Mixed Writing with Karlax and Acoustic Instruments: Interaction Strategies from Computer Music

Benjamin Lavastre[1] and Marcelo M. Wanderley[2]

[1] DCS, IDMIL, CIRMMT, McGill University
[2] IDMIL, CIRMMT, McGill University
benjamin.lavastre@mail.mcgill.ca; marcelo.wanderley@mcgill.ca

Abstract. The karlax is a gestural controller developed around 2010. Since its inception, it arose substantial interest among composers and continues to be commonly used in solo and group performances. One of the reasons for its longevity is its great adaptability especially in interaction with acoustic instruments. This article analyses six chamber music pieces for karlax and acoustic instruments by comparing the sound and visual results and the writing process (scores, patches, and mapping). We discuss different composition strategies through the use of interaction metaphors from the computer music literature. These metaphors prove to be powerful analysis tools that allow describing the use of a digital music instrument (DMI), such as the karlax, in a chamber music context.

Keywords: Mixed pieces, Computer Music, Digital Music Instruments (DMI), Electronic Chamber Music, Input Devices, Mapping

1 Introduction

Though several hundred interfaces for musical expression have been developed and described in a variety of venues, most notably in the last two decades at the International Conference on New interfaces for Musical Expression (NIME)[3], relatively few articles discuss how these interfaces ares used in actual musical contexts, for instance [1], [2], [3] and [4]. Indeed, the use of DMIs is not often discussed from the perspective of artistic and musical composition. In other words, *the "M" in NIME*: why don't we talk more about music performance with musical interfaces, beyond sound control? In part, this is the consequence that most of the interfaces described in the literature have short life spans and/or are mainly used by their designers [5]. In this sense, the karlax offers a particularly rich subject of study with an existence of more than ten years, a community of regular users from different musical cultures and several significant creations, notably with acoustical instruments, incorporating some form of music notation.

The karlax is an input device that combines several sensors: continuous keys, velocity pistons, axis, switches, and three axes of accelerometers and gyroscopes (Fig. 1) [4]. "Its ability to detect subtle as well as larger gestures, continuous as well as event-based control, its low latency and high bandwidth, its reliability and portability" has

---

[3] www.nime.org

[4] www.dafact.com

been praised [6]. Like many musical interfaces that output sensor data but which do not have a pre-defined sound, the karlax is defined by its control characteristics, i.e., its gestural identity instead of a given sonic identity. This opens up unlimited musical possibilities but requires the composer to describe the sounds controlled and the mapping between sensor data and sound generation to be used in each context. A digital musical instrument (DMI) is composed of the group: control interface + mapping + sound generation [7].
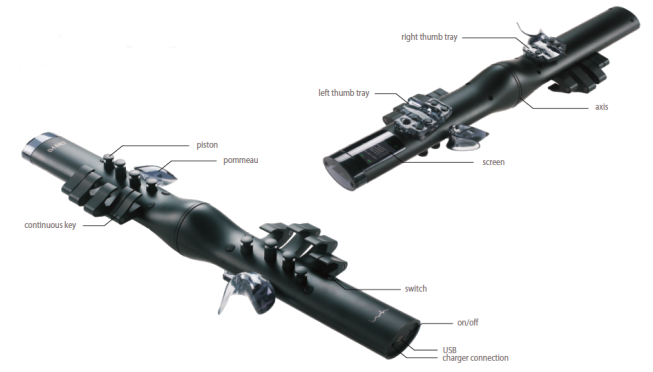

Fig. 1. Front and rear views of the karlax (www.dafact.com)

In this study, we analyze a corpus of six pieces for karlax and acoustic instruments from audio and video recordings, scores, Max/MSP patches, articles, presets, etc. We have identified three compositional models that allow us to define the main areas of inspiration for each of the pieces. In a second step, we will discuss excerpts in the corpus by detailing the action of the karlax and its interaction with the acoustic instruments thanks to interaction metaphors from Computer Music.

