PHOTONIC COMMUNICATIONS PHILIPPE MOREL

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Photonics is the physical science of light (photon) generation, detection, and manipulation through emission, transmission, modulation, signal processing, switching, amplification, and detection/sensing. Though covering all light's technical applications over the whole spectrum, most photonic applications are in the range of visible and near-infrared light. The term photonics developed as an outgrowth of the first practical semiconductor light emitters invented in the early 1960s and optical fibres developed in the 1970s. [...] Photonics also relates to the emerging science of quantum information and quantum optics, in those cases where it employs photonic methods.¹

Let me, first of all, clarify the title of this short essay which, beyond the obvious reference to a still relatively new field of scientific and technical research, refers to John McHale's famous diagram (fig. 1) published by R. Buckminster Fuller in 'World Design Science Decade: 1' (1963). This diagram accompanies Buckminster Fuller's recurring remark that all the great advances since the First World War have occurred in non-visible and non-audible frequency domains.² Although the Wikipedia definition states that "most photonic applications are in the visible range [of the light spectrum] and near-infrared light," what counts today is even more than for Buckminster Fuller, invisible and/or inaudible to our unenhanced senses, be it the Internet, wireless communications (WiFi etc.), war electronics and electromagnetic jamming devices, DNA or quantum computers.³ We have entered the age of abstraction—in fact since the end of the nineteenth century—and beyond the few declarations of principle architecture has given it only minimal attention. The widespread use of scripting and the deployment of Parametricism (as a style and global ideology of contemporary architecture) have in fact led us to grasp some of the abstraction of our new reality but they do not make it possible to cover all manifestations of 'the invisible which governs the world' or, to use Buckminster Fuller's words, the invisible which governs (human) *technical affairs*.

1 <https://en.wikipedia.org/wiki/Photonics>. Last accessed on October 15, 2018.

2 "All major advances since World War I have been in the infra and the ultra-sensitive frequencies of the electromagnetic spectrum. All the important technical affairs of humanity today are invisible." From R. Buckminster Fuller, *Design in a Dynamic Technology*, Lecture held on 7–9 November 1967 at the State University of New York.

3 We can indeed say that "everything is invisible" in the sense that it is not the light as such that matters, and therefore its visibility in the phenomenological sense, related to the fact that only certain wavelengths are visible by humans, but light as a *vector of information*—a light incidentally taken here as a paradigm because we could as well choose non-audible sound waves, etc. But nobody "sees" the information in the strict sense, it can only be measured indirectly with the help of specific devices. It is therefore in this informational sense that we must understand here the general hypothesis of communication as invisibility and phenomenological transparency which, we will discuss further, will lead to a project of "semantic transparency" which aims, in fact, within the very "communicative transparency", to "find the visible" or at least the comprehensible.

Being itself a logical-mathematical and symbolic approach to design operations that goes far beyond the narrow confines of architecture, scripting represented a first step towards a concrete apprehension of the *algorithmic* nature of the world, therefore, in fact, of its *effective and calculable* part. Beyond a purely utilitarian use of algorithms that concerns us little here, the artists, architects, engineers, designers and various theorists have, through their multiple algorithmic approaches to design, most often returned, in a traditional manner, to the terms mentioned in the presentation of this book by Selena Savić, Michael Doyle and Vera Bühlmann, namely: *code, protocol, channels, data and information*. What has hitherto been called ‘scripting’ in architectural design corresponds to the interweaving of algorithms which are, by definition, deterministic, and whose strange results are in fact only the consequence of *our* sensory and computational limitations, which beyond a certain degree of complexity prevent *us* from predicting or foreseeing. When we succeed in predicting the result, for example when we use topological optimization algorithms for form, we foresee a *global result*, in part only and not in all the details, based on our knowledge (for example in the geometry of structures) and our acquired experience (for example having already been confronted with many topological optimization results with similar input parameters). The relative strangeness of the results is thus accompanied by a relative predictability of these same results, and the couple formed by these two elements (strangeness/predictability) exists against a phenomenological background; this without the knowledge that allows us to predict being limited to a phenomenological knowledge: An abstract and highly mathematized knowledge of the mechanics of structures is, for example, quite possible. So that which escapes our *unenanced* senses or our natural calculation abilities is strange, to the extent that an *enhanced* human being would find the results provided by most current architectural design approaches perfectly predictable and ‘traditional’. Examples of this situation are provided to us very regularly. All that is required is to look at the reactions of a novice faced with the formalism of contemporary architecture, a formalism which seems *to him* to be *extraordinarily strange*, and to compare these reactions with those of blasé designers to the morphologies referred to by his algorithms. Without dealing here with the romanticism that one could possibly associate with the search for the strange or the bizarre—an association which some do make and which leads them to honour again, but above all at little cost and with even less effort, a neo-rationalist formalism—to overcome the relative lack of strangeness that can be said to be intrinsic to the deterministic and calculable nature of classical algorithmics, many architects and designers have resorted to ‘less deterministic’ models that introduce

