Making Up Instruments: Design Fiction for Value Discovery in Communities of Musical Practice

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ABSTRACT

The design of a new technology entails the materialisation of values emerging from the specific community, culture and context in which that technology is created. Within the domain of musical interaction, HCI research often examines new digital tools and technologies which can carry unstated cultural assumptions. This paper takes a step back to present a value discovery exercise exploring the breadth of perspectives different communities might have in relation to the values inscribed in fictional technologies for musical interaction. We conducted a hands-on activity in which musicians active in different contexts were invited to envision not-yet-existent musical instruments. The activity revealed several sources of influence on participants' artefacts, including cultural background, instrumental training, and prior experience with music technology. Our discussion highlights the importance of cultural awareness and value rationality for the design of interactive systems within and beyond the musical domain.

Author Keywords

Musical Instrument Design; Design Fiction; Non-Functional Prototyping; Value Discovery; Communities of Practice.

CCS Concepts

•**Human-centered computing** → **HCI theory, concepts and models;** *User studies;*

INTRODUCTION

In her article *The De-Scription of Technical Objects* Madeleine Akrich suggests that a designer "express a scenario of the device in question - a script out of which the future history of the object will develop" [2]. According to Akrich, a large part of the work of innovators is that of *inscribing* a vision of the world (e.g. predictions about specific behaviours and norms) into the future artefact. In this way, a designer provides a *key* of interpretation for all the subsequent events and uses related to the object. Although users will add their own understanding, the *script* will become a major factor for interpreting the interaction between technology and users [2].

Beside technical expertise, the design of a technology therefore entails the inscription of accountable values situated in specific communities, contexts and cultures [81]. Considerable HCI research has highlighted the benefits of cultural awareness while designing artefacts. Norman introduced the idea of *social signifiers*: perceivable cues that suggest social activities and behaviours for us to interpret "group, social, and even cultural computing" [72]. Horn, focusing on tangible interaction design, highlights the importance of the "overall experience around an interactive artefact" [50] suggesting that designers can evoke existing "patterns of social activity". If cultural values inscribed into designs imply interpretations and uses, by unfolding and revealing them we might exploit tacit cognitive, physical and emotional resources linked to social constructions and conventions [77].

This article can be considered as a value discovery exercise [59] involving design fiction [7] and community-based design methodologies [32]. We focus on music technology, both because its rich cultural influences and contexts are relatively easy to identify, and because there exists an established discourse around music and HCI. In the context of instrument design, it is possible to argue that a luthier transfers into a music technology specific cultural values [62]. Instrument makers envision for their instruments contexts (e.g. performance venues, schools), aesthetics (e.g. tuning systems) and behaviours (e.g. idiomatic performance techniques). Likewise, musicians can be considered influential vectors through which musical values are conveyed within communities. The roles played by music practitioners active in particular contexts is crucial for the generation and reproduction of cultural values. Different musical communities might then develop different values influencing the understanding and use of music tools [45].

The work presented here aims to explore how diverse musical backgrounds related to communities of musical practice influence the foresee of music technology. To do that we designed a workshop in which musicians active in different musical contexts are invited to imagine and sketch not-yet existing music instruments "as if by magic". What we are looking for is a sense of the range of interests and concerns we might find across the various groups, rather than suggesting a general

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taxonomy of musical backgrounds and instrumental values. Our intention is to show the breadth of possible values and priorities in relation to different music cultures and communities of practice [88], and by extension some processes by which values might be queried in other areas of design and HCI.

First, we will cover relevant literature on the following topics: musical interaction in HCI, value sensitive design, community-based participatory design and design fiction. We will then introduce the instrument design workshop "As If by Magic" and the analysis of its main outcomes. Finally we will discuss our findings, reviewing their implications for music technology, design and HCI communities.

BACKGROUND

Technology and Aesthetics in Music and HCI

The most common intersection of musical practice and HCI research can be found in communities concerned with the design and evaluation of Digital Musical Instruments (DMIs), such as the International Conference on New Interfaces for Musical Expression (NIME) [55]. Indeed, workshops and edited volumes on music and HCI often consist heavily of DMI-related research [48]. Whilst acknowledging the affinity between those communities in concepts and methods [87, 92], it is important to note that DMI practice does not necessarily represent a neutral *aesthetic* cross-section of possible research in music and HCI.

While digital music communities are sometimes criticised for being preoccupied with technical factors [45], an equal challenge is not the lack of aesthetic reflection but rather a surfeit of latent cultural assumptions. NIME practice partly inherits from *musique concrète* and *elektronische musik* traditions. Although a full review is beyond the scope of this paper, it possible to argue that postwar serialism, Cageian indeterminacy and *algorithmic composition* have strongly influenced NIME research [76, 25, 30, 44]. These are not idle considerations: a study of DMI performance showed that musical style had a substantial effect on audience enjoyment, while technical familiarity with the instruments had no effect [14].

Against this background, it is worth considering that even generic design principles of DMIs such as *mapping* (data relationships between actions and sonic features [52]) may have cultural overtones (in this case, perhaps a post-serialist tendency to organise musical events into multidimensional feature spaces which are systematically explored over time). Such overtones become in important in design toolkits and participatory design exercises which seek to let musicians create their own instruments [63, 68]: whatever the merit of the resulting devices, it is unclear whether such exercises can truly reveal the values of musicians not already part of the DMI community.

There remains considerable value in HCI research around musical communities whose performance practice does not explicitly involve computing. The work of Benford and colleagues is notable in this area, including ethnographic studies of Irish session musicians [12] and DJs [1] and a technology probe study involving a purely acoustic guitar accompanied by scannable digital codes [11], each of which reveal some of the underlying values of their communities. However more work remains in querying what musical communities expect from their instruments, and the role that computing might play, before committing to any particular approach to technology creation.

