance step, a graphic 3D form, a piece of furniture... The data is always actual, and its potential is always a real possibility, a way for the body to think of its movements and find its way, or to orient itself in the performative space-time. Following the logic of cause and effect, the pulsed transmission of data in a liner fashion, the counting (qualculation) from past to present to future connotes the working of digital algorithms as habitual and diachronic, restricted to a physical and compulsory level (the physical nature of the program). The computer is not a mindware running on bodies, but instead operates

and thinks in the same repetitive fashion of physical, inorganic, inert matter, pointing towards a physical conception of digital binary processing, whereby cognition as computation involves not the syntax of data but its simple repetitive patterning.



For Thrift, as well as in “Synchronous Objects”, the flux of numerical sequences derived from the mapping of the physical performance gives way to new qualities and intensities. Qualifications are therefore not simple descriptions of movements in space-time, but they also imply a construction of new qualities emerging from the very process of quantification, such as new ways to become oriented in space-time or to perceive the dance. But what about the novelty of the project? Is this novelty merely definable as a real potential, i.e. as a new way to sense space-time? In Thrift’s conception, open-endedness and the possibility of novelty are always the results of a fine grid of calculations, as if a carefully constructed absolute space could beget a relative space. Or as if novelties were prosthetic objects created by, and supporting, cognition, the latter only intended here as automatic navigation. As an example of this creation, we can look at the ubiquitous presence of tracking and mapping systems in our world, and the becoming provisional or temporary of our spatial coordination. From this point of view, a new ‘elasticity of synchronicity’ appears as the qualitative product, and nourishment, of our technological tools of mapping and synchronization. It is quantification that allows for new qualities – new sensings of space-time – to emerge. It is indeed possible, to agree with Thrift, to define the contemporary version of thought as part of an era of qualculability. The problem is that, in order to become really open to the ‘new’, calculations cannot be reduced to mere extensions of material patterns, nor can they be simply accounted for in relation to their emerging effects. For us, once again, neither the linear causality of sequential algorithms nor the perceptual qualities generated by them can suffice to explain the particular novelty of soft thought.

3. Eternal synchronous objects

We should at this point reiterate that the main aim of the “Synchronous Objects” project is to ‘compress’ the performative complexity of the dance, as an intricate composition of contrapuntal movements, into a number of discrete objects (charts, maps, scores, and then animations, graphics, computer applications) that not only visualize, but simultaneously transduce and re-animate the complexity of the dance elsewhere. In this sense, the objects are meant to act as vectorial operators, transferring the relational potential of the dance to different fields, from dance notation to music or architecture, statistics or geography. Every object becomes, in

this sense, a 'model' of the dance.

Cognitivist Alva Noe was one of the collaborators of this project. According to Noe, we are a tool-using animal. We make tools to extend our bodies, but also, in line with the 'extended cognition' theory, tools to extend our minds (such as mathematical notations for performing calculations). From this very 'McLuhanesque' point of view, the model is also a tool, a very functional one. The weather bureau models a storm system in the hopes of predicting the storm's behavior:

"Synchronous Objects" is a model of the physical dance, it is an instrument for thinking about this complex, very difficult to understand or to clearly visualize, choreographic structure (of cueing relationships, alignments, movement themes), by translating it to parallel fields. In the end, if the model-tool is effective, it will help the audience (and also the dancers and the choreographer) to obtain a clear view of the complex whole. This assumption seems to confine "Synchronous Objects" to a very restrictive domain: that of the model as an instrumental, explicative tool. But there is one point where Noe's discourse becomes more interesting: for one thing to model another, he says, this thing must exhibit something like the complexity, or all the possibilities, of that which it models. A map, for example, in relation to the city it describes. This means it is always possible to get lost in our maps, or in our models. And it also means that our models become objects of inquiry in their own right. If "Synchronous Objects" is successful, then it is likely to command our interest and attention in its own right. This conception resonates with Guattari's notion of metamodelling. Metamodels alienate us by building complexity, instead of serving us by making it more accessible: for Guattari, as we have seen, their true value lies exactly in their capacity to do without their material counterpart, their factual origin or aim. More like Forsythe's 'objects without a body', rather than simple tools.