randomness (real or not) into the actual calculation steps (for example evolutionary algorithms), or leave room for the emergence of an ‘intelligence’ resulting from the collaboration of a multitude of individuals who initially lack it (e.g. Particle Swarm Optimization), or both. In the first two cases, we are facing both sides of the same coin—and with the third case we are facing the three faces of the same die ... On the one hand, it is a question of ‘*extending the domain of the algorithmic*’ to natural phenomena that are difficult to compute (even with computing capacities far greater than those present) or simply impossible to compute (for example if they involve purely random physical phenomena), to bring them into the domain of the simulable: It is a usual phase of formalisation-mathematisation of nature. On the other hand, it is a question of naturalizing the algorithmic by showing that it is ultimately not so far removed from that which occurs spontaneously in nature. All with the following objectives: 1) to give the strangeness of nature and astonishment that it does not cease to produce the possibility of a sufficiently faithful replication in the artificial world, 2) to allow access from the algorithmic to complexity and vice versa, and 3) to also provide this algorithmic with a complementary *jus naturalis* dimension that removes it from the recurrent reproach of artificiality. In the first two cases (the third one is bordering on morality, it is not dealt with here) the results are *phenomenologically both emergent and predictable*. They are emergent because of the complexity of the phenomena dealt with and/or because of the introduction of randomness, which is real or not⁴, and largely predictable when implementing knowledge which has been long understood, whose applications have been apprehended many times, and which, in any case, are implemented in a probabilistic framework that reduces the unpredictability of isolated elements to a relative overall predictability.

PARAMETRICISM

In terms of Parametricism, things are not fundamentally different. Technically, it makes use of what we have just mentioned and all the algorithms available. If, considering agents as social actors, it pushes the semiotisation of forms further than naturalistic approaches do, it is even limited by this to a coarser granularity, superior in several orders

- 4 Strictly speaking, randomness does not exist in a computer, it is only approached thanks to various algorithms of generations of (pseudo) random numbers. As for the emergence, which remains limited to the domain of deterministic chaos, it results above all from the extraordinary capacity of computers to calculate consequences on billions of billions of steps of computation (and time) of slightly changing initial conditions. If on a conceptual level the millions of possible pseudo-hazards do not form a pure randomness, on the phenomenological level they can reasonably be considered as an introduction of pure randomness.

of magnitude to those one can find in ‘naturalistic’ approaches referring to the different scales of natural phenomena (an ant, the microstructure of a bone, the mesh of a crystalline element, a molecule, an atom, etc.), and also superior in several orders of magnitude to pure approaches for which the algorithmic granularity potentially reaches each step of a computation. From the phenomenological and communicative point of view that it calls for itself, Parametricism aims at what I would call a ‘*homogenization of complexity*’. With it, complexity is not reduced to the mathematical universality of calculation *then* made visible in its ‘raw’ form (for example by the discretism of voxelization), nor is it limited to the structural or even ‘structuralist’ approach to naturalism. In fact, Parametricism brings all phenomena back to their informational and communicative nature, phenomena for which it seeks a *unique and unitary* form of expression. Nature is perceived as what it is, namely intrinsically multi-scale, but *in fine* it is always applied and ‘*smoothed*’ on the *scale of human phenomena*, thus making Parametricism an *expressionist humanism*, also assumed by its creator.⁵ Yet it is precisely this withdrawal of all forms of information and communication to a single *expressive* and even overtly *expressionist* communication which prevents it from expressing the non-expressive part of communication, an openly *post-human, massive, invisible* part, largely made possible by advances in photonics. In fact, this communication—more precisely this *communication of information*—is as invisible to our non-enhanced senses as are photons carrying information compared to the light we perceive naturally. The only *human communication* simply does not describe *communication*, the first is only an ever-smaller part of the second and even the mere *effect* of the second.

NOISE BEYOND COMPUTABILITY

Whether the algorithmic design is accompanied by a parametric or non-parametric ‘overlay’ aiming at filling the semantic/humanistic void of a Shannon approach to information/communication, its reductionist penchant remains present in nearly all practices. If the latter try to grasp the *totality* of the ‘*architectonics of communication*’, they actually only capture part of it: The communications of which we know the context and for which we are capable of establishing a distribution law. By promoting certain forms of strangeness produced by various algorithmic practices, designers favour the *uncertain*, obviously containing more information than the known and/or predictable. *These designers*

5 We refer readers to the various conferences by Patrick Schumacher as well as the main works *The Autopoiesis of Architecture, Volume I: A Conceptual Framework for Architecture* (Chichester: John Wiley & Sons, 2011) and *The Autopoiesis of Architecture, Volume II: A New Agenda for Architecture* (Chichester: John Wiley & Sons, 2012).

