# Instruments and Sounds as Objects of Improvisation in Collective Computer Music Practice

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**Abstract.** Collective forms of improvisation are at the heart of numerous creative processes today, in a vast range of cultures, practises and artistic disciplines, each one bearing its own definitions, traditions and customs. In this contribution, we raise the question of collective sound improvisation involving digital technologies on two levels: first, by discussing the possible nature of improvisation in relation to digital artistic creation as a transversal notion that permeates through multiple fields of scientific research and artistic practise, raising fundamentally different questions than those of traditional musical improvisation. Then, by presenting a practise-based study on an emergent collective computer music improvisation project involving the authors. Subjective experiences, interrogations and remarks from this shared practise are confronted on the one hand with traditional literature regarding musical improvisation, and, on the other hand, placed within a broader scope of improvisation involving digital technologies. In particular, we will elaborate on using the computer instrument as a means to improvise both tools and sounds in one continuous flow.

**Keywords:** Computer music, free improvisation, collective experimentation, instrument and sound improvisation, live patching, digital arts

## 1 Introduction

### 1.1 Improvisation in Digital Arts

This paper introduces preliminary research initiated by the authors regarding the study of emerging creative processes in the field of digital arts. We define the latter in the broadest sense possible, i.e. any artistic processes involving the significant use of digital technologies in any manner at any point of the chain. Such practises have indeed largely multiplied and diversified in the last thirty years, drawing on (and often blurring the lines between) the fields of visual arts, music, plastic arts, scenography and theatre, in performative contexts as well as installations.

Amongst these creative processes renewed, altered or extended by the incursion of digital tools, we propose to discuss those pertaining to collective improvisation. Ideally, to do so, one would have to extensively consider the variety of what improvisation means among the various fields of Arts [1,2] (such as in dance [3,4], in music [5,6] or in theatre [7] for instance), sometimes even within each of their own currents, and, to be perfectly thorough, one should not forget how all of that will differ from one culture to another. Furthermore, and this is of the most prominent interest, one would have to consider how improvisation processes adapt to hybrid forms of performances. Obviously, even if narrowed to the specific cases where digital technologies are involved, this landscape is vast, and hoping to address it frontally and extensively in a single effort would be unrealistic.

Still, field observations in this area[3] reveal that more and more artists, especially "digital" ones, gathered in ephemeral or more durable collectives, find themselves exploring new ways to create together, almost on the spot, interlacing aesthetics and creative strategies in unusual and largely undocumented fashions. While the use of digital technologies in various art forms is now indisputably present in our everyday lives, the literature regarding improvisation with such technologies remains scarce, and generally grounded on the use of technology to augment improvisation in one domain by translating or mapping it to another (e.g. augmenting a dancer's motion with real-time sonification or generating reactive visuals from a real-time sound performance). We believe that digital technologies *in themselves* constitute a singular prism through which a broader form of improvisation may be studied.

This area of research does not aim to establish a frontal comparison of practises with and without digital tools, nor to assert the idealised virtues of technological innovation in creative processes that, upon inspection, are often the complete antithesis of digital determinism. Nor is this the place to reach for tools or technological specifications to encourage, facilitate or further hybridise collective improvisation practises. On the contrary, we begin from the simple observation that digital tools are already heavily incorporated in artistic practises, and permeate into the fields of collective improvisation alongside additional (digital or other) tools, in various and often heterogeneous aesthetics. From this initial observation, we believe in the necessity of a first analysis: to identify and document multiple practises within the scope of digital tools, in order to possibly establish certain correlations and invariants among them.

It is important to clearly position the present paper as a preliminary work, the first contribution to the larger scope described above. The authors decided to initiate it in the field of contemporary musical creation. This choice was guided partly by the inspiring context offered by the "14th International Symposium on Computer Music Multidisciplinary Research (CMMR)" special calls, and partly

[3] In particular concerning the artistic programs of "Digital Arts" or Art and Technology festivals and venues, or more generally considering the fields of popular electronic music, contemporary arts and academic research and creation. A thorough referencing of these contexts, artists and pieces will be the subject of another paper.

by the authors' own artistic, technological and scientific experiences, which will be extensively explained hereafter.

### 1.2 Computer Music and Improvisation

**Transversality of Computer Music Practises.** The field of Computer Music originates from the close relationships between music academia and technological research as early as the 1950s, resulting in over half a decade of scientific and artistic breakthroughs. While the ties to musical institutions are as strong today as ever, recent years have seen an increasing tendency of computer music artists to overflow out of strictly musical considerations, by interveawing various media forms, providing multimodal and/or immersive experiences for audiences, as well as exploring the interaction between the user and one or several digital artefacts as a central element of the creative process, including in live performance and improvisation settings. Thus, one could arguably state that the practises of many composers, electronic musicians and sound artists today are very close in nature to those of digital artists, and that they share many of the same interdisciplinary concerns.

**Musical Improvisation** is covered extensively in the literature through (often complementary) musicological, social, epistemological, aesthestical or philosophical standpoints, several of which will be discussed further in the paper. These positions generally pertain to a certain cultural heritage: improvisation certainly bears a different meaning wether one is interpreting a baroque score, improvising in a jazz ensemble, taking part in an Indian raag, or performing John Cage's works involving indeterminacy. A common point is however that, to our knowledge, the majority of such theoretical frameworks and studies are carried out in regards to a traditional and stabilised instrumentarium[4]. While this may certainly comprise electronic instruments, it rarely accounts for a broader definition of digital instruments, tools and workflows.