A question seems now to emerge: how can the almost infinite reproduction of the dance as an abstract algorithmic pattern become something new, something more than a repetitive digital model? Or, in other words, "How can the future avoid being predetermined by the past or by the relentless chain of causes and effects? How is it possible, in the world described for us by computer science, for anything genuinely new to emerge?"¹⁷ In Steven Shaviro's reading of Whitehead, the appearance of the new takes the form of an interruption of the continuous chain between past and future: a cut where past data are valued and particular ideas are selected in every occasion of experience, in order to determine what the future occasion will be. It is not so important to determine the essential nature of this cut (be it material, organic, human, atomic). What is important is to highlight how the novelty-bringing cut always happens as an ingression of what Whitehead defines as 'pure' (rather than 'real') potentials or eternal objects.¹⁸ Pure potentials are nothing else than virtual ideas; and yet, with all their abstraction, they add definiteness to existing data and relations between data (rather than simply introducing new data or relations), functioning as principles of individuation for upcoming occasions. The cut of an idea is therefore conceptually prehended or non-sensorially felt as the novelty of definiteness: 'the making-definite of something that was already existing in the 'inherited data' but not with that particular definition (i.e., something that was merely a real potential)'. The list of eternal objects, ideas or pure potentials can be infinite,

including not only qualities, but also such things as patterns, or numbers (one-ness, two-ness, three-ness, 'the square root of minus two', or Omega), and also metric ideas such as counterpoint. Ideas bringing forth the definite mathematical character of an occasion, or ways in which the occasion can be cut and re-glued from the totality of actual preexisting data.

In the dance performance, counterpoint, for example, appears as a structural form of dialogue, a rhythm of alternation coinciding with the pure and definite potentiality of an eternal object. Counterpoint therefore is simply an indeterminate idea of accord which can be realized in infinite ways and can also be conceived as a mathematical quantification. In "Synchronous Objects", counterpoint takes the form of various algorithmic/choreographic objects such as, for instance, 'alignment' (the synchronization of two or more dancers, differently actualisable as a spatial, temporal, or directional accord). Conceivable as a mathematical pattern in space-time (and simultaneously as a set of 0s and 1s), alignment is the result of an idea. This idea (counterpoint) enters the choreographic score and transforms the mapped set of performative data into a definite occasion with a precise individual construction in form and timing (the Alignment Annotations object, a visual illustration of the alignments on screen, in the form of various graphic shapes and volumes).

We are therefore, at this point, clearly already on a different aesthetic dimension from that of the live, concrete performance event, and it is important to bear this in mind. The technological transposition of the dance and the quantification and collection of data become here a way to emphasize the ordered and clear aspects of movement (the annotation of the alignments as short instances of synchronization between the dancers, the annotation of the cues where the cueing system of the dance unfolds in a rapidly shifting network of relationships, the indexing of the movement themes that serve as building blocks of the motion). In other words, the extensive, algorithmic structure of the dance, more than its qualitative nuances, exposes organization and order as parallel aesthetic aspects of creation that can often go unnoticed 'live'. The capacity to abstract the organic, or living, sensations of movement (as different from readable understandability and its related feelings) is certainly not the technology's main strength, and perhaps this is not what we should look for in its manifestations. What emerges, instead, is a different rhythmic aspect associated with the 'aesthetics of soft thought': alignment, cues, the order of the themes, as feelings (or 'conceptual feelings') in themselves. What appears is the infinite divisibility of choreography into autonomous patterns doubled by an infinite possibility of actualization by each structural object: the theme of a dance can become a dance of graphic shapes, a 3-D object, a diagram, and allow an abstract re-thinking of the choreography (even without the intervention of the physicality of a body). At the same time, without transforming the choreographic composition into a sort of Platonic realm of transcendent mathematical ideals hylomorphically imposed on the movement material, the quantitative nature of ideas weaves a parallel abstract dance, or a movement of soft thought.

4. The indeterminacy of soft thought

Rather than being a simple thinking-machine, R&Sie(n)'s VIAB incarnates the

machine-like nature of thinking procedures. This is why we agree with the critique of the autopoietic model of cognition qua sense-making and, in particular, against the autopoietic assumption that thought is always already enacted by living organisms.¹⁹ Following the autopoietic model, Varela and Thompson used the notion of enactivism to challenge the idea that cognition is a representation of the external world given by pre-set symbols. Against the legacy of computationalism, according to which cognition is reducible to a physical symbol system or a mental process carried out by the manipulation of symbolic representations in the brain, Varela and Thompson argued that cognition is instead embedded in the world. In particular, cognition is “the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs.”²⁰ By rejecting computationalism in its cognitivist and connectionist forms, the second-order cybernetic approach to the problem of the mind, as articulated by Varela and Thompson, was more directly concerned with the relation between cognitive processes and the world, including the brain, its relationship to the living body and the environment. Varela and Thompson proposed an enactive approach to explain that “[c]ognitive structures and processes emerge from recurrent sensorimotor patterns of perception and action”.²¹ In other words, cognition is not equivalent to a form of information processing that is able to run on any system, but emerges out of the performing activities of being in the world. From this standpoint, enactivism explains interaction as the effect of the environment on the brain: the environment triggers cognition to productively respond and thus enact a world. Cognition therefore cannot be programmed since it remains a question of affective consciousness and experience.

