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The history and development of synthesis.

As electricity became more commercially available over the 20th century the development of musical equipment such as the theremin and the Ondes Martenot which was used to synthesize the microtonal pitches within Hindu music.

Notably later the Hammond organ, in 1935, was the first electronic instrument to start to have success within the commercial market. In 1948, through voltage control the Hugh Le Caine a Canadian engineer in nuclear physics completed the electronic sackbut, opening up the world to future developments within the commercial market including Robert Moog's products and many more with the complex creations of different pitches and tones.

This could be seen as a relation to the early days and foreshadowing of hacking culture, using and experimenting existing technology and pushing the limits to be able to get a new outcome, and we've already seen a background in a non-musical practice being used for that purpose.

There's debate on whether the French had made earlier developments by combining piano and electronic technologies. Harder (2012) notes "Many point to the Telharmonium or the theremin -- instruments invented in the late 1890s and in 1919, respectively -- but Rhea disputes their inclusion: Nothing on these instruments grants the operator complete control over the constituent elements of sound. The first instrument to fit the criteria was a hybrid of piano and electronic technologies invented in France in 1929 by Armand Gavelet and Eduard Coupleaux, which used a paper tape reader and devices that manipulated elements of electronic circuitry in order to create an orchestra of four voices. The first time the word "synthesizer" was used to describe an instrument came with the 1956 release of the RCA Electronic Music Synthesizer Mark I, which used tuning forks and information punched onto a roll of paper tape to play music through a set of loudspeakers"

Experimentation within synthesis was developing globally, and there were two women at the BBC

who were at the early contributors to this exploration. From the 1940s, Daphne Oram who also founded the BBC Radiophonic Workshop – used electronic oscillators and tapemachines to discover new sounds beyond normal conventional methods being used at the time, then demonstrating her new findings on tv and radio.

Finamore(2018) notes within her article "A tribute to the synth: how synthesisers revolutionised modern music" Oram once said she wanted computer-like machines to be "an extension of the arm of the composer." Oram's early experiments at the Radiophonic Workshop would change how music was made for TV forever, and her experimentation - and unfinished Oramics System prototype - foreshadowed the synthesiser.

Delia Derbyshire a mathematician and musician continued on the research that Oram had started at the BBC, famously composing the classic Doctor Who theme track that continues to be reimaged and rearranged today. These were tracks that had a huge change in the taste in music for tv and film with electronic compositions becoming even more prevalent with the commercial use that came through the next few decades.

Between 1964 and the mid-1970s, synthesizers using subtractive synthesis in its own medium became commercially accepted in the home, past an organ simulator.

Coates(2018) notes "When an amplifier is operated without feedback it is operating in "open loop" mode. With feedback (either positive or negative) it is in "closed loop" mode. In ordinary amplifiers negative feedback is used to provide advantages in bandwidth, distortion and noise generation, and in these circuits the closed loop gain of the amplifier is much less than the open loop gain. However when positive feedback is used in an amplifier system the closed loop gain (with feedback) will be greater than the open loop gain, the amplifier gain is now increased by the feedback. Additional effects of positive feedback are reduced bandwidth, (but this does not matter in an oscillator producing a sine wave having a single frequency), and increased distortion. However even quite severe distortion in the amplifier is allowed in some sine wave oscillator designs, where it does not affect the shape of the output wave." Basically oscillation via the feedback of the electricity within the

electronics makes sounds and this non linear way of working may be why earlier music had been so atonal.

American engineer Robert Moog designed the moog synthesizer. Designed by he synthesizer was composed of separate modules which created and shaped sounds, modules connected by patching cables for different uses namely as envelopes, noise generators, filters, and sequencers.

Wendy Carlos was a first user of the earlier versions of the moog modules, with the release of *Switched on Bach*, using synthesis to recreate classical arrangements of music and present them with the new forms of technology, later making compositions for classics such as *The Shining* and *A Clockwork Orange*.

This time period seems more tonal in approach than previous attempts and to have more of a standardised way of working due to the developments in the past now being brought together to make something new.