**Improvisation with Digital Technologies** poses numerous additional and fundamental questions, to which certain answers may be found in a variety of communities ranging from Human-Computer Interaction (HCI) to Computer Music or Motion and Computing [8]. The meaning of the word *improvisation* in itself is manifold in these contexts, depending on the end-goal: a possibly restrictive but operational categorisation may be to separate cases in which the computer is considered as an artefact, or instrument, with which the user may interact with in order to yield creative results in an artistic setting, and those considering the computer as an improviser in itself, capable of co-articulating a

[4] This may be a consequence of the common conception that improvising requires a high level of mastery of an instrument, which is only possible on stabilised instrument designs. This, in turn, could justify why few studies have addressed extensive improvisation with novel or digital musical instruments.

performance with the user (such as teaching the computer the appropriate rules in order to improvise jazz music, or using artificial intelligence to create real-time computer generated motion in tandem with a dancer).

In our work, we will concentrate on the former category, considering digital technologies as new elements that may stimulate new user-driven creative processes. In [9], the philosophical concepts of affect and assembly (introduced by Deleuze and Massumi) are employed to illustrate and qualify interactions between users and artefacts in creative interactive digital systems. This theoretical framework is then exemplified by a collaborative musical improvisation scenario employing such technologies. Jay Silver et al. describe the accessible Makey Makey user interface prototyping tools as a *"platforms for improvising tangible user interfaces"* [10]. In works such as Sergi Jordà Puig's dissertation [11], the notion of "Digital Lutherie" is introduced to address the design systems and interfaces for new music performance and improvisation. Finally, improvisation practises may be employed as a metric to evaluate the design of new digital tools such as Digital Musical Instruments [12].

### 1.3 Our Hypotheses

We propose to discuss collective improvisation in the context of digital technologies by analysing and decomposing the creative process of a Computer Music improvisation trio composed of the authors, taking a step back from a purely music-based (and by extension computer music-based) framework. Our hypotheses are that:

- The core questions that arise from this process, both in terms of creative human-computer interaction improvisation with digital tools, are shared by many creative digital practises (as discussed above).

- The computer constitutes a singular dynamically re-configurable instrument, that may offer an expanded approach to improvisation that encompasses the instrument *itself*. We exemplify this through the analysis of synchronous improvisation of instruments and sound during collective Computer Music performance.

Such bold hypotheses can obviously not be validated or disproved through a single practise-based report, especially one with such strong ties to computer music, and one directly involving the subjective perception by the authors of their own artistic practise. This scope does however allow us to ground our reflections by drawing on musicological literature as a starting point, an anchor against which we may draw parallels and underline differences, thus painting the first initial strokes on the vast canvas for an epistemological analysis of creative processes including digital technologies, especially in improvised and collective settings. As such, the paper is both a subjective testimony and a first attempt to deconstruct our shared practice in light of existing works as well as our musical and technological backgrounds.

## 2 A brief presentation of our study material: Orcæ

Orcæ [5] is a trio of musicians composed of the authors that practices free collective music improvisation using mainly computers. Each of us has a different history of musical practices, including such diverse styles as heavy metal, jazz, reggae, *chanson française*, rock or electro-dub. Although we had never played music together before forming the band, we have a common experience as researchers in Computer Music and Digital Arts, having prepared PhDs and worked in the same team during a 5-to-10-year period. Two of us are still actively involved in Computer Music research, with an expertise in physical modelling for sound synthesis and sensory immersion (force feedback interaction with virtual musical instruments, spatial audio, etc.). After several discussions regarding playing music together over the years, the project was initiated in January 2017.

### 2.1 Beginnings and gravitation towards free improvisation

The initial purpose of Orcæ was to combine the authors' instrumental practices - namely guitar, keyboards and drums - with the idea of playing and performing post-rock music. Some songs were written beforehand, whereas other ideas were to emerge through recorded improvisation sessions, then to be transcribed and progressively fixed into song format. However, after recording and noting down a few improvised structures, attempts to reproduce them at a later time proved rather fruitless and frustrating: we all felt that something was "lost in translation" and that re-exploring the same sounds was never as fun and exciting... Gradually, the electronic drumset became evermore drowned in post-processing and effects, before being abandoned in favour of a simple laptop. Similarly, fixed keyboard virtual instruments were replaced by a modular sound-synthesis environment, and the guitar became accompanied (and often replaced) by a laptop

[5] An online repository of Orcæ 's music productions is available at the following link: http://orcaescapes.github.io