Whilst Varela and Thompson’s concept of enaction described above is insufficient to explain the kind of ‘soft thinking’ we are discussing here, we also want to highlight that the critique of computation as a form of cognition, a critique shared by both enactivism and extended functionalism, too quickly dismisses the capacity of information-processing to account for contingencies (the example often mentioned here is that of traffic controllers, where computers are unable to calculate extra and contingent factors in urban traffic).²² For extended functionalism, the formal level of algorithms always needs a material environment onto which to distribute and establish a relation.²³ According to Clark, this relation extends or transforms the interior apparatus of neural architecture (human cognition), hence producing novelty in the extended architecture of the brain.²⁴ As Clark argues, the very activity of bodily spatio-temporal orientation is what drives the development and evolution of inner states of cognition: additional memory and new capacities of symbol manipulation, new forms of communication, interaction, and digital computation. Here, the architecture of thought is no longer internal to the human brain, but the latter has become spatially extended onto the world. Such a global brain in Clark’s view derives from the co-evolutive relation between brain and environment, where the techno-extension of cognition determines what thought can do beyond-the-skin.²⁵ Nevertheless, as Clark maintains, for cognition to work it needs a physical ground on which to operate. In other words, whilst enactivism argues for a mind which is generated from the interaction between elements in the environment, extended cognition posits the primary function of thought in terms of a minimal

Cartesianism, according to which the mind exists before the body. This is why we find that extended functionalism is unable to radically engage with cognition in its own code. Extended functionalism, we argue, explains the relation between mental and physical poles merely in terms of a linear causality, whereby mental states are triggered by and bear upon systemic inputs and outputs. Thus, whilst we agree with its critique against the autopoietic explanation of cognition, we also find it difficult to see how extended functionalism could seriously challenge formal structures of cognition, or explain novel forms of thought beyond a mere pragmatics of functionality that always already needs a material ground on which to run. If algorithmic thought is more than the biological brain, then it has to be defined according to its own reality, however abstract this may be. The metamodels of I've heard about... and Synchronous Objects are machine-thoughts that disentangle the power of computation from pre-programmed instructions and, perhaps unfashionably, do not support the idea that material extensions change the internal structures of cognition. In fact, we want to emphasise that the main limit of computation is not its incapacity to include material contingencies. Quite the opposite, computation, or the formal architecture of algorithms, only remains limited to a closed formalism if one does not take into consideration how algorithms themselves tend towards abstraction, infinity, or the reality of the incomputable.

Novelty is already internal to computation, to the extent that, as Turing already envisaged, the limit of computation, or the infinite potential sequence of logical symbols and interpretation is the very condition by which algorithmic finite rules can be established. Thus, algorithms are not only actions or pragmatic functions but also, as Deleuze may call them, suspensions of action or forms of contemplation of this infinity.²⁶ These suspensions correspond to the infinite discontinuities that algorithms encounter in the processing of binary unit sequences, as these are always prehensions or captures of the incomputable data haunting their own precise sequencing. It could be argued that these forms of contemplation may appear as glitches internal to the operational functions of the system. In fact, the conceptual prehension that algorithms have of infinite quantities of data does not interrupt the digital operation but rather allows it to happen. In other words, whilst algorithms carry out the functions of processing, they are also conceptual prehensions of what lies at the limit of computation: an infinite amount of random (non-compressible) data. In this sense, algorithms are forms of contemplation, conceptual prehensions of incomputable information. It is important to point out again that such suspensions do not correspond to blockages but to the abstract passions of algorithmic thought, or the way in which ideas enter actual computational occasions. These forms of algorithmic contemplation imply the impossibility to reduce processing to mere axiomatic formulas. Even the most reductive of axioms cannot but enter a field of data infecting them with their alien, infinite logic, whilst deploying a sort of xenogenesis of information within the sequential order of rules.

