

Expression in interactive aesthetics: the case of physical computing

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Situated computing for embodied interaction

From a certain perspective, a tollgate, the latest robot at the Massachusetts Institute of Technology and a GPS mobile phone are not so different. They all integrate computation with physical processes. If the foundations of computing are built on the premise that the principal task of computers is the transformation of data, today a renewed attention to materiality unfolds alternative conceptual frameworks whose practical implications are productively engaged with vast and differentiated social and cultural realities. Neuro and cognitive sciences are showing an increasing awareness of the important interplay between perception, thought and action. Similarly, new models of HCI consider richer and more complex ecologies of people, physical artefacts and electronic systems, while robotics and AI expand their focus from thought to action, from search spaces to physical environments and from problem solving to long term activity.

With the extension of cognitive dynamics into the environment and the incremental game of perception and action into spatially and temporally extended processes, the consequences for the praxis and poetics of interactive aesthetics are manifold. In interaction design, for example, such situated and embodied perspectives not only provide an alternative framework for evaluation but also opportunities for design to take a deeper advantage of multisensory interfaces and multimedia. If today's technology can be perceived by some as intrusive and overbearing, an approach which emphasises the environmental physicality of computational action could then - along with, and thanks to, the massive increase of computing power and the consequent expanding context in which we can use it – enable fluent interaction with the minimum effort on the part of the user, bridging the gaps between cyberspace and the physical 'external' substrate of practice.

Under these conceptual premises and practical expectations though, one could argue that interaction is mainly reduced to a logic of 'integration' and 'separation' of both human agency and technological systems into wider environments through the patterns and processes of 'embodiment', whose strategies, in turn, become fundamental characterizations of the interaction itself. Materiality, in this sense, is interpreted as both the manipulation of digital information via physical objects and the use of physical environment as a medium for the exchange of digital information. Embodied interactive aesthetics is thus regarded as the process whereby the individual body is connected into larger networks of meaning at a multiplicity of scales. The computational materiality inscribed into the social and environmental complexity then respectively becomes, in my opinion, the necessary precondition to subjectivities, namely those situated agents able to activate behaviours in-between the information flows which recursively travel from the system through the 'actuator' and back to the system again. A robot, a human, an interface: they all shape ideas, concepts, thoughts and categories through their physical presence and in relation to their object-directed experiences. A situated agent as such is always in relation to a perceptive body, which make of the world an intentional representation and, most importantly, an operational perspective.

As much as the proliferation of embodied and post-desktop alternatives for interaction wants to avoid the trap of the mentalist foundation of computing by emphasizing the material dimension of information, such systems still arguably operate around a sort of kernel of subjectivity of very Cartesian memory. The conceptual implications of the subjective experience of having and using a body – the main point of argumentation – thus emerge as essentially phenomenological statements about the primacy of corporality as ontological access to the world.

The body of situated and embodied computing is, according to many aspects, a phenomenological one: primarily concerned with how it is perceived and acted, a ground for experience and a source of intentionality and consciousness. It relates diversities by means of articulation and connection in itself. By reducing lived agency to that of a subject, they re-introduce an integrated - or separated – 'dative' that flattens the ontological complexities emerging from the parts in interaction. For an innovative and fruitful unfolding of both the material and immaterial in computing we need - I propose - a non-reductive understanding of difference, multiplicity and subjectivities. We need a new set of conceptual tools for a reworking of how we think

about materiality, able to account for the micro and macro levels of variation of a body.

Expressive computation for abstract materiality

The definition of what a body is and – most importantly – of what it can do is, in my view, of pivotal importance for technologies aiming at the creative engagement between the physical world and the digital one. Historiographically and philosophically speaking, the problem of the relation between the material and the immaterial has been a favourite theme throughout the courses and recourses of speculative thought. In particular, here I consider a multifaceted philosophical tradition that has accepted the paradox that there is an incorporeal dimension of materiality as much as a physical characterization of thought. More specifically, I am referring to Bergson and his *élan vital* as movement of differentiation between the coexistence of all the degrees. Or Nietzsche's beings, composed of and by forces, so that every power is already connected with another one, differing between each other quantitatively. Again, I am thinking of William James, who announces a world where the 'material' is fabric of both matter and thought, what he calls 'pure experience'. Or of Leibniz's monadology, his infinite points and their complex identity of relation, and of Whitehead, in his declaring that processes, not substances, should be taken as the fundamental ontological constituent of reality. And finally I allude to Gilles Deleuze and Felix Guattari, their lifelong quest for an immanent plane of experience and life – absolute and real in itself, an internal condition for thought and action. Through Deleuze's analysis, above all, Spinoza's declaration of ignorance – where we speak of consciousness and will without knowing what a body can do¹ – it becomes a provocation which allows the philosopher to define the Spinozist parallelism between mind and body as the very model of his own ontology. The sameness of thinking and extended substance also grounds, consequently, the relation between ideas and their objects, so that a mode and the idea of that mode are one and the same thing, but 'expressed' in two ways. What is expressed does not occur outside of such a field of immanence, yet it is distinct from it, being the essence of what expresses itself. Expression, then, is neither representation, nor communication or content. Since what is expressed cannot be separated from the act by which it is expressed, expression is always of a relation, encompassing both the

¹ See Spinoza's *Ethics*, III, 2, Scholium.

way bodies come to be in existence and the way they are known in thought, thought itself being one mode of reality alongside all the others (Deleuze 1992).

