The Organium

A Library of Technical Elements for Improvisatory Design Thinking

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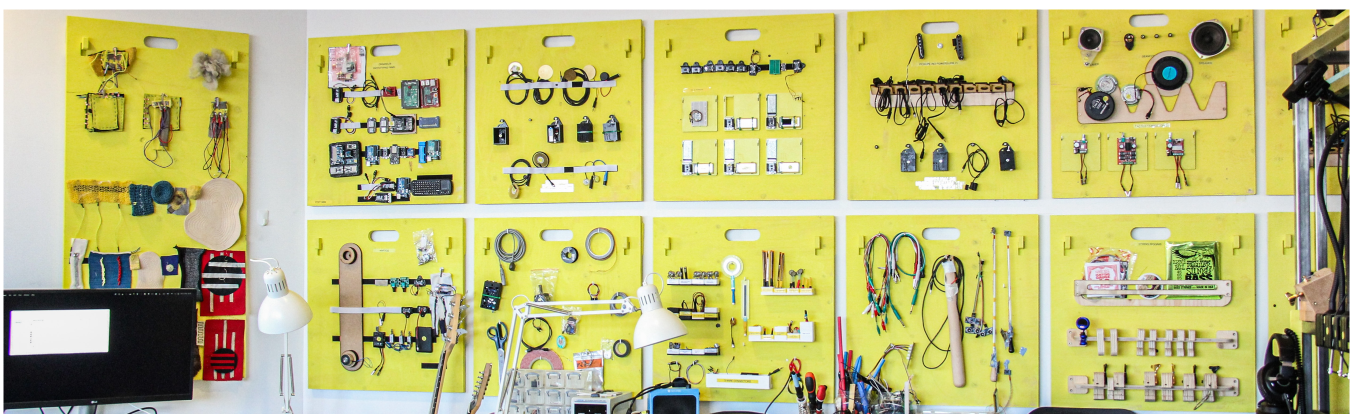

Figure 1: The Organium wall in the Intelligent Instruments Lab

ABSTRACT

Research labs are peculiar phenomena consisting of a defined research programme, technical infrastructure and social context — all crucial for generating, preserving, and disseminating new knowledge. A lab functions as an ecosystem in which we think and develop ideas, but this requires a productive technical and social platform. This paper presents the *Organium*, a system for improvisatory design thinking in the domain of musical instruments and the experimental humanities in general. The Organium is a dynamic library of technical elements, spatially arranged for rapid prototyping and systemic experimentation, serving as a central hub of our Intelligent Instruments Lab. Furthermore, the paper discusses the lab culture and research methodology for which the Organium was designed, framing the lab as an *experimental ecosystem* where technological assemblages act as *boundary objects* for transdisciplinary collaboration and discourse. We outline how the Organium supports our research methodology and present selected projects that demonstrate its functionality and impact.

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CCS CONCEPTS

• **Hardware → Emerging interfaces**; • **Human-centered computing → Interaction design theory, concepts and paradigms**; **Systems and tools for interaction design**.

KEYWORDS

design thinking, interface design, NIME, intelligent instruments, experimental humanities

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1 INTRODUCTION

Today's technological infrastructure with cheap computing power, fast access to sensors and actuators, augmented with the power of artificial intelligence for both coding and implementation, seemingly simplifies the task of designing new interfaces for musical expression. Over the past few decades we have observed the emergence of a comprehensive technical system that has diversified approaches to creating hardware and software for musical expression. However, the technical infrastructure of instrument design remains delicate. We are faced with a particular organological problem, not only considering historical origins and classification [41], but also in terms of the production, maintenance, preservation, and dissemination of technical knowledge. We must consider what kind of luthier traditions and knowledge repositories are we constructing. In this paper, we introduce the *Organium*, a library of technical elements that serves as a central hub and design methodology of our Intelligent Instruments Lab. We explore its role as a mental scaffolding in design thinking, its support for ideation, its contribution to the lab's identity, and its imaginative potential of our collaborative lab work. By presenting this infrastructure and lab culture, we aim to foster open communication with other research labs, developing different systems, research methodologies, and other more-than-human assemblages.

New musical technologies are developed by commercial companies, research labs, and various studios. The technology is reported on by means of manuals, research papers, demonstrations, and presentations. Importantly, they make their presence on the musical stage. The development of a new musical instrument generates new knowledge, constituted not only by the technical assemblage of the instrument as a functioning object but also the extended system of processes, gestures, metaphors, semiotic codes, and sociocultural contexts[42] that become manifested in the instrument's design, presentation, and performance. This new knowledge is coconstitutive with our cultural rituals, imaginaries, and traditions, both material and immaterial. However, the technical aspects are inherently transitory as digital equipment and code evolve rapidly and become quickly obsolete. Paradoxically, the non-technical elements, though immaterial, attain permanence through the acquired technical knowledge, understanding of interaction, ergodynamics, and ergophores [40], as well as the gesture-semantic acts that become standard references in instrument interaction design [31] [27].

