120bpm: A Guide
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120bpm (120 beats per minute), the second movement of Dan Trueman’s *neither Anvil nor Pulley*, requires a considerable amount of technical expertise in basic hardware and audio engineering to recreate without the help of the composer.

In an attempt to make 120bpm more easily accessible to a larger range of musicians, setup kits have been constructed. While it is very much possible to gather all the necessary parts and assemble each player space in typical DIY fashion, we expect that the kits will greatly streamline the process of setting up for the piece.

For musicians who rent the setup kit from the composer, please see section A of this manual. Section A will serve as your guide to assembling a player space from the contents of a kit.

For those who are more inclined to build each player space from scratch, see also Section B of this manual. Section B is meant to provide basic tips and some specifics on the materials and parts one will need to acquire to recreate the setup from scratch. Section A, however, will still be very useful for those who go the DIY route.

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A: *120bpm* Kit Guide

Each kit contains the basic technological parts and components that go into assembling the electronic side of the player space for one of the four percussionists in *120bpm*. Thus, the assembly of each kit will yield two electroacoustic instruments (a pair of digitally processed metal pipes, and an amplified wood block) and a purely digital tether instrument.

**I. What is in each Kit?** (for each player)
- 1 MacBook laptop and charger, with all software required for fully functional *120bpm*
- 1 *PreSonus AudioBox* Interface and USB 2.0 cable
- 1 *Gametrak* gaming tether V2.0
- 1 *Footime* foot pedal
- 1 *Belkin* multi-port USB hub
- 3 contact microphone to quarter-inch cable jack units
- 1 quarter-inch cable (male TS to male TS)
- 1 stereo to mono quarter-inch cable (dual male TS to male TS)
- 1 LMX line to mic adaptor/attenuator
- 2 metal pipes
- 1 rectangular piece of wood
- *TACKY* craft putty
- Black foam insulating padding

**II. What else do you need?**
- Audio amplification system (speaker nearby, adjust volume preferentially; feed 2 outputs [pitched, unpitched] to sound guy doing monitor mixes)
- Quarter-inch cables for audio output
- 1 or 2 towels (about 2x2 or 2x3 feet)
- Gaffing tape
- Scissors
- Table or percussion rack
III. Player Space Assembly

To avoid USB connection confusion, it is smart to set up the hardware before opening or powering on the MacBook.

A) First, set up the computer and various other digital interfaces. Place them on a table nearby to the table/rack you intend to place the instruments themselves on. The digital hardware setup should look something like Figure A.1 below.

![Image of digital hardware setup](image)

*Figure A.1: The top shown cable from the Belkin USB hub is the connection to the AudioBox USB interface.*

Don’t bother opening or turning on the MacBook just yet. You will need the MacBook, Belkin multiport USB hub, the AudioBox USB interface and its USB 2.0 cable, the Gametrak tether, and the Footime foot pedal. Follow these steps:

1) Connect the Belkin multiport USB hub to the first USB port on the MacBook.

2) Connect the AudioBox USB interface to the second USB port on the MacBook with the USB 2.0 cable.

3) Connect the Gametrak tether and the Footime pedal to the USB hub.
B) Next, set up the instruments. These should be on the player’s main playing table/rack. Ultimately the setup should look something like Figure A.2 below:

*Figure A.2:* Ultimately the *Footime* pedal and *Gametrak* tether will be on the ground, and the *AudioBox USB* interface and *MacBook* will not be as close to the instruments themselves – instead they will rest on the floor near the player. You may also secure, tape, hide, or bundle wires to make the playing area look a bit cleaner and be a bit nicer to work with.
Let’s start with the pipes. You will need the two pipes, 2 of the contact microphones, the black foam padding, gaffing tape, and the stereo to mono quarter-inch cable. Follow these steps for each pipe:

1) Put a thin layer of the craft putty on the entirely flat side of the contact microphone disk. As a rule, put a little more putty on longer pipes (a little less on shorter pipes). This will help with balancing gain inputs.

2) Make a thin strip of gaffing tape (roughly 0.5 to 0.75 centimeters in width, and 10 centimeters long).

3) Using the strip of tape, fasten a contact microphone to the pipe (flat side in direct contact with the pipe) at one of the nodes of the pipe - these are clearly marked with a circular ring on each pipe. Make sure that the wires of the contact microphone do not come in contact with the pipe. See Figure A.3.

3) Cut two, 4 - 5cm strips of black foam padding.

4) Using a bit more gaffing tape, make small tape rings and place them on the center of the pads where you will rest the pipe.

