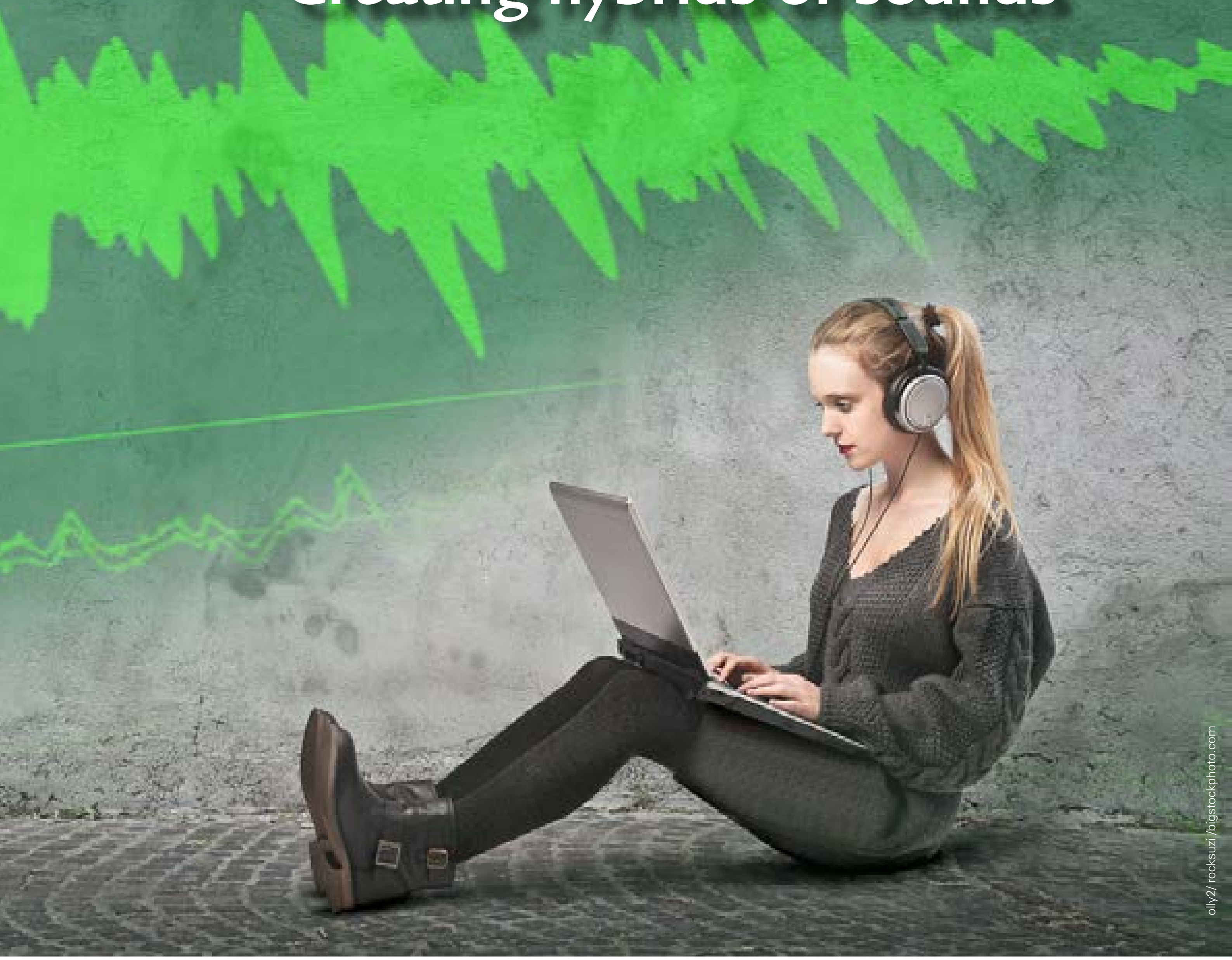
Jez Wells

Sonic husbandry

Creating hybrids of sounds



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Electronic musical instruments are getting better and better at mimicking and behaving just like their acoustic counterparts, but they can also create a wealth of sounds that would be difficult or impossible to achieve with acoustic instruments. ***Jez Wells****, a music technologist, explains how you can join in.*

One area of interest for producers and sound designers is how to create sounds that somehow combine characteristics of more than one acoustic instrument. Want to know how to combine the sound of a flute and an oboe to create a floboe? Want to find out how to make the sound of the ocean talking? Then read on ...