Value Discovery and Representation

Within HCI, a number of approaches and analyses have been developed which aim to elicit stakeholder views and values [79]. One of the most recognised methodologies for the translation of human values into technical design decisions is Value Sensitive Design (VSD). VSD was introduced by Friedman, Khan, and Borning [35, 39] and it can be defined as "a theoretically grounded approach to the design of technology that accounts for human values in a principled and systematic manner throughout the design process" [36, p.64].

A key feature of value sensitive design is the sourcing and identification of potential values. Within a project, values' working definitions should then be agreed amongst *parties* (e.g. designer and stakeholders) and it can also serve as evaluation criteria. A working definition of *value* within VSD is: "what is important to people in their lives, with a focus on ethics and morality" [36, p.68]. Methods concerned with empirical investigations for value discovery and representations include value scenario [67, 91], value sketches [90] and semi-structured interviews [37, 28].

Value-driven research is often concerned with the incorporation of moral and social values (such as sustainability, privacy, democracy, inclusivity and accountability) into technology design [84], aiming to design technologies that could help shaping better societies and improve quality of life [38]. On the other hand, various research approached the discovery of stakeholders' values based on more culturally-specific, participatory and user-centred processes [22, 59]. Our work is oriented towards these kinds of mediation [53] in order to explore patterns of experience and meaning-making [47] related to the engagement with music technology.

One of the most common approaches to VSD involves a 3-phase process that supports the emergence, development and grounding of values [53]. This represents the full cycle of a values-led inquiry: from the process of early analysis to the development of the final product. Our paper tackles solely this emergence phase, illustrating how we can support the emergence of values during the initial phase of a values-led inquiry. This research therefore foresees an empirical exploration of values as situated knowledge embedded into subjective perspectives and practices [46, 82].

Communities of Practice and Design Research

We understand communities as groups of people sharing *interests* and *practices*. More specifically we rely on the notion of *community of practice* introduced by Lave and Wenger: "a group of people who share a common interest or activity and that belong to a social structure that reflects shared histories of learning" [88]. The musicians involved in our workshops share specific musical backgrounds (learning and educational processes), instrumental expertise and ensemble practices. These elements are also situated in specific places

and social gatherings (e.g. music schools, concert halls, clubs and festivals).

Based on Anderson's contributions, we also interpreted communities as requiring shared *imaginaries* [9] intended as sets of values and symbols common to a particular social group [83]. In our case, we are interested in both the sharing of interests towards specific aesthetics (e.g. musical genres) and in common legacies received from music traditions (e.g. influential musical contributions and narratives related to specific social groups and geographical areas).

Participatory Design (PD) research often aims to work with and for communities by "focusing on the social constructs and relations of groups in settings" [32]. Within the vast spectrum of community-based PD research, it is possible to identify projects that share some of our interests and goals. These include the fostering of cultural productions as a way to *make public* subjective views and creative expressions of first- and second-generation immigrant youth [15], and the mediation of stakeholders' values during the initial phase of a PD inquiry where digital technology was designed to support the experience of adults with severe intellectual disabilities in art museum [54].

Making Fictional Designs

Design fiction can be defined as "the deliberate use of diegetic prototypes to suspend disbelief about change" [61, 16]. Researchers often refer to the notion of *diegesis* as one of the key features related to design fiction practices [17, 80]. Bleecker and Kirby introduce *diegetic prototypes*, stressing that design fiction artefacts exist within a narrative [57]. This implies a critical understanding of fictional objects as means for the creation of story worlds and discursive spaces [61].

The narratives that an artefact might convey are not just about the imagined device and its functionalities [17], they rather contribute to "the creation of *cultural objects*, allowing them to act as prompts for a story *we tell about ourselves*" [5]. These prompts might embody fears, desires and priorities within open-ended design spaces [17, 41]. Thus, the ambiguity that often characterised fictional artefacts often announces the generative power of these investigations [42, 18].

During the years, design fiction has taken various forms including textual-visual "counterfunctional" artefacts [73], pastiche scenario [20] and material speculation [86]. Our work builds on Kristina Andersen's Magic Machines workshops [7]. Drawing on diverse artistic practices [21, 78] and Dewey's notion of experience as a process of becoming [31], Andersen exploits the notion of "magical unknown" to free a participant's imagination and generate manifestations of unknown technologies [8]. The Magic Machine workshop has been developed within a larger body of work exploring embodied making processes such as "magical thinking" and "thinking with the hands" [5]. This includes workshops for the ideation of new instruments and interfaces conducted with both professional musicians and children [6, 7].

The research here presented is therefore based on the idea that "embodied making processes facilitate a different form of thinking" [5]. Through the act of building, narratives entailing the maker's intentions, motivations and feelings can emerge. The researcher should then first facilitate the generation of make-believes and then, with the help of the creator, explore possible narratives to interpret and provide clues to the fictional musical devices.

Figure 1. Workshop materials and tools: cardboard, disposable cups, paper plates, masking tape, a roll of twine, scissors, wire cutter, paper clips and pins, a roll of metal wire, plastic ball, elastic bands, straws and toothpick.

AS IF BY MAGIC WORKSHOP

This section introduces the As If By Magic workshop, a hands-on activity in which musicians active in different musical contexts were invited to envision not-yet existing musical instruments. The purpose of the workshop was to produce cultural low-fi artefacts [5, 40] through crafting activities. Since workshop aimed to explore possible design spaces emerging from the musicians' subjectivity, it was conceived as an open-ended exploratory experience. The intention of outlining an open-minded setting also influenced the selection of materials provided: mundane and everyday objects.