In our lab methodology, we aim to explore how knowledge is produced and preserved. Various proceedings in music technology and HCI demonstrate how socio-technical knowledge can be preserved and communicated, with diverse attempts develop a framework for preserving historical instruments [45][12], for example with a workshop on archiving [32]. However, as all luthier traditions confirm, knowledge is primarily developed and preserved through the living tradition, in workshops and laboratories, and further extended in social contexts involving material acquisition, technological experimentation, and instrument evaluation. The luthier might work alone, but never research in isolation [73]. Therefore, an essential method of developing, sharing, and preserving new knowledge in instrument design can be through the extensive research lab that encompasses the social relations of all members, associates, and partners. This lab might be a university research lab, public hacklab or fablab, an industry research lab, a luthier's workshop, or personal studios of new tech development – spaces that provide resources, networks, and other affordances for musical, technical, and social experimentation. The critical question is by what mechanisms the new knowledge produced in the lab is developed, maintained, and effectively shared as a living, vibrant solution space[39]. Note though, that the ideas of problem or solution spaces in the design of music technologies can be perpendicular to the idea of making a new instrument, as these are often not solutions to given problems, but rather problematisations in form of material objects that, in turn, yield interesting musical solutions.

Figure 2: From a Friday Open Lab session

In addressing the problem of living knowledge, archive, and open science, this paper presents the techno-social system of a lab dedicated to exploring new musical expression, thinking with technology, particularly with intelligent instruments.[1] Our initial challenge was to establish a technological infrastructure that is both immediately productive and sustainable in the long term. The

[1] See the Intelligent Instruments Lab's website: www.iil.is

lab should be a technical and epistemic ecosystem that serves as a fertile ground for new sprouts of techno-cultural probes [67] and ensuring the preservation and regeneration of knowledge through established traditions. In this context, Rheinberger's notion of the *experimental system* [55] is particularly relevant. This concept encompasses the experimental apparatus, technical and theoretical frameworks, research methodologies, and the scientists themselves as a socio-cultural whole. The experimental system is dynamic and evolves over time, accumulating new knowledge, techniques, and methods. The system serves as the condition for networks of thinking, where a framework for continuous and iterative research experimentation enables a multifaceted approach in addressing research problems. Given the plurality of approaches in our lab, the strategy has proven highly effective: instead of focusing on isolated experiments, we work as an experimental ecosystem, echoing Schwab, "since it is the system that provides the context against which an experiment carries meaning" [58].

We believe that, to build upon prior work, to assemble and disassemble, to prototype and demo, and create technological probes [67] that enable new ways of asking questions, we need a socio-technical framework that transcends our current projects and operates achronologically in our daily experimentation. This framework must address Anthropocene-era challenges related to social and ecological instability, as explored in posthuman HCI, de-centered design [49], entangled HCI [24] [48], and material-discursive agencies [6]. These areas recognise nonhuman elements—such as AI, ALife systems, and biological entities—as integral parts of a dispersed yet interconnected system of agencies. Our goal is to develop a practical design framework that can coexist and 'breathe-with' more-than-human worlds [25]. Extending Rheinberger's concept, we operate with the lab as an *experimental ecosystem*, as it has become obvious to us that the interminable social and technical relations that comprise the lab are practically unlimited. This relates to human and nonhuman agencies (AI or biological), for example where even the state of a plant in the lab (e.g. has it been watered or not?) will signal what is going on through various possible interpretations. The lab is not an isolated room but a dynamic network that applies existing knowledge and technologies (code and hardware), extending out through collaborations, the use of our technologies, musical stages as experimental platforms, and extensive mediation.

This paper describes the central socio-technical hub of our Intelligent Instruments Lab, the Organium, focusing its rationale, design decisions, and applications. As our technical library, the Organium is a system of hardware and software interface elements, but it is more than that: it also operates as part of a social system of tacit knowledge, relationships, and extended networks and communities. It serves both as a theoretical and technical framework to mirror and extend one's own thought, a type of scaffolding or *tools for thinking* in the sense proposed by Dennett [22] and later developed by Clark and Chalmers [17]. The system constitutes the technical development and infrastructure of our various of lab projects and we have published a database detailing each element on our website for use by collaborators and others worldwide. We seek to offer this open and dynamic technical system, along with the lab methodology described herein, to the music technology and critical humanities communities, especially in the light of this year's Audio Mostly theme of interdisciplinary sonic cultures.