2   Objectives

The objectives of this article are:

1. Study of six pieces for karlax and acoustic instrument(s) including analysis of sound synthesis, mapping, gestures, and scores.

2. Among these pieces describe the ”role” of the karlax by identifying compositional models.

3. Analyse the use of the karlax and its interaction with acoustic instruments in excerpts of these pieces thanks to Computer Music metaphors.

3   Corpus of Pieces

We have selected 6 pieces written between 2013 and 2018 that combine the karlax controller with one or two acoustic instruments among a flute, a violin, and a cello. Five of the six pieces of the corpus have been commissioned by the *Fabrique Nomade* ensemble and have been performed by it. This ensemble is an "electronic chamber music ensemble that wishes to rediscover the gestures and listening of classical chamber music"[5]. In this regard, "each musician is independent and has total control over their acoustic or electronic instrument" (each instrumentalist has their own laptop and their own sound broadcasting system). This means that acoustic instruments performers trigger their own electronic part (most of the time real-time processing) thanks to a midi pedal and that the karlax cannot process in real-time the acoustic sound of an instrumentalist. This is not the case for the sixth piece where the karlax transforms the sound of the violin in real-time.

A   *Fogg* by Lorenzo Bianchi for violin, cello and karlax, 2013 (performed by *Fabrique Nomade* ensemble)

B   *Frottement, Bourdon, Craquement* by Francis Faber for cello, karlax and electronic, 2013 (performed by *Fabrique Nomade* ensemble)

C   *Le Patch Bien Tempéré III* by Tom Mays, for flute, karlax and real time electonic, 2013 (performed by *Fabrique Nomade* ensemble)

D   *Ripples Never Come Back* by Michele Tadini for violin, cello and karlax, 2013 (performed by *Fabrique Nomade* ensemble)

E   *Discontinuous Devices "In-between"* by Michele Tadini for cello and karlax, 2015 (performed by *Fabrique Nomade* ensemble)

F   *Le Violon, l'Oeillet et le Bambou* by Raphaël-Tristan Jouaville, for violin and karlax, 2018

4   Composition models

Among these pieces, we have identified three compositional models that represent three main sources of inspiration for the composers: model based on acoustic sounds, model based on electronic sounds and karlax as model. These allow describing the main "role" of this controller in relation to the other instruments.

Model based on acoustic instruments sounds

For several pieces in the corpus, the acoustic sound of the instrument(s) with which the karlax plays is used as the basic composition material. For example, in the piece *Fogg* (A), the sound synthesis of the karlax is realized through an additive synthesis from the spectral analysis of several violin pizzicati with different "preparations" (addition of objects like pegs attached to the string). The karlax triggers and controls processes related to the spectral content of pizzicato sounds by pressing continuous keys (control of the spectral envelope) (Fig. 2).

Other examples are pieces where the karlax plays sounds very close to the sounds played by the instrument(s) it interacts with. In this way, the acoustic instrument is

---

[5] www.fabriquenomade.com

33

"augmented" by the action of the karlax. For example, in the third part of *Discontinuous Devices* (E), the karlax activates flautando and harmonics cello samples by pressing the continuous keys. Shorter samples of the same type are also triggered by the pistons. This forms a harmonic environment for the cello, which performs more percussive figures like jettatti and glissandi that let the natural harmonics of the open strings resonate. With the same idea, in Jouaville's piece (F), the karlax plays a physical model of a string by activating the pistons in a consecutive way whose pitches are previously set up (*String Studio* module). In most of the piece, the karlax highlights and develops the melodic contour of the violin and/or creates a harmonic accompaniment (Fig. 3).
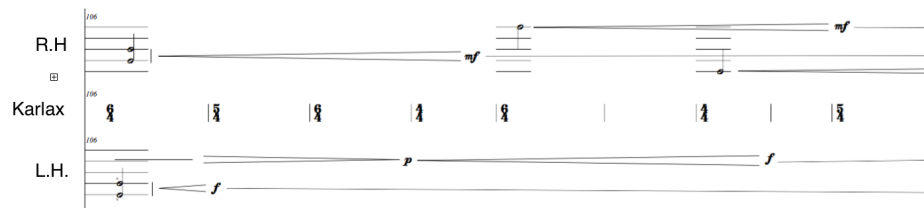