Andersen's original workshop aims to encourage participants in the direction of thinking outside the box in order to promote a shift outside their normal way of thinking about music and musical instruments. The workshop facilitator should thus carefully balance two parallel processes: the promotion of novel ideas while letting participants follow their trains of thought without interference.

Our approach is more focused in the emergence of existing musical values and instrumental concerns rather then provoking new disruptive ideas and designs. We therefore approached the task of conducting the activity with the intention of exploring latent assumptions on music technology. We are not interested in the novelty per se; instead we exploit the workshop to elicit participants' internalised musical values that influence their expectations of the nature of musical instruments.

Drawing on Andersen's approach, the terminology used while introducing the workshop tasks have been carefully pondered. The word *magic* "is used deliberately to introduce the notion of new, powerful and unknown" [7, p.39]. Instead, the word *machine* evokes something rather undefined associated to the ideas of technology and physicality. The words *instrument*, *design* and *technology* are avoided in order to prevent participants limiting themselves to ideas they already consider

possible with current technologies. The language used aims to "open up the query beyond what it is adjacent to our current technologies"[7, p.35].

As we will argue in our discussion, Andersen's methodology proved to be an effective and powerful device to access cultural assumptions and subjective experiences. The analysis of the data collected is therefore a further step introduced by us in order to shed some light on the transferring of cultural and subjective values into fictional music technology artefacts.

Workshop Materials

The workshop materials (Figure 1) were selected according to Andersen's referenced methodology [7, p. 93]. While choosing the materials, we avoided tool kits, electrical components, sensors and software units. Most of the participants involved were not familiar with hardware and design tasks, the materials have been therefore selected to be perceived as not intimidating. Moreover, to support the creativity of the musicians we aimed to bypass paradigms, uses and discourses linked to existing technology.

It is not our intention to negatively label research that encompass the design and analysis of toolkits for the development of new musical instruments (see [24, 10, 63, 68] for successful examples of this approach). However, we are convinced that a given technology always embodies specific uses, intentions and meanings. In sustaining this argument, we are particularly influenced by three well-known considerations (respectively belonging to design, media studies and philosophy). The first consideration refers to notions of *perceived affordances* as introduced by Norman within the context of HCI. In a rundown, a design provides *clues* [70, 71]. We avoided tool kits, electrical components, sensors and software units because of the affordances already present in the given technologies (as properties both related to the actual objects and dependant on culture, prior knowledge or expectations of the person).

The second consideration draws back to McLuhan's statement "the medium is the message", where the notion of medium should be understood in a broad sense. To better articulate this concept, McLuhan argues that although a light bulb does not have contents in the way that a newspaper has articles, it is a medium that has a cultural and social effect. Thus "a medium without contents" that enables people to create spaces through its "mere presence" [64, p.8].

The third consideration concerns the philosophical argument developed by Günther Anders on the *ineluctability of the technique* [4]. In his analysis of the technique in second and third industrial revolutions, Anders suggests that the mean (available technique or tool) define its own scopes (aims for which the technique is used) and not *vice versa*. In other words, the uses and purposes of a technology are nothing but the possibilities made available by the technology itself. Anders not only argues that each tool generates its own purposes, but he also advocates that in the eventuality of a technical possibility its realisation is almost inevitable.

Based on these arguments, we privileged everyday objects: by sidestepping materials directly linked to existing designs and functionalities we aimed to free the participants and facilitate the emergence of individual values and purposes.

Participant sampling

The various workshops involved 29 musicians: 20 male, 9 female, aged between 16 and 65 (average 32). After recruitment, detailed information on each participant's instrumental background, musical practices and aesthetic preferences were collected through an online survey (see "Analysis" below). Our sample consisted of musicians active in the following musical communities:

- **Ethnic**[1] - Afro-Cuban 2 musicians, Middle-East 2 musicians, Balkan 2 musicians, Italian-Folk 1 musician;
- **Classical** - Classical orchestra repertoire 6 musicians, Contemporary Classical / New Music 2 musicians;
- **Electronic** Electroacoustic 5 musicians, IDM (Intelligent Dance Music) and Alternative 3 musicians;
- **Improvisation** Free Improvisation (electronics excluded) 3 musicians;
- **Rock, Pop and Jazz** - Rock and Pop 2 musicians, Jazz 1 musician.

We are aware that the term *community* is a difficult qualifier. The appreciation of shared identities within social groups should always be balanced by the acknowledgement of pluralities that often characterise communities. Thus, the researcher should always work with great care not to reduce and essentialise participants or communities [32].

Professional musicians are often engaged with two or even three different musical communities, thus dealing with different practices, genres, aesthetics and styles. Furthermore, in addition to traditional instrumental skills, 9 participants declared to have music technology expertise (i.e. a strong multidisciplinary background). However, for each participant it was possible to identify a community of practice and two genres (primary and secondary) in line with the various backgrounds and music activities declared.

Workshop Design

During the As if By Magic workshop the musicians engage with the activity of sketching a *magic machine* that should address performative features or sonic possibilities defined by the participants themselves. The overall duration was around 1 hour, depending the number of participants. Although our workshop design is similar to Andersen's work [7, p.30], we now briefly introduce the main steps of the activity.