In my opinion, such a theoretical framework and philosophical tradition can be productively engaged with interactive aesthetics, thereby freeing interactive practices from what we have earlier commented as the normative constraints of an 'intentional consciousness' or 'lived body' situated within the horizon of a phenomenological 'being-in-the-world'. Expression, thus, is an ontological tool, intrinsically operating against any dialectical rationale that instead produces 'difference' in its immediate opposites or relation through causation. More specifically, an expressive understanding of the relation between materiality and immateriality could help media studies to put the challenge of physical computing beyond a sterile dialectics of absence (disembodiment) and presence (embodiment). In this sense, practices of interaction do not take place on an egocentric field of human involvement and participation, that understands itself as the situated cause of its interpretations and acts. Rather, a theory of expression applied to physical computing relies upon an understanding of the materiality of computation as operating at many scales and degrees. Interaction itself, from this perspective, can be thought as complex agency between different levels of abstraction - a case of virtualization in its deepest acceptance, an ontological modality - rather than a technically generated set of events.

As yet, the diversified applications of physical computing have not yet been well investigated conceptually. Arguably in fact, physical computing is thought of mainly in terms of designing interactions for a user/agent confronted with a set of possibilities in between the human and the machine. Yet, I propose that according to a logic of expression, where things are thought in their being (for the act of thinking something is the same act that produces it), what is really at stake in physical computing is in fact the role of computation, of coding that exceeds discrete code and becomes heterogeneous and differential 'processing' between all the levels of its abstract notation and physical execution. Digital code is generally understood as the operation of information encrypted through a process of reduction to a binary division between two modalities, zeros and ones. But, if computers are structured on the model of human thinking – or at least, a certain representational model of it - what might happen when such thinking draws from a continuum of possibilities and intensities: namely what can the philosophy of expression believe a body to be?

Let us develop this question through an example - Maja Mataric's robotic architectures. In particular, here I consider her neurobiologically inspired models of how rats navigate their environments (Mataric 1991). The mobile robot progresses around a simple maze, detecting points of reference, which are registered as a combination of sensory inputs and current motion. As it moves through a narrow corridor, for instance, the robot stores spatial information as a mixture of forward motion and short lateral distance readings from sonar sensors. Whenever required to find its way back to a registered location, the machine retrieves the combination of sensory and motor readings by processing the stored map of the environment. The robot is immediately ready to act, since the motor inputs are part of the stored knowledge and the relation between two landmarks is directly encoded as the set of motor signals that moved the automaton from one to another.

Authors such as Andy Clark (1998) have cited Mataric's work as an example of epistemic agency and embodied interaction, as discussed previously. However, more than an action-oriented representation where information emerges as a statement about a subject in relation to its environment, of most interest here I see the opportunity for computation to be expressive actualization of an abstract, yet real, materiality. Computation has to be acted. Such an agency though, does not simply bridge physical navigation in material space with digital cognitive representation of it. Coding and the execution of the code are experienced in parallel – not via hierarchies of the abstract and the extended - but through a continuum of qualitative differentiation between levels of organization of the very same dynamic process. The computational processing has no existence outside its expression (the motion of the robot), yet it bears no resemblance to it. In other words, while the robot moves trying to solve the maze, we cannot distinguish between what is expressed (coding) and what it expresses (a bodily navigation). Agency, extension and thought operate on the same – experienceable – plane.

Of course, a theory of expressive physical computing does not want to dismiss the importance of thought relative to extension and action - on the contrary in fact. What it does devalue is thought understood within the horizon of bodily subjectivity. Most importantly, it endows interactive aesthetics of a proper ontological framework in which entities on differential scales and levels of reflexivity and complexity are all treated in the same manner, not as formal essences, but as real interconnected and overlapping assemblages.

Let us consider another example, the Tangible Media Group at MIT, where in a ubicomp spirit, Hiroshi Ishii and his colleagues create seamless interfaces at the nexus of bits and atoms and develop 'intelligent objects' whose aim is to abolish the boundary separating the physical from the digital. Among their many 'things that think', for instance, metaDESK physically embodies the devices - such as windows, icons and handles - which have been metaphorically popularized by GUIs. In particular, *phicons* (Physical Icons) are instruments which are used on the surface of the metaDESK and which are sensed by an array of optical, mechanical, and electromagnetic sensors embedded within the table (Ullmer and Ishii 1997). By giving a physical form to digital information and so enabling users to directly manipulate data, the insolvent place of the body is, according to this perspective, essentially resolved into the key question of how to turn computation into things. From a non-reductive point of view however, *phicons* can be seen as convertible modes of the same - to use a Deleuzian adjective - 'intensive' reality. 'Difference', in this sense, is not 'diversity' in a final equilibrium of material and immaterial parts. Rather, it is a self-differentiating process by which computation is not a representation of something, but spreads throughout the metaDESK as potential ways of being - of actual singularities. In a theory of expression things think not because we give a reasoning faculty to them by means of computing power. As we move them on the table, *phicons* think because their computational thought cannot be separated from their materiality; the physical medium in which it is instantiated and transduced. To paraphrase McLuhan's slogan, the 'medium is the message', yet this is not just because information is always transmitted within or between media but, above all and most importantly in my view, because computation operates at different degrees of abstraction, both as a mode of extension (the objects on the desk and their moving in the physical space) and as the idea of that mode (the processes of algorithmic encryption and execution).

To conclude, I believe that through an expressive theoretical framework, physical computing's preposition to include the body in computation and interaction can be investigated not only as a technological promise but also as an applied philosophy and social practice of interactive 'encounters'. When embodiment and computation are in a mutually dependant relation, meaning and content (namely the coding) are directly inseparable from agency, exceeding the strictly informational and digital context. Every computation processing, therefore, is the outcome of relations between elements in composition, bodies which think without losing any materiality for their thought is already a material - an abstract yet real - experience.

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