2 LAB CULTURE

Recently, there has been an increased focus on lab culture, resulting in an updated concept the research lab, particularly in the humanities. Since around 2010, *the lab* has become an exemplary conceptual model for conducting humanities research, marking what has been called the "laboratory turn" [50]. This shift signifies a change brought about by the advent of the digital humanities, a paradigm shift in social sciences, the higher education sector's emphasis on innovation, and the cultural force of the maker movement. The lab has evolved from being a space filled with neutral technology used in defined experiments — an idea criticised by Latour [35] — to a dynamic social space where technological innovations are developed, tested, used, and communicated, enabling new socio-technical configurations to emerge. These labs range from physical spaces with technological infrastructure and development tools to virtual spaces and networks that comprise human and nonhuman agencies diverse skills and a shared focus. The digital humanities have been particularly interested in the lab as a location for transdisciplinary research, applying critical approaches to tech development as well as the use of new technologies for critical humanities research [51]. This new notion of the lab has become instrumental in enabling the humanities to become reflexive, self-conscious, and descriptive of their own praxis as collaborative entities [60].

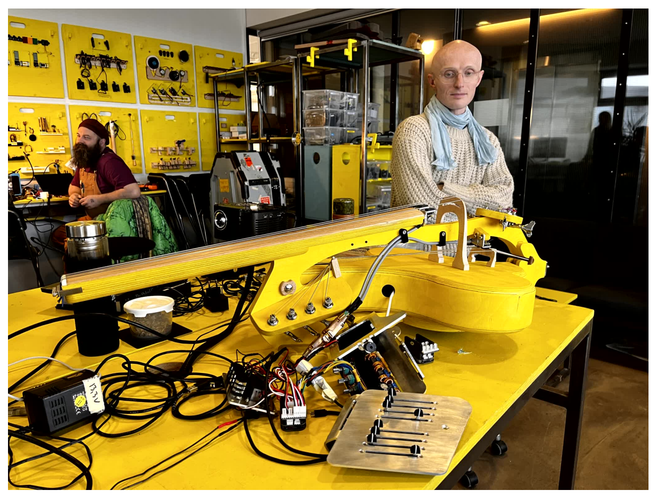

Figure 3: Working on a new instrument

Sociological theories of the lab as a knowledge-producing entity have emerged from long and extensive work in Science and Technology Studies (STS). Key contributions include Latour and Woolgar's ethnographic study of the laboratory [35] or Latour's description of the extended networks that are enrolled in scientific work [34]. STS, in proposing a method of observing science-in-the-making to understand scientific processes, describes the lab as an entity comprised of complex social relations, equipment, apparatus or inscription technologies, and objects of study; all shaped and understood through the experimental context of lab operations. Additionally, broader network nodes such as research funding bodies, academic conferences, publication outlets, media, innovation hubs, and social engagement also play crucial roles in the functioning of the lab.

For Wershler et al., the lab serves as a metaphor that permeates contemporary culture and can be applied to almost any practice. A quick survey of cultural activities reveals the widespread application of the lab-as-concept, encompassing academic research programs, hacklabs, incubator centers, culinary labs, yoga labs, martial arts labs, and beer brewing labs. Life itself has become a lab! This broad application underscores the necessity of studying the notion of the lab from the multiple perspectives of space, apparatus, infrastructure, humans, nonhumans, imaginaries, and techniques [72]. There are physical labs, hybrid labs, and virtual labs, but what they have in common is the collection of people and other agencies with shared interests and a defined research programme. A lab does not need to be a brick-and-mortar physical space; it can be a community, network, or even a series of distributed postdigital infrastructures [10] [20].

"Discipline disciplines disciples" write Barry and Born in their text on interdisciplinarity [7]. We concur and have observed how disciplinary focus can be problematic in scientific collaboration. Operating in the experimental humanities, our aim is to conduct research in a transdisciplinary mode, yet open for collaborators to retreat back to the comfort of their disciplinary method or language when necessary. A key strategy for us to foster transdisciplinary or interdisciplinary approaches is to frame the research object, such as a musical instrument, as a *boundary object* [64]. Boundary objects facilitate the exchange of ideas across disciplines, forming a shared platform for research that creates a common language while enabling the understanding of each other's disciplinary language. Our experience shows that for a lab to operate as a truly transdisciplinary experimental ecosystem, it is essential to keep an open mind for disciplinary perspectives and support ad-hoc changes to the research object through an open-access technical system which is ready-at-hand, informational, and built on practical experience and knowledge of use. While space and equipment is necessary, they are not sufficient: it is crucial to nurture the lab's culture, shape its agendas and discourses, and pay close attention to uneven power geometries to ensure the lab operates as a progressive and inclusive environment with a clear sense of place [44].

For a lab to operate as a progressive place, members must be able to create a junkheap of technical elements, allowing these to accumulate and evolve without the concern for maintaining a tidy lab (See Figure 3). This fosters the ability to think through messy and fuzzy elements that equally exist on the centre table and in the periphery, enabling technical assemblages and machinic life to evolve through the contributions of different people and shared eyes [33]. Creativity as such typically originates through messy methods — such as notes, sketches, drafts and prototypes [1][13] — as well as operating with technical elements. [2] The technics of the extended mind operate through active combinatorics, experimentation and testing of apparatus and its workings, but equally through brainstorming and discussing work with collaborators, through visits, open labs and informal coffee meetings, thereby gaining valuable insights and unique viewpoints on the experimental project.