This conception might easily seem relatable to Deleuze's notion of contemplation. In fact, rather than being connected to a vortex of qualities and bodily sensations populating the space between action and reaction (as in Deleuze's concept), soft thought also, and necessarily, involves a more abstract engagement with the mathematical reality of indeterminate quantities. For this reason, we prefer to push

the notion of contemplation towards Whitehead's emphasis on conceptual prehensions, so as to describe how algorithmic thought is infected with incomputable data, eternal objects which can be thought of as infinite series of indeterminate mathematical ideas or 'pure numerical potentials'. From this standpoint, we suggest that these indeterminate ideas are incomputable series of 0s and 1s which enter algorithmic sets to constitute a conceptual event: ideas are introduced in every actual construction of code through conceptual feelings, marking the aesthetic character of software thought. This means that the computational limit does not simply reveal the failure of quantifications, divisions, partitions in attending novelty. On the contrary, this failure is mainly a symptom of the real presence of random quantities, which cannot be reduced to what is always already axiomatized. This is why the philosophical question posed to the digital finds its true counterpart in aesthetics, or in the limit of the binary code as the point at which the infinity of data is revealed.

Bringing speculation into computer science, Omega, a discrete infinity of real numbers, as Gregory Chaitin defines it, explains how uncompressible quantities enter the sequential order of 0s and 1s at the limit of computation.²⁷ In the same way, in R&Sie(n)'s I've heard about it, the use of protocols of incertitude (i.e., protocols that include incompleteness and indetermination in their structure) and the re-scripting of source codes creates an aesthetics driven by the algorithmic prehensions of indeterminate quantities. Here, software becomes infected by algorithmic aesthetics, and the automated process establishes a relation with its limit, remaining abducted by the indeterminate quantities that it implies but cannot compress. If, on the one hand, the contemporary city is usually still formatted under Windows-cogito, foreclosing access to the programming of source codes, the use of open-source software scripts in I've heard about... invites incompleteness in the axiomatics of urban planning. This is why R&Sie(n)'s meta-model project is not a model of a city, but places indeterminate quantities of data at the core of the source code of the city itself.²⁸ To open the source code is to unlock cogito from functional cognition and to reveal an aesthetics of soft thought, whereby software operations are also, and significantly for us, conceptual prehensions of pure potentialities, eternal objects or infinite ideas passing through thousands of thinking entities. At the same time, the indeterminacy and incompleteness of the code is not principally given by the fact that R&Sie(n) use open software to design this urban structure. More important for us is that the protocols have been designed as incomplete forms of instructions that do not simply face physical variables and contingencies, but, above all, the more abstract architecture of an algorithmic infinity. In this sense, the source code is not just shared, but is open towards the very limits of computation, where data architectures have become hosts of an incomputable amount of junk data. Here the limit of computation is rather an opportunity for posing the existence of an automated thought thinking beyond its axiomatic form. The incomputable quantity of junk data indeed refers to data without pattern, chaotic and random, pressing against the sequential function of computation. In other words, openness is intrinsic to the calculation of ideas.

In the same way, for its interdisciplinary openness, the "Synchronous Objects" website could be described as an example of 'open source' choreography, a

creative resource to explore space, movement, and the movement-space composition through the constant interrelation between parallel fields and disciplines: the website itself appears, in other words, as a 'generative tool'.²⁹ The resonance of this definition with Forsythe's own choreographic technique, and particularly with the creative methodological and conceptual aims of the "Synchronous Objects" website, seems obvious: to use choreographic data and dance ideas as initial models to 'catalyze new creativity' and generate 'a myriad of other manifestations of structure'. At the same time, it is important to remember how it is the ingression of quantitative and yet indeterminate ideas such as counterpoint in the choreographic process of "Synchronous Objects for One flat thing, reproduced", that determines the aesthetics of soft thought. Being a pure indeterminate, such as Omega itself, counterpoint is certainly not determined by a preexisting level of precise human decision-making or automatic algorithmic functioning. It is only already realized form as a precise and particular alignment, that responds to these. On the other hand, it is certainly not a Platonic conception of inspiration, an intellectualization of practice, that we are suggesting here. To the contrary, what we are arguing is that it is the very capacity of software as first of all a prehension of abstract mathematical ideas to be not only ubiquitous but also able to articulate different spatio-temporal configurations in a bodily movement or a whole city.

