"Between Technology and Music: Distributed Creativity and Liminal Spaces in the making and selling of synthesizers"

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Introduction

The first commercially produced electronic music synthesizer, developed by Bob Moog and Don Buchla in the period 1964-1971, heralds a rare moment in musical culture: the innovation of a whole new class of instruments. Inventors often come up with new designs of musical instruments but few of these designs get commercially produced. In the twentieth century the application of electricity to instruments (Braun 2000) led to such instruments as the theremin (Glinsky 2000), the electric organ (the Hammond organ was particularly influential), the electric piano, and the most important new instrument of the twentieth century, the electric guitar (Waksman 1999, Millard 2004). The synthesizer with its novel way of producing sound (unlike with an electric organ, the synthesizer, at least in the early modular version developed by Moog and Buchla, has ways of producing and controlling the fundamental components of sound) is the other major new instrument of the twentieth century (Pinch and Trocco 2002).

In this special workshop on "animating passions" the focus is upon the creative process. There is much interest in innovations, such as the synthesizer, which cross between the worlds of engineering and the arts (in this case music). There is a big literature on creativity in general (e.g. Koestler 1964) and creativity in technology (e.g. Carlson and Gorman 1990, Ferguson 1992, Petrovski 1985, Hughes 1999, Vincenti 1990). I will leave it to more thorough scholars to review this literature. Instead I will use my own case study of the development of the synthesizer (Pinch and Trocco 2002) to establish some points about the creative process which I hope will stimulate discussion in terms of trying to get a new handle on this old topic.

The first major point I make is: (1) **Creativity is a distributed process**. I am drawing explicitly here on Edward Hutchin's work on what he calls "distributed cognition" (Hutchins 1995). By examining complicated socio-technological systems such as aircraft carriers and passenger airplanes landing, Hutchins shows the poverty of thinking about cognition in terms of an isolated Cartesian mind which comes up with and implements plans or cognitive acts. Cognition is better thought of as being distributed between groups of humans and as being shared with machines and technical devices. The acts of creativity in developing a new technology are something we should also conceive of as being part of a distributed process – the crucial actions cannot be pinpointed to the mind of one inventor but occur in processes that are distributed between several actors, devices and tools. For example, one of the most important new interfaces on a synthesizer (and still a standard item found on synthesizers today) is something called the pitch wheel. This is a controller for bending the pitch of a note in the same way as a guitarist or violinist can stretch a pitch by pulling the string slightly to the side on the fret board. The

pitch wheel was first developed for the Minimoog synthesizer which premiered in 1970. I will show how the creative acts which led to this new synthesizer and its unique form of controller were distributed between a number of actors, devices and tools.

The second major point I want to make stems from thinking about the sorts of activity that count as being creative. (2) **Creativity involves not only producing new artefacts but also new ways of socially and materially organizing the production, distribution and consumption of those artefacts**. This might include novel ways of organizing production (as famously Henry Ford did for the Model T) but also novel ways of demonstrating and selling products. It also should include one of the deepest points established in S&TS in recent years which is that the creation of new artefacts also creates new sorts of human activities. As I shall argue below, the success story of the synthesizer depended upon not only creative acts in designing new synthesizers, but also producing novel ways of demonstrating and selling synthesizers. Furthermore the new sorts of performance synthesizers to emerge in 1970 such as the Minimoog created a new sort of musician, who became known as the "keyboard hero". These mainly young male rock musicians - the better known ones are stars such as Keith Emerson and Rick Wakeman, but there were countless others - used the synthesizer as a solo instrument enabling the keyboardist to get the same sort of limelight usually reserved for guitarists in rock bands.

The third and final issue I want to address in this paper is to think more generally about how art worlds (Becker 1986) and engineering worlds come together. My thesis here is: **(3) Liminal spaces enable creative acts**. I will argue that what I call liminal spaces, places "betwixt and between social worlds" (Turner 1969, Pinch and Trocco 2002), are particularly important because they enable people to fantasize and play with new objects and possibilities – to dream, to model, and tinker in new ways. In talking about inventors at play I am of course tapping into a big literature on hobbyists and enthusiasts (e.g. Corn 1983, 1986, Post 1994, Hughes 1999, Franz 2006, Haring 2006). Here my focus is on how to think about the sorts of space where this play is carried out. I will chart the different career paths taken by Robert Moog and Don Buchla and the different relationships each had with the world of art.

Creativity as a Distributed Process: The Minimoog and Invention of the Pitch Wheel

When Bob Moog was awarded the Polar Prize for music in 2001 (given every year by the King of Stockholm – a kind of Nobel Prize for music) followed by a technical Grammy in 2002 (he shared it with Steve Jobs for the Apple Macintosh), it was for his invention of the Minimoog synthesizer. The Minimoog was the first commercially produced, portable keyboard synthesizer. It became a classic and is widely desired and highly valued by synthesizer players even today. A digital form of the Minimoog, the Voyager, is currently made by Moog Music.[1] Unlike the larger and vastly more expensive modular Moog synthesizer (which retailed for the price of a small house, about $15,000), the Minimoog has a built in keyboard and uses knobs and switches rather than patch wires to control the sorts of sound made. The patch wires (complete with jack plugs and sockets) used to connect different modules together, gave the first modular synthesizers the appearance of old telephone exchanges. The huge number of possible patches facilitated exploration of

a vast range of sounds, but made them cumbersome to operate. With no standard operating manual, musicians were forced to make their own maps of the instrument in order to repeat their favorite sounds. The few brave musicians who took this unwieldy beast on tour for live performance would often rehearse patch changes in advance – producing one of the most unusual sights in music - musicians rehearsing without producing a sound (because they were literally between sounds)!