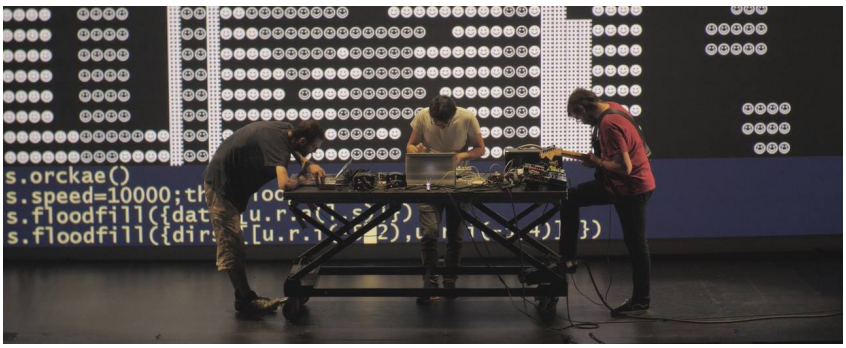


**Fig. 1.** Photo of a live performance in May 2018. Live-coded visuals were generated by Maxime Bouton and Emile Greis

| **Player A** | |
|---|---|
| *Musical experience & training* | Self-taught guitarist, formerly focused on heavy rock and metal: written music, rehearsed regularly and rendered "as is" live. Short spell in the Grenoble Conservatory's composition class. |
| *Background* | Software engineer & Computer Music PhD. Also sound engineer (mostly producing bands from punk to metal). |
| *Link to improvisation* | Small amount of jazz improvisation during first years of guitar playing - a skill now completely lost. |
| *Instruments used in Orcæ* | Electric guitar and various effect pedals.<br>Max/MSP patches with control surface. |

| **Player B** | |
|---|---|
| *Musical experience & training* | Self Self-taught musician, has successively played guitar, drums and keyboards in a now-defunct electro-rock band, before turning to solo electronic music production. |
| *Background* | Software engineer, PhD in Computer Music, former Pure Data /DAW teacher. |
| *Link to improvisation* | Has practised some free collective improvisation with his previous band (non-public jam sessions) and one-person improvisation as a way to compose electronic music. |
| *Instruments used in Orcæ* | Reason, and very recently Max/MSP. |

| **Player C** | |
|---|---|
| *Musical experience & training* | Formal education: percussion, drums and piano, then jazz school. Drummer in various projects (ska-punk, big-band, raeggea, chanson française and Klezmer). Confidential electronic music composition. |
| *Background* | Computer Music PhD with a background in physics. |
| *Link to improvisation* | Systematic tendency to improvise when sitting behind drums, regardless of rehearsal or public contexts. |
| *Instruments used in Orcæ* | Ableton Live, always starting from the default patch at the beginning of an Orcae session. Zero external controllers. |

**Table 1.** Profiles of the three players: musical and technical backgrounds, prior experience with musical improvisation and configuration used within Orcæ .

running sound transformation patches. Not only the music couldn't be written, but the instrument line-up itself was constantly evolving, sometimes expanding, other times shrinking. The progressive mutation was never planned, never completely grasped and never formally discussed by the players. After approximately 6 months of weekly sessions, our practice started to stabilise into the current workflow.

The players each have different musical backgrounds and relationships towards improvised music (see Table 1). It is worth noting that although we all

come from a sound-synthesis technical background, most of our musical activity has been in current popular music genres (exception made of one or two electroacoustic fixed-piece compositions) and that only one of us had any significant prior experience - or real interest - in free form (or *self-idiomatic*) improvised musical practice before this project. The music production tools used by each member within Orcæ also differ: Player A relies on *Max/MSP*[6], Player B creates mostly using *Reason*[7], and finally Player C uses *Ableton Live*[8].

### 2.2 Workflows and practices

**Private Sessions** start as soon as each member has connected their instrument to the main sound card and has a pair of headphones on. There are usually no directives exchanged between the members : we just start playing. One of us may occasionally propose a specific constraint (e.g. "let's not use any distortion today"), but most of the time such constraints are self-imposed as a way to avoid repetition and foster creativity. The session usually ends by an implicit common agreement, after anything from 40 minutes to well over an hour : sounds fade out, then one of us takes his headphones off, quickly followed by the others.

**Public Sessions** or performances were envisaged later (after nearly a year of playing together) and are handled a little differently. Before each performance, members usually exchange a few words about the global mood that the music may aim to achieve (although we rarely manage to stick to what we discuss beforehand). We are usually not aware of what other members have prepared (or have in mind) for the performance, and enjoy having a few "tricks up our sleeves" for the others. Additionally, it is quite common for us to communicate verbally during public performances (e.g. "let's slow down") - while we hardly ever do so in private sessions - particularly when trying to plan a "come down" for the closing minutes of the performance, as there are generally strict time limitations.

**Multi-track Recording** is systematic and has been since the very beginning of Orcæ, for both public and private sessions. This material is exploited to produce fixed audio tracks that we publish on the internet. The production process is kept as simple as possible so that the results resemble what can be heard live during a session, while filtering out certain inevitable moments were we are in more of a sonic research process than in a musical one. This work mostly consists in listening to raw material, selecting interesting portions and preparing them

[6] A modular patching environment for music and digital creation: cycling74.com/products/max

[7] The digital audio workstation (DAW) developed by Propellerhead: www.propellerheads.com/en/reason

[8] Arguably the most popular DAW for producing electronic music: www.ableton.com/en/live/

with limited editing and mixing as a stereo file (generally lasting from 3 to 15 minutes). We rarely desynchronise tracks, in order to keep the energetic cohesion from the collective improvisation. We are also rather attached to listening to the raw unedited recordings of our sessions, and have published a small amount of them, usually from public performances.

