A Notation System for the Karlax Controller

Tom Mays
Académie Supérieure de Musique de Strasbourg
Conservatoire National Supérieur de Musique de Paris
CICM – Université de Paris VIII
contact@tommays.net

Francis Faber
La Grande Fabrique
Dieppe
francisfaber@lagrandefabrique.com

ABSTRACT
In this paper we expose the need to go beyond the composer/performer model of electronic instrument design and programming to encourage the transmission of compositions and the creation of a repertory via notation of repeatable performance practice. Drawing on 4 years of practice using the Karlax controller (Da Fact) as a base for new digital musical instruments, we present our notation system in detail and cite some mapping strategies and examples from to pieces in a growing repertory of chamber music compositions for electronic and acoustic instruments.

Keywords
notation, mapping, composition, gesture, performance, Karlax, instruments and electronics, digital musical instruments, DMI

1. INTRODUCTION
Over the years, we have focused much of our energy on live performance of electronic music and intermedia. After programming and performing with the Meta-instrument (created by Serge De Laubier at Puce Muse[1]), Nintendo Wiimotes and camera-tracking based interfaces, in 2010 we discovered the Karlax, created by Rémi Dury of the French company Da Fact[2].

The look, feel, weight, precision, solidity, dependability and flexibility of the Karlax made it a good candidate for our DMI development. It is a commercially available, industrially tooled though hand-assembled wireless gestural device, combining continuous controller keys, velocity pistons, switches and three axes of accelerometers and gyroscopes. We considered that its potential to become widely used warranted not only composing for it but developing method, performance practice and notation in the creation of a repertory. Could its malleability enable it to be used in the creation of DMIs that could overcome the "split between interface and sound engine" that Magnusson[4] refers to in his dream of a better electronic instrument? Can it be expressive, virtuosic, and intuitive enough to satisfy what Machover[3] refers to as the notion of the *inevitability* of a successful instrument – not only for composers and performers, but for the public as well? In considering Wessel, Wright and Schott's desired features for gestural interfaces[5], the Karlax clearly attains them: the ability to detect subtle as well as larger gestures, continuous as well as event based control, low latency and high bandwidth, reliability and portability. In the very least we saw it as an opportunity to go beyond the composer/performer/programmer model and start to write pieces for DMIs that could be performed by others – repeatable and shareable. This requires a stable, transmissible computer patch environment, coherent mapping strategies and a concise yet readable system of notation and scoring – notation being considered essential in describing repeatable actions of sequences of control change[1]. It not only involves starting to compose and collect a repertory of pieces, but establishing certain performance practices, as well as the methods and training techniques that go with them.

A new electronic chamber music ensemble, *Fabrique Nomade*, became an exploration space for these ideas, seeking to reconnect with the practice, the attentive listening and the intimate nature of traditional chamber music. It commissions pieces for Karlax and one to three acoustic instruments where the composer provides the score and the computer programs (Max patches), but does NOT perform. The ensemble's Karlax performer then practices and rehearses the piece as would any instrumental performer – both alone and with the other musicians – true to the chamber music tradition. The work on the compositions, DMIs and scores for the ensemble was the impetus and the source of research behind this paper.

2. BACKGROUND
In order to reflect on a system of notation, we organized think tank meetings at the *Conservatoire National Supérieur de Musique de Paris* in 2011 and 2012 called *Karlax Ecritures*[3] around the idea of proposing coherent strategies for Karlax notation and mapping to facilitate composition and performance. There were several electroacoustic professors and composition students in attendance such as Luis Naón and Daniel Fígols-Cuevas, as well as outside composers and musicians such as Rémi Dury, Lorenzo Bianchi and Laurent Matheron. Many of the ideas that became the notation system that we expose in this paper have their roots in these meetings, and were often the result of collective effort and consensus. Compositions stemming from these ideas include *Kahla* by Daniel Fígols-Cuevas for large ensemble and Karlax-driven electronics, two pieces for violin, cello and Karlax *(Fogg* by Lorenzo Bianchi and *Ripples Never Come Back* by Michele Tadini), *The Well-Tempered Patch III* for flute and Karlax by Tom Mays, and *Frottement, bourdon, craquement* for cello and Karlax by Francis Faber.