Figure A.3: The figure on the top left, shows the method of taping/puttying. The figure on the right shows a pipe from a side angle, well-taped at the node so as to avoid interfering with pipe resonance as much as possible. The tape pieces used should be no wider than this (perhaps ideally a bit thinner), but should be wide enough and long enough to keep the contact microphone securely in contact with the pipe. The bottom left figure shows the connection between the AudioBox, the LMX adaptor and the stereo to mono quarter inch cable.
5) Place the two small, foam, taped pads on the playing surface at the distance between the two marked nodes on the pipe. Place the pipe securely on these pads, making sure that the nodes come in contact with the padding, and that the pipes do not shift or roll.

6) Plug one of the two male TS quarter-inch cable tips on the stereo to mono cable in to an unused contact microphone quarter-inch jack. Plug the other end of the stereo to mono cable in to LMX adaptor/attenuator. Plug the LMX adaptor/attenuator the first input on the Audiobox USB interface.

Once you have followed these steps for each pipe, make sure that no extraneous wires are touching the pipes. You may want to tape certain cables together or tape them to the playing surface so that they do not slide around and endanger the performance. You may also use the tape to conceal the wires as desired.

>> Now move on to setting up the wood block. You will need the wood block itself, 1 contact microphone, one of the longer pieces of foam padding, and black gaffing tape, and a quarter-inch cable. Follow these steps:

1) Tape the longer foam padding to one side of the wood block, about 5 centimeters from an edge, so that when the block rests on the playing surface, it will rest at an angle and will not squarely touch the surface. See Figure A.4.
2) Tape the contact microphone, flat surface down, to the wood block, just on the other side of the block from the foam support. Fully cover the microphone, using a piece of tape about 3 cm wide and 6 cm long. See Figure A.5.

3) Plug the quarter-inch cable in to the contact microphone jack and then in to the second input on the Audiobox USB interface. Tape loose cable or wire to the playing surface to constrain and conceal as desired.
C) At this point, open the MacBook. It will likely have a low or empty battery, so supply power with the charger in the kit. On the monitor, you will see a nearly empty desktop. Follow these steps to get the software running.

1) Before doing anything else, check to make sure that your computer’s sound input and output settings are set to “AudioBox USB.” To do this, go to System Preferences > Sound, and in both the Input and Output windows, select “AudioBox USB.” Close System Preferences.

2) At the center of the desktop you will see the navy blue and white logo for the 120bpm_stereo application. Double-click on this icon. Allow the program to load fully before clicking anywhere else. Two 120bpm_stereo application logos will appear in the Application Dock. Note: Here you might get an error message from the smaller of the two 120bpm application windows saying “cannot initialize audio device.” If this happens, simply quit both windows of the 120bpm application and repeat step 2 (i.e. restart the software). This fixes the issue (having to do with the computer’s recognition of the audio interface) nearly without fail.

3) You should see a window inherited from Max/MSP called “Audio Status.” Check to make sure that next to both “Input Device” and “Output Device” you see “AudioBox USB.” If you do not, click on the drop down menu and select “AudioBox USB.” See Figure A.6. Close this window. You can always summon the window by clicking “dsp status” at the bottom of the main application.

4) On the main application window, change the “player number” to whichever player number box you are currently setting up. The player number should be written in several places on the box itself, as well as on the pipes and woodblock. Do this by clicking on the number next to “player number,”
typing the correct player number, and pressing enter. When this is done successfully, a blue waveform should appear in the upper two large rectangular boxes. See Figure A.7. Do this even if you are player one.

![Figure A.7](image)

5) Check to make sure that data from the tether is being received. Pull on each of the tether strings and observe the red vertical lines moving horizontally in their white slider bars. See Figure A.8. If they do not move, then it is likely your computer is not seeing the Gametrak tether device at all; in which case you should see the USB Connections section of Section C (Troubleshooting) of this manual.

![Figure A.8](image)

6) Configure the Footime pedal to change the “current preset” parameter. Do this by (a) clicking/checking the toggle box with a + sign in it to the right of “learn keystroke.” Then, (b) tapping the large red pedal button on the right side of the Footime pedal. Finally, (c) click/uncheck the same toggle box. Do the same for the – sign toggle box and left foot pedal button. See Figure A.9.

![Figure A.9](image)

Once these steps are completed, you should be ready to start fine-tuning and playing the instruments and really utilizing the software.
IV. Fine-tuning the Interface and Instruments

A) Gain tuning

To optimize the sound produced by the program, pipes, and wood block, adjustment of the gains and mixing controllers on the AudioBox USB will likely be necessary – it is essential that the pipe and woodblock input signals are healthy. To do so, you will need to experiment with playing each pipe and the woodblock and then monitor, both visually and aurally, the signal and sound produced. Follow these steps, and see Figure A.14 for a diagram of the interface.