Not realising but since making my own synth realising its a module that can be added to others and the module market was the original medium, as well as becoming the modern trend in die hard fans which could be an interesting view on the potential full circle of things, they wanted to be made small for the sake of convenience and size in households, but now people have got all the convincing they need to fill their studio wall with eurorack synth modules.

Once available in retail stores from 1971 further companies started to appear within the market, notably ARP releasing the ARP 2600 a highly portable synth built into its own carrycase with speakers, and the Odyssey, an attempt to rival the success of the Minimoog. EMS synthesizers notably the VCS 3 was a cheaper alternative that were used by European acts including Pink Floyd. ARP, though one of the biggest synthesizer companies later closed in 1981 but there are still nods to the heritage namely the Korg ARP Odyssey.

The 80s and 90s also seen the rise of FM and digital synthesizers overall, Attack Magazine (2018) notes "FM (Frequency Modulation) synthesis has a reputation for being complicated and long-

winded, but this isn't really true in the case of modern software options. While the theory is indeed complex, contemporary FM soft synths are actually very easy to use. What's more, thanks to their ability to create complex harmonics, FM synths are capable of producing sounds not possible with virtual analogue instruments. When the Yamaha DX7 arrived in the mid 80s, producers were beguiled by its crystal clear digital tones, and its electric piano, bass and bell presets have become pop and dance staples. More recently, Native Instruments' FM8 – loosely based on the Yamaha DX – has become the instrument of choice for conjuring up cutting-edge bass growls by the likes of Skrillex, and Logic's EFM1 can be heard providing the bass tones for dozens of deep house tracks.” In 1996, Doepfer Musikelektronik released the first Eurorack-format modular synth module the Doepfer A-100, followed by other modules throughout the years 1997 and 1998.

The eurorack is an open source method which allows anyone to build eurorack modules which some could see as mirroring the collaborative styles within hacking culture.

Through the 90s to the current day software synthesis has been at the forefront of commercial synthesis, with software using digital software versions of previous creations such as Camel Audio releasing digital synthesizer plugins as well as granular synthesis being developed using digital algorithms for the sake of pitch, plugins including Serum and Massive.

It seems that recently over the last decade the appeal of retro synths has come again and companies such as Arturia creating plugin recreations in an attempt of matching these pieces of gear without the hefty price tag.

Hacker culture within music

Hacking and music has seemed to be a thing for a while be it tricks with tape machines or looking for no computer hacking a little audio toy and a collection of furbies.

Battle.S(2020) notes on his bio “I have no training in electronics, and about a year and a half of music at uni, so I wouldn't trust anything I say because I don't really know anything in an academic sort of sense, think of me more as a backyard engineer. “

I think that this is a common view within music and possibly a few other creative industries and do see it as a great view, as education can be a great way in creative industries to solidify foundations and fast track some of the things by pin pointing learning topics, some people simple do not need that form of structure nor direction they as many others will just ...kinda work it out.

As well as individual engineers and artists there also seems to be many genres, mainly subgenres of noise that use unconventional means in order to be able to get a “brand new sound”. Noise music can be an interesting place to look for similarities in music and hacker culture, even noting Wood(2018) If you agree with David Novak, the author of *Japanoise: Music at the Edge of Circulation*, then you probably believe that writing a history of noise music is inherently impossible. According to Novak, noise comes from the circulation of cultural ideas and artifacts, emerging from the accumulated meaningless debris that accompanies all forms of communication. Vinyl pops and scratches, for example, become noisy if what you want to hear is the recordings on that record. Noise music, therefore, comes from artists purposefully activating that noise. And since that noise comes from an infinite number of contexts, it’s impossible to map the history of noise music, or even to document the entire contemporary noise scene. Both, by definition, are constantly and unendingly regenerating.

Japanoise.

Edwin.P(2000) notes s Masami Akita quote, “I threw all my past music career in the garbage. There was no longer any need for concepts like 'career' and 'skill'. I stopped playing music and went in search of an alternative.

masami akita is half of the japnoise project Merzbow, known for using a mixture of tape loops and amplified percussion, I would assume from live footage via contact mics with one or more being played through a guitar amplifier, this musically interests me as if im honest their music puts me and many others off trying to make art with the uncoventional means is amicable.

