

# *INSTRUMENTS THAT ARE MORE THAN INSTRUMENTS (AND OTHER STORIES)*

## INSTRUMENTOS QUE SON MÁS QUE INSTRUMENTOS (Y OTRAS HISTORIAS)

**Marinos Koutsomichalis\***

Correo electrónico: [m.koutsomichalis@cut.ac.cy](mailto:m.koutsomichalis@cut.ac.cy)  
Website: <https://marinoskoutsomichalis.com/>

\* Media Arts & Design Research Lab,  
Cyprus University of Technology

**RESUMEN:**

Este tratado, en parte etnográfico, en parte investigación explicativa y en parte ejercicio de escritura académica atípica, se enfoca en instrumentos musicales/multimedia (y en paradigmas de los mismos) que celebran un replanteamiento más o menos radical de la condición de ser instrumento. 'Relatos' de este tipo son narrados para demostrar la amplitud de la gran cantidad de diferentes (fascinantes) maneras en las cuales los instrumentos pueden ser mucho más de lo que la mirada dominante hylonoética sugiere. Los instrumentos se discuten en amplias secciones temáticas, elevando preocupaciones comunes y esbozando líneas de investigación relacionadas. El autor se refiere a una emergente oposición entre las perspectivas hylonoética y morfogénica, y examina asuntos de post o hiper optimización en la realización de DIY (contando un último 'relato'). Este tratado concluye con bosquejos para un trabajo futuro — para exploraciones creativas y juguetonas e instrumentos posibles (que están destinados a ser 'más que instrumentos').

**Palabras claves:** instrumentos radicales, nuevas interfaces para la expresión musical, instrumentos críticos, instrumentos especulativos, instrumentos reduccionistas.

**ABSTRACT:**

Partly auto-ethnography, partly explanatory research, and partly an exercise in nontypical academic writing, this treatise focuses on music/multimedia instruments (and paradigms thereof) that celebrate a more or less radical rethinking of instrumenthood. 'Stories' of a sort are recounted to demonstrate the breadth of the many different (fascinating) ways in which instruments can be indeed much more than what the dominant hylonoetic view suggest. Instruments are discussed in broad thematic sections, raising common concerns, and outlining related research veins. The author discusses briefly a surfacing opposition between hylonoetic and morphogenic perspectives and examines affairs of post or 'hyper' optimality in DIY (recounting one last 'story'). This treatise concludes with sketches for future work — for playful creative explorations and prospective instruments that are intended to be 'more than instruments'.

**Keywords:** radical instruments, new interfaces for musical expression, critical instruments, speculative instruments, reductionist instruments.

## Introduction

The dominant view of instruments implies clear-cut dichotomies between composers, instruments, performers, and listeners. Compositions more or less assume the existence of the instruments to perform; performers execute compositions—very often extra-contextual—with respect to what the particular instruments involved are capable of; audiences are largely passive receptors of what performers with instruments deliver; and it is perfectly valid to talk about the very same piece of music/art regardless of the specifics of its manifestation, even when it is performed by others, with different instrumentation, for another audience, in another place, and in some different (live or reproduction) context. This treatise focuses on experimental (DIY) instruments and making paradigms that somehow challenge this dominant view, celebrating instead a more or less radical rethinking of instrumenthood. The author draws—from his own practice, as well as from the recent state of the art in DMI (Digital Music Instruments), NIME (New Interfaces for Musical Expression), HCI (Human Computer Interfaces), and media arts—to recount brief (and often informal or fragmentary) ‘stories’ of a sort; that is, tales of ‘instruments that are more than instruments’ in some fascinating way. In doing so, it is shown that multimedia instruments often do afford very broad and complicated hybrid agencies, so the necessity for expanded and holistic frames of thought to properly contextualise and to programmatically scrutinise them becomes explicit. That said, this paper should not be thought of as an attempt to formulate such framings. The focus here is to merely present several examples and to selectively examine how they draw from, or otherwise relate with, particular traits in design, techno-scientific research, culture-making, and creative arts.

Instruments that are more than instruments appear throughout the entire history of electronic music and media arts, so that we can certainly talk of a continuous tradition. This treatise is not concerned with historical examples, nevertheless, but rather pinpoints contemporary approaches to radical instrument making, that is, primarily as of the last decade. Note that this last phrase should be read as both ‘radical-instrument making’, and ‘radical instrument-making’. Those approaches are too varying to be properly dealt with in this paper. However, there are a few persistent veins that are relevant to many: DIY culture and its numerous direct and indirect offshoots; HCI research, physical computing, and subareas in experimental computer interfaces; the broad tradition of extended instrumental techniques; practice-led research in creative arts; critical and speculative design. Related empirical and theoretical contributions help to formulate what said above. DIY/maker cultures have been shown to draw inspiration from rather contradicting veins, such as punk, formal educational institutions, the European alternative ‘squat’ culture of self-organisation and political activism, the American spirit of entrepreneurship, or ‘commoning’ and peer production (Kera, 2011; Kuznetsov, 2010; Kostakis, 2015; Wilczynski, 2016). Thence, they may intensify very different, even antagonistic, ideals and perspectives. Gaver (2003) promotes alternative orientations that do not fear to be ‘ambiguous’ or ‘ludic’, suggesting a plausible way out of the clear-cut functional design norms that are often encountered in HCI contexts.

In a similar vein, Bjögvinsson et al. (2012) offer a replacement to the typical analysis-design-construction-implementation schema that governs traditional design. They propose a variable and performative staging of socio-material elements that are brought together in some context to enable different kinds of making. Dunne (2008) elaborates on the potential of electronic objects to articulate critique and defends their right to non-functionality and post-optimality. With Raby, they set out speculative design practices as the means to imagine and to try more or less possible, utopian, and not necessarily market-driven futures (Dunne and Raby, 2013). Maybe most importantly, instrument makers themselves have come up with own ways to describe and to situate their practice, *e.g.*, 'speculative sound circuits' (Richards, 2018); 'literal critical' DIY electronics (Jordan, 2015); 'rough-hewn hertzian instruments' (Koutsomichalis, 2020); 'absurd making' (Lepri et al., 2020); and others, some of which will be discussed in subsequent sections.

This treatise is unorthodox in method, scope, and structure and, to some extent, it is also meant as an exercise in nontypical academic writing. It does not address the question of radical instrumenthood in an integrated analytical fashion, nor is it meant as a critical inquiry or a position paper. Unlike what is accustomed in academia, there is no well-defined set of research sub-questions or goals to be put under scrutiny herein. Instead, a range of related endeavours, concerns, interests, and theories are brought together in a fashion that is partly auto-ethnographic and partly reminiscent of rather fragmentary explanatory research. In doing so, it offers detailed accounts of instruments made by the author and other fellow practitioners, outlines related affairs, provides important clues on where further information on the latter can be found, and delineates topical directions for future research insofar as experimental and radical multimedia instruments are concerned. Emphasis is put exactly on those accounts (that is, on stories of instruments that are more than instruments) rather than on a critical or analytical scrutiny thereof, so that the former constitutes the greatest part of this treatise.