All synthesizers have ways of producing and controlling sound. The main sources of sound on analog synthesizers are oscillators and noise sources (such as for producing "white noise"). The technology used in these early analog synthesizers is known as "voltage control". A varying voltage, such as a sine wave output from an oscillator, can be used as an input to vary the pitch of another oscillator (known as frequency modulation). On the modular Moog the controls were knobs and patch wires, keyboards, and a special long box-like device Moog designed known as the ribbon controller. The latter was essentially a resistance strip along which the performer could run his or her fingers thereby changing the voltage continuously which in turn could be used to continuously control a parameter such as pitch. Much in the same way as a violinist or cellist controls pitch. This permitted sweeps of sound and pitches to be bent. The Minimoog, which also used the same transistor technology of voltage control, was controlled by knobs and switches, a built-in keyboard and by a totally new sort of controller, known as the pitch and modulation wheels (see figure 1). These were two upright plastic wheels which protruded from the keyboard casing and were mounted perpendicular to the keyboard at the left end. The pitch wheel had a detente spring device fitted so that musicians, when turning the wheel, could "feel" the wheel's middle position. The Minimoog is a monophonic instrument which means that it is capable of playing only one note at a time. The right hand is typically used for playing a succession of notes on the keyboard while the left hand adjusts the amount of pitch bend or modulation on individual notes.

Musicians immediately took to these new controls. Jam Hammer, whose trademark instrument in the rock jazz combo, the Mahavishnu Orchestra, was the Minimoog, is quoted as saying, "the pitch wheel really sets the min apart from any other keyboard synthesizer." [2] Roger Powell (a well-known mid-1970s synthesist) found that the pitch wheel and modulation wheel "are the most humanized controls that I have yet found on synthesizers."[3] Soon other synthesizer manufacturers, had developed a similar a form of the pitch and modulation wheels and it has become a staple of almost every keyboard synthesizer since.

How did this new form of control get invented? The origins of the pitch wheel lie with the Minimoog itself. Incredibly this classic synthesizer originated almost by accident and its first version was built out of discarded modules and other pieces of junk found in the attic of Bob Moog's factory in Trumansburg, upstate New York.

The year was 1969 and the Moog company for the only year in its brief life was actually turning a profit. The modular Moog synthesizer with its spacey sounds and unusual timbres had become part of the psychedelic revolution and had been used on hit records

by the Doors, Byrds and (later) the Beatles. Furthermore the instrument had become a star in its own right with the 1968 release of Wendy (formerly known as Walter) Carlos's "Switched on Bach". This rendition of several classic Bach pieces, made on the modular Moog synthesizer with the aid of Carlos's recording skills (she had been a former engineer at Gotham studios in New York) and an early eight-track tape recorder, was an overnight sensation and is still one of the best selling Bach records. The modular Moog synthesizer became the latest gimmick for the recording industry and it sent its representatives to Trumansburg in droves to purchase the new instrument. After 1968 nearly ever genre of music was in the process of being Moogified; with albums appearing under such titles as "Switched on Rock" "Switched on Country", Switched on Bacharach", More Switched on Bacharach", and even "Switched on Santa". None of these records had the artistry or commercial success of "Switched on Bach" but they did enable Moog to build his business. In 1969 he hired three new engineers and his company expanded to 42 employees.

One of the new engineers to arrive was Bill Hemsath and it is Hemsath who originated the Minimoog and the pitch wheel. Bob Moog had hired Hemsath after he had made several visits to the factory in connection with electronic music projects he was involved with in Cleveland. Hemsath, like Moog himself, had got his start as a hobbyist building ham radio sets - he had learnt radio physics from a borrowed correspondence course during third grade! He was also a self-taught keyboardist. He studied electrical engineering at Case Western Reserve University where he took a course in the history of music – his electronic talents were spotted and he was soon enlisted to help build an electronic music studio. He went on to work with Don Erb, a well known electronic composer at the Cleveland Institute of Music, and this brought him into Moog's orbit. He was hired as engineer-in-chief at the Moog company in the spring of 1969. He was 26 years old at the time and had just finished his draft deferral at Cleveland Ordinace, building torpedoes.

At that time it was barely possible to use a Moog synthesizer for live performance. A famous early concert featuring live modular synthesizers (which turned into a "happening") took place in the sculpture garden at the Museum of Modern Art in the summer of 1969. One of Hemsath's first jobs was to modify the modular Moog synthesizers used by adding a special box that enabled the synthesizers to be switched between several standard sounds. The modifications were done at the last moment and Hemsath and the other engineers were still soldering away at MOMA on the morning of the concert. Hemsath had become familiar with the standard sounds and the patches (the configuration of patch wires) used to produce them after demonstrating the studio Moog on countless occasions to potential customers. He got the idea that it would be fun to have a Moog that just made the standard sounds – something he could tinker with:

> I got into a set routine. I would always use the same patching and I would always use the same settings. I would always play the same and so forth…And I got to thinking that I would like to have something like that just to tinker with on my own…something to play with.[4]