Power electronics.

During the time of japnoise in the uk power electronics as a culture seems to be around in some underground music scenes including SPK with their use of non standard percussion and Throbbing gristle with their use of noise and tape samples , these are often noted as early pioneers of industrial music, and it could be seen to lay the groundwork for the less commercial soundscapes of electronica to be accepted within the main stream.

I think that Throbbing gristle's noted use of art and imagery being tied in with the music can even be seen on a base level of using outer influences in a non traditional way to create a new outcome, though its not the first time, it was heavily independent and with a record label owned "industrial records" theres some obvious influence in the world of industrial.

American harsh noise.

Seems that later similar techniques of using equipment in a non conventional way passed over to the states an act the haters using a few distortion pedals, contact mics, and a few bits of hardware to amplify, also worth noting there is footage available of a Merzbow and The hater live collaboration set.

Industrial.

Though previously mentioned throbbing gristle and their record label industrial records, the term industrial had been created with acts such as Front 242 and later Nine Inch Nails later reaching commercial success, I believe in some ways that it was all the previous years and inovaters mentioned that collaborated to this becoming a thing, for acts like Front 242 to become commercially accepted, without the shock or bias may just not have happened in many years prior but its not as if it aint still a lil left field.

NOISE ROCK

Turns out noise kids also like punk, metal and hardcore as over the years noise rock with the use of noise, rock instrumentation and non conventional instruments, a lot of heavy use of reverb and delays, making extended notes through feedback notably butthole surfers which I think hugely inspired mr bungle and the melvins.

I think that the more progressive rock and hardcore up to the modern day may owe a nod to a lot of the developments from hacking culture within music.

There have also been psychology research into whether noise and music is in fact one and the same in vibrational and transferable energy. Reybrouk.R, Podlipniak.P, Welch,D(2019) note “we consider music and noise in terms of vibrational and transferable energy as well as from the evolutionary significance of the hearing system of Homo sapiens. Music and sound impinge upon our body and our mind and we can react to both either positively or negatively. Much depends, in this regard, on the frequency spectrum and the level of the sound stimuli, which may sometimes make it possible to set music apart from noise. There are, however, two levels of description: the physical-acoustic description of the sound and the subjective-psychological reactions by the listeners. Starting from a vibrational approach to sound and music, we first investigate how sound may activate the sense of touch and the vestibular system of the inner ear besides the sense of hearing. We then touch upon distinct issues such as the relation between low-frequency sounds and annoyance, the harmful effect of loud sound and noise, the direct effects of overstimulation with sound, the indirect effects of unwanted sounds as related to auditory neurology, and the widespread phenomenon of liking loud sound and music, both from the point of view of behavioral and psychological aspects.

I think it's an interesting consideration that it's not in anyway the timbre of the instrument that can cause some emotion in all cases, some could also argue that if pitched correctly separate uses of "noise" could be used to generate chord and melody.

Outside of the noise genre of music, Mick Gordon I think is a brilliant example of making a new instrument for a musical context while working more tonally, with his use of the "doom synth" in his compositions for the doom video game, by using sine waves through distortion pedals he managed to create harmonics, which were linked to side chained compressors as well as delays with triggered feed back to make something unheard of within especially video game sound tracks, as with all these acts highlighting the overtones created in harmonics.

I like this as one of the requirements for creating the sounds was something in his response to how do you compose such a soundtrack as Gordon is noted within a interview Bethesda(2016) "Haha! Well, you take angry 7, 8 and 9 string guitars, vintage Soviet synthesizers and punch-knuckle-smacked drums. Then, you spice it up with burning valve distortion, electrically starved transistors, dusty ancient reel-to-reel tape machines, bleeding feedback arrays and gut-grinding sub-woofers. Finally, you smash all these elements together, give the player a shotgun and let the hunt begin" a fun and entertaining way to look at music with feedback being a main source.

The experimental approach is also noted by Favis.E.(2016) "He used cassettes, old guitar pedals, and an antique Soviet synthesizer to compose the soundtrack. "I don't speak Russian, and operating [the synthesizer] is kind of an adventure," says Gordon. A short section in the video demonstrates what the synthesizer sounds like alone, and it's off-kilter, foreboding vibe suits the game incredibly well."