**Collaborations** have occurred regularly since the earliest stages of the project, through additional players occasionally performing with us as guests. We have worked with musicians and vocalists, video makers (in the context of producing spontaneous soundtracks for a short film playing in a loop during the session, or someone improvising live with us using a wide range of pre-recorded video capsules) and even live coders for real-time image generation. The latter have been a steady collaboration (during both private and public sessions).

## 3 Collective Computer Music Performance and Improvisation

In the following section, we will use Orcæ's creative process as a basis for analysing fundamental questions of performance and improvisation in collectively-practised Computer Music. We propose to reflect upon these elements by combining various positions and results from the corresponding literature with interrogations and observations related to our personal practice. Although the acts of performance and improvisation are highly linked in this case, they will first be treated separately, as each bring forward a number of specific questions.

### 3.1 Performance

Performed Computer Music can designate any number of things. Our background lies in experimental music and academia. However we will consider here any public representation in which music is (at least seemingly) produced in the presence of a computer - englobing everything from electroacoustic contemporary music, to popular DJs, underground artists, to Laptop Orchestras and NIMEs[9].

**Authenticity.** Computer Music performance in many of these contexts can spark a certain degree of confusion or scepticism among audiences since, as Andrew Schloss [13] remarks, it is not always possible for spectators to *"understand the performance from a direct/physical standpoint"*. It is indeed not trivial for an audience to know if all or part of the sounds that they are hearing are being generated through live performance or if they are simply pre-recorded and then played back. To Schloss, this situation is deceitful: *"Tape music was boring to watch, but at least it was honest, with no false expectations of performance"*. He decries *"knob twiddling"* and other computer performance gestures that display no visual effort as things that should be either predetermined beforehand or discretely (and anonymously) performed behind the mixing desk.

[9] New Instruments for Musical Expression - conference: www.nime.org

**Role of a Human Performer.** Schloss' primary focus is to bring back certain *theatrics* of effort and of corporeal causality from gesture to sound, a goal shared by much of the academic research on NIMEs, and by most of today's popular electronic music performers. One could argue that the question of ergonomics allowing the performer to finely control a Digital Musical Instrument is sometimes superseded by the need to convey "readable" gestural efforts for the sake of the observer/audience. One way or the other, designing meaningful corporeal links from gesture to sound in modern music is often problematic as a) one-to-one gesture-sound mappings are easily understandable but rarely sufficient for the musical discourse and b) complex gesture-sound mappings (e.g. triggering complex sound processes by means of relatively simple gestures) can generate even more frustration from the observer, who is a spectator to seemingly abstract gestures, perceptively unlinked to the sonic result.

For Guy Garnett [14], the human performer harbours more fundamental aesthetic consequences, such as the gestural nuance generally associated with human instrumental performance, rarely present in electroacoustic tape music:

*it is more difficult to incorporate "performative" inflection into tape music, and therefore, for practical reasons, it becomes less likely to occur. [...] because [these subtleties] are difficult to produce, there is a definite tendency to avoid them.*

Garnett also underlines the physical and cognitive constraints of human performance that affect the composer, the performer and the listener:

*The performance gestures [...] must be cognizable: the performer must be able to get their mind around them in some way. The composer without physical limitations of performance can more easily convince himself or herself that they have created something real and comprehensible, whereas what they have may be an unhearable ideal. It is relatively easy to create algorithms that generate sounds whose qualities as music are inscrutable, beyond the cognitive or perceptive abilities of listeners.*

One can therefore conclude that human performance in Computer Music is not only a question of adding readability to a restitution by expliciting (possibly caricatured) musical gestures, primarily directed towards an audience. Rather, human performance factors can be considered as fundamental structuring elements in the writing (or *thinking*, in the case of improvisation) of interactive Computer Music. As such, they are both meaningful and relevant even in the absence of performance, during any individual or collective creative processes.

**Contexts & Expectations.** Considerations such as those presented above stem at least partially from heterogeneous conceptions of what could be identified as a *performance* according to composers, interprets or the audience - and, by extension, what each considers important or acceptable as a Computer Music performance. They certainly result in distinct expectations from each party towards the others. These co-expectations will tend to match if the context of the gathering is clearly specified: is it entertainment? A formal representation

pertaining to a strongly-codified music genre? A scientific and technical proof of concept? An exploratory approach? An organic and open artistic journey?

We are, of course, in no position to judge of the relative artistic validity of any of these contexts, however, finding which context Orcæ's performances "fit into" and which expectations we will confront has been a matter of trial and error.

**Orcæ's concerns.** Given that our public performances are constituted entirely of spontaneous real time improvisation, an inherent aspect of trust must be installed between the audience and us. We invite them to embark on an open sound exploration, knowing fully well that it could be transcendental... or uncomfortable... or just very boring.

That being said, two recurring questions still obsess us and remain largely unanswered. The first, regularly expressed by the audience is : "who is doing what?". The subsequent second question then becomes : "what should we explain to the audience beforehand, or what should we show, of what actually goes on during our performances?". Should we stick to a purely acousmatic listening experience and hide behind curtains? Should we face the audience even though we barely seem to move during the whole session? Should we visually project parts of our tools/screens (as a Causal augmentation) or should we go all out and build a complete dynamic scenography and audio-visual counterpart (as an abstract augmentation)?