Fig. 2. "Shaping" of the spectral envelope with karlax continuous keys in *Fogg* by Lorenzo Bianchi (mes. 68-69, karlax part) (with the permission of the composer). Each staff line represents the activation of a continuous key that will control the volume of a group of oscillators.
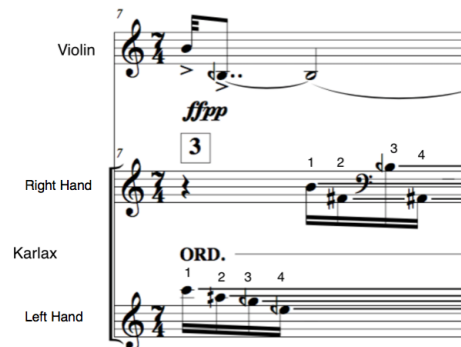

Fig. 3. Results of pitches played by the karlax pistons with the corresponding fingerings in *Le Violon, l'Oeillet et le Bambou*, by Raphaël-Tristan Jouaville (mes. 7) (with the permission of the composer). See video from 00:30 to 00:32 www.youtube.com/watch?v=IrCmiwwFSUs

Model based on electronic sounds

This type of composition model is the most common in the selected pieces. In this category are represented the treatments and manipulations associated with electronic music such as filtering, delay, granular synthesis, additive synthesis, ring modulation, arpeggiators, freeze, etc. Also, this control interface is often associated with the processing of electronic synthesis. By assigning certain parameters of the sound synthesis to

different sensors, the karlax can "drive" processes in real-time and bring an expressive dimension to the transformations. In this model, the sound of the karlax is perceived as independent from the acoustic sound of the instruments. For example, in the piece *Le Patch bien tempéré III* (C), the composer focuses on complementary electronic techniques such as harmonizers, delays, and "paf" synthesis based on voice formants [6]. In this piece, the input device activates different synthetic voices and modifies parameters. In general, the accelerometer data corresponding to the forward, backward movements are correlated with dynamics (brightness and intensity) and the left-right movements are correlated with pitch (glissandi) while the central axis applies a speed tremolo [8]. In the score are noted the part of the flute, the karlax movements laid out on four staves, and the acoustic results (Harmonizers and Synthesis staves) (Fig. 4).

Fig. 4. General score of *Le Patch bien tempéré III* by Tom Mays (mes.6) (with the permission of the composer). The karlax part combines -movements ("Gesture" staff with circle symbols) which controls intensity, brightness, and pitch-bend of the sound synthesis, -rotation of the axis (dotted lines) which control a speed tremollo and -continuous keys depression ("Right Hand" and "Left Hand" staves with thick lines) which activates "paf" synthesis voices. The numbers at the top of the score represent the time in seconds. See video from 01:44 to 02:00 https://vimeo.com/80464641