After a brief introduction (welcoming and presentations) the musicians are provided with two prompt activities: (i) write down a relevant aspect of your instrumental musical practice (ii) draw one sonic element of a music you particularly enjoy playing or listening to. The aim of the prompts is to situate

[1] In this context we use the term 'ethnic' as shorthand for specific regional musical traditions rooted in the history of a particular community, while acknowledging that the other musical communities in this study may also be considered to exhibit these properties.

the work within the musical practice of each participant (i.e. instrumental and aesthetic outlooks). The prompt activity is an achievable and fast task that frames the upcoming design phase.

The musicians are then asked to use the available materials to build the *machine* that addresses the prompt. Thus, participants are invited to build mock-up instruments that work *as if by magic*. The contents of the prompts must be translated into an imagination of the device that privileges, supports or produces them. Once the group has finished building the *prototypes* the facilitator invites the musicians to present their machines and explain its functionalities (e.g. how should the machine be played?). After each presentation, the facilitator invites the whole group to share comments, impressions and ideas.

This activity takes the form of a group discussion and it aims to explore possible divergent interpretations of the artefact and the degree of agreement in regard to the ideas proposed. During the first phase of the workshop, we provided general instructions and clarified requirements while taking care not to suggest ideas. For group discussion, the facilitator tended to ask open-ended questions, often inviting participants to elaborate on phrases the participants themselves previously said.

Overall, we ran 8 workshops with an average of 3 participants per workshop. The scheduling of the activities was organised to group together musicians belonging to the same communities of practice, with the aim of eliciting shared values and concerns within each community.

ANALYSIS

The analysis of the data focused on establishing connections between the workshop results and the cultural heritage of the musicians involved. More specifically, once we were able to identify analogies within communities, we aimed to look for theoretical explanations in relation to the similarities and differences spotted between the groups. This is based on the idea that cultural phenomena can be better understood when they are compared in relation to contrasting (meaningfully different) cases [23]. This process led to the identification of different perspectives related to the interpretation of not-yet-existing music technologies (see "Discussion").

Our analysis included both the workshop outcomes (i.e. mock-up instruments and interviews) and the information gathered through the online survey. For each participant, we were able to gather information related to (i) the instrument(s) played and the year of practices, (ii) the genres of music studied and currently practiced, (iii) aesthetic and stylistic preferences (i.e. favourite genres and influential musicians or ensembles). These data related to the musicians' background were organised in a set of variables:

- **Main Genre** - Jazz/Blues, Classic, Rock, Soul, Middle East, AfroCuban, Balkan, Electroacoustic, New Music, Free Improvisation;
- **Second Genre** - Classic, Electronic, Funk, Alternative (misc), World music, Pop Rock, Middle East, Europena Folk, Ancient, Jazz, Free Jazz, New Music;
- **Main Instrument** - Guitar, Bass guitar, Plucked Ethnic, Percussion Ethnic, Trombone, Flutes Ethnic, Piano, Electronics, Karlax, Cello, Flute, Violin, Saxophones, Voice
- **Year of instrumental practice** - Ranging from 2 to more than 20.
- **Second Instrument** - Bass guitar, Modular Synth, Electronics, Percussions Ethnic, Piano, Marimba, Plucked Ethnic, Guitar, Theremin, Voice, None
- **Instrument Design Expertise** - High, Medium, Low

Regarding the level of instrument design expertise, almost half of the musicians involved (12 participants) did not have specific knowledge and experience related to instrument design. On the other hand, 10 participants declared to be involved in the development or modification of instruments or technologies for music performances. The remaining participants declared to have had some experience in repairing existing instruments or building simple music interfaces.

Both prompts and machines were documented (i.e. pictures) for the later analysis. The group discussions and presentations were audio recorded and manually transcribed. These data were analysed following a thematic analysis methodology [29] characterised by a data-driven (inductive) approach: looking for patterns, similarities and correlations while analysing the data [75]. The various codes were collected in a codebook which as been systematically updated and refined. The various codes were organised by categories: groups of codes that shared specific elements and features.

We conducted five iterations of coding, and only once the code book was established did hypotheses or theories emerge. The method adopted (from open coding to categories formation) forced us to critically look at data through many lenses [49] and each concept earned its way into the discussion by repeatedly being present in "row" data [27]. The full process of our data analysis can be summarised in the following steps:

- Open coding - formation of initial codes from our interview data. We read the data in order to become aware of (i) the most present words and phrases and (ii) the information that seems to be of importance or interest to the research.
- Codebook - collection and re-assembling of initial codes. The codebook is constantly updated and refined at each coding iteration. Each code is made of a label, a definition (with inclusion and exclusion criteria), and examples. The codebook was developed to: (i) identify central phenomenon (e.g. representation of musical activity); (ii) explore causal conditions (e.g. presence of puppets and figurines representing musicians); (iii) identify context and intervening conditions (e.g. musician declarations on the artefact).
- Category emergence - hypotheses (i.e. themes relevant to specific issues) were formulated using the codes defined. This process entailed the selection of the core themes, systematically relating them to other themes and validating