Moog's Trumansburg factory was a former furniture store. The ethos was very much "make do". As another of Moog's engineers, Jim Scott, described it:

> If I needed a niche in the wall to park my phone, I just went down and got a hammer and nail and pounded a hole in the wall and cut up some wood and put a shelf in.[5]

On entering the factory you walked straight into the assembly area (staffed mainly by local women who were quilters) – several large tables in the middle of the room (see fig 2.). Benches ran along both sides, where the engineers designed, aligned, and tested new modules (later engineering moved to the second floor). There was a machine shop towards the rear of the building and a front office (first in the basement, later moved upstairs as the business grew), and a ramshackle studio at the rear of the building where visiting musicians and Moog's own studio musicians worked. Modules from this studio were often missing having been filched to make up a new order. The overall atmosphere was described by one of Moog's former employees:

> They were pretty chummy and informal and excited about what they were doing and at the same time always a lot of talk and speculation about what Moog was up to, what the next invention would be, would it crash and burn, would it succeed.[6]

Hemsath's office was on the attic floor; the attic itself was unfinished and laden with abandoned pieces of equipment. At lunchtimes Hemsath would take a walk through this attic. He describes what happened next:

> I would go through that every once a while in my lunch hour because I'm a pearl diver, and the thought started to gel… that there's a half case over there and all I have to do is saw the end off and glue… I loaded up my bottom desk drawer with cast off pieces… at noon I'd open up the drawer and chump on an apple while putting stuff together…the only piece that's in there that's a new part [the envelope shaper] - I actually went down to the construction area and stole it… I found an old keyboard… I was able to slice that down to two and half or three octaves.[7]

By the time his lunch-time excursions had ended, Hemsath had collected most of the elements of what was to become the Minimoog. He found two abandoned oscillator modules and a module for shaping sound known as an envelope generator. He had made the key decision to get rid of the patch cords and hardwire all the modules together in the same box with a keyboard. The instrument he built is known as the Model A Min Moog (the prefix Mini came later) (see fig. 3). Hemsath decided to simplify the ribbon controller form of pitch bender and make a pitch bender by using a slide potentiometer which he mounted on the left side of the keyboard (the ARP synthesizers notably used slide pots for many of their controls). His decision here was dictated by what he had available:

> In the original keyboards on the left [was]... a little control panel... all I was able to salvage was the left and right cheeks and one had a large notch in it. So that's where I put the little slide pot… It's playable but it takes technique.[8]

Hemsath had initially built the Min for his own amusement (he was after all a keyboardist) and he took it home to play with it. "I had it at home for probably a couple of months. I played with it every night the first week, and two months later I brought it back to work because it's in the way".[9] For Hemsath the device was not particularly memorable, at that time he was "wading in synthesizers daily". As Bob Moog recalls, "Well Hemsath was always doing shit like that. And so was I. We were always putting stuff together. Nothing unusual about it."[10] The device was referred to by the other

engineers as "Hemsath's toy". None of the engineers could at that stage see the commercial potential for such an instrument. Moog himself thought it might conceivably be of use to session musicians as a replacement for the large modular instruments they dragged from session to session. At this point in time synthesizers were not a mass marketable item sold through retail music stores; they were expensive high-end pieces of audio-engineered equipment used by a few composers, famous rock stars, and academic studios. They were sold direct from the factory (although Moog did eventually hire a sales rep in New York and two in Los Angeles). The uncertainty as to a possible commercial market for the Min was nicely captured by engineer, Jim Scott:

> Nobody was going to buy these things…so what are we doing this for? And none of us really knew the market very well, none of us. We were a bunch of engineers, right, theorizing what the world out there wanted to buy.[11]

The close interaction between engineers and musicians which Moog's funky factory fostered now played a part. One of Moog's studio musicians was David Borden. Based at nearby Cornell University (where Moog had recently completed his PhD in engineering physics), Borden led the first ever live synthesizer ensemble, Mother Mallard. He was friends with Hemsath and saw the potential of the Min for his ensemble as a way of changing sounds quickly. Borden asked Hemsath if he could borrow the instrument and it became such a standard part of the Mother Mallard set up that to this day the Min has Mother Mallard's trademark duck insignia plated onto its side.

As 1970 dawned it dawned on the engineers that their company was going under. Orders for modular synthesizers had dropped from ten a month to one a month as none of the new "switched on" albums succeeded commercially. Moog was away most of the time looking for investors. Scott:

> There was a sense of urgency we might not be able to meet payroll next week…Our credit was cut off… we were literally digging transistors out of cracks in the floor and testing them to see if they were any good or not.[12]

The engineers, with the support of Moog's business and marketing managers, decided that they would have to enter the mass-market to survive. And the most likely product looked to be the new Min. Hemsath decided that to win Moog over he would build a new prototype with a sleeker look. This Model B version had many improvements including a new standardized front panel, easy to use layout, the addition of a third oscillator, and rocker switches to switch the control and audio signals between different parts of the synthesizer. The Model B had a particularly effective and elegant case that latched onto the synthesizer like a sewing machine case. Hemsath had given Art Phelps, who ran the woodshop, a drawing, and he came up with the details of the case design. It meant that musicians could actually carry the Model B to gigs – one such early user was the famous jazz musician, Sun Ra, who took a Model B after a visit to Trumansburg to use in his space spectacles. He eventually sent his Model B back for repair by putting it on a flight to nearby Ithaca.