[2]Baird [5] gives a brilliant example of how Watson and Crick discovered the double helix of DNA "not through logic but by serendipity" when playing with different modes of creating DNA models. It was the material that offered the solution.

Being progressive also means embracing risk and stepping out of comfort zones. The lab must concurrently operate as a stable constant in the working practices of its members, yet remain unpredictable, variable, and exciting. Serendipity is a key concept that should be nurtured: to keep an eye for the accident, be observant of chance, and embrace errors as a productive strategy [19]. In art, often it is the realisation of a mistake or the unexpected that leads to new insights and novel contributions, a pattern also evident in the history of science [62]. Surprise is delightful and its causes can be iteratively inscribed into the experimental methodology post factum.

For a holistic lab performance practice, it is essential to map out actor-network constellations of more-than-human relations and trace the threads leading to key notions and ways of being that emerge through discourse. We examine the epistemic nature of the instruments, exploring their core engagements, including their origins, material participation, and politics [43]. Pickering's *mangle of practice* informs the epistemological framework of the lab, particularly his performative idiom that addresses the temporality and material agency of laboratory settings [52]. Pickering further describes the *dance of agency* between humans and nonhumans, shifting the lab's function from epistemological to ontological; this suggests focusing on performance and agency rather than static scientific facts [53]. When studying agential material with intelligence, we note how current AI trends exclude the multiplicity of epistemologies and ontologies that exist in the world [38]. Therefore, we aim to maintain a critical yet playful reflection upon the lab as a performative space, where various human and nonhuman agents interact in the study of knowledge production and being. This approach embodies a true "aesthetics of experimentation" [56].

In operating with a plurality of ontologies and epistemologies, we draw insights from feminist, indigenous, and decolonial theories, particularly the approaches of feral, ontological, and care-oriented design. These frameworks challenge anthropocentric notions of agency by decentring power dynamics and the situatedness of knowledge and incorporating material participation [23], as exemplified by Bennett's "vital materialism" [9]. By 'thinking-with' the lab, we observe how co-creation practices unfold as matters of care—a speculative modality requiring an ongoing ethical commitment to addressing the asymmetries of power, access, and agency that shape these relations [8]. Engaged epistemologies further support this approach [21]. By thinking-with others, as lab-agents beside and alongside other lab-agents, we honour the challenges as well as opportunities of what it means to 'give voice' to nonhuman entities [15] and to acknowledge the ethical responsibilities of design practice [26].

3 THE ORGANIUM

The lab requires a robust technical infrastructure. In his theoretical framing of technical elements, Simondon [61] illustrated how technical objects should not be viewed in isolation but rather as interdependent parts of a network or ensemble. The technical elements that comprise a technical object acquire meaning and function only within the context of the whole. Each part has its own "mode of existence," history, and cultural and technical context, contributing dynamically to the overall functioning of the technical object. Magnusson has problematised the organology of digital musical instruments and their heterogeneous technical elements [41], contextualising this within Stiegler's concept of *mnemotechnics*, and explored how we inscribe our thinking with discrete elements, shaping our world through "epistemic tools" [42]. This relates to the concept of *ergodynamics*, which enables the study of technical elements in their historical and cultural contexts, and examines how the instrument presents itself in a dynamic relationship with the performer, transcending subject-object distinctions [40]. Technical elements thus become ready-made components for assembly, operating as mnemotechnic devices that enable us to create via technology, where elements serve as a part of a vocabulary of grammatisation [66] in a coherent technical protocol. For Stiegler, grammatisation signifies the technical history of memory, a process of exteriorisation, or "the process whereby the currents and continuities shaping our lives become discrete elements" [66]. Language and technology formalise our gestures, intentions, and agencies, shaping how we interact with the world.

Figure 4: The modular technical library of the Organium

The Organium is designed from the perspective of a large dictionary or a library with both physical extension and online database. In this library of technical elements, we have things to think with, a technical vocabulary that allows us to connect ideas and put them to test through the making of assemblages of various sorts. The library is spatially presented on a large wall (See Figure 4), where technical elements function as semantic components analogous to the vocabulary of natural language. In this context, meaning is derived from usage, context, and relationships; not from the isolated elements themselves. This analogy extends further into design thinking, which becomes a mode of technical assemblage, defining potential technological grammars [18].