3. BASIC KARLAX NOTATION AND SOME MAPPING NOTIONS
In the chamber music context of the *Fabrique Nomade* ensemble, the Karlax needed a precise, time-based notation system in close relation to the writing for the acoustic instruments. The notation needed to be detailed yet not clutter the page with overly precise indications that would make it unreadable – a condition described by Burtner[2] in his notation

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.
NIME'14, June 30 – July 03, 2014, Goldsmiths, University of London, UK.
Copyright remains with the author(s).

[1] Serge de Laubier / Puce Muse: http://www.pucemuse.com
[2] Rémi Dury / Da Fact: http://www.dafact.com
[3] Karlax Ecritures: http://karlax.tommays.fr

simplification strategies where too much detail makes performance impractical.

We sought to develop notation and mapping strategies for the Karlax, while creating DMIs involving the elements of "controller, gesture, mappings, mapping metaphors, sound generator and sound emission" as described in Wessel, Wright, Schott [5]. In doing this, we understood that there are certain generalities implied from its physical characteristics, outside of the design of any specific computer-based instrument. We will look at each group of controller functions and suggest some basic notation ideas that stem from those physical and technical characteristics, along with some mapping strategies that can be applied.

3.1 The keys

The Karlax, held somewhat like a clarinet, contains ten keys, one for each finger with two smaller keys for the each little finger (see Figure 1). These are continuous controllers that send either MIDI or OSC values.

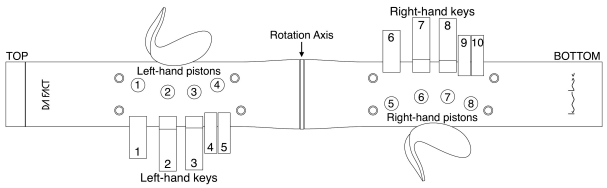

Figure 1: Keys, pistons and rotation axis

The most direct way of mapping the keys would be as a series of faders that could be applied directly to various parameters of a sound generator or other process – much like any common MIDI fader box. This seems simple on the surface, but in practice it can quickly make for very difficult and complicated performance. The keys are under spring tension so it very difficult to maintain constant intermediate positions, especially with several fingers at once. In addition, achieving specific, accurate, pre-determined values is nearly impossible since the physical distance of the movement is fairly small and the only real point of reference is feel. Whatever precision might be possible where only one finger is involved becomes exponentially more difficult as more fingers are added. It is our conclusion that it is better to not rely too heavily on the MIDI fader paradigm and focus rather on the dynamic gestural possibilities that the keys provide. In practice, this means establishing mappings that allow a certain tolerance in terms of the positions of the different keys. This could involve calculating the velocity of the key press or applying smoothing techniques that depend more on the time that a key is pressed rather than finding an exact position. The notation should reflect this tolerance by not indicating position too precisely, and by trying to focus more on dynamics, interpolation time and duration.

A less precise position indication in the notation makes it more important for the musician to respond to audible cues – hearing the result and adjusting the position or velocity accordingly. This underlines the interpretive quality of the performance and emphasizes the musician's need to hear what they play and not just execute commands. We believe that a successful notation will balance indications of action (tablature) and results (audible feedback).

We chose to keep the notation of the keys as simple and traditional as possible so as to be easy to combine with instrumental writing. We use two 5-line staves, one for each hand, and indicate each key on consecutive lines with a normal notehead. We chose to put the left-hand staff on the bottom and the right-hand staff on the top for reasons of a certain pianistic sensibility of the ensemble's Karlax performer[4]. This make the first line on the lower staff correspond to the left index finger or key 1, and so on. The little fingers can press keys 4 and 5 (left) or keys 9 and 10 (right), individually or together. Figure 2 shows this notation, the numbers relating to the image of Figure 1.