Hemsath was still experimenting with the pitch slider. He found it awkward to use on the Min with the left hand as the slider sometimes used to stick. Instead he now mounted the slider horizontally on the control panel of the Model B right over the center of the keyboard.

Moog was impressed with the progress his engineers had made and hired an outside design team who came up with yet another distinctive feature of the Minimoog – its hinged control board which can be locked flat for transporting the instrument but flipped upright at different angles for performance. Improvements were made in the electronics to stabilize the oscillators so that they did not go out of tune with changes in temperature (an annoying feature of the modular Moogs). The new design, including an elegant walnut wooden case,[13] is known as the Model C and is essentially the production model.

As the engineers finalized the design of the Model C Hemsath was still not happy with the pitch sliding device. The final form for the pitch wheel came from a totally different project. A customer had ordered a set of six calibrated joy sticks to control two voltages at the same time (in the X and Y directions). Hemsath experimented with commercial joysticks but found he could not eliminate the backlash problem. So he decided to build his own joy stick by connecting two potentiometers together with a metal angle bracket. This simple but effective design solved the backlash problem. The joy sticks ended up looking like paddle wheels (Hemsath likes to refer to them as "rollers" that could be pushed smoothly either forward or backwards). Obviously the bigger the knob on the potentiometer the more touch sensitive it would be, but a big knob would look ungainly. Hemsath hit upon the idea of mounting the knob horizantally under the end of the keyboard so only a small part of it (but enough to give it the needed range) would be above the surface. He decided to place his new device at the left end of the keyboard again because, "I just simply watched a lot of musicians and they could either play the ribbon [controller] with their left hand, or anything over here, just fine."[14] To manufacture such a device with such a large wheel he turned to the help of Don Pakkla, whose official job at the Moog factory was buyer – he ordered everything from transistors to toilet paper. Pakkla had previously been a machinist and he and Hemsath hit upon the idea of manufacturing batches of pitch wheels out of plexiglass (later the pitch wheels were injection molded). Hemsath and Pakkla worked closely together refining the design by adding a notch in the middle and experimenting with springs and a detent device so that the operator could "feel" in the dark when the pitch wheel was back in its center position. They were proud of what they had come up with and showed it round the factory to their co-workers. They had no idea that they had created the "most humanized" control on a synthesizer and that it would be used on synthesizers to this day. They had no inclination to patent the device – it has often been pointed out to me that if the Moog company had patented this one device, Bob Moog would have been a wealthy man.

Now we can unpack a little more of the sort of creative effort involved in producing this new device. In one sense there is very little new about the device – controlling pitch by a variable resistor has been a familiar technique since the dawn of analog synthesis. The novelty lies not so much in the idea as in its execution. As for most musical interfaces it is the subtleties of feel, look and sound which matter. For the pitch wheel it is crucial that it feels good to performers in the context of the overall ergonomics of the instrument. Also it must look like the sort of inviting control musicians want to use – and here the etched knobs standing out at the end of the keyboard are just asking to be pushed. Lastly the dramatic electronic pitch bending obtainable turns the piercing monophonic sound of

the Minimoog in the hands of a Keith Emerson, Jan Hammer or Rick Wakeman into a novel and useful musical effect (especially within the context of the genres of progressive rock and jazz rock). It enabled rock keyboardists to step out of the shadows and take some of the limelight guitarists generated with their solos. What the pitch wheel does paradoxically for a synthesized instrument is to turn it into a human instrument. It shows the machine is not doing everything and that the human can still exert and display his or her virtuosity and control (Bijsterveld and Pinch 2003). The pitch wheel provides a direct and dramatic way to amplify the presence of the performer. As Keith Emerson pitch bends you not only hear the sonic shattering squeal of the instrument but also see his elbow bending to dramatic effect. The spectacle of the instrument for live performance is thus also enhanced.

What of the creative act in making this device? Where and with whom does it lie? The two questions are related because as we have seen there is no one "where" just as there is no one "who". The pitch wheel did not arrive de novo, neither did any single engineer have an exact notion of what it would look, sound, and feel like before its creation actually materialized. The design started with a conventional potentiometer and evolved over time with several prototypes in the context of the overall design of a new instrument.

The same is true of the Minimoog. Clearly Bob Moog who was awarded the prize for its invention had a role to play, but several other engineers played key parts including Bill Hemsath and Jim Scott. Yet other actors made significant contributions such as Art Phelps in the woodshop, Don Pakkla the machinist and the anonymous outside design team who came up with the hinged-control panel. Musicians such as David Borden played a crucial role too. In this case what is already there heavily constrains what is possible in terms of the new instrument. Without a modular Moog synthesizers, live concerts, performing musicians, and an engineer such as Hemsath needing to demonstrate the instrument, none of this was possible. Also crucial are material factors such as an attic full of abandoned parts, machines shops and wood shops, and the various materials from which the instrument was made.

The invention of the pitchwheel does not happen de novo either. An existing potentiometer is adapted to fit an existing keyboard and over time and with each succeeding version it is developed further. Also other projects such as the specially commissioned joy stick play a role. Non-human elements such as machines and plexiglass also are crucial.