The Organium functions as both an experimental ecosystem and a meta-instrument, enabling lab members and collaborators to build prototypes and design experiments ad hoc through diverse modes of co-creation. It houses sensors, microcomputers, actuators, and open-source code, all of which can be rapidly assembled into intelligent systems, new musical instruments, or various systems applicable in the experimental humanities. The system supports our investigations of human-AI creativity by facilitating encounters with boundary objects that serve as technical, experiential, and discursive focal points. Our goal is to cultivate an environment where the lab itself becomes a machine for experimentation and knowledge dissemination. Here, technical elements are readily available for assembling prototypes and demos, allowing for the rapid generation and exploration of ideas, and if they do not exist there is a quick production line in experimenting with and making new elements. This approach aligns with Barad's concept of apparatus [6], where the world we come to know — such as a world of sound and sonic interactivity — emerges through the intra-action of technological elements and intent. There is no pure instrument or musical intent; rather, dynamic interpretative relations emerge through the design process and the encounter with new instruments.

As designers or inventors, the Organium encourages us to connect diverse elements and ask questions such as, "What musical expression might be afforded if this element is connected to that?" or "What new meaning might emerge through performing with this type of an interactive system?" Often it also introduces new "words" or technical elements to a novice user, such as instrument builders, enabling them to envision various extensions of their instrument by quickly glancing at the wall and forming connections that might not otherwise emerge. This aligns to theories of the spatial nature of our memory and the concept of the extended mind [17]. It is therefore important that the elements are visible, ready-at-hand, and quickly enrolled into new assemblages. These elements are not limited to physical components on our lab wall and shelves; they might encompass software solutions, design approaches, usability methods, and ergophores (designed tropes of motor memory) of tacit human knowledge.

We felt we needed this technical infrastructure to start a well-functioning lab environment so we designed a comprehensive lab system, ranging from our own furniture as modular structures that can be turned into instruments or serve as extensions of existing instruments, through technical elements of all kinds, to code and hardware protocols. The furniture is modular, movable and dynamic, and so are our code libraries. This setup allows for rapid reconfigurations: strings can be strung on deconstructable tables, shelves can become resonating bodies or soundboards, sensors can be mounted on artificial arms, and actuators and motors can be set into motion for sound generation or haptic feedback. This allows for quick ad-hoc experimental setups and encounters. We have written about our methodology, the first instrument encounters in an earlier paper [3].

In the Organium, analogue sensors are built with mini jack connectors, the digital ones (using SPI and I2C) with Stemma QT, which makes it very easy to try out different sensor types during operation, facilitating the exploration of different interactive modes. The sensors include proximity, temperature, tilt, flex, magnet, photo, accelerometers, infrared, e-textiles, and more. Actuators include all kinds of motors, transducers, speakers, amplifiers, and coils. For low-latency embedded computing, we typically use Bela,[3] while

[3]https://bela.io

ESP32 microcontroller boards[4] are employed for connecting to laptops. A basic prototyping panel (one of the yellow boards) is set up with a Bela computer running simple DSP software, ready to test sensors and actuators. Detailed information about these elements is available in our online database (See Figure 5).[5] For both the hardware and code library, we have developed a card system where cards with QR codes link to database entries or GitHub repositories. Each database entry includes an image of the element, its name, device type, operational principle, voltage requirements, functional description, and notes on its optimal and suboptimal uses. Additionally, links to Sensorwiki[6] and purchasing information are provided. For complex build instructions, sub-pages offer step-by-step guides. Following these detailed instructions, developers around the world have successfully reproduced our technical elements. We hope this system will continue to evolve with contributions from other researchers.

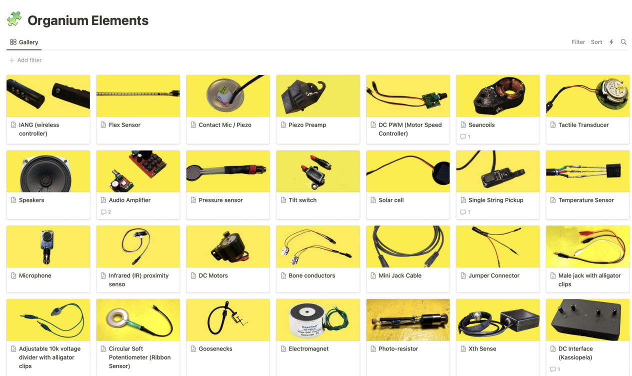

Figure 5: The Organium online database with its technical elements

Our wall-based infrastructure and online database allow musical processes and works to emerge through real-time technical creation, even as part of a performance. Instrument development becomes a form of design thinking akin to live coding, where code is rewritten during runtime as part of the performance [11]. For us, to think musically is to operate with elements external to our mind: thinking is social and the social is technical. More specifically: to think musically is to compose or define a performance from an ecosystemic perspective. This approach entails inventing systems to explore expressive potential, following Magnusson's argument in *Sonic Writing* [42], where the composition of work is increasingly replaced by the invention of systems, a *new systematicity* [40]. This opens up opportunities for exploration, co-agential relationships, and ecosystemic thinking in performance [71]. This evolution in music reflects a broader movement shaped by our current socio-historical context. Concepts such as nonhumanism [28], more-than-humanism [68], and posthumanism [29] frame the relational articulations of the Anthropocene era, emphasising the interconnectedness of human and nonhuman agents, as well as embracing material agency.

