# Effect Tapper: Interactive use of Effects for Musicians

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## ABSTRACT
In this paper we describe a prototype development for an interactive effect for musicians. This project was made with members of the horn section in the band Damn! They are also performing together with the Swedish hip-hop act Timbuktu. The instrument we focused on was the trombone. The trombone is played without a strap and is held and played with both hands. You use it by blowing into its mouthpiece and regulating its slide brace with one of your hands. The trombone itself is a rather long instrument and since it is not attached to your body by straps, this attribute can be an advantage when designing an interactive effect. It makes the instrument interesting for using sensors to read its position and movement (Y-axis, X-axis, and Z-axis). One sensor that we in this paper argue for is the accelerometer which proved to fit perfect for this task. The result ended up as a prototype for what we call Effect Tapper – software that with the help of an accelerometer and a tap tempo pedal let you use an interactive and controllable delay effect. In the tests with trombonist Jens Lindgård of the band Damn! we show that the prototype improved interaction, his possibility to control the effect and become more creative when playing.

## Keywords
Trombone, Accelerometer, delay, effect, tap tempo, sound design, movement, performance, interaction design.

## 1. INTRODUCTION
The trombone is an old, non electronic instrument that while being played live in several contemporary bands, is only hooked up with a microphone to amplify its signal. Many smaller horn sections are also bound to choreography or certain moves to make them look more alive during a live performance. These two things combined are what drive our exploration of aesthetic expression and technological solutions in this project.

Just like what Jan C. Schacher said in his article on the interactive dancers: "Gesture mapping builds the bridge between the domains of space, bodies and motion and the abstract structures of a real-time interactive audio composition" [4]. Just as he wanted to make dancers able to control we want to give the horn section in Damn! a resembling possibility. In our project the musicians have been able to combine playing; moving choreographed to music and control of the delay effects on their instruments.

## 1.1 Effects
Up until the mid 60s the standard equipment for a mainstream electric guitar player was three things; an electric guitar, an amplifier and a cable that would connect these. There had been built-in effects in amplifiers earlier dated back to the mid 1950s some with effects such as spring reverb and/or electronic tremelo unit. Early fender amps labeled tremelo as "vibrato". From the evolution of distortion to amplifiers in the 1960¨s a new box was introduced known as the effect box. Many other bulit in effects as well could now be controlled via this pedal. The effect box would create the same result an overdrive amplifier (distortion) but could now also be controlled via a switch known as a pedal or distortion pedal. The pedal usually had a couple of knobs that would control the amount of distortion the user desired. Several other effect boxes were developed as well. Among these were compression and delay [3, p 117-120].We thought that a standard horn section might want to expand its possibilities when performing, so adding effects to their sound might change the way they are used in a band.

### *1.1.1 Delay*
Delay is an audio effect which records an input signal to an audio storage medium and then plays it back after a period of time. [1] The delayed signal may either be played back multiple times, or played back into the recording again to create the sound of a repeating decaying echo. In the early days pioneers and composers like Pierre Schaeffer and Karlheinz Stockhausen used a technique where they had tape loops in different lengths and several tape recorders [3, p 66-74]. The audio signal would be played through the tape machine and by adjusting the read and write heads on the tape recorders, they would create a sound that sounded like natural echoes. This technique fascinated audio engineers and others who adapted it to make plate verbs and other equipment that could simulate natural echoes. Some companies were interested in this new techniques and later developed their own delay effects such as Mike Battle's Echoplex (1959) and Roland Space Echo (1973) [6]. Many musicians also found it interesting and applied delay effects in their music. The digital delay is the one we use in our Effect Tapper. Digital delay is accomplished by storing sampled audio direct into to the RAM. After a length of time (in milliseconds), this sampled audio can be read out from memory for output or further processing [2, p 390-391].

## 1.2 Aims
Over the past years many audio and gesture parameters have already been investigated with sensor data, audio and video analysis in the fields of exercising, teaching and performing of musical instruments [5]. We were asked to develop a system that could be applied to the horn section of a band. At first we were shown a video of them playing together and they used certain choreography as they were performing based on the video and how they would act move on stage, we decided to use their moves as a source of the project. To start with, we met with the saxophonists in Damn! to try out some ideas but mainly to hear their opinions and thoughts. During this meeting we tried out a range of different analogue and digital sensors. Here we could exclude certain sensors based on ease to activate

and play on, reliability, how the musicians moved, and lightning conditions on the stage. The final choice of censor came down to the accelerometer. A second meeting took place in Malmö where we met the two remaining horn players and exchanged ideas. This meeting proved to be the most crucial one for us since we now knew where to put our focus. To get these things working together became our goal with the project.