This unorthodox approach reflects on the structure. There is no background section reviewing the state of the art following this introduction. Instead, several thematic sections with stories of different kinds of instruments are told. Some are presented briefly, while others are scrutinised in greater detail and with respect to related concerns. Two distinct discussion sections come next, selectively raising theoretical implications concerning an hylonoetic versus morphogenic opposition, and the question of 'hyper' optimality in DIY instrument making. There is no conclusion section. Rushing to conjecture a conclusion makes little sense to the author given the current state of affairs and the breadth of different approaches that characterise this fascinating area of research. The most meaningful concluding remark can be laid out succinctly: there is an urgency for new frames of thought that would both enable and fuel a systematic analysis of radical multimedia instruments (and making paradigms thereof) in all their eclecticism and disparity. Instead of a conclusion, there is a section on future research where the author announces own ideas for playful creative explorations and prospective instruments to make. As is typically the case with ideas

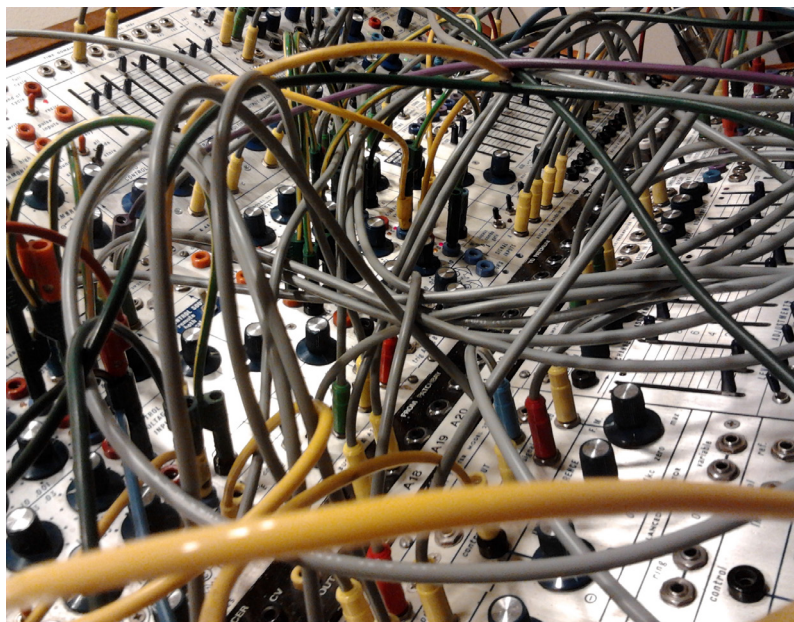
of a sort, most of these plans will not be accomplished. Regardless, they can function as both the means and the motivation for further ideation, theoretical inquiry, hands-on empirical research, and provide important clues on the inner working of a real-world research agenda pivoting on radical instruments. In this sense, future work sketches are expected to prove much more useful than a rushed concluding conjecture.

## Instruments that are (records of) their own (un-)making

To some extent all things are, of course, records of their own making. There are cases, notwithstanding, where an instrument's primary function is to foreground the very process of its making and to somehow intensify aesthetic, conceptual, or material traits related to it. This is certainly not the case with violins, guitars, pianos, samplers, or drum machines. It is to some significant extent the case, however, with modular synthesizers. Practitioners typically assemble their own systems bringing selected (commercial or DIY) modules together in a case to later 'patch' them in unique fashions—that is, to produce new original instruments on occasion, since each patch is nothing other than a new circuit configuration and since there are virtually endless options to interconnect an arbitrary number of modules. The following abstract from a practitioner's MA thesis describes plainly, but also very succinctly, how performance, composition and the making of a patch naturally converge in this context:

*The modules interact and behave like a complex organism. I interact with the 'organism' to make different sounds and through the sounds, the 'organism', in a way, communicates back to me. [...] Through our interaction we converse and my performance with the modular synthesiser is a display of a conversation between myself and the 'organism' I configured.*  
(Davidsen, 2018, p. 15)

It is sometimes the case that practitioners actively and dynamically reconnect the modules during their performances, so that we can speak of performing the very making of an instrument on the fly. The author has extensively explored this technique in a few different contexts and with all sorts of modular synthesis systems. In the context of 'The Buchla Project' and '*Marinos Koutsomichalis é stato eliminato*' endeavours (both executed in Stockholm in 2012) he aimed at the unconditional interrogation of a modular system (a Buchla and a Serge, respectively) and to somehow foreground the contingent material properties of their circuitry. All recording sessions have been rather fleeting, dynamic, and alternating for him to try out comprehensive patching configurations in an ever-going, continuous, and improvised manner. On this construal, it is nonsensical to differentiate between composing, patching, and performing; all of them naturally entwine in a unified interaction with the available hardware.



**Figure 1. Snapshot from a dynamic improvised patching session with a Buchla modular system. Image by the author.**

Both projects have resolved into an extended archive of selected audio fragments that exemplify possible states of the studied system, so that dynamic patching becomes sort of a probe to explore what the available circuitry may afford. The author follows a very different approach in ‘Metaichmiakó (for solo EMS Synthesi100)’, made for Documenta 14 in Athens in 2017. Over a period of several weeks, and very much relying on dynamic patching, he painstakingly composed an improvised piece of music to be performed live. The performance follows a loose trajectory from a particular patch to several contingent transfigurations of it, then an eventual target configuration — all in the course of a continuous live patching and knob-twiddling activity — and also using the key clavier and the built-in sequencer. During the performance, and following the graphical score shown in Figure 2, the author dynamically reconnects the available modules in various fashions and employing the two matrices, a few different kinds of patching pins, and DIY patching cables that enable links from one matrix to the other. The different shapes, colours, and arrows on the score indicate how to proceed from the initial configuration to the target one in a rather liberal manner that also leaves space for live experimentation.

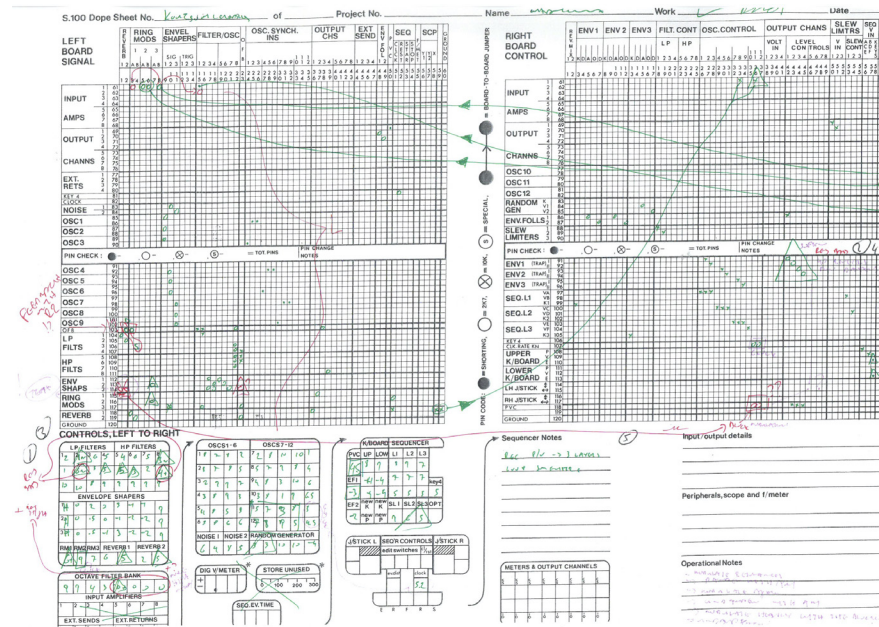
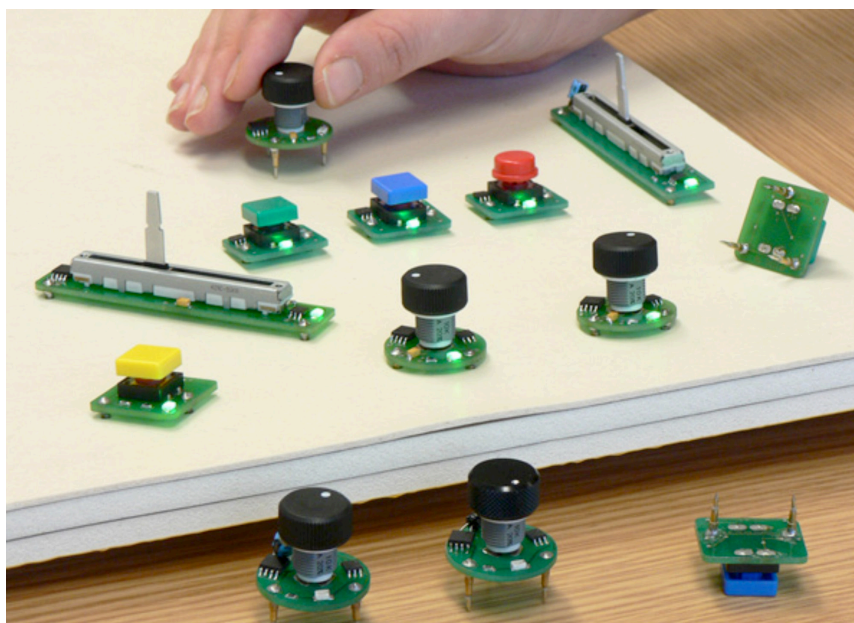


Figure 2. Score for Metaichmiakó (for solo EMS Synthesizer 100). Image by the author.