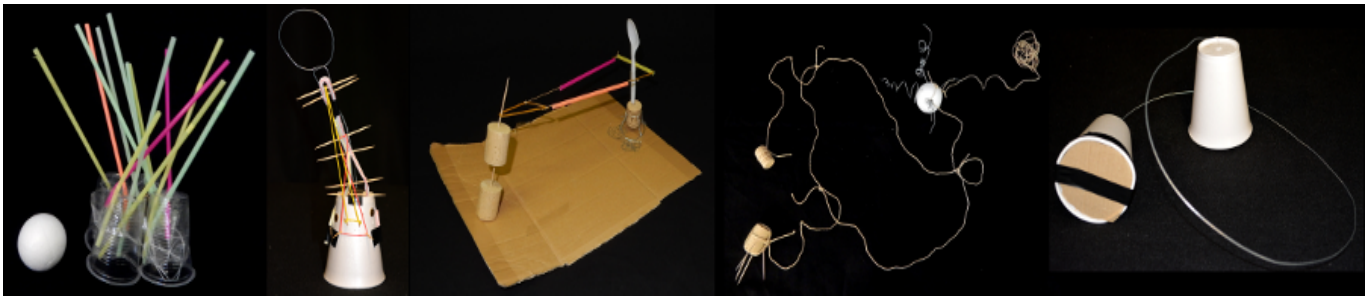

Figure 2. From left to right: (a) *Corpo Souno* an organ inspired instruments with tubes filtering the air, (b) *Antenna Lele* guitar like instrument with bendable neck, (c) *Conductor and Orchestra* representation, (d) *Sonic Alarms* wire based instrument for upper and lower limbs, (e) *Personal Shaker* connected cups filled with materials that only the performer is able to listen to.

those relationships. Codes relate to a common theme were grouped together through a criterion of higher order commonality defined as category.

- Concepts - grouping categories to find yet higher order commonalities for the emergence of high-level ideas [3].

FINDINGS

Artefact Interpretation

One of our main findings relates to the participant understanding and interpretation of the produced artefacts (i.e. the nature of the objects designed). It was possible to identify three main approaches to the presentation and interpretation of the various mock-ups: functional artefact, prototype and representation.

Representation - the artefact is described as a representation of a musical activity (e.g. playing or listening music). The artefact components are often associated with elements related to the targeted activity (e.g. people, objects, spaces or actions). The artefact does not imply any functional element and it is not linked to the ideas of machine, tool or instrument. These mock-ups often include puppets, dolls or figurines. The artefacts can also represent a more abstract idea (e.g. notion of music) or a state of mind (e.g. intimate and focused condition achieved while playing). This approach is rather common within the classical and ethnic communities, and nearly absent in the other groups.

LF (classical, see Figure 2 (c)) - *"So, mine is not exactly a musical instrument.. it is more like a representation of music.. and I did represent the orchestra.."* **CP** (classical) - *"This would be the musician, and this would be the audience.. and so the elastic bands are the connection between the musician and the audience.."*

Non functional prototype - the artefact is introduced as a model for a potentially workable instrument. Although there might still be abstract or undefined elements, the makers tend to associate specific functions to specific parts of the artefacts. Moreover, the participants might evaluate the model in terms of plausibility (e.g. considering scale and range). In order to describe the prototype, the designer might refer to: modalities of input, interactions between the artefact elements, structural or aesthetic elements, different versions of the same object. This type of artefact is prevailing within the electronic music community but it can also be found amongst classical and pop-rock-jazz musicians.

GN (classical, see Figure 2 (a)) - *The air should go through the tubes, which have different timbre and frequencies, because they are made of different materials and different lengths.. so each of them is conceived for a type of sound"*

Functional artefact - the musician builds an artefact that can actually make sound, although this was not required by the workshop instructions (i.e. make as if by magic). Most of these objects are intended literally as functional and often a proper demo showcased to the participants (eventually playing the instruments together as an improvised ensemble). In some cases, musicians apply basic instrument design knowledge (e.g. making a reed out of a straw) as an easy solution to the workshop task. This often happened with ethnic musicians. Free improviser and electronic musicians were instead more interested in the actual exploration of the sonic possibilities of workshop materials.

AN (impro) - *"You just have the reaction of the elastic bands.. you move these around.."* **HE** (rock-pop, see Figure 2 (e)) - *"I was trying to make a certain sound with the things that are available to me.. so I was like what can I do with these? It's like a proper sound!"*

Technological References

Further elements emerging from our workshops are the analogies with familiar musical tools. While introducing the artefacts, the musicians tended to discuss the objects in relation to traditional instruments or current music technologies. However, ideas and designs not easily associable to actual music performance devices are also introduced.

Traditional instruments - while analysing the presentations, it is possible to identify direct analogies to traditional instrument (e.g. classical orchestra or ethnic instrument) or traditional playing techniques (e.g. air emission, bowing, singing, plucking). Moreover, the artefacts themselves often resemble features clearly suited to the Hornbostel & Sachs original classification [85] (i.e. electronic instruments excluded). Apart from electronic musicians, all the groups generously refer to traditional instruments.

PB (ethnic) - *"The Egyptians call it 'Mismar'.. the idea was [to build] a wind instrument broadly from this family"* **AB** (jazz, see Figure 2 (b)) - *I'm gonna call mine Antenna Lele.. it has a neck then you can fold in several parts to get different notes..*

Current electronic music technology - Musicians also tend to provide references to existing electronic music technologies and instruments (e.g. synth, sampler, sequencer, drum machine, laptop and software instruments). These are generally not easily classifiable using the Hornbostel & Sachs original system. Allusion to existing techniques and tools used in sound and music computing contexts (e.g. representation and retrieval of audio data or digital sound processing techniques) were also reported.

Interestingly, within our groups, these references are the least frequent. As expected electronic musicians were the most active in mentioning this type of technology. However, regardless the musical community, participants with a music technology background tended to include current music technology in their descriptions.

AA (electronic) - *"It looks kind of like the Laetitia Sonami thing.. built at STEIM right? so the Web.."* **BL** (classical, working in a music technology lab) - *"This is like a programmable instrument.. either it can take some input and then play it by itself or it records what do you have played and output some MIDI files or OSC"*

Not existing music technology - the artefact is introduced as a not-yet-existing technology (not necessarily electronic) or technique for music performance. These could be completely imaginative or related to objects not belonging to music performance contexts. Within our groups, electronic and improvising musicians seemed to be the most keen to envision disruptive instruments that tend to step outside the borders of current technology.

