Turning welding into music
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Summary
Good welders use their ears as much as their hands and eyes. Many research articles have tried to relate welding sound to weld quality or to attributes of the finished weld. We believe that this is the first time that welding sound is used for a completely new purpose: the creation of raw sounds as the foundation of music.

An original EDM (Electronic Dance Music) song was produced using only welding and welding-related sounds, and an accompanying music video was made at the CCWJ. This project was part of the CCWJ welding outreach program for high-school students, which aims to attract young talent to the field of welding by exposing them to the excitement of welding, and showing them how welding can be the path to almost any fulfilling endeavor.

Learning
The high-school student spent two weeks as a full-time member of the CCWJ lab. In addition to this project, he helped with experiments, exchanged ideas with undergraduate and graduate students, tried GMAW welding by himself for the first time, and was also exposed to SAW, GTAW, and the metallurgy of welding. The rest of the CCWJ learned about very advanced techniques for manipulating sound signals and a couple of dance moves.

Materials and Method
Welding Equipment
The power supply was a Lincoln S500 with an 84 dual power feeder and advanced module adapter. All welds done with 0.045” (1.143mm) diameter ER70S-6 wire electrodes on A36 steel. Pure Argon shielding gas used at 35 Standard Cubic Feet per Hour (SCFH). Manual welds were performed with varying Contact Tip to Work Distance (CTWD) and varying travel speed.

Sound Sampling
Sounds were recorded using the “Voice Memos” feature on an iPhone 6. Sampling was made at a distance of approximately 1 ft from the arc. Typically 3 samples were made of each process to select the best for editing.

Sound Editing
The sounds were processed using Ableton Live 9. This is a powerful sound manipulation software that enables advanced filtering for the creation of sounds and MIDI sequencing of the sounds into a song.

Drum and wrenches (“kick drum”) A kick drum was emulated using a combination of two different sounds. One of them being a rubber mallet against a barrel. The other being two metal tools hitting each other. The sounds were played simultaneously for each “kick” beat.

Pulse weld (bass). The audio waveforms produced had a distinctive fundamental frequency. The original sound frequency was between 1.1 and 1.3 kHz. Sound processing used a gate with a linked automation which made the volume rise and fall accordingly to the spike in audio of from the “kick drum”. A low pass filter cutting off frequencies above 250 Hz was applied. The sound was transposed 12 steps lower (1 octave, or half the frequency) to obtain a better bass range.

Spray weld (“up lifter”). The audio waveforms produced resembled white noise, ideal for the “up lifter” sound typically used in EDM. The fundamental frequency was between 1.9 and 5.2 kHz. Sound processing used a high pass filter cutting off frequencies below 450 Hz. The “up lifter” feeling was repeated through an automated low pass filter with a cutoff frequency that varied from 26 Hz to 17.2 kHz at a constant rate.

STT weld (“up lifter”). The audio waveforms produced also resembled white noise, and were mixed up with spray weld to create the “up lifter” sound. The sound was processed with a high pass filter at 250 Hz and an automated low-pass filter varying from 26 Hz to 12.5 kHz at a constant rate. The two metal transfer modes combined gave the “up lifters” a nice full feeling.

Rapid X weld (lead instrument). The audio waveforms produced are similar to the waves from the Pulse weld, except that this one has more amplitude at the beginning of the wave and a longer sustain. The original recording had a frequency of about 800 Hz to 1kHz. This sound was processed with a filter lowering the gain at around 1 kHz by 2.6 dB, an auto-filter to cut off frequencies from 500-700Hz, and a delay effect.

Drum and wrenches (“kick drum”). A rubber mallet on a barrel gave a low frequency sound. Transposing it down 17 steps made it perfect for the low end of the kick.

The two metal wrenches gave off a higher frequency which was used to create the top end of the kick.

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Link to Video: search “CCWJ this is welding” in YouTube
https://www.youtube.com/watch?v=KtP0b2SQmiA