1) Strike a pipe or woodblock with the mallet you intend to use in performance. Try to get as much clear resonance out of the pipe as possible, and a solid click out of the wood block.

2) As you strike the instruments, watch the meters in the bottom right hand corner of the 120bpm_stereo software, just to the left of the white circles. Since the contact mics are very sensitive, they may peak to red on solid strikes.

If they do, turn down the input gain on the AudioBox (knob 1 for pipes, knob 2 for woodblock). This is not so important for the woodblock, but may be crucial for the pipes.

If, after decreasing gain significantly, striking the pipe still makes the pipe gain meter jump up to red, apply more putty to the underside of the contact mic where it is making contact with the pipe.

On the contrary, if the apparent input gain of one pipe is much lower than the other (but both are in a healthy range), consider taking some of the putty off of the contact mic on the weaker pipe. You may need to do this with the smaller pipes.

3) With headphones out of the AudioBox or through the amplification setup of the performance space, listen to make sure that the sound is clean and not distorted. Do this over and over again, adjusting input gains on the AudioBox as necessary, until you reach a balance and signal that you feel is healthy.

Try to make the gain meter max out around the orange level. You may get a red peak if you really whack it, though one shouldn’t be insensitive about playing the instrument in the first place.
B) Threshold tuning

Both the pipes and the wood block trigger digital synthesis of sound when struck. Thus, it is important to fine-tune just how softly one can strike a pipe or woodblock and still trigger the synthesis. It is important to consider that even striking the table or playing area hard enough may cause a trigger on the woodblock or pipe input. Or, even striking the pipes may trigger the woodblock. Tuning the trigger thresholds can help minimize this problem, though you should still be careful not to disturb the playing environment too much when playing the piece.

In order to change the thresholds, click-hold on the number to the right of the words “trigger thresh” in the 120bpm_stereo software, and scroll up or down. Alternatively, click once on the number, and type a desired threshold. The higher the threshold the harder you have to strike the instrument to get a trigger.

Fool around with this threshold so that a light strike on the woodblock will trigger the woodblock synthesis, but a strike on the pipes will not trigger the woodblock synthesis, and vice versa. Furthermore, make sure the threshold is high enough so that a hard strike will not trigger the same synthesis multiple times in a row, one after another.

This all will take a bit of experimentation, but should not be difficult.

C) Mixer settings and saving presets

Now, once you have achieved a healthy gain input and trigger threshold level on each instrument, you may want to adjust the output gain balance. However, note that the default presets for the gains of each parameter of sound may be absolutely fine to begin with, making the following unnecessary – you can be the judge of this via trial and error. Nevertheless, if you deem the balance unsatisfactory, read on.

In the bottom left of the 120bpm application, you will see a box labeled “mixer” with 5 sliders inside of it. These sliders (see Figure A.10) control the output gains of the clicks triggered by the woodblock, click, the clicks triggered by the woodblock and also accelerate in tempo, accelclick (see Figure A.12), the gain balance of the accumulation section towards the end of the piece, accumulation, the synthesis triggered by each pipe, pipes, and the scrubbed samples controlled by the tethers, tethers.

Using studio headphones plugged in to the AudioBox or through to the sound setup in the acoustic environment of the performance space, listen for your preferred balance and adjust the gain sliders accordingly.
Once you have reached a desired balance in your performance space, you may save all of the current mixer settings and data by *Shift* + clicking on one of the 5 circles in the mixer box at the bottom left corner of the *120bpm* application. Then, by simply clicking on that same circle you can recall the saved preset.

*However,* the above process only saves the preset on the current application process, such that when you return to the application after quitting, the same preset will not exist. In order to save a preset on your computer’s hard drive and thus save presets between uses of the application, click “write,” name your preset, and choose a folder in which to save your preset file. To recall this preset, click “read,” navigate to the folder in which you saved your preset and open the file. This will load a preset into one of the five circle buttons shown – it will look bluish. Click that circle to set the mixer and other saved parameters from that preset (see Figure A.11).

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**Figure A.11 (above)**

![Figure A.11 (above)](image)

**Figure A.12: (left) Point in score at which acceler-click gain becomes a concern.**

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**D) Methods of amplification**

The application is in stereo. That is, there are two outputs, one for pitched (Left out) and one for un-pitched sounds (Right out). An ideal system of amplification will involve a studio-quality mixing console (mixer) so that a sound engineer can adjust the balance between these two groups of sounds. To make the software’s audio output mono, you will have to merge the Right and Left outputs from the *AudioBox*. This can be done in many ways with adapter cables and jacks.