### *1.2.1 Target groups*

The target for this project was the horn section of the band but for us it was mainly Lindgård and his trombone. He was the one we discussed with the most and whose preferences we designed it for. Our target group is a professional horn section with great demands of control both technical and aesthetically so everything have to function during a live performance. This implies that only real time technique on effects and zero tolerance towards technical latency is acceptable. By including the Effect tapper in their live performance we want to enhance the technique from being an entertaining gadget to instead become a great part of the music and choreography as well.

## 1.3 Method

Together with trombonist Lindgård, we tried out where to place and how to attach the accelerometer. Based on other effects traditionally used within the genres of contemporary funk, soul, and hip-hop to achieve musically cool effects, we chose to work with delay effects. A challenge with delay effects is that its delay time isn't always very match able with the tempo of the music, so we added a tap tempo function to be able to control this. We tried to figure out how a trombone player best could control the effect on and off while playing and being creative on stage. We decided to move the interface from the traditional pedals on the floor to the actual trombone. Discussions like these were the main source of the project and requests from the musicians formed the way of working and the result.

# 2. CONCEPT

We have made a computer based system consisting of a computer with Max/MSP, Arduinos processing based program, a VST-plug, the Audrino microcomputer with an Atmel 168 chip , a real time interactive sensor system, a button, Velcro and a tempo pedal of our own design. The accelerometer, the buttons and the tap tempo are connected to the arduino which itself is connected to the computer. The arduino program connects it to Max/MSP. The button is included in the Velcro making it attachable to the trombone.
You use the Effect Tapper by attaching the button on a trombone together via an accelerometer and a microphone connected to the computer. We decided to put it at the bell of the trombone, a position where the accelerometer will get the most data when the trombone is being moved around The Max/MSP program patch reads what the Arduino sends and starts to play. Depending on the tempo you tap on the tap tempo pedal and the angle of your instrument from a Y-axis point of view up-down the sound of delay will change.

## 2.1 The Interaction

The accelerometer is used to determine where on the Y-axis you are, the angle of the trombone pointing upp-down. .Therefore if you choose to have the accelerometer on the instrument you will control the feedback of the delay by moving it up and down. Depending on the angle of the trombone, a different preference will be used for the delay's settings. The tap tempo works the same as most pedals. Just tap the tempo with your foot and the delay time will be adapted after the tempo you tap in.

## 2.2 Effect Activator

The effect activator, as we call it, is basically just a button built in to Velcro to make it possible to attach it at different places of an instrument. It's connected to a digital input on the Arduino and its only purpose is to tell the program whether to turn the delay on or off. During the development of this whole project we realized that there wasn't much time left to finish the hardware before our final meeting with Lindgård. With our focus being on the software we had to improvise to get a physical button made. The first set of buttons was created with dishcloths and foil in order to be able to try out different places on the instrument. Seeing how poorly these buttons worked technically, we replaced them with a normal factory made button. We would place this new button on the instrument and use as a tempo switch during the final meeting. Seen in figure 1 below.

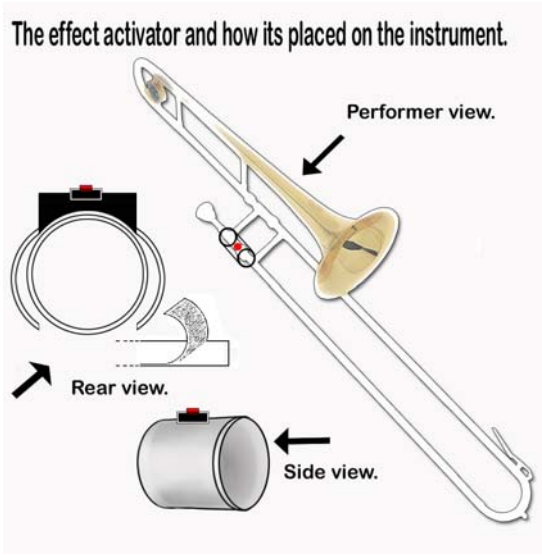


**Figure 1.Effect activator here seen from three angels. Rear view shows how it's attached to the trombone with Velcro.**
(Graphics by Anna "Eliz" Troedsson".)