assume that the quantity of information—therefore the amount of thought—communicated is directly proportional to the degree of strangeness reached.⁶ Nevertheless, this approach has its limits: 1) By producing information massively and at the same time (valid in isolation), we give rise to a background noise that no human can interpret as a *carrier of information*. This is the problem of the strangeness of so-called ‘subversive’ art in a globalized world as much as Parametricism is used as ‘protest formalism.’⁷ The multiple subversions are indeed only *big data* for which the original meaning has long disappeared ... 2) By favouring the uncertain in the sense of ‘a little strange’ but not ‘radical strangeness’, the contemporary designers limit, for understandable reasons, their approaches to that which can be measured and computed, and thus to a form of *mathematical and semantic stability*. At an instant *t* of the progress of an algorithm (thus of a step-by-step calculation) or of a computer simulation, an element *E* represents, however, a Boolean variable, an agent, a beam, an abstract node of a graph or a physical assembly node of a structure, but at time *t*+1, this element *E* represents either *the same thing* (the most common case) or *another thing but of which we can predict the appearance*. Nobody imagines doing a simulation in which a variable would pass *perfectly unpredictably* from a numerical quantity to a human agent, or a beam, a doorknob, a shower curtain or whatever ... We could no longer really talk about ‘variables’ as the latter, not being definable, would simply not exist. The ‘variable’ would actually only be a simple random parameter ... *Radical strangeness* does not exist in a computer simulation for the simple reason that it only leads to the absurd. But in nature, for example with certain quantum phenomena, we encounter intrinsically random phenomena whose knowledge at an instant *t* tells us nothing of what it was at *t*-1, nor of what it will be at *t*+1. For all that, we are not only reluctant to qualify these phenomena as absurd, but we even try to understand them in order to deduce a meaning. In fact, a causality of the type ‘if we have this at instant *t* it is because it occurred as a consequence of

6 This relationship between strangeness and information is reminiscent of the strategy theorized by Berthold Brecht under the term *Verfremdungseffekt* (“effect of strangeness”) which aims, in his plays, to create a necessary distance at the critical reception between the work and the viewer. Nevertheless, although Brecht’s modern theatre with its “*explanatory and interrogative realism*” was situated in a pre-information society, today we are evolving within an information society for which explanations no longer really exist ... To convince oneself of this, we need only look at the stream of unanalysed data that is created every second, or the effectiveness of artificial intelligence based on Deep Learning and for which there are no mathematical explanations or, at least, they come *after* the algorithmic deployment. Faced with the acceleration of the electronic media society, Marshall McLuhan said that “*if it works it’s old-fashioned*,” we could say 50 years later that “*if we understand how—and why—it works, it’s old-fashioned*.” On B. Brecht, cf. *Notes on Mahagonny, Writings on the Theatre*, 1930.

7 It is important to note that Patrik Schumacher avoids this pitfall and even this *contradiction* by claiming the “mainstream” dimension which must be that of parametricism.

t-1 according to a certain probability'. In doing so, we could quantify the phenomenon, transform it into positive knowledge and thus *exploit* it. In the words of David Hilbert and the famous epitaph of Göttingen, 'there is no ignorabimus', 'we must know, and we will know' (*Wir müssen wissen, Wir werden wissen*). This general desire to render computable what is non-computable or to quantify a mere manifestation to make it real information⁸ illustrates in fact the positivism intrinsic⁹ to all forms of contemporary design, including those that call at random for emergence, etc. In fact, each time it is necessary to find the causal links that will allow (all) the phenomena to enter a (large) '*architectonic of communication*' within which everything is reduced to a series of effective procedures (algorithmics).

This dream or at least this *project* is a sort of hunt for the '*phantom of transparency*' as expressed in the eponymous title of the book by Jean-Yves Girard¹⁰ as in this publication. For J.-Y. Girard this 'hunt', under cover of objectivism and 'verismo' is only an ideology that he calls 'transparentism'. The latter "[...] is based on three subliminal slogans: We can answer everything, we can compare everything, we can predict everything."¹¹ But "the experience of knowledge teaches us that there is no Final Reality, that every train hides another. Evidence that it is not easy to accept, hence the idea of this ultimate train, the one that would hide nothing. Transparentism postulates the existence, beyond the immediate perception, of a world, a level of reading, completely intelligible, that is, explicit and immediate. Hence this belief in so-called 'X-rays of knowledge' that would unveil the other side of the universe." To understand, to master and in particular to instrumentalize at all times what we 'do not see'—in the phenomenological sense but also in the abstract sense—to 'make ourselves master and possessors of nature', no longer, as Francis Bacon invited us, to old hydraulic machines, or steam, etc., but thanks to the algorithms, it remains the only current large-scale project, whatever the approach: openly positivist, naturalist-biomimetic, symbiotic, etc. The world has become transparentist simply because of the massive use of algorithms, AI or big data, which no longer have meanings, strictly speaking, but only *correlations* that force (and forge) meanings. At the very moment

8 Knowing that such a life jacket is red would be of no use if we were not sure that five seconds later—just as certainly five seconds earlier—it will still be red, unless its colour is erased by sea water, etc. The stability of phenomena is simply what allows us to operate in the world.