In the *120bpm* stereo application, R and L outputs on the *AudioBox* are used, as stated above, where the Left output is pitched sounds only (pipes, tether sounds) and the Right output is unpitched (woodblock). The two different outputs can go to two different channels on the mixer console and they can be rebalanced for each player at the discretion of a sound/audio engineer. This setup is particularly handy in a performance setting as the audio engineer has greater control over each player’s sound output and the overall group balance than he would were the outputs mono, and players should not be worrying about their sound balance during the performance itself. Don’t forget that various other deeper parameters of the sound can be balanced via the software itself, under “mixer,” in the bottom left.

Mixer output should go to some sort of speaker, studio monitor, or amplifier. The use of a subwoofer is optional, but desired.

**E) Other necessary steps and considerations**

Make sure that the knob labeled “Mixer” on the *AudioBox* is turned *all the way to the right*, towards “PLAYBACK”. No direct audio interface throughput is desired. If you want greater amplification of the acoustic resonance of the pipes, you should rig together one or two external condenser microphones and feed them through another audio interface or directly in to some amplification system. It is only in certain rare performance environments (very large spaces, or acoustically dead spaces) that you will need extra amplification.

You can change the output gain of the *AudioBox* with the bottom right chrome knob on the front of the interface. However, it is recommended that this knob be turned *all the way to the right*, for maximum gain output, and that the audible volume of the outputs from the L and R channels are instead controlled by an external mixer in the hands of a “sound person” or audio engineer.
For these and other *AudioBox* interface considerations, see the diagram below, Figure A.14.

![Figure A.14: The green boxes highlight the gain 1 and 2 knobs, which should be tuned for healthy gain levels as described previously. The red box highlights the ‘Mixer’ and ‘Main’ knobs, which we recommend are turned all the way to the right](image)

**V. Troubleshooting**

1) **USB device problems**

Most technical problems will boil down to issues with USB devices. Often times this just means you need to check the hardware connection between the USB ports, the hub, and the devices themselves.

Check to make sure that your computer is seeing all of the USB devices (the *Audiobox USB* interface, the *GameTrak* tether, the *Footime* foot pedal, and of course the multiport hub). To do this, open System Profiler (and System Information on later OS X versions), click on Contents > Hardware > USB. You should see something like the picture in Figure A.15 below. You should see a “AudioBox USB” immediately under one of the High-Speed or regular USB bus. You should see “USB2.0 Hub” under another bus, and beneath the Hub should be “USB Keyboard” and “Game-Trak V1.3.” If you see all of these devices then your computer is recognizing the USB devices.

If you are still convinced the *120bpm* software is not working because of USB problems, it never hurts to close the software, unplug and re-plug all of the USB devices and components, reset your Audio I/O once again, and restart the software. The order of this process is important, as emphasized earlier in the guide.
2) Audio input and output problems

If you are experiencing audio problems (no sound, bad sound, poor balance) and reconfiguring USB devices does not resolve the issue, then check to be sure that the gain levels on the AudioBox USB are correctly tuned as described above and that the main output gain knob on the interface is at the desired output volume level. If retuning gain and correcting the balance does not solve the problem, then check to be sure that the contact microphones are securely attached to the pipes and woodblock and do not shift around when the instrument is struck. If these steps do not resolve your issues, quit the program, check to make sure that all of the cables are securely attached to one another or their appropriate devices, and then restart the program.

If you are getting a distinct distortion/clicking but gains seem to be balanced and all else seems to be functioning properly, try power cycling the interface and restarting the program. That is, close 120bpm_stereo and unplug the AudioBox from the computer. Then repower the AudioBox by plugging it back in, reconfigure the device as your computer’s audio input and output and reboot the 120bpm software.

*If the steps in the above guide are followed appropriately, you should not experience many issues. However, if you need more help, contact the composer, Dan Trueman (manyarrowsmusic@gmail.com), and his assistant, Mike Mulshine (mulshine@princeton.edu).*
**B: 120bpm DIY Guide and Tips**

This DIY guide is intended to be a source of tips and suggestions for how to go about assembling the kit described above from scratch or with parts that you already own or desire to purchase. Below, we will step through the acquisition and formulation of each of the parts, starting with the electronic technology and moving through the other physical hardware. From there, use the kit guidelines in part A to assemble your kit.