## 2.3 Tap Tempo

As mention earlier, we decided to go for a delay effect. Lindgård appreciated the fact that he would be able to control it with his instrument and the accelerometer, but when we started talking about the delay time of a delay, the idea seemed less suitable. We presented the whole tap tempo idea to him and he liked it. Tempo-tracking algorithms track musicians tapping their feet to the beat of the acoustic signal, which can vary as a function of rubato or abrupt tempo changes. This is useful in a concert situation when a computer accompaniment is trying to follow the performer of a human instrument or vocalist [8, p 521-522]. The idea of an analog signal that detects bmp was the conclusion we made when we started to sketch out tap tempo pedal in Effect tapper. The analog signal in Effect tapper consists of a foot pedal placed in front of the performer. The person using it can tap in the correct tempo of the song just before he/she uses the delay. This helps to set the correct tempo of the delay time which is the best solution during live performances when the performer is not using a metronome. If the performer wishes to use the delay for another song with another tempo he/she can tap it over and over again and not only be bound to one tempo.

## 2.4 The Accelerometer

One of the most common sensors is the accelerometer, a dynamic sensor capable of a vast range of sensing.

Accelerometers are available that can measure acceleration in one, two, or three orthogonal axes [9]. We use it for position tracking.The accelerometer is placed on the bell of the Trombone and controls the amount of delay, depending on the angle the instrument is pointing up or down. A scale that reaches from 0 to 100 percent controls the feedback where 100 are maximum effect and 0 minimum. Fixed delays, the sort of delay we use, can be grouped into three time spans. Corresponding to different perceptual effects they create: short (less than about 10 ms), Medium (about 10 to 50 ms) and long (greater than about 50ms) [7, p 435]. Seen in figure 2 below.

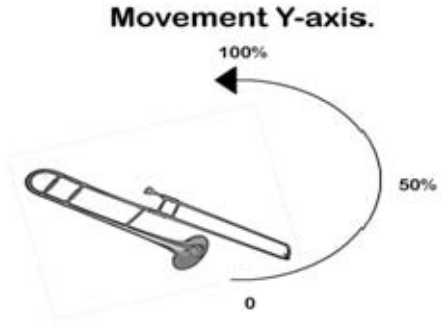


**Figure 2.The trombone movement with the accelerometer showing where the lowest and highest outsput of values are.**
(Graphics by Filip Persson.)

## 2.5 The construction

**Figure 3.The setup with accelerometer and tap tempo pedal seen below.**
(Graphics by Anna “Eliz” Troedsson”.)

## 2.6The Software

You can say that the software is divided in to two parts: the arduino code and the Max/MSP code. The arduino code is written in arduinos own platform which is based on Processing and the application works as a link between the arduino and Max. The arduino code is there to define the ports, inputs and outputs of the arduino so that Max can be able to read it and use the information the arduino sends to the computer.

### 2.6.1Max/MSP

The Max/MSP patch is divided into one main patch with one sub patch called arduinoReader (see top-left part of figure 4), which also contains yet two more sub patches. One of them, not visable is patcher s where the connection between the arduino and Max/MSP is made. It's from here all the information that Max uses comes, whether it's a digital or an analog signal. The other one is called tap tempo and it is where the calculations for the tap tempo are made and sent out with a send/receive object. The tap tempo sub patch also uses information from patcher, namely a digital signal from the tap tempo pedal used for calculating the bpm (beats per minute) in milliseconds.

The information inside the sub patches are not displayed in figure 4. Basically the arduinoReader only has one purpose (other than containing the two other sub patches) and that is treating the analog information from the arduino. The digital signals are just passed through to the main patch but the analog ones need some treatment first. The signal it receives is information described with numbers from a scale of 0 to 1023, depending on the accelerometers position. Depending on what you want to use the information for, you need to scale it down, and in our case it's a decimal number between 0 and 1 that we need. After the scaling we pass it out to the main patch along with the bpm from the tap tempo and the digital signals from patcher.