---

[6] *Phase Aligned Formant* developed by Miller Puckette in 1995

Karlax as model

The design of the karlax can also inspire the composition and constitute a model in itself. Indeed, this controller is conceived by being inspired by the keys system of wind and keyboard instruments (pistons and continuous keys) enriched with an axis (with bends) and movement sensors (accelerometer and gyroscope). The instrumental aspect of the karlax is developed among others in the introduction of the Faber's piece (B). Indeed, the instrumentalist performs a "call" thanks to the pistons produced by short harmonic synthetic sounds. The play of the karlax can be compared to the play of pistons of a trumpet (Fig. 5). Also, the possibilities of the karlax can inspire the "trajectory" of the piece. For instance, *Discontinuous Devices* (E) starts with an extensive use of the pistons and then in the second section the karlax triggers and controls long sequences through the accelerometer and gyroscope data, making the karlax gestures more and more expressive.
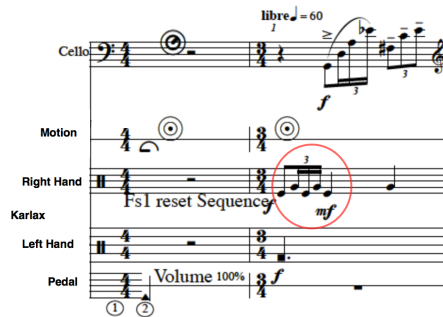

Fig. 5. "Call" played by the Karlax pistons in *Frottement, Bourdon, Craquement* (mes. 1-2) (with the composer permission). See video from 00:00 to 00:04 https://vimeo.com/118148219

5   Interaction Metaphors from Computer Music

In this part, we analyze excerpts of the corpus pieces thanks to metaphors from Computer Music. We have selected five metaphors from three articles: [9], [10], [11], for their relevance to describe the action of a gestural controller such as the karlax (particularly in interaction with acoustic instruments) and for their capacity to give an overview of compositional strategies.

"Shaping" [Caramiaux et al., 2014]

Shaping "refers to scenarios where performers control sound morphologies by "tracing" in the air those salient sound features they desire to control"[9]. This metaphor is described as the "transfer of variations into a gestural morphology" and as synchronization of sound with movement. It is widely used in the pieces thanks to Karlax motion sensors but also with continuous keys. For example, in (C), the karlax imitates the distortions of the flute sound (created by harmonizers, flatterzunge, etc.) by "shaping" the "paf" synthesis. At the same time, the ancillary gestures of the flutist seem to imitate the gestures of the controller (Fig. 4). With a more reduced gestural expression,

36

the continuous key activation allows the karlax performer in (A) to "shape" the spectral envelope in a differentiated way to provide a harmonic accompaniment to the violin and the cello (Fig. 2).

"Catch and Throw" [Wessel & Wright, 2002]

This strategy of interaction "involves the notion of selectively trapping musical phrases from an ongoing performance, transforming them in some way, and then sending these transformed materials back into the performance"[10]. This way of interaction, which could be defined as delayed real-time processing, is exploited in improvisational situations by Tom Mays in the early 2010's, where the direct sound of the acoustic instrument is captured, transformed by the karlax and broadcast in real-time[7]. This type of interaction is also employed at the end of Jouaville's piece (G) where the acoustic sound of the violin is processed by resonator, delay, and pitch shift modules (*GRM Tools)* whose parameter nodes are controlled by the karlax movements. This brings a sonic halo to the violin[8].

"Fishing" [Caramiaux et al., 2014]

This metaphor is related to the learning stage in gesture recognition. When a gesture is recognized by the dedicated program, a sound will be "fished" out to be played. One can compare this scenario of interactions with certain compositional strategies. For example, at the beginning of (A), several violin and cello actions with obvious gestural characteristics such as jettato, glissandi, strokes on the body of the instrument seem to be "recognized" by the karlax, which reacts by imitating gestures, triggering and transforming nearby sounds[9].

Musical tasks [Wanderley & Orio, 2002]

In the same idea as the composition model based on instrumental playing presented above (see *Karlax as model*), the article [11] proposes two levels of metaphors: *Musical Instrument Manipulation Metaphor* and *Other Metaphor*. In the first category are listed the interactions metaphors that refer to traditional instrumental playing (isolated notes, basic musical gestures like glissandi, vibrato, musical phrases, rhythmic playing, etc.) that appear for example in Faber's piece with the "call" (Fig. 5). In the second category, the authors evoke the actions of triggering of sequences but also their organization in time: synchronization, envelope control, continuous modulation features, etc.