WC (electronic, see Figure 2 (d)) - *"The idea of making this thing, that is between a fishing hook and a bolas.. maybe it would be nice to have an instrument that could throw things.."* **GB** (electronic) - *"The problem here is that this instrument is a one-shot instrument, you can use it only one time.."* **AK** (impro) - *"It makes me think of like a really badly made spaceship.."*

Expression and Perception

Our musicians often used the mock-ups to talk about the act of communicating with listeners and stimulating feelings through sound. Emotions, then, might belong to the audience as well as to the musician herself that feels while playing.

LF (classical, see Figure 2 (c)) - *"Even if it is not very easy to represent.. it is there.. the conductor passion is what moves and transfer everything to the orchestra.."*

The perception of music and sound it is also an emerging theme. The act of listening is often considered as a fundamental ability that musicians must constantly develop. The artefacts might support the abilities of listening and feeling both yourself and the others (e.g. audience or ensemble members). Thus, the idea of feeling inner and outer musical worlds is crucial and abilities such as focus and sensitivity are important elements often embedded into the fictional instruments.

OM (ethnic) - *"This is something that amplifies listening abilities.."* **LT** (folk-ethnic) - *"This element is related to the perception of sound, meaning and emotion.."*

These concerns are generally distinctive of the classical, ethnic and pop-rock-jazz groups. The idea of *expression* intended as *moving* people through the music produced by the instrument was a recurrent topic in these communities. Moreover, these concepts were sometimes linked to the interpretation of a *repertoire* that is culturally grounded and codified.

LF (classical, see Figure 2 (c)) - *"One of the first thing I thought about is Rhapsody in Blue.. the piece we are playing with the orchestra.."* **AB** (jazz) - *"That's related to a MIDIfied representation of a Jazz standard I am listening a lot lately"*

On the other hand, electronic musicians and free improvisers tended to manifest compositional interests and the use of the term *expressive* would typically refer to the possibility of exploring and manipulating sounds.

FC (electronic) - *My instrument basically allows for different expressive possibilities.. it allows for the possibility of creating different timbres.. rubbing, impulsive and emission..*

Musical Aesthetics

As hoped, many subjective preferences on musical aesthetics and stylistic taste turned up. Classical and pop-rock-jazz musicians mainly described the imagined output of their instruments in terms of music theory: notes, pitches, rhythms, dynamics and polyphony. The sonic qualities foreseen were mainly associated with traditional instruments with allusions to rock-pop-jazz ensembles or to orchestral sonorities.

AB (jazz, see Figure 2 (b)) - *"I wanted an instrument that was able to play single notes, melodies and harmonies but with lots of flexibility.."* **TV** (rock) - **SS** (classical) - *"I guess it's a sort of like organ sound that I have in mind.. you could actually be operating something quite chordal altogether and moving quite polyphonically.."*

While introducing musical ideas, the notion of timbre was predominant within the electronic group. The alleged sounds produced by the mock-ups were often described in relation to physical behaviours (e.g. interacting objects) relying on acoustic and physical principles. Moreover, mathematical and scientific notions often drove the musical and compositional imaginations.

AA (electronic) - *"I've been thinking about how to build an instrument, an acoustic instrument, that only outputs prime number frequencies.."* **VR** (electronic) - *"I like the sounds of the rain like granular that start from nothing and arrive to everything.."* **FC** (electronic) - *"this sums up the different expressive possibilities: rubbing, impulsive and emission.."*

Similarly, improvisers were interested in using the artefacts to navigate sonorities and explore musical ideas. However, we found two main differences from the electronic group. First, rather than starting with some compositional idea in mind, improvisers tended to build their instruments from scratch. Second they tended to empathise the importance of feeling sounds and materials while composing them.

AK (impro) - *I think it's plucky both in nature and in personality.. you're immediately in this funny realm of something that sounds quite like fakely..* **EW** (impro) - *"being grounded and open enough so that the voice emerges as if by itself.."*

Body Interactions and Technological Agencies

In regard to the instrument-body relationships we were able to identify different trends. Various musicians, often classical and pop-rock-jazz, tended to specify how to control specific artefact elements with specific body parts, often focusing on hands gestures and comparing these to traditional playing techniques. Ethnic musicians used to have very similar concerns but, in addition, they often mentioned the possibility of having their instruments reacting to external sounds (as if able to resonate with the external world).

SS (classical) - *"The way you alter the sound would be similarly to the way that the French horn alters the pitch.."* **MF** (ethnic) - *"It receives vibrations and transforms them in itself.. it expanding them, like it resonates with other sounds.."*

Electronic musicians instead used to refer to gesture and control in a variety of ways. Besides hand gestures, full-body interactions were also considered. Gestures were sometime directly envisioned in relation to potential sounds, almost transcending the physical interaction to focus on the sonic dimension. Furthermore, this group tended to introduce notions such as autonomy and unpredictability. Thus stochastic and semi-predictable behaviours were often included into the instrument conception.

FC (electronic) - *"I'm interested to explore gestuality.. compositional gestuality.. as this is a creative gestuality, a gestuality that brings to build the sound through the material"* **LM** (electronic) - *"It would create a rhythm.. but it would always have slight differences"*

Finally, improvisers often focused on the exploration of the sonic potential of the materials as well as their possible combinations. In this sense, we could somehow identify a fluid approach to the assemblage of physical elements, where parts could be easily exchanged or removed without necessarily resolving into a definitive structure.