5. A germ of conclusion: towards the capitalization of soft thought

We will now conclude this article by reiterating that the aesthetics of soft thought does not necessarily have to pass through the dysfunctionality of the glitch and its generative effects, or through the affective interaction between body and technology. It has been extensively argued, in many accounts of digital art, as well as in the architectural and choreographic envisioning of algorithmic relations, that the quantitative nature of digital code can indeed unleash signs of aliveness, but only thanks to the capacity of perception to transform a series of bits into a folding of qualities and sensations (the intensity of a dance, the textuality and habitability of a building). Contrary to this approach, the aim of this article has been to argue that, rather than having to follow the causality of sensorial and perceptual effects, complex algorithmic or quantitative ideas, such as the binary infinity of Omega implicit in every computational process, or the indeterminate rhythmicity of counterpoint present in every choreographic process, already imply an aesthetics of soft thought. These indeterminate mathematical ideas constitute in fact a level of conceptual feelings, or prehensions, through which algorithms open themselves to the openness and randomness of thought.

At this point, we would like to highlight here a possible germ for future thought, by stressing how soft thought does not simply point towards creative openness, but also involves a new aesthetics of power which capitalizes on the capacities of rules and variables to prehend new ideas. As recent debates on pre-emptive power have suggested, cognitive capitalism does not simply operate on the realm of possibilities, but forecloses the realm of potentialities to packaged possibilities, whilst capitalizing on thinking processes themselves.³⁰ As much as automated thoughts have the power to transform data into a meta-software (where all processing is possible), such as for with instance Lev Manovich's idea of media as

a subset of software,³¹ the ingression of indeterminate potentials in calculating procedures has turned pre-emptive power into a metamodel for the speculative programming of novelties. A power, in other words, exercised through the aesthetics of soft thought.

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1. Kim Cascone, "The Aesthetics of Failure. 'Post-Digital' Tendencies in Contemporary Computer Music," *Computer Music Journal* 24 (2002). As a further example of glitch art, see Tony Scott's website <http://www.beflix.com/> See also Toni Sampson, "Error-Contagion: Network Hypnosis and Collective Culpability," in *Error: Glitch, Noise and Jam in New Media Cultures*, ed. Mark Nunes (New York and London: Continuum, 2010) and Iman Moradi and Ant Scott, *Glitch: Designing Imperfection* (Brooklyn, New York: Mark Batty Publisher, 2009). (up)
2. See <http://www.softlabnyc.com/work/>; see also <http://www.field.io/project/> (up)
3. See Mark Hansen, *New Philosophy for New Media* (Cambridge, Massachussets: MIT, 2004) (up)
4. For an example of Chris Salter's interactive installations, see <http://www.chrissalter.com/projects.php/> (up)
5. For a definition of 'conceptual prehension', see Alfred N. Whitehead, *Process and Reality* (New York: The Free Press, 1985), 32-34. (up)
6. For a clear discussion of the computational view and extended functionalism

see Michael Wheeler, "Minds, Things, and Materiality," in *The Cognitive Life of Things: Recasting the Boundaries of the Mind*, ed. Colin Renfrew and Lambros Malafouris (Cambridge: McDonald Institute for Archaeological Research Publications, 2010), 7. (up)