The main patch is where the sound from the musician and his/her movements meet. We start with a MSP object called ezadc~ which is an object for a microphone input, or whatever you choose to have as sound input. This object can be found at the top of Figure 3 and is the one with a microphone symbol on it. The signal is then passed via chords through the patch. First it goes through a gain which controls the volume/strength of the input signal. After that it comes to the core of the patch: the vst object. For now we have used a vst plug as a delay effect, but this can be changed. The vst object is either on or off depending on the performer who controls it with the effect activators button. If it's on the signal will go through the vst and therefore get modified after the settings set in the vst plug, in this case the delay.

The settings on the delay can be modified and we have used our tap tempo sub patch and the accelerometer to do so. The tap tempo sends its bpm in milliseconds via the send/receive object mentioned earlier to a message called LDelay which controls the delay time in milliseconds. So depending on the tempo you tap in, the delay time will adapt after that. The other thing we do is to control the feedback of the delay with the accelerometer. Depending on the decimal value between 0 and 1 the feedback will change and either be high or low. Why we chose to use the Y-axis to control this is because of the trombone itself and Lindgårds wishes. The trombone is long and therefore ideal for getting big values with the accelerometer in a Y-axis movement. We explained this to Lindgård and he agreed. He personally also preferred the Y-axis movement since it fits with the expressive performance qualities of the delay itself the more you aim for the sky the more delay you

get. The only problem with this is that depending on who's playing you might need to calibrate the values in another way since ones movement might not be the same as another person. After passing through the vst object the signal goes through a clip object that keeps the signal from unwanted peaks and distortion. Then it goes through yet another gain where the signals volume/strength can be controlled and finally ends in an object called ezdac~, which is an output/speaker object so that the signal can be heard. This object can be found on the bottom of Figure 4.

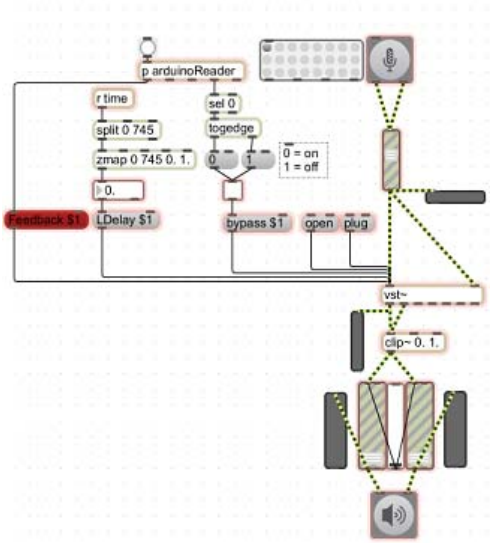


**Figure 4.The main patch in Max/MSP**

## 3. RESULT

The result is an interactive form of effect trigger that uses movement to generate different settings on a delay effect. The tap tempo that sets the delay time and the accelerometer that changes the feedback of the delay – all in the same system. The result was achieved with the help of the meetings with Lindgård and his Trombone, fellow musician and saxophone player Sven Andersson and also David Yanagisawa, a teacher at Kristianstad University who helped us with the Max/MSP patch.

### 3.2 Discussion

We are proud of the result we achieved during the short period of time that we had, but we do think the system has its flaws. Another axis, like the X-axis could have been added with improved interaction and more interesting performance possibilities. The result of the delay could be improved since we only used a VST-plug for it but we're satisfied with the way the delay is designed. The fact that you can tap its tempo and make it adjustable for every song you play is a great solution to the delay time problems we thought could occur. We are also pleased with the fact that it is easily maneuvered with the delays on and off-button. The cooperation with Lindgård went smooth and clearly affected the result. All aims and goals were set by all of us together and without his wishes and preferences about the project the result would probably not have ended up the same.

### 3.3 Further development

There are many things you could do to develop this project further. First of all you could add another axis to the accelerometer which could contain another effect and then simply add another on/off button. Another thing that would make attaching the effect activator easier would be a wireless system. A desire Lindgård had was to make a record function for the user. If you found a nice sound while using an effect you could record it, save it in a buffer and play it again using some buttons put on the effect trigger for example, looping the previous recorded input.

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