Modular synthesizers aside, there are several other instances of instruments made to perform their very own making or produced while performing with them. In '20 oscillators in 20 minutes' Hewitt (2015) attempts to build a series of square wave oscillators in a certain time duration and in front of a live audience. The eventual piece of music only comprises the sounds of the very production of the former (or from the maker as they engage in this process) so that a music performance becomes a tactic instrument making itself. In another instance, that of 'Parfileuse', the historical practice of removing precious metal threads from clothes and vests (to recycle or steal) is reinterpreted with e-textiles that are connected to audio circuits only to be taken apart during a performance and after many hours of labour (Lepri et al., 2020). Here too, instrumenthood lies not at all in what the instrument does but, rather, on the theatrical, conceptual, symbolical, and acoustic footprint of how to make and unmake it. Bowers and Villar (2006) attempt to systematise such approaches under the term 'ad hoc instruments', that is, instruments that are made and played at the same time. The authors trace this concept in musical praxis associated with extended instrumental techniques and, most importantly, they explore this idea in a research-through-design fashion and with their own empirical exercises. Their approach involves a flexible laminated substrate material that can be cut in arbitrary shapes and sizes also acting as an interface to a computer running audio-generating software. Hardware controllers, such as sliders, knobs, potentiometers, and others can be then pinned on the fly and without interrupting the software operation, thus producing a unique new instrument in each different performance.



**Figure 3. An instrument produced while interacting with it. Image from (Bowers & Vilar, 2006).**

While the above-mentioned cases draw upon the performative/interactive affordances of instrument-making, there are also other ways in which an instrument can be all about its own construction. ‘Substrate’ by Howse and Kuentz is a live music performance pivoting on a bricolage of salvaged electronic equipment, scattered components, and miscellaneous digital technology oddments (Jordan, 2015). While the artists describe their work as a ‘tabletop micro-material-theatre’, it could be as well thought of in terms of a messy hybrid instrument that is distributed across different kinds of raw materials and foregrounding its very own ‘messiness’. Indeed, the artists have very limited (if any) control on the output sound that is rather epiphenomenal; the comprising materials can be as well said to compose themselves. Patel & Richards (2020) detail several approaches in which making, studio recording, and live electronics converge to an ongoing hybrid activity, so that the resulting instruments acquire aesthetic and compositional value in exposing their own material and cultural integrals. In such a vein, ‘hardware mash-ups’ concern the combination of circuit parts from different instruments to produce new electronic devices that also explore how different music cultures may combine, while ‘reverse design’ concerns a trajectory that goes from product to prototype (rather than the opposite); *e.g.*, they have deconstructed and reconstructed a commercial market-oriented synth using nails, wood, and DIY assembling instead of a printed circuit board and standard user interface (UI) elements. They understand such approaches as ascribing to a ‘DIY Nomad’ ethos, concerning workshoping on the move and with the “*creative licence to use limited skills to define the scope of their work*”. On this construal, technical inaccuracies and an overall poor workmanship are celebrated as essential aspects of one’s work that, nevertheless, enable them to create unique instruments with own quirks.

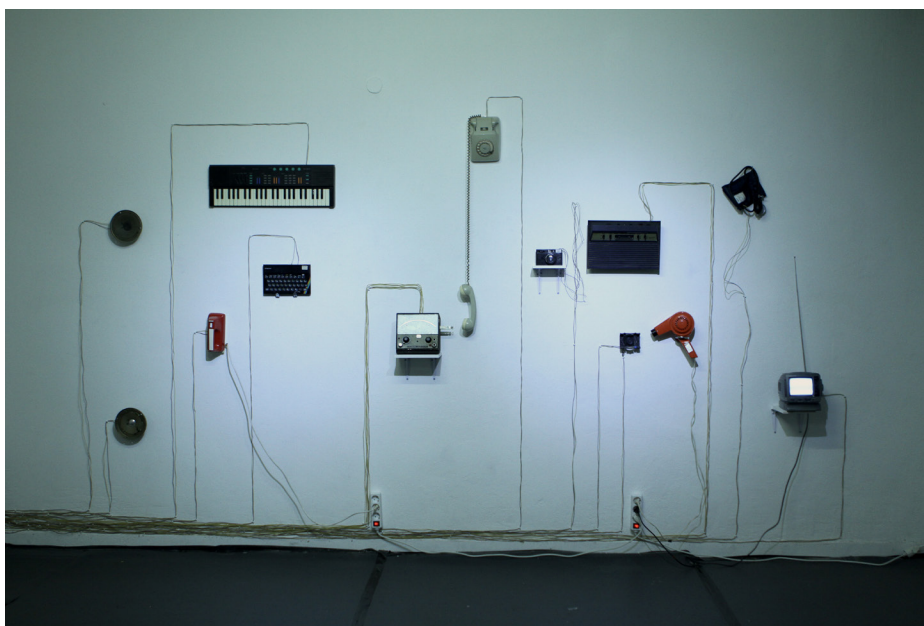


## Instruments that are (records of) their own co-making

Co-making and co-design with respect to multimedia instruments are discussed in different contexts, such as the DIY Nomad mentioned above, ‘dirty electronics’ (Richards, 2013), ‘magic machines’ (Andersen & Wakkary, 2019), ‘serious silly designs’ (Blythe et al., 2016), ‘ad-hoc aesthetics’ (Koutsomichalis, 2018), and others. Much in the same fashion that instruments can be all about their own making, they can also foreground and intensify the social dynamics that govern the contexts of their co-design or co-production. This very often occurs in the case of thematic research workshops, hackathons, co-prototyping events, and curated research projects. The “*one knob to rule them all*” provocation has been the motor behind such a project (Bowers et al., 2016). Frize’s ‘Hyperpot’ has been the first response and concerned a reductionist UI comprising just a rotary potentiometer extended with capacitive sensing. This first prototype has reverberated across two collaborating research groups to eventually become the point of departure for an entire series of experimental instruments that, arguably, embody the complex material and social dynamics that define the overall endeavour.

Socio-material dynamics of a sort are also ascribed to instruments meant to be enhancements or specialisations of some parent instrument. For instance, Sullivan et. al. (2020) describe an entire series of children instruments that somehow extend or improve their original ‘Noise box’, namely: ‘Key box’, ‘String Box’ and ‘Tap Box’ pivoting on key, string, and tap interfaces, respectively. It is quite explicit that the memory of the original Noise box resonates its offshoot instruments, so that the latter can be also thought of as surfacing the performative staging of their own socio-material constituents. This stands more or less true, of course, with all instruments that are designed to still reference the original technologies upon which they are based.