"Space" [Wessel & Wright, 2002]

The purpose of using a control interface like karlax in this type of strategy is to "suggest musically interesting trajectories for gesture [10]". Moreover, the article emphasizes the importance of proximity and timbre in the perception of these trajectories.

---

[7] In this video, the karlax controls the transformations of the acoustic sound of a Sheng, a mouth-blown free reed instrument: https://www.youtube.com/watch?v=fg9TgbI4gTM

[8] See video from 05:43 to 06:42 https://www.youtube.com/watch?v=IrCmiwwFSUs

[9] See video from 00:00 to 01:10 https://vimeo.com/67049071

In addition, various strategies to suggest movements and trajectories are employed by the composers of the corpus. For example, in *Ripples Never Come Back* (D), the composer evokes a distancing through repeated sequences where the violin and cello instruments begin a quasi homorhythmic figure which is "taken up" by the electronic part performed by the karlax in the form of arpeggios towards the high register. The karlax controls a flow of notes produced by a subtractive synthesis: the axis controls the pitch of the arpeggio, the continuous keys control parameters like volume, filtering or speed while the inclination combined with a key activation controls the envelope (Fig. 6).

Fig. 6. Sequence that evokes a distancing in *Ripples Never Come Back* by Michele Tadini (mes. 32) (with the composer permission). See video from 00:48 to 01:00 https://vimeo.com/72995021

6 Discussion

The use of compositional models and Computer Music metaphors provide a framework and powerful analytical tools to apprehend pieces that appear at first sight very complex. It allows to categorize certain roles of the karlax in this precise context, with a small number of acoustic instruments, and allows to discuss situations.

For example, the piece (A) seemed to us to belong to both the first and the second composition model, depending on whether one considers the process of composition or the sound result. Indeed, the process of additive synthesis and the fact that the "target" sounds are prepared (with the addition of pegs) make the sound synthesis played by the karlax particularly distant from the acoustic sound of the violin. From a perceptual perspective, we would then need to determine whether or not the timbre of the sounds played by the karlax "blends" with the sound of the instrument and determine what allows us to assert this. For the other examples given for the first model: (E) and (F), we can use the terminology of "timbral augmentation" as presented in [12].

The selected metaphors are thought in real-time interactions context. While the composition process necessarily evolving in a delayed time, we have seen that these metaphors are proper to comment on typical situations of the pieces of the corpus. Firstly, because they offer situations of real-time transformations and secondly because the composition strategies in terms of dramaturgy can be compared to situations of improvisations. Moreover, the setup chosen by the *Fabrique Nomade* ensemble influences these strategies. As the instrumentalists are independent and trigger more or less random processes (for example delays), the composer tends to opt for "encompassing" strategies, highly describable by the metaphors [13]. On the other hand, these metaphors are limited to comment precisely on temporal and rhythmic aspects as specified in the article [11]. In addition, metaphors that qualify the action of a controller such as *Shaping*, or *Musical Tasks* facilitate the interaction with the instrumentalist(s) and the "reading" of the piece by the spectator/listener as they help to identify acoustically and gesturally the part played by the karlax.

Another important aspect to qualify the action of the karlax is its notation. Depending on the project of each piece, composers adopt a prescriptive (oriented on the action of the karlax player) and/or descriptive method of notation (which reports the acoustic result)[14]. As a reference point, the composers of the corpus use the basics of karlax notation presented in the article [6]. We can mention however the more pragmatic approach described in the Jouaville's piece (G) which consists in assigning events in order of appearance to a simple range of fingerings and allows to visualize the pitches played by the karlax and movements on a single staff (Fig. 3). Also, it is particularly interesting to relate the approach of the composer Andrew Stewart notably in his piece *Ritual* (2015) for karlax solo, based among others on gestures categorization and a spatial representation of space in the form of a grid [15]. In general, composers add rarely information related to mapping and sound synthesis, which would allow performers to further appropriate the karlax instrument. Simultaneously, the notation must be practical and represent the composer's intention in a precise and concise way. As such, an indication in the score of the metaphorical context, as presented above, would provide valuable information about the way(s) the karlax is played and how it interacts with other instrument(s).