We seek for simplicity, and if we were to consider only ourselves (as is the case during private sessions - which in the end are simply performances in which we are both the performers and the listeners), we would not even think about anything but the sound for itself, disembodied of its producers. The fact that the performance aspect might not be seen at all or even known from the audience makes little difference to us. But it clearly does for the audience. And while the literature largely states that fact, each one of our performances has been an occasion to measure it. We have played in various contexts and configurations (music only or working in collaboration with visual artists, playing on stage or amidst the listeners, fantastic to disastrous listening conditions, etc.) to various audiences, each time expliciting the bare minimum of our process (if we did so at all). Sometimes, the expectations of the audience converged with ours, some other time they did not. And the questions remain.

Further still, while the essence of our music may not have changed (too) drastically depending on these performance contexts, our subjective experience of each of them undeniably differs from the experience of private sessions. In other words, we don't feel any need to be considered as performers, however being put in a performing position/context significantly impacts our process.

### 3.2 Improvisation

In this section, we will not address the notion of improvisation in regards to the notion of composition. While the historical interest accorded to each has

been very uneven (with a clear emphasis on composition, at least in western culture), numerous works have since proposed ways to formalise their relative positioning (see Sarath [15], Smith and Dean [16], Andy Hamilton [17]). We will restrain ourselves to the matter of musical improvisation involving computers. This specific field has seen distinct kinds of practices emerge and develop since the earliest ages of computer sciences. The first one would be to consider the *Computer-as-improviser*, able to generate structured musical information (e.g. MIDI then rendered by synthesizers). The second practice considers the *Computer-as-instrument* and emerges from the possibility of calculating real-time streams of synthesised or transformed audio data [18].

The practice of the authors within Orcæ is clearly positioned in resonance with the latter, in the sense that the computer is not perceived as an agent whose role is to respond creatively to the player's input (for instance by following procedural rules) but is instead considered as an extensively controllable and reconfigurable instrument that allows for each parameter of each sound-producing process to be observable, editable or even stoppable at any given time[10].

Below, we will contextualise our approach and practice of computer music improvisation. From there, in the next section, we will posit that this context brings forth a second level of improvisation, referring to real-time design/deconstruction/re-construction of computer-based instruments.

**Orcæ's improvisational process** can be identified as pertaining to the codes of *self-idiomatic* music, as defined by Michael Bullock [19] (building upon Derek Bailey's term of *non-idiomatic* music):

> *self-idiomatic music is the concentration on sound-making actions for their own productive potential rather than in the service of representation of an external, received idiomatic identity.*

There is generally no prior agreement between players regarding any thematic, musical or stylistic directions, be it harmonically (no set key or preference for tonal or atonal material) or rhythmically (no shared tempo or clock synchronisation between machines). Sessions pass without any form of communication other than the sound itself.

Active listening is pivotal to collective improvisation[11] and may be even more so in this case, as each player's gestures are essentially limited to clicking, occasionally typing, and of course the infamous "knob twiddling". In other words, the sound is the only communication vector between players and the only means

[10] This doesn't mean that we don't use emergent or chaotic sound processes (i.e. strongly nonlinear systems or feedback loops) but we don't consider the computer to be *improvising* in these cases - an electric guitarist controlling amplifier feedback is still a musician playing an instrument, even if the instrumental system is no longer passive in the mechanical/electrical sense.

[11] Marcel Cobussen [20]: "the constant process of decision-making that takes place during an improvisation is for a large part based on the listening attitude of the musicians involved."

for developing a collective musical discourse[12]. As a result, the *who-is-doing-what* can occasionally become totally blurred, resulting in moments in which each individual sound component dissolves into a greater entity and none of us are certain of the sound that we are each contributing.

**Specificities of public improvisation.** Marcel Cobussen [20] states that *"The possibility of failure is an intrinsic element of all improvised music"*, and while we certainly fail as much in private sessions as in public ones, the former feels much safer than the latter (at least for two of the three players). We tend to aim for a more "controlled" experience during public performances, often restraining our exploration of more "extreme" sonic territories, partly because there is a risk of producing uncomfortable sounds for the audience - but possibly because certain fears and inhibitions reappear in a public setting.

Conversely, being in front of an audience yields a strong tension that develops focus and the feeling of flow, and as a result time seems to fly during public performances, to the point where it can be very hard for us to remember what actually happened[13].

Another consideration is that it may be difficult for a member of the audience to know, based solely on our performance, if the music is improvised or not - especially since we are not concerned with effort-based control gestures. Knowledge about how a piece of music was or is being produced has a significant impact on the listener's judgement [21], therefore we do ask ourselves if performances should start with a little disclaimer ( *"be nice, it's impro!"*). Nevertheless, doing so may result in the audience focusing on us as performers, on what we are doing, how we are controlling sounds... whereas our aim is for the sound to be the object of interest in and for itself. As of yet we choose to say nothing beforehand.