‘Down-time: Post-domestic fiction’ has been the outcome of a several-month-long workshop that took in place in Athens in 2012 under the author’s coordination and for a mixed group of participants. Following an introductory period of ideation, extensive brainstorming, and hands-on experimentation with all sorts of materials, it has been collectively decided that each participant would contribute a found electric appliance or some arbitrary object to be hacked or tinkered with (thus having its original functionality re-invented) to be made part of a complex interactive multimedia instrument/installation. Audiences would then engage with this system, interacting the hacked appliances to modulate the generated audio and video signals. The modes of interaction are varied and range from twiddling knobs and pressing buttons to shooting a photo, dialling a number on a phone, or measuring one’s blood pressure.



**Figure 4. 'Down-time: post-domestic fiction' instrument/installation. Image by the author.**

Down-time: post-domestic fiction faces the depreciation of its constituent devices as an opportunity for further exploration and reuse. This exploration is enabled by the work of all workshop participants and their engagement with one another, as well as by a situated audience that intervenes and collectively performs the resulting hybrid. The latter embodies the material and symbolical affordances of the elements that comprise it, the complex social dynamics forged between the group of individuals that produced the instrument as reflected in the juxtaposition of the former and the logic of the applied hacks, and the impromptu interaction patterns brought forth when an audience engages with the work. The presence of an actively involved audience is required to perform the hacked devices and set the work in action. In this sense, the resulting instrument can be considered a record of its own co-making in which it stages and performs the social, technological, and physical dynamics that have afforded its production.

In a similar vein, the author has facilitated 'Neural (r)Evolution' in Vilnius in 2016. This project is again structured around a workshop (this time only lasting a few days) that conceptually and technically pivots on the topology of a simple Artificial Neural Network. Local participants have been asked to contribute own instruments and physical objects to eventually build a distributed audio and light generating instrument made up of electronic components and other objects scattered in space and staging their own (rather messy) co-production.

## An Instrument that (hopefully) sets out its own reality

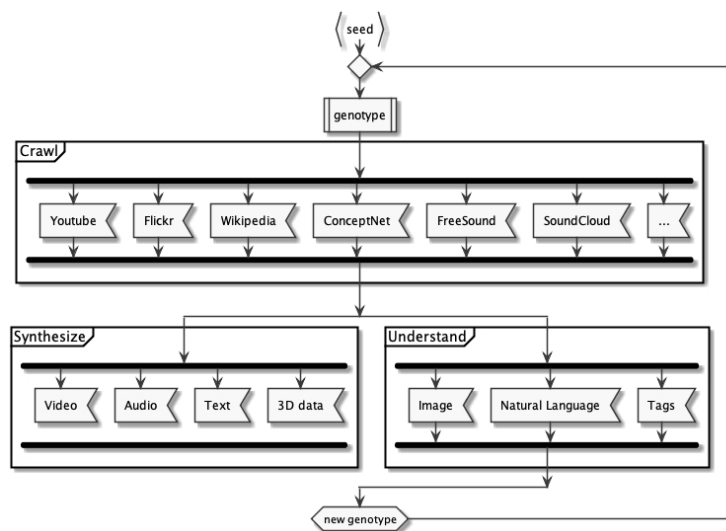
Drawing inspiration from the notion of ‘hyperstition’ — that is “*narratives able to effectuate their own reality*” (Williams, 2013 as quoted in O’Sullivan, 2017) — the author’s ‘Hyperstition bot’ is a speculative instrument seeking to enact its own emergent computational culture. The bot is a complex cybernetic ecosystem involving four distinct micro-computers that are interconnected in a local network; several software crawlers, synthesisers, ‘comprehenders’, and helper/maintenance modules; and several auxiliary hardware components. When switched on, it continuously crawls online media repositories for human-generated media (audio, image, video, user-comments, meta-data, etc.) to ever-produce own media streams by virtue of mashing-up and re-synthesising what it retrieves. Hyperstition bot is, then, envisioned as a machine that relies on the WWW footprint of human culture to somehow establish its own genuinely nonhuman computational reality.



**Figure 5. Hyperstition Bot in Children of Prometheus group exhibition in NEME Arts Centre, Limassol, 2020. Image by the author.**

Its appearance is quite brutalist, with all its integrals hosted in concrete blocks and beneath steel net-wire. Inside the block, hardware and software modules interact with one another enacting the evolutionary cycle shown in Figure 6: a series of crawlers iterate genomic space (weighted graphs of natural language tokens in any human language that can be encoded with Unicode) in parallel, retrieving related queries and employing them to download digital media and associated meta-data. A series of ‘comprehender’ submodules analyse the retrieved media, updating the graph and ever-producing at new genotypes; at the same time, a series of more or

less complex synthesiser modules mash-up or otherwise process the retrieved files to algorithmically generate audio, image, video, text, and 3D data. This is a complex process that involves sophisticated techniques, the overall architecture is elaborated upon in (Koutsomichalis, 2021a) while some of the constituent submodules are detailed in (Koutsomichalis & Gambäck 2019, 2018a, 2018b).



**Figure 6. Hypersition Bot: software submodules and their interplay. Image by the author.**

Hypersition Bot does not involve critics or some fitness function anyhow. In the absence of any evaluation schemata, the bot does not seek to arrive at some optimal or otherwise acceptable result. It only processes the available content unveiling larking relations and exploring semantic co-resolution chains. Genomic fragments result in digital media and text meta-data that are then computationally processed to further the evolution cycle, so that the bot is liberated from human-specific discernments and can intensify all sorts of other relations, interdependencies, and cross-correlations. That is, the bot is designed to set out a computational perspective on human culture, to unveil intrinsic links that their original creators did not necessary consider and, in doing so, to eventually question the human authority/exclusivity in establishing a culture as well as to speculate on how such a culture may look like.

### **An Instrument that is itself the score it performs (and the means to compose it)**

A hylonoetic lens sees instruments as existing independently of the compositions they perform so that artists are expected to be acquainted with an instrument before they commit to compose for it. Out of the numerous instances where such a schema collapses altogether, this section discusses the case of 'THEBRICK', produced by the

author in the context of the ‘Sāk vitt ok vītt of verǫld hverja’ project. The context is a multi-level field investigation of the North Nordic landscape via photography, video, on-location sound recordings, audio synthesis, interviews, sonification/visualisation of scientific data, demodulation of radiofrequencies, poetry, gastronomy, knitting, and other manners. Accordingly, and over a period of two years, the author has arrived at a sizeable collection of digital media with the intention to perform live with them. But how navigate oneself in such an eclectic pool? How to compose a meaningful aesthetic experience *in situ* for live audiences and in a number of different performance settings?



**Figure 7. THEBRICK. Image by the author.**

A way around these questions is, of course, to work on a fixed timeline and in a more or less linear fashion. However, and to sustain the unconditionally experimental nature of the overall endeavour, the author decided to build a dedicated instrument that would enable him to juxtapose the available material in less straightforward fashions. In principle, THEBRICK is a dual infra-computer that can be programmed to perform various actions with respect to the available hardware controllers and outputs. Once the hardware specifics had been put in place, it became possible to try out different kinds of algorithms, UI interpretations, and media/data content to fuel multimedia improvisation within certain constraints while at the same time help defining what exactly these constraints should be about. The author has experimented with several different configurations, eventually arriving at an idiosyncratic set-up that nevertheless exploits the available material in very interesting ways that are reminiscent of the overall spirit of ‘Sāk vitt ok vītt of verǫld hverja’. That is, that THEBRICK has been produced in an iterative fashion and to afford experimentation with what its eventual operation would be. Thence, in its very making the composition

is meant to perform as it embodies the aesthetics, the logic, and the particular tactics at play with respect to composition and live performance.

