TOWARDS A NOTATION FOR TRUMPET VALVE ROTATION

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ABSTRACT

Many contemporary performers and composers seek new sounds through extension of traditional instrument techniques. For the trumpet one such extended technique is valve rotation, the rotation of a trumpet piston valve within its casing affecting the timbral complexity of airstream effects. This paper describes the development of a system for notating valve rotation using a prescriptive graphical language and an animated interface for entering continuous rotation and airstream data.

1. INTRODUCTION

Valve rotation is an extended technique unique to the trumpet and other valved brass instruments. The technique employs the rotation of the valves within the valve casings, directing the air that is moving through the trumpet in unconventional ways and altering the timbre and complexity of airstream effects.

Although the possibilities of the technique have been apparent since the invention of the valve, the historical origins of valve rotation in performance are not clear. Extended techniques such as flutter tonguing, growling, half-valving and lip bends, have a long, documented history in recording and, more recently, notated composition. However, valve rotation appears to have remained relatively unexplored perhaps because its relatively quiet, detailed and granular texture is more suited to amplified performance, recording, personal listening and the microsound, lower-case aesthetics of the Post-Cage/post-Walkman era.

Trumpeters Craig Pedersen [1], Nate Wooley [2] and Axel Dörner [3] all currently include valve rotation amongst their extended techniques, suggesting that its use in performance originated in non-idiomatic and free improvisational contexts. While notated solo works for trumpet by Stockhausen [4], Gruber [5] and Turnage [6] employ a wide range of extended techniques, including airstream effects, multiphonics and slide removal, the only notated composition involving valve rotation uncovered by this study was Rama Gottfried's *speckle* [7] (Figure 1). Gottfried provides a basis for the depiction of the trumpet valve block in composition and the rotation of valves.

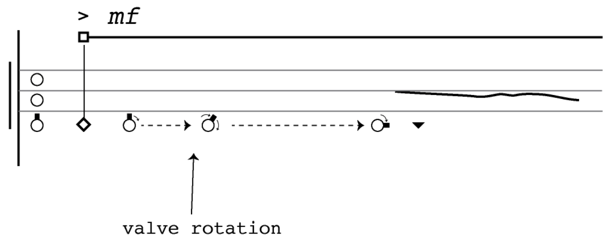

Figure 1. Excerpt of trumpet valve notation from *speckle* [8] notates a 90-degree valve rotation, clockwise.

Currently valve rotation is a difficult technique for performers and composers to communicate due to limited:

- documentation referring to the sounds created by valve rotation;
- investigation into the application of valve rotation in improvisation and composition; and
- methods for the effective notation of the technique.

This study is a starting point in the exploration into trumpet valve rotation and in particular the communication of this technique through the development of an animated score creator/player software application: Valverotator. This paper outlines the concurrent development of a valve rotation notation through a practice-based approach involving improvised experiments.

2. GRAPHIC NOTATION

Due to the difficulty of describing the nuances of sound made with the valve rotation technique, notating the actions required to generate the sound is more practical. Kojs [8] defines this approach, found in works such as Cage's *Variations III* [9], Kagel's *Pas de Cinq* [10], Berio's *Sequenza V* [11] and Lachenmann's *Pression* [12], as action-based. In developing this action-based notation the intuitive nature of the symbols was of utmost importance. Vickery, et al., note the importance of "semantic soundness—the degree to which the graphical representation makes intuitive sense to the reader—rather than necessitating learning and memorisation of new symbols" [13].

2.1 Evolving through practice

The initial impetus to notate valve rotation was born of the need to document interesting sounds that occurred during improvisation with the technique. This lead to the preparation of the valve buttons to include marks as a visual representation of rotational position — achieved by marking the valves with a permanent marker pen. When an interesting sound was discovered by O'Connor the orientation of these marks was transcribed onto paper — *Set and Forget* (Figure 2, left) is an example of this.