7. It is important to specify that Valera and Thompson's work on embodied cognition is characterized by the concept of 'enaction'. From this standpoint, the feedback activity between the mind and the environment is the enactive motor of cognition. This notion will be explained later on in the text. (up)
8. For a definition of ideas as 'eternal objects', see Whitehead, *Process and Reality*. (up)
9. An exhaustive documentation of this project can be found at <http://b.durandin.free.fr/iveheardabout/chris.htm/> (up)
10. It may be interesting to note that Guattari's most used example of a-signifying semiotics are the virtual particles of contemporary theoretical physics. As these particles are theoretically formed and only discovered through mathematics, rather than empirical experimentation, and are not directly detectable, they can only be experienced through their effects. Guattari then insisted that if physical particles can be formed solely theoretically as in mathematics, then the relation between theory and practice, sign systems and physical entities needed to be rethought. This meant that nature was not prior to the sign. Physicists invent particles that do not exist in nature and thus nature cannot be ontologically prior to the machinic or diagrammatic process, which instead produces nature anew. Felix Guattari, *Molecular Revolutions: Psychiatry and Politics* (New York City: Puffin, 1984), 125. From this standpoint, the theoretical invention of physical particles is an example of a diagrammatic, metamodeling process. See also Janell Watson, "Schizoanalysis and Metamodeling," *The Fibreculture Journal*, (2008). URL <http://twelve.fibreculturejournal.org/> (last accessed August 2010). (up)
11. See Gary Genosko, ed., *The Guattari Reader* (Oxford: Blackwell, 1996) (up)
12. From this point of view, I've heard about it is symptomatic of another kind of thought architecture developed from the n(certainties) of formal systems, adding new contrasts, tensions and evaluations of form and matter, of planning and implementation. Automated procedures are symptoms of the ingression of new ideas that change what can be empirically experienced. (up)
13. According to Whitehead, "[i (up)
14. It is interesting to look at the documentation of the VIAB machine that can be found at <http://b.durandin.free.fr/iveheardabout/iha.htm/>. In particular, check the secretion machine driven by growth algorithms. See also <http://b.durandin.free.fr/iveheardabout/nano.htm/> and click here for images of biomolecular secretions. (last accessed June 8th 2011). (up)
15. As a pioneer in contour crafting, Khoshnevis is the director of the Center for Rapid Automated Fabrication Technologies at the University of Southern California. <http://www-bcf.usc.edu/~khoshnev/>; <http://craft.usc.edu/> (last accessed 8th of June 2011). (up)
16. Nigel Thrift, "Movement-space: The changing domain of thinking resulting from the development of new kinds of spatial awareness," *Economy and Society*

- 33 (2004): 582—604. [\(up\)](#)
17. Steven Shavero, “Interstitial Life: Subtractive Vitalism in Whitehead and Deleuze,” *Deleuze Studies*, 4 (2010): 107-119. [\(up\)](#)
18. See Whitehead, *Process and Reality*. [\(up\)](#)
19. Drawing on Francisco Varela, Evan Thompson, highlights that ‘sense-making is tantamount to cognition, in the minimal sense of viable sensorimotor conduct.’ Thus, cognition corresponds to the sense-making activity of living, which enables the conservation (or the autopoietic endurance) of the living by adaptation to the environment. See Evan Thompson, “Life and Mind: from autopoiesis to neurophenomenology. A tribute to Francisco Varela,” *Phenomenology and the Cognitive Sciences* 3 (2004): 381-398. [\(up\)](#)
20. See Francisco J. Varela, Evan Thompson and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge, MA: MIT Press, 1991), 9. [\(up\)](#)
21. Varela, Thompson and Rosch, *The Embodied Mind*, 13. [\(up\)](#)
22. This example is discussed by Wheeler. See Wheeler, “Minds, Things, and Materiality,” [\(up\)](#)
23. Wheeler, “Minds, Things, and Materiality,” [\(up\)](#)
24. Andy Clark and David J. Chalmers, “The extended mind,” *Analysis* 58 (1998): 7-19. [\(up\)](#)
25. Andy Clark, “Where Brain, Body and World Collide,” *Deleuze: Journal of the American Academy of Arts and Sciences* 127 (1998), 257-280. [\(up\)](#)
26. See Gilles Deleuze, *Cinema 2. The Time-Image* (New York and London: Continuum, 2005), 14-16. [\(up\)](#)
27. Gregory Chaitin, *MetaMaths. The Quest for Omega* (London: Atlantic Books, 2006), 130-157. [\(up\)](#)
28. Source code is primarily used as input to the process that produces an executable program (i.e., it is compiled or interpreted). It is also used as a method of communicating algorithms between people (e.g., code snippets in books). [\(up\)](#)
29. For a definition of the concept of ‘open source choreography’, see Scott DeLa Hunta, “Open Source Choreography?,” in *Code: The Language of Our Time*, ed. Gerfried Stocker and Christine Schopf (Ostfildern: Hatje Cantz Verlag, 2003), 304-310. More specifically, the Synchronous Objects website has also been defined as an example of ‘conceptual parametric technology’. See Beth Weinstein, “Performative Opportunities within the Parametric_” (paper presented at The SEAM2009 Symposium Spatial Phrases, Critical Path and the Centre for Contemporary Design Practices, University of Technology, Sydney, in association with University of Hertfordshire UK, September 7-20, 2009). [\(up\)](#)
30. See Brian Massumi, “Potential Politics and the Primacy of Preemption,” *Theory and Event* 10 (2007). [\(up\)](#)
31. See Lev Manovich, “Software Takes Command,” a Software Studies Initiative publication, last accessed August 2011, <http://lab.softwarestudies.com/2008/11/softbook.html/> [\(up\)](#)