Until the second half of the last century, sounds made by electronic instruments were very rare. Now we are surrounded by synthetic sounds and there are whole genres of music (electronica, drum and bass, ambient to name just a few) that would sound very different without them and might well not even exist!

When they first appeared, electronic instruments were analogue and one of these, a device for combining two sounds, was called the vocoder. The word vocoder is short for 'voice coder' because it was originally developed for making telephone calls more efficient. However it was quickly realised that the same technology could be used to combine speech with other sounds, to make it sound as if the objects that made those sounds were talking! Vocoders have been used in studios to create interesting sounds and effects for many years.

Acoustic or electronic?

Sound is a disturbance in the air that surrounds us. This disturbance travels through the air as a wave and as it meets other substances and objects (such as our eardrums) it causes them to move. When our eardrums move at frequencies in the range of 20 times per second (Hz) to 20 kHz we perceive this movement as sound. An acoustic instrument makes sound directly: when it is played (e.g. struck, bowed or plucked) it begins to vibrate and produce sound as a direct result of this interaction.

An electronic instrument creates waves that are disturbances in an electric current, that is, a flow of electrons. These disturbances can be very easy to control and we can create an astonishing variety of them, but we cannot hear them. We need an amplifier and a loudspeaker in order to be able to hear these waves. The loudspeaker cone moves backwards and forwards in the same pattern as the variation in the electron flow in the instrument, but with much greater power (thanks to the amplifier). This forwards and backwards motion converts the wave from an electrical one into an acoustic one, a disturbance that travels through the air and that we can hear.

Analogue or digital?

The difference between analogue and digital electronic instruments is how the wave is represented in the electronic components. In an analogue instrument the pattern of the wave is directly represented in the patterns of electron flow. The word 'analogue' has the same root as the word 'analogy' – the wave pattern in the analogue instrument is a direct analogy of the wave pattern that is produced by the loudspeaker that it's connected to. In a digital instrument the wave is represented by a series of numbers (just like those that might make up a bar chart). Digital instruments are much easier to control but analogue instruments can offer subtle textures and behaviours that are hard to achieve via digital methods.

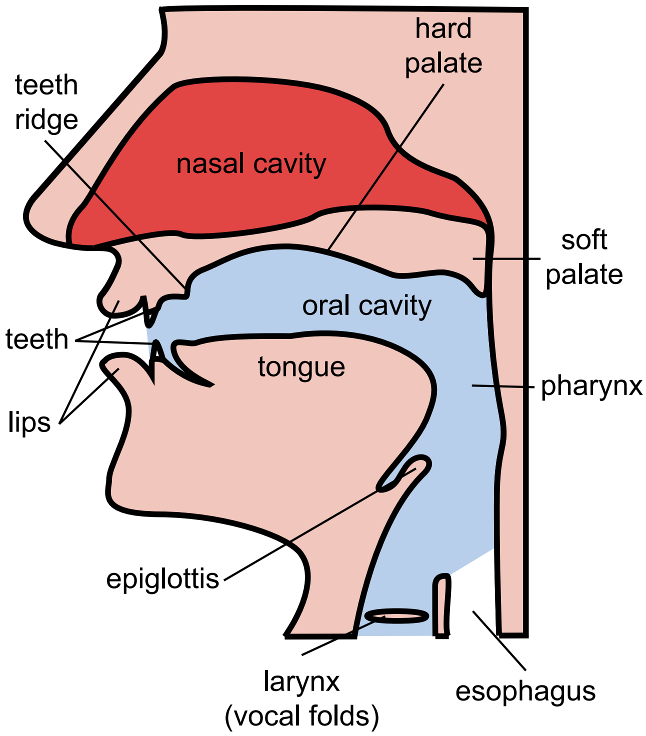
An analogue synthesizer from the 1970s. The piano-style keyboard used to control which notes it plays can be seen, along with knobs to shape the waveform produced and cables to move the signal from one part of the shaping circuitry to another. Digital synthesizers use computer-based technology which can make them smaller, more reliable and software-based, meaning that they can be run on a personal computer, tablet or even smartphone.