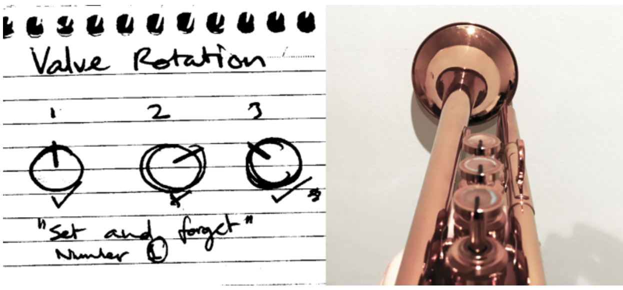

Figure 2. Score for O'Connor's *Set and Forget* (left) and the performers perspective of the trumpet (right). The authors note the difference in orientation of the valves and valve notation.

It became apparent that the orientation of the symbols in Figure 2 was not particularly intuitive, as the horizontal placement of the valve graphics did not reflect the perspective of the trumpet player (Figure 2, right), in which the first valve is at the bottom of the frame and the third at the top. Due to the angle from which the valve buttons are viewed, it is also easier to read the valve marks when they are directed back towards the player, which led to selecting this direction as the neutral, unrotated position.

The notation in *Progression Sketch #1* (Figure 3) takes the perspective of the trumpet player into account, orienting the valve symbols vertically and the rotation marks toward the player when unrotated. The 'ticks and crosses' in *Set and Forget* indicating the removal of valve slides, have become squares — a filled square meaning slide in place (filled), and slide removed (unfilled). The ticks and crosses possessed established meanings that were unhelpful, or even confusing when used in this way.

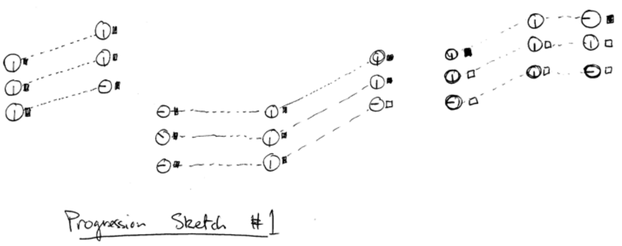

Figure 3. Excerpt from O'Connor's *Progression Sketch #1,* read left to right with dotted lines instructing when to blow air.

Progression Sketch #1 attempts to choreograph valve rotation and air velocity, with the aim of creating a piece solely involving valve rotation. In *Progression Sketch #1* the dotted lines indicated that air is to be blown through the instrument, and the height of the valve cluster graphic on the page, the velocity of that airstream. The sketch is played left to right and duration is proportional to the spacing of the valve cluster graphics. Experiments with *Progression Sketches #1,* and (not illustrated) *#2* and *#3* identified the more challenging parameters to represent in this notation — duration of events, direction of rotation, and air velocity.

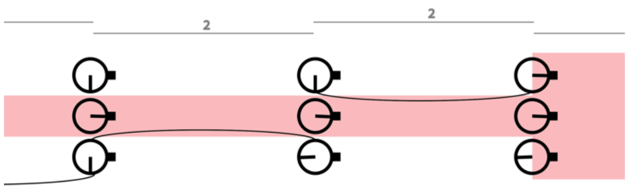

Figure 4. Excerpt 1 from *Valverotator Test Score* 2 by O'Connor notates 1st valve rotation, 90 degrees clockwise, then 3rd valve, 90 degrees anticlockwise.

Valverotator Test Score 2 (Figure 4) was designed in Adobe Illustrator and presents solutions for notating the rotation and air velocity parameters. In this score, airstream velocity is indicated by the depth of the red block of colour. When the air velocity block encompasses the whole valve cluster graphic, the air velocity is at its maximum, if it is a very thin red line a very slow air velocity is required, and if no red block is present then the performer does not blow through the instrument. The score also indicates the direction of valve rotation via a line with an upward arch (clockwise rotation) or downward arch (anticlockwise rotation) attached to the top of a valve diagram. Above the valve cluster graphics are the durational indicators, both geometrically proportional and with a duration in seconds inscribed above.