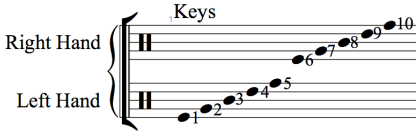

Figure 2: Basic *keys* notation

If a velocity mapping paradigm is used for the keys, traditional dynamics notation would be the most appropriate, but in the case of pressing the keys slowly over time or only partially, we needed other mechanisms. One possibility is to use *silence to crescendo* and *decrescendo to silence* lines in front of and after the noteheads to show when to begin or end the change of position. Figure 3 shows an example of this notation, while also proposing a slashed notehead to indicate a partial key press. It is taken from *The Well-Tempered Patch III* by Tom Mays[5].

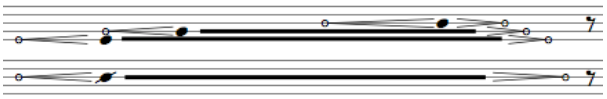

Figure 3: Pressing and releasing keys

In spite of the difficulty involved, Michele Tadini chose to employ a key percentage technique in *Ripples Never Come Back*[6], as we can see in Figure 4. Upon closer inspection, we can observe that he limits the key presses to 4 values: 25%, 50%, 75% and 100%, which is a reasonable compromise between precision and simplicity.

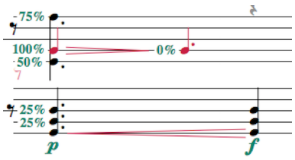

Figure 4: Percentage technique for key presses

3.2 The Pistons

Positioned just in front of each key (or pairs of keys as is the case with the smaller 4-5 pair on the left and the 9-10 pair on the right), just under the base of each finger, at the level of the proximal phalanges, are 8 velocity-sensitive pistons. These can be directly mapped to synthesis notes or samples, or with a threshold detector can be used to activate/deactivate processes by pressing at any velocity greater than a defined threshold.

It makes sense to simply notate these as one would any MIDI note instrument, though in order to fit them within the same staff lines as the keys, we chose to notate them in the 4 spaces using square noteheads. The pistons are numbered 1 to 8 and are played starting with the left index and ending on the right little finger (See Figure 5).

[4] A *woodwinds* approach could also be imagined which would reverse the two staves and all of the lines, placing the left hand on the *upper* staff and the right hand on the *lower* staff.

[5] *The Well-Tempered Patch III* for flute, Karlax and live electronics by Tom Mays, 2013. Commissioned by La Grande Fabrique.

[6] *Ripples Never Come Back* for violin, cello, Karlax and live electronics by Michele Tadini, 2012. Commissioned by Studio Art Zoyd.

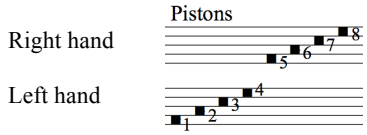

Figure 5: Basic *piston* notation

Figure 6 shows another passage from *The Well-Tempered Patch III* involving piston notation.

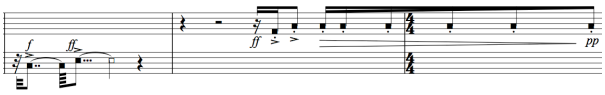

Figure 6: Musical example of piston notation

3.3 The axis rotation and bends

The two halves of the Karlax are joined together by a rotary axis that is adjusted by turning either hand, or both hands in contrary motion – although we prefer turning the left hand to affect changes in axis position because turning the right hand may alter acceleration/gyroscope values due to the fact that the sensors are located in the bottom or right-hand section. At each end of the axis movement is a spring-loaded bend, which feels a bit like half of a keyboard bend wheel.

This makes for three distinct controller values: axis, bend left, bend right. Throughout the different pieces of the ensemble's repertory, two different notation methods for the axis and bends have developed – one involving symbols describing position, and the other indicating position by noteheads on a 3-line staff.

3.3.1 Axis rotation - method 1

The first method involves a one-line staff positioned above the keys and pistons staves which is used for motion. The axis rotation symbols are placed under the line, and orientation symbols are placed above (See 3.4 The motion sensors). Symbols representing the position of the axis are placed at the appropriate time in the score. Dotted lines indicate gradual change from one position to another. Figure 7a shows an example of a very simple icon inspired by the 180° rotation of the axis. To this we add a small curved arrow to indicate a free movement and a thick curved arrow at the right and left extremities to indicate the two benders (Figure 7b).