How individuals conceive of their work is also important. For Hemsath there was no clear distinction between work and play. The element of joyful tinkering using scrap parts strongly evokes the hobbyist ethos. That Hemsath can show and discuss and eventually enlist his fellow engineers and other personnel in the factory points also to the importance of the social relations in the factory and how these different groups interacted. The architectural layout of the factory also combines with the social arrangements in interesting and unexpected ways. Hemsath can be alone in his attic office to tinker, he can walk untroubled into the attic (or "graveyard" as he called it) for abandoned parts to use, and he can stroll down into the studio to talk with the musicians. Lastly even the

business economy plays a role with the engineers fully aware that Moog's business is going down the tubes (no Enron type structural secrecy in this small business!) thus providing them with that extra incentive to try to produce a new instrument to save the company (and their jobs).

There is no one creative act and creativity does not solely reside in the minds or bodies of the engineers; it also resides in the physical layout of the factory and the material and social arrangements of machines wood shops, materials and so on. Creativity is, in short, distributed.

Creating a new form of Synthesizer Demonstration

Completely new sorts of musical instruments are hard to sell. Musicians like to try out an instrument before purchasing it – this is especially true if the instrument is an unfamiliar one. As a thought experiment, imagine the violin had arrived de novo and now violin makers had to sell it with hardly anyone being able to play it and no repertoire of music developed for it. Would people see the potential in this strange scratching sound which only became musically useful after a lot of practice?

Retail music stores were well aware of this problem with new instruments. Electric organ manufacturers and retailers had developed slick demonstrations (known as dems) to show off the key sounds and potential of the new organs. Well known keyboardists were hired by organ companies to showcase the new instruments by playing popular pieces of music particularly suited to their electric timbres.

The Minimoog keyboard synthesizer when it was first introduced faced a similar problem. Synthesizers had never before been sold in retail music stores. The forty four knobs and switches made the Minimoog look complicated and there was no easily available orchestral or instrumental sounds to be conjured up at the flip of a switch as with organs. Unless you knew what you were doing it was hard to get the instrument to make any sound at all. Salesmen hoping to sell the Minimoog and ARP's keyboard synthesizer, the Odyssey, reported going into music stores and being thrown out because the owners could see no hope of selling such a complicated instrument.

One legendary Moog salesman, David Van Koevering, was responsible for changing the prospects of the Minimoog by devising a new way of demonstrating them. David Van Koevering is a former TV evangelist (he was known as "little David") who had a background playing in his father's novelty musical instrument show (the show not only brought kids to music but also to God). Van Koevering took over his father's show and was always on the lookout for new instruments to include. He had a theremin and as soon as he got word of the Moog synthesizer he incorporated one into his show. Van Koevering describes his first encounter with the Moog in an almost spiritual and visionary way. He had accompanied Bob Moog to an early live modular Moog performance at Carnegie Hall in January 1970.

> I saw something…the power of the sound, the sonic energy, and I believed it could become common, and I imagined it as powerful as the electric guitar to the first guys who ever played that thing.[15]

What Van Koevering realized was that this new instrument had the same potential to transform musical practice as the electric guitar had. But exactly how this potential would be realized was still unclear to him. He knew the effect of the Moog on live audiences, but what genre of music was best suited to it? It seems he initially conceived of the Moog as a form of instrument to play popular tunes on, a kind of Hammond organ. He even teamed up for a short while with a Florida business acquaintance, Glen Bell, the founder of Taco Bell. Van Koevering presented his novelty musical show in schools and afterwards handed out vouchers to the kids for free tacos at their local newly-opened Taco Bell restaurant. There they would find Van Koevering later that evening playing popular music on his modular Moog synthesizer (see fig. 4). Tacos in Florida have never tasted better!

Van Koevering's next venture was more ambitious. He leased from Glen Bell a man-made island off the coast of Florida at St Petersburg, renamed it "The Island of Electronicus", and used it to stage Moog spectacles. It seems he wanted to realize the potential of the Moog for making soundscapes and spacey effects (the same sort of sounds and effects used in psychedelia). He built a massive sound system in a glass domed rotunda and offered cushions for the audience to lie on in front of the "Love and Peace" stage as they listened to live and recorded Moog music. The shows involved a mix of Van Koevering's preacher's rap and soundscapes where he talked about the spiritual uplifting effects of the sounds, describing the Moog as an "eternity" and heralding the "dawn of a new enlightenment". He would use sounds to create the impression of motorbikes and a four cylinder sports car roaring around the rotunda. "And you'd hear the motorcycle going one way and you'd hear the sports car go the other way, and a horrendous crash would happen over the stage...And the audience would go nuts. They'd stand and they'd cheer and they'd clap."[16] The shows were a huge success and Van Koevering charged for two a day. He even persuaded Bob Moog to make a guest appearance at the Island. As soon as the new Minimoog synthesizers came off the production line, he ordered three and incorporated them into his show. He allowed kids from the audience to solo on the Minimoogs, with a spotlight on them. It was the perfect way of satisfying the 60s ethos of audience participation.

We can think of Van Koevring's Island as a novel kind of sound test laboratory. Van Koevering was experimenting on his audience to find the sorts of Moog sounds and music that was effective and how to set up and operate Minimoogs to produce these sounds. He also was able to observe the popularity of the Minimoog amongst the younger members of his audience.[17] With the Minimoog, Van Koevering became even more convinced that the world was ready for live performance synthesizers. He resolved to go out on the road and sell them. He set up a company in partnership with a local music store and, in classic American salesman fashion, he loaded up the back of his Cadillac with six Minimoogs and went on a tour of Florida to try and convince retail music stores to sell the new synthesizer.