In order to choreograph the removal of valve slides the small black squares symbolising the slides are detached from their corresponding valve. The valve slide choreography is via a dotted line pre-empting the slide removal (Figure 5), warning the trumpet player that by the next frame the slide should be removed.

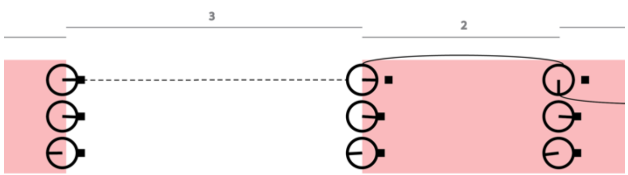

Figure 5. Excerpt 2 from *Valverotator test score 2* by O'Connor shows 3rd valve slide detached notation.

In Figure 5 the third slide graphic appears detached in the second valve cluster, instructing the performer to remove the third slide from the instrument. Slide removal can be slightly clumsy whilst moving air through the instrument. In *Valverotator Test Score 2* all the slide movements are undertaken without the flow of air through the instrument, to avoid unintended timbral variation.

Having developed a set of symbols that allow for the transcription of valve rotational position, therefore facilitating composition with the valve rotation technique, the question then arises; how does one create and present a composition? Two methods, the static score and the animated score, were considered.

3. THE SCORE

3.1 Static score

In the history of notated music the creation of a static score, often on paper, is the predominant form of presenting a composition; "The paper-based technology of CPN [common practice notation] has remained almost unchanged for 400 years" [13]. The advantages of the static score are:

- Accessibility due to the lack of necessity for technical equipment required to perform the work.
- The value of the aesthetic nature of an arrangement of symbols on a page.
- The ease of discussion and education — everything is potentially visible at all times and thus can be referred to efficiently.

Valverotator Test Score 2 is an example of a static score for valve rotation. In O'Connor's practice he found these scores both playable and aesthetically pleasing. There are some deficiencies in the static score; the time-consuming nature of graphically composing the score and potential issues of precise ensemble synchronisation.

In order to find a more efficient means of composition for valve rotation within a medium in which multiple scores can be precisely synchronised, a software application (app) for composition and performance of valve rotation scores was developed.

3.2 Animated notation

Animated notation offered the possibility of more precisely specifying the degree and rate of valve rotation and the potential to bundle other specifications such as airflow and detachment of slides from their corresponding valve. When seeking models for an animated notation for trumpet valve rotation Ryan Ross Smith's *Study No. 8* [14] provided a starting point. The use of animated rotating dial-like objects to indicate percussive actions for performers in *Study No. 8* (Figure 6 left) provided a constructive analog to valve rotation that was similar to the graphic representation of the trumpet valves O'Connor had devised for static scoring (Figure 6 right).

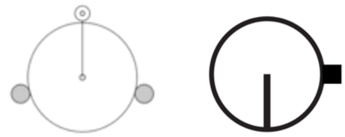

Figure 6. Smith's [14] percussion notation (left) provided a starting point for O'Connor' valve button symbol (right).

Smith's 2015 paper, "An Atomic Approach To Animated Music Notation" [15] also provided a useful touchstone for the conceptual development of the app. The terminology proposed by Smith is used to describe the graphical language that was adopted:

- Primitive – an irreducible static or dynamic symbol;
- Compound primitive — Two or more primitives seamlessly combined in such a way that a secondary primitive enhances or embellishes the primary;
- Structure – two or more primitives in some interrelated relationship;
- Aggregate – a collection of primitives, structures, and their respective dynamisms that corresponds to a single player; and
- Intersection – a dynamic attack cursor intersecting a static node or playhead.

3.3 Software considerations

A number of platforms for the software development were considered. Decibel ScorePlayer was first considered due to the recent development of 'Canvas' mode [16] which can accommodate scrolling and stationary objects simultaneously. Unfortunately, the ability to rotate score segments was not achievable in Canvas mode during this study. A recent score, *Southern Currents* by Meg Travers,[1] does employ a rotating playhead in the ScorePlayer environment and may allow further consideration of ScorePlayer in the future.