**Increasing risk - Alleviating failure.** One thing is for certain, for the audience as for ourselves: improvising computer music demands for perpetual richness, variety, curiosity and surprise. It seems that this posture must be considered on two different time-frames:

First, there is the time of the performance, during which we try to build an interesting exploration path for (with?) the audience. As expressed in section 3.1, the ability to match the expectations of an audience is of first common interest. This matter turns out to be even more crucial in the context of a free improvisation with computers. It leads Mazierska to express the following advice: *"[...] current electronic musicians are free to improvise, but if they want to keep*

[12] The degree of engagement and pleasure experienced during a public performance is then highly dependant on the quality of sound monitoring. Proper channels for this communication have to exist and low end systems can easily lead to frustration or even jeopardise the whole process.

[13] Ed Sarath [15]: *"The improviser experiences time in an inner-directed, or 'vertical' manner, where the present is heightened and the past and future are perceptually subordinated"*.

*their audience interested, they have to balance this need with the requirement to work with templates and observing traditions*" [22]. This statement brings us back to the inherent necessity of a (possibly unconscious) *common language* between performers, and between performers and audience. Nevertheless, we find it important to emphasise on the widest possible interpretation of what these traditions or templates might refer to. We feel that they may include those from codified music, but also those closer to natural or evolving cultural hearing, such as our inherent tendency to relate to organic or artificial sounds through their potential to evoke the physical world, ambiences or even individuals.

Secondly, there is - mostly for us, but maybe also for our most die-hard fans (if we have any) - a need to explore new creative fields on a wider time scale, from one collective public or private session to the next. This need was never defined as a prerequisite of our work together, it simply emerged from the fact that at some point, one of us would identify a routine coming from another (a recurring sound, effect, pattern, or way to respond to or place himself in the macro form, etc). For some reason, being spotted was spontaneously felt as a personal failure in contributing to the collective effort of improvisation, and it progressively pushed each of us to rethink and reinvent our improvisation processes. This ultimately led to deconstruct the very notion of "musical instrument" and widen the scope of improvisation from sound only, to the low-level elements allowing us to produce it. In other words, one of our common practices now consists in starting from an entirely blank page/patch at the beginning of every session. As if the significant increase in risk was somehow the safest way not to fail our pairs or the audience.

## 4 Synchronous Improvisation of Instruments and Music

### 4.1 Plasticity of the Computer Instrument

On the topic of the use of computers in improvised music, Frisk [23] expressed:

*A computer does not have a sound but rather comprises the possibility of (nearly) any sound [...] to say that any sound is possible is not quite true [...] the kind of minute variation and dynamic change that constitute the very notion of a musical sound is still difficult to achieve on the computer. This is a programming challenge, a need to further develop synthesis techniques, but it is also a question of the interface between musician and computer.*[14]

Despite the ambiguous notion of *musical sound*, this statement relates directly to Orcæ's posture towards tools for Computer Music, and the need to investigate new paradigms of *improvising these tools*. The computer constitutes a highly reconfigurable instrument, that may be shaped and twisted to express any number of sonic possibilities.

Indeed, since the late nineties research in software environments and programming languages for Computer Music has led to several tools - both high and

[14] This resonates directly with what Max Mathews stated at the dawn of Computer Music: the perspective of infinite possibilities versus our ability to explore them in a sensible way.

low level - that allow performers to program and produce sound in real-time. The strongest movement that inherently carries such possibilities is live coding: *"Live coding is the writing of rules in a Turing complete language while they are followed, in order to improvise time based art such as music, video animation or dance"* [24]. It brings together a large community of performers/developers (for the most part academics or close to academy) around tools such as SuperCollider and Chuck.

Another tool worth mentioning is the Reactable [25], a - potentially collective - hardware interface that engraves physical objects with logical functions to be assembled on a visual display. In fact, it stands as a tangible version of visual programming environments such as PureData and Max/MSP, which allow for what can be called *live-patching*, although it is not their most frequent use-case. And, finally another very interesting work relying on lower-level programming is the UrSound audio and multimedia engine [26].

Although the listing of these dedicated and often expert environments is relevant, luckily one does not need to graduate in computer sciences in order to explore this path. Numerous free or commercial solutions allow synthesising, controlling and manipulating live audio without requiring intricate knowledge of software or digital signal processing.

### 4.2 Instrument Improvisation in Orcæ

A schematic representation of the typical workflow during an Orcæ improvisation session is given in Figure 2. Below, we discuss certain technical aspects and offer personal insights on the synchronous improvisation of both computer instruments and sonic material.

**In-session tool improvisation** is mostly practised by players B and C, as they generally start with blank *Live* or *Reason* workspaces. Although these environments possess advanced mapping possibilities for control surfaces, the players use almost exclusively the mouse & keyboard. Indeed, control mapping is usually employed when performing with pre-structured musical environments, whereas player B and C's processes are qualitatively different in that they consist in creating work/creation environments in real time. To this day, the classic mouse and keyboard combination remains the most effective way to perform such operations.

**Pre-session tool improvisation** is practised by Player A, whose main tool is Max/MSP. Live-patching entire instruments from scratch during sessions is rather tricky, so they are often (although not always) conceived beforehand. However, we still refer to them as improvised tools as they are often devised rapidly in the days or hours preceding a session, and are experimented in a *work-in-progress* state, tweaked, broken and fixed on the fly. The few of these experiments that stabilise over time into reusable tools are generally mapped to a control surface in order to facilitate exploration of the offered parameter space.