My synthesizer.

With my project I decided overall to go analogue rather than software based, so I could learn from a base level what is involved in synthesis to a deeper level than knowing how to use individual modules for use in musical context.

I decided to make a simple oscillator module with a high pass filter, I decided on after mixing and experimenting different value capacitors and resistors in order to be able to come up with an oscillator that is in a lower octave range, once I settle on this I noticed the low pass filter only works in the higher frequency spectrum, before marketing this product I think a further look into electronics and components and circuit diagrams or someone with that knowledge a bit more indepth as part of a team would be necessary for the project to have substance in a commercial sense.

Within building the product the surprise of how much the components actually cost past the box found, I don't believe anything in the design costs over three pounds, and makes me consider the options of making certain product rather than purchasing (with a lot of practice).

I think this may be a reason for why the clone market of synthesizers, microphones as well as other hardware has opened up over the years, with the costs of components lowering as time has gone by and schematics of famous equipment becoming readily available online.

This may be a bit of an in the know situation, as it simply was not of interest prior, enjoyed using commercial synths, even had a play on a eurorack, but to be able to build something like this for less than five pounds with less fancy dials, where some similar box synths (probably working a bit better) sell for upwards of fifty pounds on ebay and reverb.

With the marketing of my product I would before release of the product, take the work simply as a talking piece to conventions and fairs without the use of stands etc to start, with the jam sessions and networking events use it as a talking point for networking within this world and to maybe spark interest in a more natural forming fashion While also getting to enjoy the benefits of the social

events. There are many that go from the mega commercial like moogfest to the more broad Synthplex.

Later through the year obvious uses of the internet be it social media and the products own website, crowdsourcing could also be used to generate interest while also generate finance.

I'd attempt marketing the project as the purchasers own personal project with the packaging suggesting this with the options of making they're very own "synthboy" and having instructions to different configuration models be it a oscillator with a high pass filter or a low pass filter, keeping it simple with the bread board and jumper wire system with the dials presolderd.

Future thoughts could be expanding the series similair styling to anologue solutions synthbox (each box having its own function) but with each of my boxes have a visual look similair to a robot face with names such as – oscoboy, filterboy and delay boy.

There could also be a DIY series which then leads on to a pro series, which the pro series would have more professional features prebuilt e.g metal casing and the consumer would not have to build a thing.

If there was to be a full pro version, I would look more into pcb boards as well as circuitry on a whole, having to work out the actual spacing of the components better than with the prototype.

I'd see this being more of a household operation in the starting phase and if it was to develop further take advantage of spaces like hacker spaces to work in with 3d printers, laser cutters amongst other machines, as I could not see the need or size for a non handmade version, though if this was to become more than this excersise locations like that would be great for networking or the complexity of the work withput prior knowledge, spaces like these can be great for like minds to work together and potentially then colaborate on further more innovative products.

I think this can also work to convey the ideas of modular synthesis and rather than going for the full euro rack system a cheap and fun little way of doing something, even if on a far smaller scale for the sake of its gimmick.

CONCLUSION

I've really enjoyed the project overall, and believe it has opened up some new methods of thought, especially with the experimentation side of technology and music Instrumentation using it, I don't think I'm going to start Merzbow cover band in the next few decades, but as Trent Reznor experimented and developed his style from his influences to then make a production with a more contemporary sound for the pop industry, or where Mick Gordon used techniques similar to noise acts, I'd like to use these skills within my own musical productions and can now see in some ways where acts from the 1970s had influenced some of the more publically commercial acts such as deathgrips then to the mega commercially successful acts like Billie Eilish. I also believe to have noticed this is less prevalent in the world of digital, whereas in the 90s I hear of Marilyn Manson's guitars being recorded played double the speed on tape, to then slow it down on another tape machine, for those experiments on sound to happen I think there would have to be more hardware around, though it's not impossible to just mess around by using things unconventionally to hope to come across a happy accident, as a happy accident could be the difference between something stale and something new.

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