He quickly discovered that most music stores were not interested in stocking the new instrument because of its complexity. Van Koevering would demo the instrument but it looked hard for a sales assistant to do likewise. Also it was still a comparatively

expensive piece of equipment. Retailing at $1,195, it was about the price of a rock group's van. To get stores interested he discovered that the best thing to do was to bring customers to the store – that demonstrated the demand. To get musicians interested he would find young rock keyboardists in clubs and lend them an instrument to use in their shows. He showed them the power which the Minimoog could have in turning them into stars:

> Because of its sonic energy, it could make the keyboard guy a superstar – a monophonic, piercing sound coming out or four or five.. amplified speaker stacks, could give him some energy and he could compete with the guitar, and he wanted to do that.[18]

But first the keyboardist had to learn to play the new instrument. Van Koevring devised a quick and easy way to help them set up sounds they wanted using little pieces of colored tape to mark the sounds:

> I would create a sound that he liked, and we'd put red slivers on all the 44 knobs and switch positions that meant all the red is sound red, and all the yellows are sound yellow.. these are the presets. "But on the way from one preset to the other, anything you find that's musical, play it, experiment, create a song for the for the sound….I was teaching them synthesis and they would get it.[19]

This idea of marking the different sorts of sounds later was incorporated by the Moog company into the instruction manual they wrote for the Minimoog. Different sounds were described in "sound charts" that marked the positions of all 44 controls to produce sounds such as "trumpet", "xylophone" or later "Emerson's Fat Bass From Brain Salad Surgery" (a popular ELP album where Keith Emerson uses the Moog). Van Koevering would post the word MOOG is big silvery letters on the back of the Minimoog and would instruct his musicians to ask the audience whether they liked the sound of the Moog. He was even known to take the slow-blow fuse out of instruments between sets so that musicians and their audience would experience what it was like suddenly not to be able to hear the Moog. Van Koevering would often wait in his car outside the club with the loan papers ready to be signed and then take his prospect to the music store the very next day to demonstrate at least one interested customer. Van Koevering did this for countless Florida music stores and then later spread his network wider to other states. At the same time well known performers on the Minimoog such as Rick Wakeman and Keith Emerson were touring the States creating even more demand for the instrument.

Word of Van Koevering's success spread to the Moog company. In a bitter sweet moment for Van Koevering, in 1971 Bob Moog finally found a venture capitalist, Bill Waytena, to buy him out – thus losing control of his company. One of Waytena's first acts was to bring Van Kovering back from the field and hire him for the new company where he eventually rose to become vice president of marketing. Van Koevering now started to attend trade shows such as NAMM. As performers became familiar with the new instrument, and its sound Van Koevering was able to train a sales force to dem the instrument. They also widen the sorts of musician to whom the instrument would appeal to include other genres of music. They also start to build a global market. ARP was doing similar things to sell its instruments and gradually performance synthesizers were stocked by retail music stores everywhere – where they have remained to this day.

In discussing creativity and technology it is important to recognize the novel way whereby Van Koevering developed a means of persuading retail music stores to stock the instrument. Like other acts of creativity this one is distributed over time, actors and materiality. Van Koevering does not work alone and needs the backing of people like Moog and Glen Bell and retail music store owners; he needs to develop new sales practices; and crucially he needs the experience he gained from setting up his "sound lab" at the Island of Electronicus. He depends upon the skills of musicians to play the new instrument and extract new sounds from it. Even the mystic tape and scissors he always carried with him is part of the creative act. It is the potential in these materials which he enacts so that they serve as a way of stabilizing sounds, help persuade musicians of the merits of the instrument, and provide the template for the sound charts which came later.

Van Koevering also seems to be the first person to realize that the new instrument in effect could create a new form of musician, the "keyboard hero". Of course it is the rocks keyboardists (and their fellow band members) who must create and play the songs and music to be effective, but without the new performance synthesizer in their hands they cannot do it. Again it is apparent that this is best talked about as distributed creativity shared between musicians, instruments and salesman. Van Koevering and other pioneering salesmen's legacy is enormous. The boundaries of what counted as musicianship and the boundaries of sound were forever changed by their activities.

Liminal Spaces for Creativity

I would like to conclude this paper by thinking a bit about the sorts of spaces and places where creative acts occur. There is a danger in any such discussion that we over emphasize one place at the expense of others. As I have shown for the case of the Minimoog it can be over quite casual interactions where creative work is carried out. Nevertheless it is useful to try and generalize about these sorts of spaces.