EW (impro) - *" I thought well maybe it just needs to remain loose.. It's an open instrument in the sense that open to things that can happen.."*

DISCUSSION: DISCOVERING VALUES

This section presents emergent values from our workshops in relation to current topics of discussion in music technology. The following section then generalises the findings to broader areas of design and HCI.

Communication-oriented Values

Mudd [65] examines two different perspectives on musical interaction: *communication-oriented* and *material-oriented* approaches, noting that "communication-oriented perspectives tend to foreground the agency of the human, whilst material-oriented perspectives draw attention to the agency of the technology". The communication-oriented approach is often supported by embodied music cognition with the instrument behaving as a *transparent medium* for human intentionality: "transparent technology should give a feeling of non-mediation, a feeling that the mediation technology disappears when it is used" [60, p.2].

We found communication-oriented values manifested in two ways: (i) the creation of abstract representations which essentially are about communication itself and (ii) the design of prototypes often intended as transparent technology for communication oriented processes. Examples of the first case include artefacts representing the orchestra and the conductor (see Figure 2c) or representations of the listening process. The second case includes functional prototypes of instruments through which specific body parts will manipulate well-defined musical elements (e.g. pitch, rhythm); in Mudd's words, these suggest "a sense of control, in order to tame the instrument and ensure that it accurately transmits the musician's intentions ... The subtleties of the sounds produced are manifestations of a performer/composer's whim" [65].

The first type occurred manly amongst classical and ethnic musicians, while the second occurred in these communities but also amongst pop/rock/jazz musicians. Both tendencies are generally *situated* in specific performative settings, e.g. considering the interpretation of a repertoire and the act of communicating to the audience or with other musicians.

Material-oriented Values

Gurevich and Treviño observe that within much of the NIME and HCI literature, there exists a tendency toward communication oriented values [45]. While we agree with their critique of the "reductive engineering" conception and evaluation of DMIs, our sense is that those community members most engaged with aesthetic theory are the ones already grounded in a material oriented approach. This approach sees technology as "a necessary mediation that can be a source of ideas itself rather than simply a means for their transmission" [65].

In our research, members of electronic and improvisation communities tended toward material-oriented values, expressed in two ways: first, through making functional artefacts focusing on the exploration of the literal sounds of the everyday materials (an approach found mainly in the improvisation community); and second, through nonfunctional prototypes accompanied by topics of discourse such as compositional metaphors [66], sonic exploration and artefact agency or autonomy.

An open debate in the NIME community concerns to what extent the use of computing technology rather than acoustic tools enables or even *demands* a material-oriented approach. In other words: if material-oriented interaction is a value of NIME, is this because of its use of technology, or in spite of it? Some useful reflections emerge from our work: first, the improvisers involved are not primarily music technologists, yet they still show material-oriented values. Second, **we found 7 participants** with a strong music technology background, but not involved in experimental music practices, whose values were communication-oriented in nature. Collectively, this suggests that the dividing line between approaches is not established by affinity for particular technologies but a shared

cultural heritage (e.g. experimental and vanguard musicians of the mid-20th century).

Recasting Tradition: Practice-oriented Values

While analysing the processes behind the innovation of classical musical instruments, Bijsterveld and Schulp introduce the notion of *recasting tradition* [13], arguing that successful innovations are characterised by design moves that readjust tradition. Thus, in the context of instrument design, a successful approach is to introduce *go-between* elements that can link strong cultural heritages (e.g. instrumental features or orchestral culture).

By looking at the workshop outcomes it is possible to associate this idea across multiple communities. These artefacts are often based on the principle of preserving key features of existing instruments while recasting others. A clear example is the *Antenna Lele*: a guitar-like instrument with a bendable neck that can be used to "shape melodies and harmonies" while playing (Figure 2b). This tendency diverges from the simple re-purposing of existing instruments due to the introduction of specific innovative elements that expand or alter the musical possibilities of the instruments. Another example of this approach is the *Personal Shaker* (Figure 2e): an altered traditional percussive instrument for private music practice and enjoyment.

We observed 11 instances in which participants made instruments which resemble or are inspired by instruments they themselves play. Amongst the musicians whose first instrument was guitar (or similar plucked string instrument), 5 out of 9 produced artefacts with similarities to plucked string technique. Likewise, 3 of 4 wind players made simple but literally functional wind instruments using straws; all were ethnic musicians with instrument design expertise. We also saw one pianist, one singer and one electronic musician make instruments connected to their practice (respectively, a mock-up with keys, an artefact which involves the voice, and an interpretation of the Karlax MIDI controller).

IMPLICATIONS FOR DESIGN

How we conceptualise and interact with the material world results from the encounter of social, cultural and technological environments. Cheatle and Jackson suggest that "artists are often at the forefront of this process since they act as creative and critical users of tools" [26]. The following sections highlight some broader implications for HCI and design from our study of technology and values in an aristic context.

Dealing with a polyphony of sources

The first transferrable observation from our study is that individual participants' values derive from a multiplicity of sources. Their musical community was an obvious source of influence, and the one around which we organised the workshops. As expected, values seem to correlate strongly with community, such as the view of an instrument as a transparent mediator (typical of classical players) versus an explorable device that might have its own agency (typical of improvisation and electronic communities).

However, other sources of influence emerged as well, including embodied knowledge from instrumental training. For example, guitar players tended to make fictional instruments resembling the physical features and body movements typical of guitar-like instruments. A further source of influence, irrespective of musical community, was technology training. We found that despite the prompt to build instruments "as if by magic", technologically-trained participants were influenced by what they believed to be possible with current (mostly digital) technology. These findings resonate with embodied cognition theories arguing that tools reshape our perception, altering how we act, thus changing how we think about things [58].