[4]https://en.wikipedia.org/wiki/ESP32
[5]https://www.iil.is/research/organiumdb
[6]https://sensorwiki.org

4 LIBRARY DEVELOPMENT AND USE

The Organium has been developing since the inception of our research programme, in 2021, into a cornerstone of our ideation and design processes. Its theoretical foundations are built on a heterarchical organology of digital musical instruments [41]. We have reported on projects built with this technical system in various publications [3][47][69][2][4][54][59], but to illustrate how this ecosystem supports collaborative lab methodologies, we highlight a few side projects, collaborations, and previously unreported work that exemplifies the Organium's role as a creative platform for extensive collaboration and technical development.

Our lab maintains an open-door policy, frequently inviting individuals for dialogue and transdisciplinary collaboration. A key aspect of our methodology is hosting visiting researchers, musicians, and students who come to design their own instruments, experiments, or musical systems. Sometimes people are wanting to create a small technological function, but when developed together, it becomes part of our library. These collaborators therefore become part of our research programme, engaging with our questions and challenges in a proper citizen science manner [70], which also enhances our public engagement as their work finds use in music or other scientific experiments. Collaborating with people outside the lab has been invaluable: it has been interesting to behold how people use the library, introduce new ideas, request features, or speculate about possible interfaces. The organic growth of the Organium relies on concrete use cases rather than abstract potential ideas. In the following sections we will explore several organic developments that demonstrate how the Organium serves as a catalyst for collaborations and co-development of new work.

4.1 Open Labs

One of our key strategies for supporting citizen science is to open our lab weekly for discussion and experimentation.[7] These sessions are informal meetings where we invite participants to present their work, discuss our research, and engage in dialogue over coffee or maté. The open labs serve a dual purpose: to wind down from a hectic week through conversations about interesting projects and to critically reflect on our lab's creations. Additionally, these sessions allow us to observe the language, metaphors, and discourse emerging around our work and engage in real-time with users of our technologies. This public engagement has established itself as an essential part of our research methodology and resulted in research awards.[8]

A large table is placed in the middle of the lab. A project of some sort is placed on the table, at times projected on the wall, and the project becomes a boundary object for transdisciplinary engagement. Through informal presentations we have been able to get critical comments on our work-in-progress and experiment playfully in real-time. Expert voices from various disciplines provide invaluable insights, enhancing our understanding of our work. The Organium is crucial for supporting quick experimentation, facilitating the creation of ad-hoc technological assemblages, and enabling the realisation of ideas that emerge during discussions.

[7]www.iil.is/openlab
[8]http://www.iil.is/awards

Figure 6: From a Friday Open Lab session

For instance, during a presentation by two lab members on a no-input mixer with e-textiles, the performers used their fingers to manipulate the textiles, affecting the sound parameters. An idea arose to use a wooden *txalaparta* stick [30] from the library to press the material, simulating finger pressure. However, this did not work. Was the conductivity of the e-textiles not dependent on the material being pressed, thus increasing electric current? We tried adding aluminum foil to the stick's end, but this also failed until two fingers were placed on either side of the aluminium. Of course, it was the grounding of the human body that was needed, the bodily conductivity. But this quick experiment was enlightening for many in the room and in almost every open lab we run where we discuss our projects, we learn something new through the physical and conceptual poking, probing and prompting of our systems.

4.2 The Skerpla course

The music department at the Iceland University of the Arts offers a course called *Skerpla*, which focuses on experimental music, intermedia practices, and innovation in composition and performance. We were invited to lead a segment of this course, during which students visited our lab to build their own instruments. This collaboration significantly accelerated the development of the Organium and introduced numerous new ideas to the system. It was highly beneficial for the students, who could rapidly shape their ideas, and equally valuable for us, as it allowed us to refine our methodology for working with collaborators, emphasising speed and ease of use. To think with technological elements requires the ability to think quickly and here it is crucial to have technical elements readily available. Interrupting a session to switch into engineering mode, such as soldering or programming, disrupts the flow of thought and can lead to impatience among students. Therefore, ensuring that all necessary components are at hand is essential for maintaining momentum and fostering a productive learning environment.

Nicola Privato, a lab member and course tutor, reports that seeing the Organium in action, spatially laid out during the first lesson, significantly helped students to conceptualise their projects. The visual and physical layout of the Organium allowed students to brainstorm effectively with the library, leading most to develop project ideas by the end of the first session. This approach helped reduce their intimidation and encouraged creative and original reconfigurations. The Organium's prototyping panel facilitated this process, as students could try different sensors, and imagine them as part of their instrument or piece. In this context, lab members acted as facilitators or "organs", in an Aristotelian sense, where humans can also be considered to be organs or parts of the lab's ecosystem of knowledge. Most of the students, once they had defined what they wanted to do, needed some guidance. Different members of the lab would assist in areas such as e-textiles, programming, wood crafting, and with general maker technology, and here it was helpful that the system has many basic examples of hardware and software to build upon.