The origin of the commercial electronic music synthesizer lies in the coming together of two fields: engineering and music. It is possible to trace this "coming together" in the careers of the two main synthesizer pioneers Bob Moog and Don Buchla. Robert Moog was trained as an engineer. After graduating from Bronx High School for Science in 1952 he obtained a joint degree in physics at Queens College and electrical engineering at Columbia University in 1957, before entering the PhD program in engineering physics at Cornell. It was while he was at Cornell that Moog first started to develop his modular synthesizer. Equally important as Moog's formal engineer training, was his hobbyist background. Moog's father was an engineer for Con Edison and had a well-equipped basement workshop where Bob loved to tinker as a young man. He and his father founded R.A. Moog and Co. in 1958 – they sold coils for theremins and designed theremin kits (one of Moog's designs appeared on the front cover of the hobbyist magazine, Electronics World) and later they sold fully assembled theremins as well as kits. Moog also had some musical background. His mother insisted on him receiving piano lessons as a kid and he even played for a while in a college band but apparently showed little talent as a musician. Despite Moog's lifelong involvement with music and musicians, he always thought of himself as above all an engineer. All the early pictures of

him show him with a pen protector in place. As he himself said, "I'm an engineer. I see myself as a toolmaker and the musicians are my customers. They use my tools."[20]

The moments of creative impulse in Moog's life seem to have stemmed from two sources: (1) his tinkering and futzing around with electronics - a lifelong interest which started with his hobbyist background, (2) his encounters at key moments with musicians. Moog hung out with musicians a lot because of his theremin hobbyist business. He employed a sales rep for his theremins in New York, Walter Sear (who later became his synthesizer rep in New York). Sear, himself had an unusual career, starting off playing tuba in the pit at Radio City New York, later manufacturing tubas and guitar amplifiers (in a short-lived ill-fated venture with Moog); he then turned to audio engineering, and built (and still runs) a well-known all tube recording studio in New York (Sear Sound). It was Walter Sear who introduced Moog to the musician who turned out to be the most significant for the future of the synthesizer, Herb Deutsch.

It was Deutsch who first saw the need for a new more portable electronic music studio, finding the off-the-shelf oscillators he used to make experimental electronic music cumbersome and expensive. But Moog's encounter with Deutsch was not just a matter of cerebral interaction, although their first meeting was marked by a three-hour conversation over the possibilities of building new sorts of electronic music devices. They soon found they could help each other. One of the formative events in Moog's life was a concert Deutsch put on in the artist Jason Seley's Manhattan loft. Moog was there ostensibly to record the event. The loft was full of Seley's large automobile bumper sculptures and occasionally Deutsch would bang these sculptures accompanied by taped music. The event was an early "happening" (the avant garde art scene was lively in New York at this time with the Fluxus group) and Moog reports that he had "his mind blown". It was Bob's first real experience with the avant garde music scene. Later Moog invited Deutsch to take a summer holiday staying in a cabin on Lake Cayuga near Trumansburg, and it was during these few weeks in the Spring of 1963 that Moog and Deutch worked together and produced their first synthesizer modules. "Worked together" implies work but both Moog and Deutsch stressed that what they were doing was as much fun as anything. They simply had no idea that a new instrument was being developed and that this would lead to a gigantic new industry. As Moog recalled: "I've always had trouble with differentiating business from hobby… It was fun, it was interesting, maybe it would lead somewhere who knows?"[21]

The clues in the story I am telling are the references to play and fun (recall also the creation of Hemsath's Min moog). It seems that creative engineering involves this element of playfulness and fun. Now we have most of the parts in place for the theory of creativity with which I want to conclude this paper.

Creativity comes from bringing together two separate social worlds - in this case the world of engineering and the world of music, but it does so in a special sort of space - what I will call a liminal space. In a liminal space the social worlds and the concomitant identities become less important. It is like a fantasy world where the imagination can run free to imagine possibilities which the normal social world would constrain. The

imaginative and fantasy part is similar to children playing their typical imaginary games where they chose and build elaborate characters. But this liminal space is not an unreal space – it is populated by real social relationships, materials and skills. It is space where real work is going to get done. In short when Moog enters this liminal space he does not leave behind all his engineering skills, he does not suddenly become a musician with all the skills and experience that musicians accumulate. Ultimately he will remain an engineer and he will take what he has created and run with it in the world of engineering and eventually manufacturing. What happens is that the boundaries and identities around these two separate social worlds relax or blur a little enabling musicians and engineers to work together on a common project. That Moog has some familiarity with music helps a lot. Deutch too is familiar with the world of engineering having built his own equipment since an early age. Moog later runs into other musicians that are important for him such as Wendy Carlos, with whom he had an almost "telepathic" rapport, and Keith Emerson. In our book Analog Days (Pinch and Trocco 2002) we describe Moog as a "boundary shifter" – someone who enters a liminal space and reconfigures the boundaries around the object he creates. We describe the synthesizer itself as a liminal entity – one that has the power to cross social worlds and reconfigure and transform boundaries.

The liminal quality of the early modular synthesizers (before they became more like musical instruments with built in keyboards) is best seen in the problems people had with describing the skills needed to operate them. On the early albums the people who operate the synthesizers are sometimes described as programmers, sometimes as engineers, sometimes as keyboardists and musicians, and in one case as a "mad cap scientist".

This notion of liminality also applies to Van Koevering's activities. Van Koevering has a constantly shifting persona. At one moment he is a preacher, then an educator and entertainer, then he is a musician, then an impresario, before finally ending up as a salesman. The account of his achievements selling Minimoogs is replete with visionary semi-religious talk of his "mission" to bring the Moog to musicians. Is this just salesman's bluster or something more significant? If liminal spaces are important for creative acts then it can be argued that visionary talk provides just such a liminal space. In such talk the person imagines a different world, a world of possibilities, like the world of possibilities found in play, visions too seem to provide a space away from the usual social worlds we inhabit. Van Koevering saw before anyone else how young rock keyboardists could take to the new instrument and what it could do for their music and star potential.