In its final iteration the instrument can print text in paper strips, reproduce photo stills and video footage, and generate or reproduce multichannel audio in real time. A series of toggle switches trigger up to 14 distinct printing routines may be triggered. These concern printouts of scientific data as well as food recipes to be shared with a live audience (both are important aspects of the research pursued in the context of *'Sāk vitt ok vītt of verqld hverja'*). Six lapse switches trigger an equal number of precomposed sequences of video and photo stills. Audio synthesis is controlled in a much more complicated fashion: eight toggle switches select among the available parts and eight more among an arbitrary number of subparts within them. Subparts concern either the reproduction of audio files or, occasionally, more complex digital sound synthesis. Each subpart comes with its own interaction schema that utilises some of the available knobs to control synthesis parameters. It is then possible to change between parts at any time, but once in a part it is only possible to move forward in a sequential fashion. Feedback from the instrument is spartan: there is a green LED blinking whenever video plays back, and a red one that flashes once and slowly whenever different parts are selected, or a few times and rapidly on subpart changes. Juxtaposing audio, video, and text enables the author to construct mini narratives in real time and to improvise modulating synthesis parameters as well as the order of their elements and the ways they may succeed one another.

## Instruments that span countries

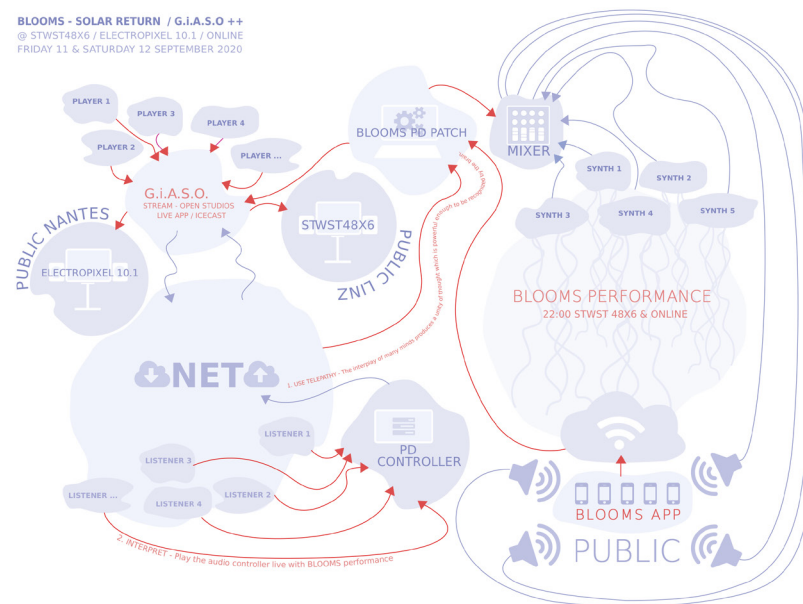
While framing works of net-art as instruments would be generally misleading, there are instances that can (and maybe should) be thought of in exactly this way. 'Global String', a collaboration between Toeplitz and Tanaka is a proper multi-site network-driven music instrument<sup>2</sup>. It involves a physical string that is extended by virtue of communication technologies so that a global network becomes the resonating body of the instrument utilising a real time sound synthesis server. The instrument conceptually draws from string instruments since while in, *e.g.*, a violin, the string spans the body and the neck of the instrument, in Global String a (technological enhanced) one is conceptualised as spanning the entire world. Sensors translate the analogue pulses in the physical string to digital data so that when struck its vibrations will propagate to the network, streaming data, and video to each of the connected sites, and allowing musical communication and collaboration among the people therein.

'BLOOMS'<sup>3</sup> by Solar Return (Ottavi and Pickett) has been premiered in Ars Electronica 2020 and presents another instance of an instrument that extends across several countries. It draws inspiration on the behaviour of schools of jellyfish, in the way they

<sup>2</sup> <https://v2.nl/archive/works/global-string> Accessed February 4t 2022

<sup>3</sup> <https://stwst48x6.stwst.at/en/blooms> Accessed January 28, 2022

grow with respect to their surrounding environment, and as if nerves in a distributed system. This behaviour is mimicked with an audio synthesiser played with touch and tactile gestures that is extended across mobile devices and the internet with an arbitrary number of participants contributing live streams. Participants are provided with a graphical score (Figure 8) and have two options to engage: a web interface via which they can manipulate the overall sound and the composition; or one out of the 11 available special ‘singular neuron phone apps’, which modulate just one single aspect of the sound in the performance space.



**Figure 8. BLOOMS performance score. Image courtesy of Solar Return.**

A final case to be discussed is the author’s *(Ir)rationalités In/Ex-térieures*, composed during the COVID19 pandemic and presented at the Audio blast #9 Divergent Landscapes festival (Nantes and online, 2021). It explores the possibility of a (post-) pandemic distributed utopia; that is, the possibility of a new hybrid public/private space wherein fragmented aspects of the everyday are juxtaposed and orchestrated in ever-creative fashions. Participants from across the world are asked to compose and to selectively live-stream local (ir)rationalities concerning their immediate surroundings and utilising objects, radio receivers, web-cameras, window views, poetry, improvised bedroom noises, their own moving (and sounding) bodies, and anything else they think appropriate. These streams are then manipulated by an automaton (running on the author’s server) and transmitting a live composition to a performance space. Anyone on the internet can communicate directly with this automaton, sending ‘suggestions’ on how it should behave — a user only has to key in a URL (in the form of, e.g., ‘http://anulios.space:3000/decelerate’, where ‘decelerate’ is the actual message to be propagated to the automaton). The automaton will understand

a total of eight messages (such as `accelerate`, `make_dense`, `make_sparse`, `make_clean`, and others). It continuously weights the instructions it receives to internally adjust a series of probability vectors. For instance, if at some given moment 15 ‘accelerate’ versus 7 ‘decelerate’ messages have arrived in total since the launch of the automaton, a speed up of the ongoing truncation and concatenation processes would be much more likely to happen. By virtue of the user-generated streams and web interaction, *(Ir)rationalités In/Ex-térieures* becomes a distributed hybrid instrument to set out an improvised cybernetic audio-visual landscape; one that is intended as an introspection of the complex dynamics forged at the intersections of local pandemic ‘(ir)rationalities’, their improvised and semi-automated manipulation, and a public broadcast thereof.

### **An instrument that is also a poem**

‘Sentience’ is a speculative infra-instrument designed by the author which has a spartan interface of just a key switch (and a balanced audio output). It has surfaced impromptu experimentation with materials, ideas, and poetry that happen to lay around the author’s workplace at the time of its making. It is based on hybrid circuitry involving a microcontroller and a series of analogue filtering and amplification stages — technical details are given in (Koutsomichalis, 2021b). On the turn of the key, Sentience transmits a particular message (a poem by the author) in Morse code with trains of very low frequency pulses. The instrument is meant to be connected to a powerful array of subwoofers so that the surrounding architecture would physically resonate (the exact frequency of operation is adjustable via a trimmer inside the box). Accordingly, when ‘unlocked’ Sentience may be left unattended to transliterate poetry into rhythm that would be make a performance space and any bodies where it physically resonates within. In (Koutsomichalis, 2021b), the author argues that this device is, at very same time a speculative electronic object, questioning some of the norms associated with both market-oriented DMIs as well as with experimental NIMEs; an instrument facilitating a media performance of a rather prominent gestural/theatrical quality; and a piece of conceptual art on its own sake, capturing a certain uncanniness in its design and exemplifying some tension between its individual hardware constituents and their related cultural bearings. On this construal, it is further suggested that the above ascribe an overall poetic quality to the device.