For effective interfacing, our approach to structuring the Organium was to group technical elements according to each facilitator's area of expertise. Instead of categorising strictly by sensors and actuators, we organised elements by interaction modes, materiality, communication protocols, or performance usage. The Organium's online database also played a crucial role, as students could access detailed information on specific components, brainstorm ideas, and develop potential projects. The intense development and application of technology and methodology for this course was an intense use case for the system. Following this core development of the system, we have conducted various workshops where highly advanced projects were developed in a very short amount of time, thanks to iterative refinements of both processes and technology.

4.3 Sonic Prosthetics

An ongoing collaboration with artist Marco Donnarumma has been invaluable for the development of the Organium. Donnarumma's practice, with focus on the creation of technological bodies, explores the interplay between sound and the human form in performance, emphasising our inherent cyborg nature [16] while critiquing the technodeterministic tendencies of the notion. As an associate researcher at the lab, he is working on his project *I am Your Body*, which involves individuals from the d/Deaf and hard-of-hearing communities in processes of artistic research as well as in the development of techniques for sonic prosthesis. The core of this project is to explore how d/Deaf bodies perceive sound and envision alternative ways of performing, expericencing, and thinking about sound and music. Here, sound is not necessarily auditory but felt on the body through various perceptual modes, with AI acting as a mediator.

During his residency in our lab, Marco Donnarumma furthered his technological and artistic development, applying components of the Organium in workshops held in Germany. Participants in these workshops experimented with technical elements using instructions and information from our online database. The outcomes formed the foundation of the performance piece *Ex Silens*, which debuted at the PACT Zollverein Centre for Art in Essen in 2023. In the piece, various custom-made prosthetic devices were developed and used, such as vibration transducers placed on the skin in the

Figure 7: Prosthetics for sound perception developed by Donnarumma

form of ear bones driven by a real-time audio generation and processing system created by the artist using our tools Tölvera and Anguilla, among others.

These devices emphasised the importance of non-cochlear sound perception, challenging audist approaches to listening and musical performance. The workshops and symposium highlighted the role of prosthetics in the d/Deaf community, often viewed negatively — as one keynote speaker termed it, "the tyranny of the prosthetic." The workshop and the following symposium generated a broad discourse on non-cochlear prosthetics and the perception of sound through various sensory modalities, expanding the understanding of sound beyond traditional auditory pathways. According to Donnarumma the Organium worked extremely well for this purpose, as it was easy to rebuild the technical elements in another country, and consequently extend the lab's experimental ecosystem.

4.4 E-Textiles

Sophie Skach, a postdoc at the lab, focused on developing innovative technical elements. Her primary research, apart from being highly involved in other lab research projects, consisted of creating a system of e-textiles that became an integral part of our technical library [63]. With her background in textiles, e-textiles, and interface design, Skach introduced the concept of textile interfaces as fuzzy controllers: soft textures that offer a distinct ergodynamic feel compared to the hard, cold surfaces of typical musical interfaces made from plastic, rubber, metal, or glass. Skach conducted experiments with knitted and woven materials, integrating them with embedded computers and actuators from the Organium. The Organium's readily available resources facilitated prototyping and quick making of assemblages. The e-textile elements she developed have since become valuable components of the Organium, showcasing the potential of new material agencies to expand interactional gestures. These elements are particularly useful in interface design when the goal is not precision and control, but rather feel, exploration, and intuition—key aspects of haptic communication and affective computing [57].

Our experience with e-textile interfaces—whether in the feedback circuit of a no-input mixer, for parametric control of an FM synthesizer, or while exploring the latent spaces of RAVE neural audio synthesis models [14], showed that high precision control, often necessary in studio work and typical of conventional MIDI controllers, is not always needed nor preferred in musical expression. Instead, the e-textile elements encouraged exploration and tactile navigation of sound within the neural synthesis model. The open lab sessions focused on e-textiles were both educational and enlightening, facilitating new collaborative and expressive modes of music making. Textiles, with their diverse connotations for different demographic groups, sparked productive ideas, comments, and suggestions. For instance, in discussions around using locally sourced wool people described their affective relationships with the material, detailing its treatment and knitting in ways not seen with typical HCI interface materials. This highlighted issues of gender diversity [65] and opened up new collaborative opportunities. Integrating e-textiles into the Organium introduced playfulness, experimentation, and improvisation in creating new interfaces and fostering new forms of collaboration. The exploratory nature of interacting with soft materials like textiles positions the user in a fresh phenomenological relationship with the device, constructing a new embodiment of HCI and AI in the realm of music.