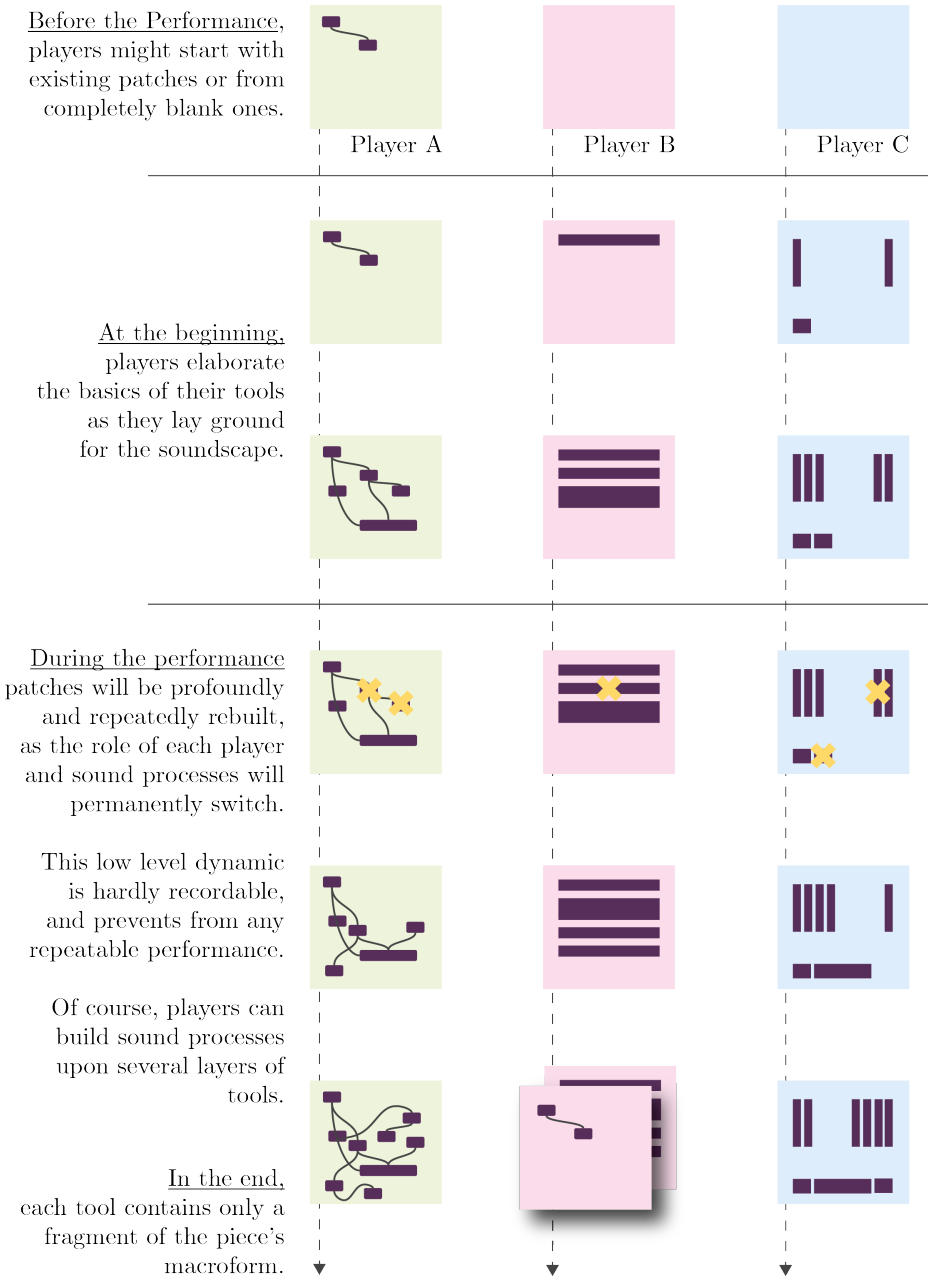


**Fig. 2.** Symbolic representation of changes on computer instruments (hence sounds) during the performance. This occurs without any interruption in sound and in a continuous flow of music. Each player handles his own set of tools (generally modular environments). No digital data circulates between the players.

**Imperfect digital tools.** In each of the above, one of the factors that drew us towards improvising Computer Music tools is the fascination for imperfections, a term often cited as a central aspect of musical improvisation [17]. Discovering unexpected properties (and possible artefacts) of live-patched audio chains or synthesis processes and exploring how to put them to use in a collaborative setting is a large part of Orcæ 's creative process. In this sense, our approach is very tolerant to imperfections and faults, with no prescription even to phenomena such as hard audio-clipping or harsh digital artefacts.