**Figure 9. Sentience. Image by the author.**

Sentience transforms poetry into rhythm to be physically felt through one's body as well as through one's visceral sensation of space. Of course, audiences would not realise immediately (if at all) that what they listen to is indeed a poem recounted in Morse, and even they are most likely to fail to decipher it, so the content remains forever disclosed to all but just a privileged few with the necessary skills. However (and despite the absurdity of transmitting a poem in such a manner), the semantics are preserved throughout at a structural level so that recognising/understanding the poem is still possible in principle. This situation bears a certain element of drama. Then, the instrument's appearance is altogether governed by poetic rather than functional traits. The clear-cut — some would even say 'cute' — design is rather atypical, both insofar market-oriented and experimental instruments are concerned. It evokes neoplasticism or early minimalist art wherein simplicity of form meets functional ambiguity; so that an object is accordingly transformed into the means to investigate material affordances and perception processes or just to aestheticize simplicity. A certain dialectic opposition emerges accordingly: clarity of design contra unintelligibility, functional ambiguity, and some certain awkwardness/absurdity (why reproduce poetry by virtue of a code most people would fail decipher, or even recognise?). On this construal, Sentience is a speculative instrument performing a poem as much as it becomes a very theatrical staging of the poem it transmits.

## Instruments that do not exist

Strange as it may sound to some, imaginary and ‘mock’ instruments are indeed thoroughly researched in certain contexts. Lepri and McPherson (2019a, 2019b) account for a number of such instruments that have surfaced workshoping; they discuss in some detail the values they entail with respect to the participants’ profiles. Fictional functionalities are attributed to mock prototypes made of everyday objects and readily available materials such as plastic cups, straws, pieces of carton, toothpicks, and so on. Some of the resulting instruments are: ‘AntennaLele’, an ukulele-like instrument with a bendable neck that would supposedly shape melodies and harmonies; ‘CorpoSuono’, an organ-inspired instrument with tubes filtering the air that are imagined to produce complex timbres; ‘Plucker’, a glove like polyphonic instrument featuring internal strings that would control pitches and volumes; ‘NonStopSound’, that would produce sounds when tilted via two balls interacting with a plate; and ‘Stochastic’, a percussive malleable instrument featuring with many different tools/materials for sound generation and exploration. While some of these instruments are realistic enough to be constructed, the explicit focus is on how they empower us rethink instrumenthood and instrument-making from ground up.

Fictional instruments are also produced in a workshop by Holzer et al. (2021) drawing inspiration from a Dataton System 3000 — a 1970s modular synthesizer and audio mixer designed as a pedagogical tool. Having thoroughly examined and analysed this antiquated system, participants go on to imagine their own instrument prototypes. In a fashion that is reminiscent of media archaeology, the authors intend an examination of the ethics and affordances of electronic devices from the musical past and to speculate how they could reverberate a technologically distant future. Each stage of the workshop pivots on some very specific utopian idea and as a creative response to the particular logic governing the Dataton. Among the resulting instruments it is possible to find: ‘BONK’, an one-knob biometric instrument that would turn any surface into a synthesiser; ‘Velvet Pancake’, an endlessly-reproducible organic hybrid synth; ‘Sound Cubes’, a physical patching system of small blocks laid out in space and communicating wirelessly; ‘Dataton Cube’, a Rubik’s Cube like instrument comprising rotating rows/columns with touchscreens; and ‘Torn’, a hexagonal tower of analogue synthesiser modules that encourage a collaborative approach to music making.

Instruments of the sort described above are imaginary because they only exist as non-functional mock prototypes or merely as concepts. Notwithstanding, they can still promulgate ideas, articulate critique, stage thought-experiments, or bolster theoretical research. More importantly, they pave the way to focused curated research and intensify inquiry in certain directions. Design fiction enables participants to dynamically follow the potential of their ideas without the burden of having to solve the technicalities involved (of course at the cost of a research style that is no longer seriously informed by the real-life complexities of the materials and the methods it concerns). In the case of Holzer et al, the authors understand this process as the means

to eventually arrive at new electronic sound instruments. That is, design fiction here more or less functions as focused ideation for prototyping. In contrast, Lepri and McPherson understand fictional instruments as the means to explore the breadth of perspectives different communities might have in relation to the values inscribed in fictional technologies for musical interaction.

## Instruments that are micro-democracies

Co-making and DIWO practices have been extensively discussed with respect to curatorial practices (Arrigoni & Zics, 2016; Manousakis, 2016), ‘commoning’ (Dragona, 2014), socio-economic factors (Koutsomichalis & Rodousakis 2015), participatory art (Bishop, 2012), and other contexts. Insofar as multimedia instruments are concerned, certain endeavours go as far as to seek bootstrap micro-communities pivoting on open-ended making. For instance, Fukuda et al. (2021) intend to set out a longer-term community around their ‘T-Stick’ instrument and by means of commissions, workshops, mentorships, and long-run technical support. In doing so, they discover more aspects and uses for their instrument. Setting up communities around an instrument is, of course, a very common affair, with companies actively supporting groups of users and fora concerning their hardware or software products. However, such communities are, more often than not, far from being democratic since the technical know-how and the rights to repair, customise, or specialise are exclusively kept to the company’s hands as a rule of thumb. Contrasting this situation, the open-source paradigm fosters the establishment of long-term democratic communities where users can also be actively involved in developing or specialising the available technology.

The author’s ‘Inhibition’ is a very conscious attempt to stage together in a unified holistic fashion instrument making, techno-scientific research, creative experimentation, artistic performance, co-design, improvisation, education, and exhibition. The author intends to democratise his own practice, not merely opening up the making of an artwork to the public but also drawing artistic value on a democratic doing-it-with-others. Inhibition could be most importantly inspired by Dewey’s (2004) ideas on education and democracy, according to which learning is a necessarily hands-on, social, and interactive process. According to such a train of thought, the traditional view of pedagogy as an inter-generational (lossless) transmission of authorised knowledge appears fundamentally flawed. Education should be, instead, understood as sharing lives with things, technologies, and one another within a broader community, and to allow for “*commoning and variation*” to naturally occur (Ingold, 2017, pp. 5-6). Drawing from such a framing, Inhibition revolves around an intelligent headset that is capable of EEG, algorithmic sound synthesis, and machine learning. The work has been premiered at the Hybrids media art exhibition, curated by Ars Electronica, and hosted in Athens GR between November 2016 and January 2017, with subsequent exhibitions or workshops taking place in Berlin, Sofia, and Nicosia.



**Figure 10. Inhibition headset. Image by Theodora Ziaragka.**

The author's prototype is exhibited so that audiences may use it in an interactive fashion and to listen to an ever-going individuated sound composition (synthesised in real time with respect to monitored neurophysical activity and pivoting on those particular kinds of sounds that are most likely to inhibit concentration in each individual case). With this prototype as a point of departure, Inhibition establishes (temporary) micro-democracies of its own, calling for hands-on audience participation and socially empowered experimentation. Related technology is designed and implemented from ground up as workshop material, comprising parts that can be digitally fabricated, a circuit board with ample space between components (so that it can be easily soldered by amateurs), and an open-source micro-computer employing open-source programming frameworks. The overall design makes the prototype headset relatively cheap to make, and safe to use (being battery-operated). Schematics, 3d-printable/cnc-millable models, text instructions, and code are all made publicly available online in a dedicated hub providing information on the project and aspiring to become a meeting place for makers, artists, scientists, hackers, and creative technologists interested in this technology. These individuals can then use the hub to socialise with one another, to contribute technical material, or to upload images/video displaying their own creative outcomes. At the same time, local audiences are guided to create their own individuated headsets in dedicated workshops lead by the author, to exhibit them alongside the artist's original prototype, and to participate in a series of performances, technological showcases, and impromptu music ensembles.