Figure 8: Testing of some e-textiles elements

4.5 Ludic Systems

A key aspect of our phenomenological approach to studying instruments focuses on the first encounter—the initial moment of seeing and touching—followed by a more extended process of familiarisation from both conceptual and embodied perspectives [3]. How do we perceive these systems, and how do we make sense of them? This approach was explored by postdoc Giacomo Lepri while working with various materials as part of the Organium. Lepri has an extensive practice of creating playful interfaces, engaging with design fiction, and developing fictional instruments. He explores the notions of use and uselessness in interface design, investigating how we make sense of AI and examining technological agency as a relational and perceptual phenomenon. Lepri frames digital interaction as a magical unknown, where technological liveness and intelligence are perceived with a sense of wonder and metaphorically expressed. This aligns with his broader exploration of absurd making, fictional systems, and playfulness in design practices [36][37].

While working at the lab, Lepri explored the notion of fetish in musical instruments and explored our anthropomorphic tendency to assign agency to inanimate objects. His installation project, called *Pluma*, sought to exploit our understanding of AI instruments through what Andersen calls the "magical unknown" [1]. This perspective can help us better understand AI and musical agency as relational phenomena, not solely as properties of a given design. To provoke thought, we aim to evoke this magic: technological intelligence exists because we believe it does. Lepri built a system that responded to people's behavior, creating a peculiar relationship where a feathery speaker object would whistle at spectators, often responding in an "animistic" manner. This project opens new research directions in our lab, particularly in the area of animistic design [46].

Figure 9: The Pluma sound installation

During the development of the work, the Organium facilitated the design process in various ways. From a material perspective, it provided direct access to a vast collection of basic and interconnectable tools, which were used to prototype elements of the instrument - e.g. testing different actuators and speakers. Most notably, these material stimuli then fostered exchanges with the researchers which developed them. In the case of Pluma, the Organium functioned as an advantageous platform to get to know and experiment with e-textile elements developed by postdoc Sophie Skach. The configuration of fabric (to hold feathers) and conductive threads (to sense touch) present in the instrument directly resulted from the interaction between Lepri, Skach and her artefacts. Pluma illustrates how the Organium promoted the emergence of socio-material networks combining human synergies and material assemblages. Beyond the technical domains, the Organium then supports transversal trajectories of collaboration which usually are in-between disciplines and shaped by both personal knowledge and situated technologies.

5 CONCLUSION

In this paper we have presented the Organium: a library of technical elements designed for improvisatory design thinking. We have demonstrated how it serves as a crucial infrastructure for a dynamic lab which operates as a performative experimental ecosystem in the fields of music technology and experimental humanities. We described some key features of the library, including its physical layout which affords spatial thinking, quick access, and plug-and-play assemblage. The paper gives illustrations of the database system and a link is provided where the system can be explored. We discussed how the Organium integrates code and hardware technologies into a cohesive ecosystem, offering an effective solution for improvisatory design. Additionally, we highlighted its central role in our lab culture and methodology, emphasising its importance in supporting transdisciplinary collaborations and using projects as boundary objects to facilitate deeper understanding of our research topics. Furthermore, we outlined how the Organium reflects and enhances the intelligent system of the lab-as-infrastructure, both technically and socially, co-producing knowledge and innovation with its users.

One of the primary motivations for writing this paper at this point in time is to establish open communication with other research labs that host other systems, research methodologies, and more-than-human assemblages. We are interested in supporting other collectives in adopting and contributing to the development of the Organium. By framing the Organium as a collective boundary object, we invite further discussion and scrutiny of its material and software agencies. We are particularly interested in researchers' insights on how a spatial layout of technical elements influences their technological thinking, invention, and experimental practices. Given that this year's Audio Mostly conference focuses on the "interdisciplinary exploration of sonic cultures" and "fostering dialogue and collaboration across disciplines" it provides an ideal platform to introduce our system and foster more extensive collaborations.

As this paper has argued, technological elements evolve — encompassing hardware, protocols, code libraries, operating systems, and more — but what remains is the technical know-how and interaction modes that are developed, tested, and shared. These are types of technical memories that manifest as ideas, implementations, and embodied gestures, that persist and can be utilised in other assemblages. The next step in our project is to explore, through critically engaged ethnographic design inquiry, how the living knowledge of the lab is produced and preserved through the co-creation of its multiple agencies. Additionally, we aim to understand how the lab is embedded within, and interacts with, the broader Icelandic cultural and geographic landscape. We seek to delve into the knowledge that both generates and is generated by the socio-technical networks of more-than-human agencies. Can such a system-within-a-system enable feral means of "making kin" across human-built infrastructures, which are revised by non-human entities? In these interstitial spaces, much remains to be examined. Our goal is to trace the layers of the past and prepare to store the technicity of the future within a library system of living knowledge. The digital luthier is always a media archaeologist of the future.

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