9 About 12 years ago I called this positivism intrinsic to *all knowledge*, including that denouncing positivism, '*embedded positivism*'. Here I would therefore like to refer the reader to the original essay, *Embedded Positivism (or Everything is Theoretical)*, Haecceity Papers, Vol. 1 / issue 1 — "The End of Theory?", Fall 2005.

¹⁰ Jean-Yves Girard, *Le Fantôme de la transparence*, (Paris: Éditions Allia, 2016).

¹¹ *Ibid.*, 49.

when paradoxically—but apparently only—individuals constantly denounce ambient opacity (financial arrangements, the stock market, algorithms, deep learning, etc.)... Indeed, to produce *mechanically*—i.e. *algorithmically*—from opacity, it was previously necessary to know and master a certain number of ‘laws of nature’ to concretely launch into the pursuit of the ‘ghosts of transparency’. Asking society for more transparency is a paradox that is not really a paradox, since this same society is far more transparentist than the most radical dream of transparency ideologues ... It does not need a global project, a politician or theorist but only the accumulation of tens or hundreds of millions of individual scientific research, multiplied today by the phenomenal computing power as by the “unreasonable efficiency of artificial intelligence.”¹² There is no longer any need for the moral imperative of D. Hilbert (‘we must know’) to affirm that ‘we will know’. And even if we never know it, it will have no consequence on the nature of a society which will behave on every occasion *as if* it knew or as if it were going to know. If for almost all individuals of the pre-computational era the world was opaque as it was mostly unknown, for most inhabitants of the computational era the world is opaque because it is mainly *known*. At the same time, it is transparent *and* opaque: conceptually transparent and phenomenologically opaque, the exact opposite of what has always been until us.¹³

What can this imply from the design point of view? *Indirectly*, being aware of the double transparent/opaque nature of our future environments¹⁴ will distance us as much from the ‘desire for meaning’—the

12 I refer here, evidently, to the essay by physicist Eugene Wigner (‘The Unreasonable Effectiveness of Mathematics in the Natural Sciences. Richard Courant Lecture in Mathematical Sciences Delivered at New York University, May 11, 1959’, *Communications on Pure and Applied Mathematics*, 13.1 (1960), 1–14), which observes that the structural descriptions of mathematics apply to a number of physical phenomena that lie outside the framework for which these descriptions had been established, “*beyond any reasonable explanation*.” It seems to me that we can say the same about artificial intelligence especially when, unlike the mathematics mentioned by Wigner, we do not even fully understand “why it works.”

13 The primitives see the “same” stars as us but do not see the same concept ... They do not see the same stars.

14 Without doubt these environments will be (they are already) those of multiple “logical (re)constructions of the world,” environments produced by computer simulations which testify to the entry into the expansionist phase of the “science of computation”—that of the pancomputationalism—which follows its reductionist phase—from the origins to Turing and, on the philosophical plane to the logical positivism including that of Rudolf Carnap. Of all the scientists and thinkers who have directly taken part in the work that led to IT and computers as we know them today, it is Charles Babbage who has best understood the exceptional power that the “Science of calculation” would deliver in the future, in all fields of knowledge, theoretically and practically, and without exception. He understood, better than anyone, that the reductionism that would culminate in the *universal* Turing Machine could only logically be accompanied by an expansionist phase linked to the widespread and universal application of calculation *over the whole of the existing world*.

semantic, holistic, and transparentist research of Parametricism—as from the anti-scientific rejection of transparentism—this time because of scientism¹⁵. *Directly*, this consciousness invites us to introduce into the design an extended vision of information, not only as probable knowledge (by analogy with Shannon’s information theory) but also as ‘non-knowledge’, as an irreducibility of real complexity (by analogy with the algorithmic theory of information). Then conceptual and formal horizons open up that go beyond most ‘traditional’ problems such as optimizations, whether or not they are bio-inspired or topological, now too little to express the nature of the world present or to enrich it.

15 J.-Y. Girard’s critique of transparentism is based on the fact that this transparentism is intrinsically scientistic. It is therefore in no way an anti-scientific or anti-rationalist critique. Nevertheless, and unfortunately, it must be recognized that in most cases the critiques of scientism are in reality antirationalist critiques of science, and therefore scientistic critiques themselves.