It is also interesting to consider the career of Moog's fellow synthesizer innovator, Don Buchla, in the light of the above considerations about creativity. Buchla is of the same generation as Moog, and like Moog did a science degree at university (Berkeley in physics). Buchla meets avant garde composers Morton Subotnick and Ramon Sender at the mind blowing San Francisco Tape Center in the middle of Haight Ashbury almost at the same time Moog is meeting Deutsch. Buchla too develops a voltage controlled modular synthesizer and starts to manufacture them from his small garage-like workshop in Berkeley. But unlike Moog, Buchla has aspirations as a musician. He makes his own electronic music and throughout his career considers himself an artist who happens to be

skilled at electronics rather than an engineer. As Suzanne Ciani, a pioneering synthesizer musician, who was one of Buchla's closest collaborators, puts it: Buchla was "an artist who lived off his art."[22] Buchla himself expresses the dilemma of art and commerce:

> I don't regard it as important to be a commercial success… It's a fine line to tread, but you want to stay in the arts at the creative end of it and not mass produce anything, and yet you still have to make a living if you choose to do it.[23]

These differences between the identities of Moog and Buchla are crucial for the future of the synthesizer. Buchla rejects keyboard interfaces and is influenced by the more radical experimental musical ethos of artists John Cage and David Tudor (David Tudor was Buchla's first ever customer). Buchla is also part of the emerging San Francisco counterculture and friends with the Grateful Dead (for whom he makes some synthesizer models). He refuses to call his synthesizers "machines" and always refs to them as instruments – one off creations which contain all the little resonances and uncertainties which makes a traditional instrument especially valuable. He rejects standard names for the white noise source found on synthesizers – preferring to call it "the source of uncertainty". He refuses to call his work space a "factory" and employs "like minded friends, philosophers, artists and zen budhists" who must work stuffing circuit boards in total silence. A more different ambience to Moog's funky upstate factory could not be imagined. Moog is ambiguous about the counterculture preferring to watch from a distance (smoking pot but never inhaling); he lets his west coast sales reps Paul Beaver and Bernie Krause deal with what he call the "hippies". Moog is also uneasy about the take up of his synthesizer in psychedelia preferring to see it used for the classical creations of Wendy Carlos. In short despite his boundary crossing Moog's identity remains firmly rooted in fifties engineering values. He wants to manufacture a robust, reliable product – he once told us it might as well have been manufacturing drills as synthesizers. Moog's synthesizers are famously reliable on the road while Buchla's are more delicate and repair was never his strong point.

I do not want what I am saying here to be misunderstood. Professions and the identities that go with them are remarkably stable and are only rarely reconfigured. Inventive creativity seems to flourish in the sorts of liminal spaces which allow the boundaries around social worlds to blur a little, but it does not happen often. Identities can change but it is very hard in a world with a rigid institutional ecology to manage hybrid identities in a career which continually crosses two worlds. In the end, despite the similarity of their creative acts, neither figures are able to sustain careers as hybrid figures. Moog keeps his identity as an engineer and Buchla as an artist. Both men were equally creative and equally passionate and both made significant devices which changed our soundscapes and our notion of musicianship (Pinch and Trocco 2002). In the world of synthesizer manufacturer Moog's name has lasted because he became a synthesizer manufacturer rather than an artist.[24] But Buchla is still out there doing his art and making as beautiful and evocative instruments with as amazing sounds as ever.

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[1] Moog's company was revitalized in the 1990s as he recovered the right to use his own brand name, became a cult legion, and musicians increasingly found value in analog synthesizers.

[2] Jan Hammer in interview with Tom Rhea, *Imooginations* II, (Lincolnwood, Il.: Norlin Muisc, 1977) p. 9.

[3] Roger Powell in interview with Tom Rhea, *Imooginations* II, (Lincolnwood, Il.: Norlin Muisc, 1977) p.12.
[4] Interview with Bill Hemsath, 8-8-98.
[5] Interview with Jim Scott, 10-26-97.
[6] Interview with ken Fung, 4-24-96.
[7] Interview with Bill Hemseth, 8-8-98.
[8] Interview with Bill Hemsath, 8-8-98.
[9] Interview with Bill Hemsath, 8-8-98.
[10] Interview with Bob Moog, 11-15-97.
[11] Interview with Jim Scott, 10-26-97.
[12] Interview with Jim Scott, 10-26-97.
[13] The outside designers had suggested molded plastic cases. Fortunately Moog couldn't afford to get these made; and the much more classic wood look was preserved
[14] Interview with Bill Hemsath, 8-8-98.
[15] Interview with David Van Koevering, 1-30-99.
[16] Interview with David Van Koevering, 1-30-99.
[17] Van Koevering's movement from the wider world to his test lab and back again into the world to sell synthesizers is reminiscent of Bruno Latour's (1983) story of Pasteur's lab in the pasteurization of France.
[18] Interview with David Van Koevering, 1-30-99.
[19] Interview with David Van Koevering, 1-30-99.
[20] Quote is from Wikipedia entry on Bob Moog.
[21] Interview with Bob Moog, 6-5-96.
[22] Interview with Suzanne Ciani, 8-23-98.
[23] Interview with Don Buchla, 4-4-97.
[24] Here the wider story of capitalism and the culture industries enters. The story line is familiar - there was money to be made from best selling records and mass producing and selling synthesizers – not that Moog himself ever made much of it. But some sorts of activities are valued in our society more than others.

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