Figure 7: a. Basic axis notation, b. free movement and right bend

Figure 8 shows a musical example from *Frottement, bourdon, craquement* de Francis Faber[7] that uses axis rotation, with a gradual transition from left to right in the 4/4 measure, and a free movement in the next measure. The staff below is for the right-hand keys and pistons.

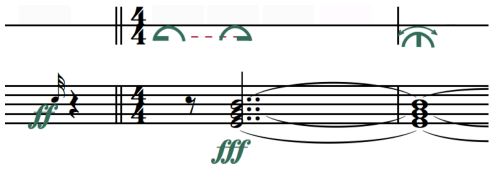

Figure 8: Musical example of axis rotation

[7] *Frottement, bourdon, craquement* for cello, Karlax and live electronics by Francis Faber, 2013. Commissioned by La Grande Fabrique.

3.3.2 Axis rotation - method 2

The second notation method for the axis rotation and bends involves inserting a 3-line staff in between the left and right hand keys/pistons staves – underlining the physical position of the axis which is the middle of the instrument. The lines are spaced 50% farther than normal in order to be able to place noteheads at two different positions within the lines. In this way, seven total positions can be notated (middle line for center, just above middle line for 1/3 left, just below top line for 2/3 left, top line for full left, and the same below the middle line for the right (see Figure 9).

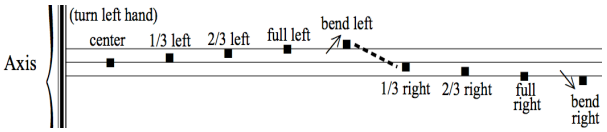

Figure 9: Axis rotation on a 3-line staff

Square noteheads help the performer identify the relative positions more quickly, and thick dotted lines show gradual transition between two positions. The bends are identified by noteheads above or below the top and bottom lines, with a small arrow for clarification and ease of reading.

Figure 10 shows a musical example taken from *The Well-Tempered Patch III* where the axis goes progressively from center to 2/3 left, to 1/3 left, to full left, then back to center.

Figure 10: Musical example of Axis notation

3.4 The motion sensors

For motion detection, the Karlax contains three axes of accelerometer and gyroscope sensors, sending derived x-tilt and y-tilt values as well. Whether using direct accelerometer/gyroscope data, tilts, or some other derived values such as azimuth and distance, we opted for a notation method indicting various spatial orientations of the Karlax which can be starting or ending points for gradual or rapid transitions.

We had initially experimented with a set of left-right, front-back indicators (shown in Figure 11), but these proved to be too rigid as they considered each axis separately rather than holistically, making it very difficult to indicate complex movements.

Figure 11: Initial symbol proposal for Karlax motion

We then designed a new system of icons that symbolically represent the position of the Karlax as "seen from above" in a polar format. This system tries to balance precision and simplicity by giving approximate positions, with the understanding that the performer will complete the missing precision with audible feedback – adjusting the performance based on the sound of the instrument, as would any instrumental performer. Tested in at least two pieces up until now, it has proven very easy to use.

There is an outer circle and an inner circle with a thick line something like the hands of a clock stemming out from the center. If the Karlax is in the neutral position (pointed up, or else in a natural slightly off-center position compensated for by zeroing the sensor data), we see two thinly drawn concentric

circles and a thick dot in the center. As the Karlax is angled outward, in any direction, we consider that it is at the first distance level, drawing the stem out to the first circle which is made bolder for emphasis. If the Karlax is positioned to lay horizontally in any polar direction, we consider that it reaches the second circle, the stem is lengthened and the second circle is made bold (see Figure 12).

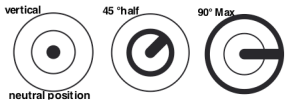

Figure 12: Current "view from above" notation for Karlax motion.

We determined that the right balance between simplicity and precision requires eight positions for the inner circle (every 45 degrees), and 16 positions for the outer circle (every 22.5 degrees) – more precision being necessary in the outer circle. This makes for a total of 25 symbols, including the neutral position.