Although our analysis aimed to identify commonalities, our data also shows that each musician introduced a unique collection of sources and references, some of which might be in contradiction with others from the same group of participants. Language, was sometime a source of discrepancy, with terms taking on very different meanings. For instance, the word "expressive" could refer to the ability to communicate artistic intentions, it could be used to indicate high control bandwidth, or might evoke the possibility of producing many different timbres with an instrument. The term "gesture" instead might indicate abstract musical metaphors or denote physical movements.

In summarising the most salient tendencies, we do not propose an explanatory model of any particular individual's values based on their musical or technical background, and we acknowledge that our sample of 29 musicians is likely not representative of musical practice as a whole. As authors, we also cannot claim cultural neutrality in our analysis, though we present in previous sections a thematic analysis process that seeks to minimise bias. We self-identify with electronic and classical communities, which may colour some of our reflections. Acknowledging these sources of variation, we nonetheless seek to highlight the importance of seeking a diversity of sources of influence for every participant and acknowledging the breadth of priorities within each community.

Context-based value rationality

Flyvbjerg writes of the contrast between the *instrumental rationality* common in technical problem-solving within science and engineering and the *value rationality* provided by the social sciences, which contribute to elucidating "where we are, where we want to go, and what is desirable according to diverse sets of values and interests"[34, p.167]. In the design of interactive systems, a risk is to jump straight into an instrumental-rational problem space without first considering the underlying values. In the music-HCI domain, this can take the form of techno-solutionist approaches which devote considerable engineering effort toward the goal of enabling people to make music, without explicit consideration of what "music" might mean to different communities and individuals.

In that context, our workshops could be seen as an evidence-gathering step as part of a value-rational approach, which may be especially appropriate for HCI contexts that target "activities motivated by curiosity, exploration, and reflection rather than externally defined tasks" [43]. A value discovery

exercise seems then to be directly relevant for those design activities characterised by anti-solutionist attitudes [19]: views of design offering a critique of the traditional representation of "good design" as a solution to well-defined and delocalised problems.

The involvement into specific communities of practice implies "ways of learning - of both absorbing and being absorbed in - the culture of practice" [89, p.169]. Studies on human learning indicate that people pass through several phases in the learning of skills, where "skills" is understood to range from technical to intellectual (e.g. building a house, being socially adept, analysing a text) [34, p.167]. Novices mainly act on the basis of predefined rules and best practices. Experts, drawing on intimate experience and personal perspectives, balance standard procedures with intuitive behaviours and holistic judgement [33]. Our research provides the possibility to engage with this type of knowledge: context-dependent values emerging from situated practices and interpretations.

Materials and embodiment

The crucial role of materials and the possibility of conducting "research trough a material lens" are established matters within the design and HCI communities [56]. In that respect, while designing an activity such as the one presented in this paper, researchers should carefully choose the workshop materials. From our viewpoint, a different selection of materials (e.g. including more pliable and flexible materials like play-doh or fabric) could equally work, as long as the these elements would keep those mundane and ordinary qualities that characterise the materials introduced by Andersen.

Our choice of materials largely followed Andersen's guidelines. We acknowledge that the materials used in our workshop are characterised by specific perceived affordances. We would argue that any selection of materials, in its own way, would inevitably influence the design process [74]. However, for our purposes, the most important factor is that our materials did not embody one specific musical purpose or aesthetic. Andersen avoids the selection of objects such as elastic bands that, despite their everyday quality, might resemble some features associated with traditional musical instruments. Since the goal of our workshops was not solely related to the generation of novel design ideas but rather an investigation of cultural concerns and priorities, we did not take such a strict approach to excluding such materials.

Notably, materials that might have instrumental associations were not interpreted that way by the majority of our participants. This might suggest that the evocative power of such materials influenced specific sub-groups of musicians. We indeed noticed that mainly guitarists made plucked string instruments featuring elastic bands, and *only* wind players made wind instruments using straws. This suggests that musicians' imaginations are heavily shaped not only by their cultural backgrounds but also by the particular physical objects they play, lending support to theories that the instrument is a tool which shapes how the musician thinks [69]. We found these findings in line with the idea that "affordances can go unnoticed if they do not fit with real-world experience and cultural knowledge" [51].

Avoiding technology to privilege subjectivity

In interactive system design, technology should not itself be the value. Rather, a specific vision of the world (e.g. assumption and predictions about behaviours and norms) precedes the technology. Values inscribed into a design therefore become crucial for its interpretation and use [2]. We exploited design fiction to access those contextual values (subjectivity of skilled individuals engaged with specific communities) that were inscribed into imaginary (not-yet-existing) music technologies.

The clearest expression of that outcome in our workshops was the emergent dichotomy between communication-oriented values, expressed for example through artefacts which were abstract representation of communication amongst musicians, and material-oriented values, expressed through literally functional sonic objects and discourses on material agency and exploration. A technology-driven design exercise might have defined a specific problem space according to the affordances of that technology, privileging "what" and "how" of achieving particular outcomes over the questions of "why" that showed the greatest difference between musical communities.

Instead, the question of "why" can be examined both through the artefacts themselves and the explanations the participants give about their reason for existence. Following Andersen's proposal that "the object [fictional artefact] is not important in itself, but rather, it forms the container through which a vision or idea might be relayed" [7], we then suggest that design fiction activities, such as the methodology outlined in this article, can be used not only to generate new ideas (following Andersen) but also as an analytical tool to reveal sources of influence and value systems which should be explicitly considered before moving to the next phase of designing technological systems.

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