### 4.3 Relationship Between Player and Computer Instrument

Regarding musician and instrument in improvisation, Cobussen states :

*The instrument does not simply yield passively to the desires of the musician. Likewise, he does not just bend it to his own will with no consideration to the resistance it offers. Rather musician and instrument meet, each drawing the other out of its native territory.*

Embracing the computer instrument as part of the improvisation process precisely offers a means to perpetually renew this play of resistance and exploration. In our case, novelty and personality in improvisation do not stem from virtuosity developed in relation to a given computer-instrument - something we see as difficult and possibly restrictive given the diversity and rapid evolution of available tools - but in systematically "*(re)discovering the specific characteristics of their instrument, its unique and perhaps unexpected possibilities*". Rather than acquiring a form of virtuosity, we would say that this perpetual renewal of the player/instrument relation fosters a form of agility over time: one learns to embrace the state of musical flow, and to bounce back when faced with unpredicted scenarios without breaking this flow. This brings forth another crucial element, developed hereafter: the means for interacting with such volatile computer instruments.

**Mapping strategies for evanescent instruments.** Mapping strategies are of course a major concern in New Interfaces for Musical Expression and Digital Musical Instruments. Regardless whether the mapping strategy is formalised before, during or after designing the gestural control and sound synthesis sections of a digital instrument, it is assumed that the instrument will stabilise into fully mastered key functionalities, audio processes, parameter ranges, etc.

In our case, the sound generating process can be ephemeral, evanescent, ever changing. Hence, any mapping strategy will either have to preexist, as a very generic and versatile system, or will have to be created on the spot, remaining "raw", minimalist and low-level. As expressed in Table 1, Orcæ players have different approaches and we can easily observe a balance between the modularity/persistence of their sound processes and their need/capacity to map them to external controllers. Player A does use external controllers and will generally begin a performance with a loosely rooted mapping, of which he will progressively increase the scope. Player B will use at most an external keyboard, using

the standard MIDI rooting to trigger notes in his patches. Player C refrains from using any external controller other than his laptops' mouse and keyboard. In any case, the mapping strategies remain empirical and very far from a natural interaction paradigm, with a necessity of looseness and effectiveness, and an acceptance of imperfection. All of these features appear to us (in our subjective experience) as inherent conditions for expressiveness, richness and surprise during our collective musical performances.

**Causal relationship with evanescent instruments.** As we interact - and dynamically condition the modalities through which we interact - with the instrument, it responds. Usually, this visual and/or haptic and/or auditory feedback closes the loop, establishing the most intimate and causal relationship between an instrument and its player. In the classic scenario of an unchanging instrument, the player will (extensively) explore the response domain(s) of the instrument in order to progressively build a mental representation of causes and effects, and develop an expressive language. In the case of ever-changing instruments, the time in which a mental image of control-to-sound causality can be inferred is extremely constricted, imposing different exploration methodologies. Hence, the causal bond between actions and effects, which still exists in a particularly thrilling way, has to be dynamically and efficiently captured, even if it is only partially, and put into practice.

These very "un-intimate" or superficial relationships actually work for the best when it comes to Orcæ's general approach. But if we had to find it one negative consequence, it would be the sometimes occurring scenarios of the "lost sound(s)" or even of the "is this mine?". This effect is very specific to a collectively improvised performance where nothing else exists than a merged auditory feedback. In this case, it may be impossible for a player to isolate the sound that he produces, or even be able to observe other players' movements as a way to infer a causal relationship between a part of the sounds that are heard, and the "owner" of these sounds. Ultimately, each player has his own strategies to undoubtedly establish the paternity of a sound and recover a certain amount of control over it. Interestingly though, the situations of confusing, entangled, hardly tamable masses of sounds are amongst the most exhilarating experiences for us as players, often perceived as a climax or high point during a session.

## 5 Discussion

Through this work, we have offered a brief introduction to the transversal concerns that may arise when addressing improvisation with digital technologies in the scope of digital artistic practises. We have illustrated this position by a practise-based report of our own shared practise of collective Computer Music improvisation. Although the positions advanced in this work inevitably fall into the domain of subjective evaluation and self-analysis of our own artistic process, it seems to us that the freely-improvised Computer Music context constitutes a

unique and intriguing object of study. We believe that this improvisation scenario differs significantly from improvising with traditional musical instruments and that, in addition to the vast creative potential that it harbours, it brings forth enticing interrogations as to multilayered improvisation paradigms and the creative exploration that occurs during the interaction between users and digital artefacts. We are convinced that further insight into this area can be gained by addressing the question of improvisation with digital technologies as a broader and more general notion, encompassing a variety of artistic disciplines and interdisciplinary scientific topics.

The format of this first attempt has led us to skim over a number of key considerations such as multi-modal collective improvisation and performance. This seems to be the obvious next step in pursuing this work. Indeed, collaborations with visual artists have taken place in several of our private and public performances (with movie makers for short-film sound-tracks, with visual live-coders and visual jockeys for full-live audio-visual performances) and bring forth many new questions and concerns regarding how to achieve the best possible collective creative process, how to co-articulate a constructive dialog between the different media, but also how one media may take predominance over another, both for participants and for audiences. Further investigation and analysis of these aspects is one of many long-term objectives in the larger research scope described in the introduction of this paper.

In parallel with a direct continuity of this work, we aim to initiate two other (hopefully converging) ramifications oriented towards a more exhaustive coverage of the scientific literature, artistic pieces and artists/collectives pertaining to collaborative improvisation involving digital technologies in the fields of Dance and Theatre. This perspective will (and must) be instigated through collaborations with experts in these two fields, and by observing and analysing related artistic creative processes, for instance through prolonged research/creation residencies.

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