Making a hybrid

To understand how we can make a hybrid of the voice and another sound first we need to think about how speech is produced. Our vocal folds make a buzzing sound when we speak (you can feel this happening if you gently hold your throat – at the point where the Adam's apple is on a male – and speak). The space between the vocal folds and our lips (i.e. the top of the throat and the mouth) is called the vocal tract.

The different vowel sounds (eeee, aaahhh etc.) are produced by us changing the shape of our vocal tracts, by moving our tongue and jaw. By changing the shape of our mouths we change the frequencies at which our vocal tracts resonate. When an object, or a system, resonates it responds more strongly to some frequencies than it does to others. The buzzing sound our vocal folds make is made up of lots of different frequencies and the resonance of the vocal tract makes some of those frequencies much louder than others. As we change the shape of our tracts different frequencies are affected and this changes the character of the sound (in this case from vowel to another).

A vocoder works by attempting to retain the resonant properties of the speech sounds, but replacing the vocal cord buzzing that feeds into that resonance with a different sound. For example, if we can replace the vocal cord buzzing



The anatomy of speech: the vocal tract comprises the oral and nasal cavities. By changing the shape of these we change the frequencies and strengths of resonances to create different vowel sounds.

with sound of the ocean then we will hear that ocean producing the different vowel sounds produced by the changing resonance! But how, without performing some pretty drastic surgery, can we replace our vocal cords with a roaring sea? This is where electronics come in.

Firstly we need to capture our two sounds, the ocean waves and human speech, and then process and combine the electronic versions of the sound waves. The vocoder analyses the sound of the speech and works out at which frequencies the resonances occur. It does the same with the sound of the ocean, but it attempts to remove any resonances (i.e. it tries to ensure that the amplitudes of all of the different frequency components are the same). Then it applies the resonances it measured from the speech to the resonance-free version of the ocean. As those resonances vary over time so we hear the sound of the ocean talking: the vocoder has combined different attributes of two sounds to produce a single hybrid sound. Of course, it doesn't have to be the sound of the ocean; it can be any other sound. For example, by replacing the ocean with the sound from a synthesizer, a robotic effect can be created which has been used on many records over the last few decades.

If we apply the same method to remove the resonance of an oboe's body from its vibrating reed and then feed this sound into the resonance of flute's body, then we have a curious hybrid that is neither an oboe, nor a flute, more of a floboe really. For a hybrid to be effective and interesting it is usually best to find a sound that contains lots of different frequencies across a wide range and combine that with a sound that has distinct resonances. Its resonance that gives the character of one sound, but to hear that resonance there must be energy at being fed into it at (or near) those resonant frequencies.

Of course, we could attempt an acoustic hybrid of an oboe and a flute, by building a new instrument comprised of an oboe reed connected to a flute body, but this could be very time consuming and costly and the result might be impossible to play. Vocoding is probably a more cost-effective and controllable way to get into creating hybrid sounds!

Whilst analogue vocoders can achieve sound hybridisation with good results they can be expensive and bulky. Digital vocoders, with all the power and precision of modern computing behind them, can identify the resonances with much more accuracy and better separate these from the other parts of the sound. Many digital vocoders are available as 'plug-ins' for music technology software (such as Audacity, Reaper, Logic and Cubase) for recording and mixing sound, and some of these plug-ins are available for free. If you are interested in the fascinating world of combing sounds to create brand new ones then see if you can find some of these online.

A horn-violin. Although common in countries such as Romania, this hybrid is unusual elsewhere in the world. Making hybrid instruments like this would be costly and difficult - electronic musical instruments offer much more convenience and flexibility in trying to combine the sound of two instruments.

Programs such as Audacity allow anyone to manipulate electronic sounds on a computer.

Jez Wells teaches music technology at York University. He is also a recording engineer, DJ and composer: www.jezwells.org