**Figure 11. Inhibition workshop. Image by Panayiotis Goubouros.**

## Instruments that are manifestations of care

An intriguing research vein that is very often overlooked is that of instruments meant to assist persons with special needs or individuals in need of help. Such instruments also have a therapeutic role or may function as boosters for social inclusion. ‘Felt’, for instance, is designed to enable a shared music experience between deaf or hard of hearing and individuals without any hearing deficiencies (Cavdir & Wang, 2020). Performing with Felt unites the visual-gestural with the vibrotactile sensation of airborne sound; it features separate modules that can capture different kinds of hand, arm, wrist, and finger gestures and that are also capable to deliver physical sensations of low-frequency sounds (so that they could be used both by musicians and their audiences). Rather than trying to overcome the disabling factor by virtue of technology, Felt enacts a common space where people who suffer certain deficiencies can co-exist and co-create with those who do not, and in a way that does not necessarily privilege the latter (or at least that is the original intention). Inclusion is a central concern, too, in the case of the British Paraorchestra, comprising musicians with (serious) disabilities as well as ones without. Accordingly, it makes extensive use of assistive technologies (such as DIY sensors, computer interfaces, and musical GUIs). In this context, Jewel et al (2013) discuss ‘Tailored Touch’, an instrument meant to aid people with limited motor control perform music. It pivots on bespoke interfaces made of touch-sensitive pads that can be applied to almost any surface, in any size, and any position.

Unlike acoustic instruments, DMI/NIMEs can be designed to afford been played by people without any training so they allow the design of specific exercises for disabled individuals (Camurri et al., 2003; Kontogeorgakopoulos et al., 2013). Project SATI (Therapeutic Interactive Audio-visual System, by its Spanish initials) concerns the treatment of individuals with moderate or severe cerebral palsy (Partesotti et al., 2018). The system employs motion sensing and audio-visual feedback, converting a

patient's movements into notes and transforming their voice and any other noises they produce into sound effects to interact with. On another instance, a textile-based user interface — that is, 'Olly' — is designed from observations of a group of five children with autism who like music and with the intention to support scaffolding social interactions and sensory regulation during open-ended playful activities (Nonnis & Bryan-Kinns, 2020). Olly uses an inflatable gym ball wrapped in felt and also stretch sensors embedded in elastic ribbons that are interfaced via a MIDI touch board. Each of the ribbons corresponds to a different instrument and can trigger chords. There are two different performance modes: on solo mode, only 'pleasant' melodies are possible, while when playing with other more complex harmonies can be performed.

As a final example consider the project 'CARE HERE' (an acronym standing for 'Creating Aesthetically Resonant Environments for the Handicapped, Elderly, and Rehabilitation') (Lewis-Brooks & Hasselblad 2004). The instrument consists of a user interface with a library of audio-visual contexts ready to be employed by therapists and other people. Subjects are provided with an audio-visual response when in an interactive virtual space to enhance body awareness, perception of movement and the externalisation of perceived experience. 'CARE HERE' draws on the concept of aesthetic resonance, a process that occurs when the subject is provided with an immediate and aesthetically pleasurable response of technological origin that would enable them to continue moving, despite of, and while forgetting, the required effort.

## Discussion: The morphogenetic contra the hylonoetic

The stories recounted heretofore very often imply an opposition between hylonoetic and morphogenic schemata, either ascribing to either of these ends or escalating this tension in their very design. Since the time of Aristotle, hylomorphism has governed occidental thought; it proliferates an explicit dichotomy between matter and form and proclaims that pretty much everything is unavoidably a compound of both. Throughout such a lens, making is generally thought of as the imposition of largely preconceived forms on an external material world, and multimedia composition is generally dealt with as the externalisation of more or less pre-formulated (intellectual) patterns. As elaborated upon in Koutsomichalis (2018) such a schema is discrepant with contemporary trains of thought and would succumb close scrutiny altogether as it fails to do justice the enactive nature of our interaction with an external environment and the real-life complexities at play. Notwithstanding, and however simplistic or outdated such a standpoint may be, it is indeed in tandem with a general understanding of art and does indeed back up composition and instrument making in several different contexts and to a more or less significant extend. Accordingly, it cannot be altogether denounced as irrelevant to contemporary practice — not even when purely experimental practices are concerned. As a matter of fact, a closer look would often reveal explicit or implicit traces of such an understanding. The design fictions in Holzer et al. (2021), for instance, arguably ascribe to an overly hylonoetic understanding of instruments in that it is, indeed, suggested that they could be

implemented once they have been thoroughly worked as ideas.

Non-hylonoetic approaches are typically morphogenic; that is, dealing with making as a dynamic oscillation between one's internal representations and real-world material affordances. Through this prism, ideas and forms are no longer seen independently of a physical world and the materials and structures encountered there but as being to some extent forged by the latter. In Ingold's words, man...

*Far from standing aloof, imposing his designs on a world that is ready and waiting to receive them, the most he can do is to intervene in worldly processes that are already going on [...] adding his own impetus to the forces and the energies in play. (Ingold, 2013, pp 21)*

A very interesting perspective is also given in Malafouris, according to whom:

*Humans have developed the morphogenetic habit of building and then using what they have built for changing (willingly or unwillingly) what the world affords and how the world is revealed. We bring things to life and into human consciousness, and we use them to reshape our bodies, reconfigure our minds and reinvent ourselves. That is, we are creative thinkers. (Malafouris, 2014, p 144)*

Such framings suggest a reciprocal relationship between internal representations, social structures, and the material world. Accordingly, it can be argued that the very ideas/content that an instrument supposedly actualises are rather forged themselves by, and in the course of, making it — in a constant enactive give and take with one's exteriors.

Such a morphogenic dimension is prioritised in most of the instruments presented in this treatise, particularly when the making process somehow pivots on its own material prerequisites. In all those cases, instrument making cannot be reduced to, or properly accounted for as, just the implementation of given ideas. That said, concepts and ideas do very often pertain; at times they are so prominent that we cannot simply get away just by foregrounding the material/physical aspects of the instruments in question (and even if we are still very well within a morphogenic framing). Indeed, and to a varying degree, BLOOMS, Sentience, Global String, or even Patel & Richard's reverse design stratagem, to name a few examples, all pivot on well pre-formulated concepts or narratives. As a matter of fact, several cases of projects that revolve around material experimentation or co-design/co-making arguably stem from ideas, provocations, ideological or political standpoints, or other cerebral affairs — even if just for the sake of opening up the possibility for research of this kind. Thence, a certain tension seems to arise very often between trying to faithfully actualise a pre-determined design/idea and to intentionally 'let go' adapting to, and adopting, whatever may haphazardly occur in the process.

## Discussion (and yet another story): from post-optimal to hyper-optimal DIY

Experimental instruments of the kind discussed herein have been generally praised for being critical, speculative, post-optimal, or in an ever unfinished/prototyping phase (Richards, 2008; Ghazala, 1993; Collins, 2006; Koutsomichalis, 2020). Yet, DIY ethos is not at all exhausted in those attributes and radical instrumenthood can as well draw from very different concerns. An interesting oxymoron is that its very own ideological proponents would occasionally overlook post-optimality as being a compromise, so that DIY instruments are often thought of as inferior and somehow lacking compared to commercial products. Such an assumption is implicit in, *e.g.* (Patel & Richards, 2020), where DIY Nomad practice is indeed associated with 'poor craftsmanship', and, much more importantly, in Collin's (2006) seminal 'handmade electronic music' book where he openly admits that the motor behind DIY making for his generation has been financial to some significant extent:

*My generation of composers came of age [...] at a time when electronic instruments were far too expensive for anyone but rock stars or universities [...]. A small, merry (if masochistic) band, we presumed to Do-It-Ourselves. (Collins, 2006, p. xiii).*

He goes on explaining that the particular projects to include in the book are selected to keep things 'simple', 'cheap', 'stupid', and in a fashion that errors can be forgiven. But does DIY necessarily suffer in terms of technical excellence, functionality, or quality of design? Are cheap, simple, and largely suboptimal products all it can offer? Is it in technical deficiencies where the creative or critical affordances necessarily lie in DIY making?