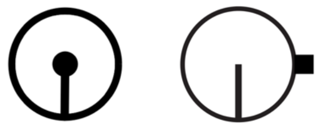

Figure 7. Max 6 dial object's (left) similarity to O'Connor's valve button symbol (right) lead to development of a Max 6 app.

The standard Dial in Max 6 (Figure 7, left) bears a resemblance to the valve graphic representation O'Connor developed for static scoring and quickly became the

[1] *Southern Currents*, by Meg Travers: concert performance at Perth Institute of Contemporary Arts, Perth, Australia, 24th October 2017.

platform for the development of the animated notation for valve rotation.

3.4 Development in Max 6

The initial versions of Valverotator employed Max 6 function objects that the composer could graphically program to input the degree of rotation at desired points in the composition. When pressing play this information would then be fed into the Dial objects, rotating them continuously. Each Dial had a corresponding function object and the velocity of air was directed by a fourth function object that controlled the opacity of the background colour of the Dials.

In practical trials the immediacy of rotational movement was noted as problematic in that there was no forewarning to an upcoming rotational gesture. In discussing 'contact' in animated music notation Smith [15] notes the 'setup' before a point of contact and the ability of the setup to convey performance instructions. To build on Smith's example, the conductor's baton falls (the 'setup'), stopping at an invisible boundary (the 'contact') to denote the instant of the downbeat. If the falling of the baton did not precede contact with the invisible boundary the performer would not have the necessary information to decipher this as the instant of the downbeat. To translate this to the dynamic valve rotation notation, there needed to be an analogous 'setup' before the motion of a dial in order to convey performance instructions to the performer, giving them forewarning of the rotational gesture. The concept of the setup is perhaps even more pertinent to the exhalation of air through the instrument, which of course requires a preparatory inhalation.

Similar issues had been resolved by scrolling notation from right to left across the screen and actualising them at a playhead — a point of contact at which the instructed gesture is to be actualised [17]. It is the influence of this scrolling score, playhead relationship that manifested the animation of the function objects within the Valverotator app.

The function objects contain graphically visible 'x, y' data points connected by a line, and from version three onwards of the Valverotator app the function objects themselves scroll from right to left into a playhead. Due to the close proximity of the valve and slide compound primitive to the left side of the playhead the scrolling objects are terminated at the playhead, so as to avoid cluttering of the other information presented.

The scrolling function objects bundle three pieces of information for the performer:

- Direction of rotation via the direction of slope of the line;
- Relative speed of rotation via the gradient of the line; and
- Instant of the actualisation via the contact point of function line and playhead.

This seems to be all the information the performer would need to execute the gesture, however the scrolling function objects lack 'semantic soundness' in this scenario, decoding of rotational information from scrolling line graphs being unintuitive. Valverotator combines a playhead, valve symbol, and scrolling function object for each valve, a more intuitive and fully descriptive structure (Figure 8). In rehearsal O'Connor found keeping focus on the valve diagrams and the scrolling information in his periphery was most effective.

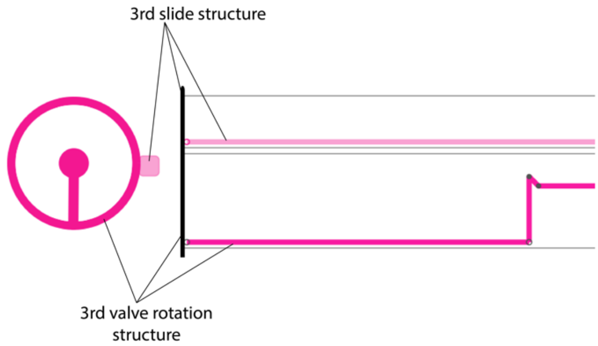

Figure 8. Screenshot of the Valverotator 3rd valve aggregate, a combination of the 3rd slide and 3rd valve rotation structures.