7   Conclusions

In this article we presented an analysis of six pieces for karlax and acoustic instruments. Three models of compositions have been identified and five metaphors from Computer Music have been proposed to characterize typical musical situations. To go further, it seems particularly interesting to deepen the analysis of these pieces by providing a detailed description of their conception and by comparing them both in terms of sound synthesis, mapping, gestures, notation, and interactions. In addition, it would be interesting to compare the use of the karlax with other DMIs like T-Stick in the same type chamber music context.

References

1. Dobrian, C., Koppelman, D.: The E in NIME: Musical Expression with New Computer Interfaces. *Proc. Int. Conf. on New Interfaces for Musical Expression*, pp. 277–282 (2006)
2. Palacio-Quintin, C.: Eight Years of Practice on the Hyper-Flute : Technological and Musical Perspectives. *Proc. Int. Conf. on New Interfaces for Musical Expression*, pp. 293–298 (2008)
3. Morreale, F., McPherson, A.: Design for Longevity: Ongoing Use of Instruments from NIME 2010-14. *Proc. Int. Conf. on New Interfaces for Musical Expression*, pp. 192–197 (2017)
4. Hödl, O.: 'Blending Dimensions' when Composing for DMI and Symphonic Orchestra. *Proc. Int. Conf. on New Interfaces for Musical Expression*, pp. 198–203 (2019)
5. Ferguson, S., Wanderley, M. M.: The McGill Digital Orchestra: An Interdisciplinary Project on Digital Musical Instruments. *Journal of Interdisciplinary Music Studies* (2010)
6. Mays, T., Faber, F.: A Notation System for the Karlax Controller. *Proc. Int. Conf. on New Interfaces for Musical Expression*, pp. 553-556 (July, 2014)
7. Miranda, E., Wanderley, M.: *New Digital Musical Instruments: Control and Interaction Beyond the Keyboard*. A-R Editions, Inc. (2006)
8. Mays, T.: L'Harmoniseur augmenté : Le dispositif d'écriture mixte dans l'oeuvre *Le Patch Bien Tempéré III*". *Proc. Journées d'Informatique Musicale* (July 2015)
9. Caramiaux, B., Françoise, J., Scnell, N., Bevilacqua F.:Mapping Through Listening. *Computer Music Journal*, 38(3):34-48 (Fall, 2014)
10. Wessel, D., Wright, M.: Problems and Prospects for Intimate Musical Control of Computers. *Computer Music Journal*, 26(3):11-22 (Fall, 2002)
11. Wanderley, M., Orio, N.: Evaluation of Input Devices for Musical Expression: Borrowing Tools from HCI. *Computer Music Journal*, 26(3):62-76 (Fall, 2002)
12. Touizrar, M., McAdams, S.: Aspects perceptifs de l'orchestration dans *Angel of Death* de Roger Reynolds: Timbre et groupement auditif. Dans P. Lalitte (Ed.), *Musique et cognition : Perspectives pour l'analyse et la performance musicales*, (pp. 55-78). Editions universitaires de Dijon (2019)
13. Dahl, L., Wang, Ge.: Sound Bounce: Physical Metaphors in Designing Mobile Music Performance *Proc. Int. Conf. on New Interfaces for Musical Expression*, 15-18 (June, 2010)
14. Kanno, M.: Prescriptive notation: Limits and challenges. *Contemporary Music Review*, 26(2):231-254 (2007)
15. Stewart, A.: Karlax Performance Techniques: It Feels Like... *Proc. Int. Computer Music Conference* (2016)