Certainly not. As a matter of fact, DIY making is very often expensive, very demanding, and at the forefront of what is technologically possible (as also shown in several of the examples discussed in this treatise). In any case (post-)optimality has to be seen in context and with respect to real life challenges. The original prototype for Inhibition, for instance, could be easily made excel in electronic performance but has been significantly downgraded to facilitate workshopping, but not because of limited skills or poor workmanship. Indeed, the use of SMD components, higher grade components, proper electromagnetic insulation, and a DC power supply would result in a much smaller and more efficient device. Yet, electronic performance has been sacrificed in order to better serve the agenda of the project. In this sense, designing Inhibition has been indeed all about optimality; just that the particular kind of optimality sought for has been a socially and community informed one and not exclusively governed by a laboratory logic of decontextualised excellence.

DIY making can very much about producing something better and still in a very critical/speculative fashion, too. While in a capitalist economy the industry implicitly promises to satisfy all clients' needs with optimal products, the simultaneous demand for them to be competitive (to the market) and profitable (to their makers) frequently



compromises quality in several important respects (substandard performance, bad repairability, planned obsolescence, budget style UIs, design for just the average user, etc). In the real world, clients are very often left with very limited choices reflecting a company's marketing concessions, rather than their own needs; not because what they want is something 'weird', alternative, or post-optimal, but simply because the quality or the degree of customisation they are after would make the product not competitive or profitable enough. It is then possible to have instruments that are simultaneously experimental, critical and, techno-solutionist. The last story to be recounted here — that is, the author's 'Stahlblock' — is exactly such a case.

Stahlblock could be thought of as simultaneously an optimal solution to a given problem and as an explicit critique towards the ability of the industry to provide these solutions. As seen in Figure 12, and albeit still reflecting a few of the author's obsessions (made of die-cast aluminum, bearing no indication whatsoever of how it should be used, etc.), it does look as, and is indeed, designed with nothing but functionality in mind. The problem it 'solves' is how to trigger audio recordings for live performance in a straightforward and dedicated fashion (a necessity that very often arises in the author's artistic practice as well as in electronic music performance contexts in general). Stahlblock is a multichannel instrument that can trigger up to 32 audio recordings of arbitrary duration and by means of an 8x4 matrix of buttons. There can be up to four stereo and eight mono simultaneous audio recordings reproduced in different audio outputs. Accordingly, the buttons are grouped in 12 banks, four columns of four buttons each, each one may alternate between four different stereo recordings and eight button pairs (that appear topologically indistinguishable to the former) and these may alternate between two mono recordings. So, in total Stahlblock can draw from 16 stereo and 16 mono audio files, reproducing up to 12 of them at the same time and accounting for a total of 16 audio outputs (four stereo, eight mono).



**Figure 12. Stahlblock. Image by the author**

Prior to Stahlblock, the author would use a laptop running software in something like Supercollider to this end; an approach that is functionally sound but suffers in many respects. Laptops require setting up, they are also fragile, non-waterproof, their standard UIs (keyboard, mouse, trackpad) are not the ideal means to alternate between audio files and commercially controllers seem to favour plastic pads over metal buttons (that are preferable to the author); and most importantly, they are not dedicated music instruments but devices ascribed with a very prominent theatricality and bold connotations of their own that undermine a DIY/experimental ethos (that is generally very important to the author). A laptop-based solution would indeed allow a practitioner to process audio in many additional ways, but the author's practice increasingly favours restricted user interaction (keeping things simple and focused) so that this would be a disadvantage in reality. Many hardware synths, samplers, or audio recorders could be also programmed for such a task, yet severely compromising immediacy and introducing new distractions. Stahlblock successfully tackles all the above: it is robust, waterproof, dedicated to do very well just what is required, it doesn't explain out the 'mystery' of its interface, and arguably promulgates a DIY ethos and a certain aura of uniqueness.

To author's knowledge there is not a commercial product available that would do the job better than, or at least as good as, Stahlblock. At the same time, however, Stahlblock would most likely fail miserably as a commercial product. The cost of its materials is substantial, so that a retail price would be too high for it to attain any serious market prospects while, at the same time, it is too specialised to be used by many. Nevertheless, it is a perfectly optimal solution to a perfectly sound need of a real-world performance artist; a need that cannot be satisfied by what is commercially available, not because of its advanced technology, its experimental nature, or some idiosyncrasy, but simply because of the intrinsic contradictions of market-driven economy and market-oriented design.

## Future Work

As announced in the introduction, this treatise concludes with plans and ideas for future work to give the reader some perspective on the inner workings of a real-world research agenda. It is, of course, expected that only some of these schemes will be further pursued, and that those will end up being quite different than what is herein announced. Each plan is then sketched out on a separate paragraph and under its tentative title.

'A block of concrete that tweets' does not account for a multimedia instrument, it nevertheless relates to several concerns raised herein. The device would comprise electronic circuitry in a cubic block of cement and would automatically broadcast algorithmic tweets. A tentative scenario is that of an embedded micro-computer running an AI-driven text synthesiser which is automatically trained every few hours

with text retrieved from news sites and to tweet its 'opinions' on everyday concerns every now and then.

'DataVox' is conceptualised as an instrument to sonify data of all sorts and in a variety of fashions on the spot. It should be possible to directly plug in a USB storage device containing data (several formats should be supported) to have them immediately converted to audio and in a few possible ways. The latter could involve audification, oscillator glissandi, granular clouds, frequency modulation, trains of pulses, and others. The instrument should feature several switches and knobs to also control the various synthesis parameters.

'Post-human radio' is a prospective performance project involving instruments and techniques inspired by radio technologies. Sentience already aligns with such a vein. Another plan in this context concerns a wearable suit equipped with DIY coils, aerials, demodulators, micro-controllers, and 'soft' UI elements to enable the sensing, demodulation, and creative manipulation of the radio spectrum on the fly and in an ambulatory fashion. The author has already experimented in this direction and a few hardware parts have been already realised. There are several additional ideas to be considered with respect to this suit, such as the transmission of Morse code, the use of portable loudspeakers or horns, or the wireless radio transmission of the generated audio. Another tentative instrument for post-human radio would be a morse-code controlled synthesiser. This is conceptualised as only featuring an audio output and a two-pin terminal, so that it could be manipulated either by a Morse code key (or paddle), or through the output of some special receiving module. In this case, it would be possible to send Morse-code instructions over some amateur radio band and from anywhere in the world, as long as the atmospheric conditions are appropriate.

'Inhibition+' is envisioned as an extension and a specialisation of the original technology developed for Inhibition and in a way that it simultaneously acquires artistic and clinical prospects. The original prototype pivots on parallel binaural beats and cross-modulations, and it will self-adapt following brainwave responses to learn the particular configurations that would cause a subject's cerebral rhythms to change. This is experimentally confirmed to be the case, at least with certain subjects. As long as there are sufficient indications on what the desired change should be like, it might be possible to affect a subject's brainwaves in a way that also functions therapeutically, *e.g.*, to prevent a crisis or help treating some disorder. Research in this direction would, of course, require close collaboration with neuroscientists and neuro-feedback experts and might eventually prove entirely unsuccessful.

Finally, 'Multimedia Cube' would concern a customisable platform for both artistic research and education/workshopping. The instrument is ideated as an expandable one, hosted in a structure of laser-cut or 3D-printed materials and involving modular circuitry, programmable micro-controllers, a loudspeaker, motors, LEDs, and sensors. The idea is to facilitate the construction of individuated cubes yet employing prepared parts so that audiences or students can more easily get their hands dirty with hardware

and software prototyping. In its eventual form, each Multimedia Cube would somehow sense an immediate or more remote environment employing a different set of sensors, processing the input data, and somehow generating light, sound, image, or movement. The author could then experiment with participatory and net-driven art incarnations, encouraging audiences (or students) to co-produce and co-exhibit along his own prototypes (very much as in the case of Inhibition), but also having the various cubes interconnected one another in worldwide networks and maybe exhibiting some kind of collective ambient intelligence.

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