Smith's term 'intersection' [15] lends itself to discussion of the animated notation of the trumpet valve slide. Valverotator 3 employs a Max 6 multislider bar oriented vertically to communicate air velocity (Figure 9). In practice this is intuitive because the minimum and maximum air velocities are clear at all times, the full multislider bar and empty multislider bar respectively.

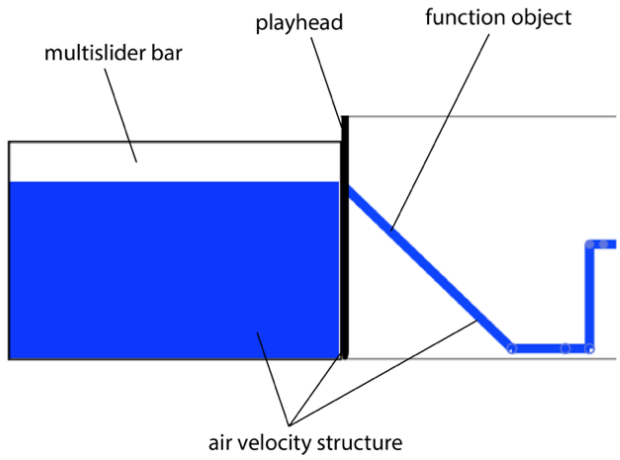

Figure 9. Screenshot of the air velocity aggregate made from multislider, playhead and function object.

Figure 10 shows the valve slide geometric primitive, simply a square. It is not the slide primitive's shape that is important in transferring performative instruction but its intersection with the valve button primitive. As the scrolling slide function object contacts the playhead the slide primitive detaches from the valve primitive (Figure 10 right). It is this state of attachment or detachment that is intuitively decoded by the performer.

Colour is used to visually separate aggregates. Each aggregate is formed from identical primitives to control the same parameters for each valve and air velocity, thus the use of colour differentiates the streams of information, preventing ambiguity in the decoding process.

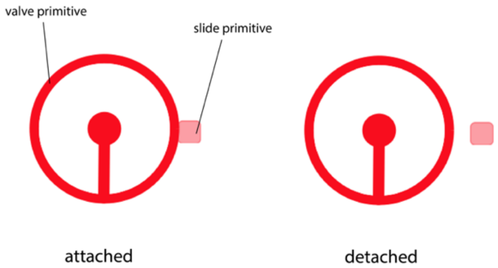

Figure 10. Slide primitive in attached (left) and detached (right) positions.

The specific colours were intuitively selected to contrast with one another and the white background. The valve slide compound primitive is subtly different in opacity to its relative valve rotation compound primitive (Figure 10).

3.5 Composing in Valverotator

Figure 11 shows the screen when the Valverotator app first opens. The composer must first input a total duration for the piece. Next the composer simply draws onto the function objects, via a sequence of x, y coordinates, a line representing temporal changes in each parameter under the trumpet players control — valve rotation, slide position and air velocity. Figure 12 displays a complete score. The piece can then be played by pressing 'space bar', paused by pressing 'enter' and reset to the start by pressing 'esc'.

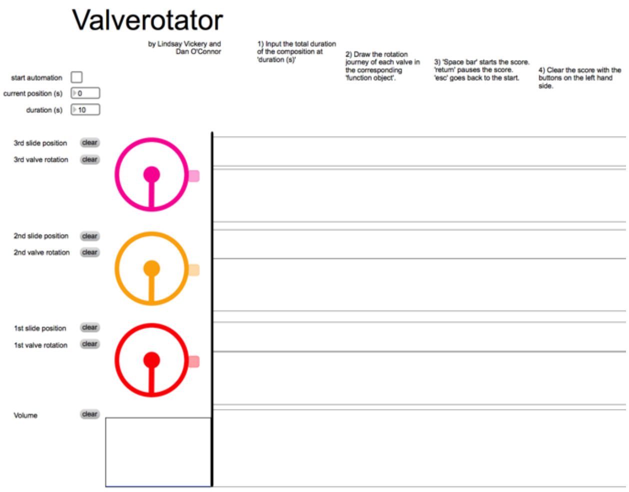

Figure 11. Valverotator app opening screen, before composition input.