These symbols are placed in a dedicated motion staff (which may share space with the axis rotation in some cases as described in 3.3.1). The symbols are placed in specific temporal positions in the score that indicate fixed position, point of departure or point of arrival, while thick dotted lines show interpolation between positions. In practice, this is fairly easy to read and effective. Figure 13 shows a musical example taken from *The Well-Tempered Patch III* involving motion, key-presses and axis rotation.

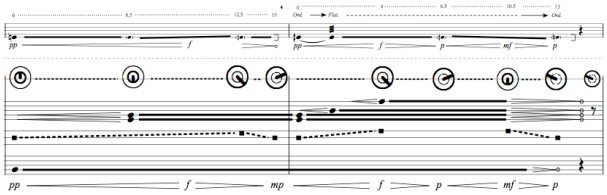

Figure 13: Musical example of motion notation

3.5 Impulses

The Karlax sends fixed velocity note information relating to impulse movement in any of the six spatial directions. These are internal values derived from the accelerometer information. These impulses have not yet found their way into compositions for *Fabrique Nomade*, and so we do not have a tested, validated notation technique. However, a simple arrow butting into a line should suffice to indicate an impulse movement in a certain direction – stopping suddenly (see Figure 14). These would logically be placed on the motion staff.

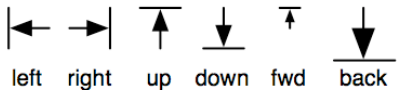

Figure 14: proposed symbols for impulses

3.6 The switches

The multiple finger switches on the front and back of the Karlax can be used for triggering or for turning processes on and off. These switches are not often used in our pieces, and when they are, we tend to re-use our older symbols for switches on the wiimote nunchucks. See Figure 15 for a *front switch 1* (FS1) symbol located on an additional lower staff line for pedals and switches. These switches serve more as actuators than sources of gesture.

3.6.1 The pedals and switches staff line

In concerts by *Fabrique Nomade*, the Karlax performer is often seated. In these case, we add two foot pedals, one switch for triggering an event change within each composition, and one continuous controller for main volume. We create an additional one-line staff to notate the event pedal as a triangular notehead with an associated event number (to be verified with the current number in the Max patch display that the performer refers to from time to time on his computer screen), and the continuous pedal with traditional dynamic markings, crescendos., decrescendos (See Figure 15). We also place any Karlax *switches* as described above.

Figure 15: Pedals staff line

4. Conclusions

Our proposed notation system for Karlax has proven functional, expressive and readable in several pieces written for and performed by the *Fabrique Nomade* ensemble. There is still room for improvement and the system will evolve with subsequent pieces, but we have presented here what we consider to be a solid base for future work.

This notation system can be considered more of a tablature than a sound result-based notation, which, while it does not indicate much about what is going on in the electronics, is very useful for the performance, and as a training aid in learning how to play the Karlax. One can easily add a staff or two to notate the resulting electronics separately.

Notation is only a part of the equation of the idea of transmission of a work created for a DMI. Not only should the gestures indicated by the notation be repeatable, but the program (patch) part of the DMI needs to be stable, portable, expressive and intuitive. With this proposition to solve the basic notation problems, a rich area of necessary development will be a set of standard patches for performing expressive, gestural-based sound with the Karlax. These patches, and existing ones, combined with our notation, can be directly applied to composition and the establishment of a repertory for the Karlax controller.

5. REFERENCES

[1] M. Burtner. Composing for the (dis)Embodied Ensemble : Notational Systems in (dis)Appearances. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, (NIME 2003), pp. 63–69, 2003.

[2] M. Burtner. Noisegate 67 for Metasaxophone: Composition and Performance Considerations of a New Computer Music Controller. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, (NIME 2002), pp. 24–29, 2002.

[3] T. Machover. Instruments, Interactivity, and Inevitability. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, (NIME 2002), pp. 115–115, 2002.

[4] T. Magnusson. Designing constraints: Composing and performing with digital musical systems. *Computer Music Journal*, 34(4):62–73, 2010.

[5] D. Wessel, M. Wright, J. Schott. Intimate Musical Control of Computers with a Variety of Controllers and Gesture Mapping Metaphors. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, (NIME 2002), pp. 192–194, 2002