A) **Computer**

You will need a computer running some recent version of Apple’s OS X - 10.8 or higher is ideal. Laptops are preferable, of course, given the limitations on the size of the performance space. The MacBook, MacBook Pro, and MacBook Air are all great options, though one may also use a Windows machine or other types of machines as long they are running OS X 10.8 or higher. Make sure you also have a charger.

B) **Audio interface**

Each kit is equipped with a *PreSonus Audiobox USB* interface. This interfaces is by no means the only option – there are plenty of great interfaces out there. You minimally need two line-level instrument (quarter-inch cable) inputs, and two outputs. It is nice to have an audio interface with hardware-level ‘mixing’ capabilities, in the sense that there is a knob that allows the possibility of enabling, disabling, or balancing direct audio throughput. In *120bpm*, audio throughput should be disabled – it is nice to have control of this so directly and accessibly on the interface. Recommendations for AIs: *Focusrite, Steinberg, PreSonus, Avid, Mackie,* etc.

Ultimately, *use what you are most comfortable with.*

C) **Contact microphones**

For a 4-player set up you will need 12 contact microphone apparatuses; that is, the piezo element/disk, wiring, and quarter-inch female jack. Depending on your resources and time, you may consider purchasing contact microphone or drum trigger kits or assembling your own contact microphone from more cheaply acquired parts. We use *Drum Dial* Drum Trigger contact mics, which sell at around $70.00 for a set of 5 of them. Some companies sell contact microphone kits at lower prices, or sell less processed hardware with wiring but without quarter-inch female jacks. Furthermore, it is not difficult to find the piezo elements (disks), wires, and quarter-inch female jacks necessary to assemble a usable contact mic apparatus. However, if you go this route, you will need to solder parts together with a standard soldering iron and solder wire.

D) **USB devices**

1) **The Gametrak tether.** Believe it or not, these tethers were originally built for a golf video training game, and so are packaged along with the PC game on disk. The tether and game can still be purchased via *Amazon.com* and some other vendors. Search for “gametrak controller” and you should promptly see the necessary item – “Mad Catz GameTrak Golf Interactive Video Game for PC w/Golf Club Controller.” If purchased new they are around $70.00; if used, you can find some that are between $30.00 and $50.00. In some cases, the Gametrak controllers need to be modified in order to function properly. If they do not work after you have tried them, see this page for modification instructions:

   [http://x37v.com/x37v/writing/mad-cat-z-gametrak-mod-for-maxmsp/](http://x37v.com/x37v/writing/mad-cat-z-gametrak-mod-for-maxmsp/)

2) **The Footime page-turner pedal.** The necessary product can be purchased at various online vendors including *Amazon.com*. Search for “footime page turner” and you should find a product that matches the description “BiLiPro Footime Page Turner (iPad/PC/Mac/Android). They currently sell at just under $70.00 a piece.
3) The USB hub. You have many options here. We use the Belkin “USB 2.0 4-port Ultra-mini Hub.” They are quite affordable. Search for “multiport usb hub” on Amazon.com and you will find all sorts of options and various price ranges.

E) Pipes and woodblock parts

At Home Depot, various other department or hardware stores, or online, you should easily be able to find and acquire some 7/8-inch stainless steel pipe. They sell at around $3.00 for 10 feet of pipe. 10 feet is plenty enough for our purposes. You will also need a small pipe cutter to cut the pipe to the correct lengths. These are also easy to find at your local hardware store – ask a store employee if you are having trouble.

Below are the note name and length specifications for each player’s pipes in So Percussion’s setup, which are the same pipes as those used in the kit.

Player 1:
- A-natural – 40.10 cm
- F-sharp – 30.80 cm

Player 2:
- G-sharp – 41.40 cm
- A-natural – 40.10 cm

Player 3:
- G-sharp – 41.30 cm
- A-natural – 40.30 cm

Player 4:
- Low A-natural – 57.20 cm
- High A-natural – 40.10 cm

There are no real measurement or material specifications for the woodblock. In fact, it does not necessarily have to be wood, though the composer intends for whatever is struck to sound like a woodblock. In the kits described above, we use plywood about 1.25 cm thick cut into blocks that are each around 20cm x 15cm.

For the foam pads, we are using insulation material similar to what you might use to insulate doors on a house. Here again, you have some flexibility. Ultimately, the material used should be strong enough so that the pipes don’t easily deform the material and ultimately rest on the playing surface, effectively dampening the sound.

Need more help?

Email Dan Trueman at manyarrowsmusic@gmail.com, or Mike Mulshine at mulshine@princeton.edu.