As mentioned earlier the Valverotator app bypasses the use of image creation software to notate composition and facilitates fast turnaround from idea to score. Furthermore, the ability to make small adjustments or additions with minimal disruption to the entirety of the score is an advantage. Over the course of the research three scores were created with Valverotator app, two being translations of static scores and the third composed entirely within the Valverotator app. It was noted by O'Connor during the composition process that "the magic of Valverotator is the immediacy with which one can compose".

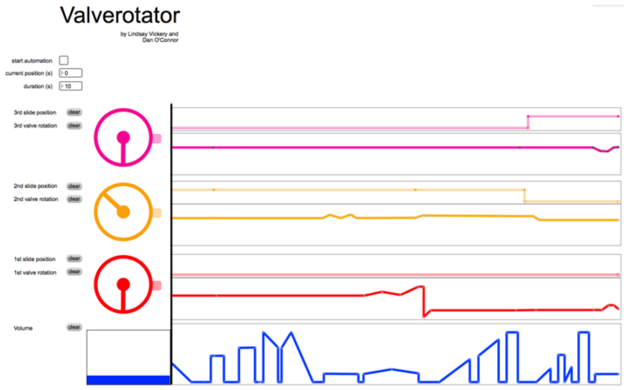

Figure 12. Screenshot of completed composition in Valverotator.

3.6 Distribution and performance

Valverotator, the composition app, is a Max patch that can be distributed to be run within Max 6 installed on any computer. There is also a standalone OS X app that requires no additional software to run. It has been successfully tested in OS X El Capitan 10.11.6.

When considering the completion, distribution and performance of scores, the robust and universal nature of the delivery format is critical. Thus, in the course of this research Quicktime's 'screen record' function has also been used to capture, as a video, the animated score for distribution and performance of Valverotator scores. The plethora of devices available to performers at this time mean that the playback of video is easily within the grasp of most.

4. CONCLUSION

At present Valverotator works effectively as a fast and efficient way to craft a score, though continued development and refinement are necessary. The following challenges are yet to be addressed:

- Addition of numerical readout in degrees of rotation when placing a point anywhere on the function object in order to increase accuracy when composing.
- Relocation of the air velocity multislider to place it at the centre of the performers focus.
- Increased codification of the slide compound primitive. Can degrees of extension be informed by degrees of slide compound primitive movement? — rather than just the binary, attached or detached, movement currently employed.
- Currently manipulation of total composition duration affects individual event duration. Separation of these

parameters would allow greater compositional freedom.

- Inclusion of directions for tongue position, posture and valve depression — techniques that O'Connor found complementary to valve rotation during improvised performance.
- Compatibility with current versions of Max. Creation of a jsui object is in progress for Max 7 (and potentially 8) versions of the software as a replacement for the Max 6 dial.
- Consideration of graphical human interface (GUI) with regard to the alignment of function objects and corresponding multislider object.

Further research and development will extend Valverotator to involve these techniques. In order to do this the transition or incorporation of the Decibel ScorePlayer or similar system may be necessary.

Another avenue for future development is the extension of the valve rotation technique to ensembles with brass instruments capable of valve rotation. Currently the performance of multiple scores in video format could be synchronised using software such as Multivid. The Decibel ScorePlayer also has networking capability for performance in this way.

It is hoped that this paper is a starting point for the discovery and use of valve rotation by composers and performers alike. In developing a unique notation for trumpet valve rotation performers and composer now have a communication tool with which they can discuss valve rotation and create new work. The notated form is by no means universally codified and the continued assessment and development by third parties is welcomed by the authors — hopefully creative people will take this notation, develop and refine it, and create interesting music.

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