Curatorial > PROBES

In this section, RWM continues its line of programmes devoted to exploring the complex map of sound art from different points of view, organised into curatorial series.

Curated by Chris Cutler, PROBES takes Marshall McLuhan's conceptual contrapositions as a starting point to analyse and expose the search for a new sonic language made urgent after the collapse of tonality in the twentieth century. The series looks at the many probes and experiments that were launched in the last century in search of new musical resources, and a new aesthetic; for ways to make music adequate to a world transformed by disorientating technologies.

Curated by Chris Cutler

PDF Contents:

At the start of the seventies, Chris Cutler co-founded The Ottawa Music Company – a 22-piece Rock composer's orchestra – before joining British experimental group Henry Cow, with whom he toured, recorded and worked in dance and theatre projects for the next eight years. Subsequently he co-founded a series of mixed national groups: Art Bears, News from Babel, Cassiber, The (ec) Nudes, p53 and The Science Group, and was a permanent member of American bands Pere Ubu, Hail and The Wooden Birds. Outside a succession of special projects for stage, theatre, film and radio he still works consistently in successive projects with Fred Frith, Zeena Parkins, Jon Rose, Tim Hodgkinson, David Thomas, Peter Blegvad, Daan Vandewalle, Ikue Mori, Lotte Anker, Stevan Tickmayer, Annie Gosfield and spectralists Iancu Dumitrescu and Ana Maria Avram. He is a permanent member of The Bad Boys (Cage, Stockhausen, Fluxus &c.) The Artaud Beats and The Artbears Songbook, and turns up with the usual suspects in all the usual improvising contexts. As a soloist he has toured the world with his extended, electrified, kit.

Adjacent projects include commissioned works for radio, various live movie soundtracks, *Signe de Trois* for surround-sound projection, the daily year-long soundscape series *Out of the Blue Radio* for Resonance FM, and p53 for Orchestra and Soloists.

He also founded and runs the independent label ReR Megacorp and the art distribution service Gallery and Academic and is author of the theoretical collection File Under Popular – as well as of numerous articles and papers published in 16 languages.www.ccutler.com/ccutler

PROBES #37

In the late nineteenth century two facts conspired to change the face of music: the collapse of common-practice tonality (which overturned the certainties underpinning the world of art music), and the invention of a revolutionary new form of memory, sound recording (which redefined and greatly empowered the world of popular music). A tidal wave of probes and experiments into new musical resources and new organisational practices ploughed through both disciplines, bringing parts of each onto shared terrain before rolling on to underpin a new aesthetics able to follow sound and its manipulations beyond the narrow confines of 'music'. This series tries analytically to trace and explain these developments, and to show how, and why, both musical and post-musical genres take the forms they do. In PROBES #37, we consider the revolution ushered in by the thermionic valve and, in particular, the disorienting but transformative changes electrical amplification brought into a world until then predicated solely on acoustical laws. We then examine the cybernetic entanglement of its mirrored portals (the microphone and the loudspeaker) through the generative instability of feedback which, it turns out, has accessible expressive powers...

01. Transcript. Studio version

[Gregorio Paniagua, 'Anakrousis', 1978]

If any single invention could be said to have ushered in the electronic age, a good contender would be the thermionic valve. It made radio, television, radar, long distance telephone communication, public address systems and the first generation of computers possible – as well as being a vital component in almost every electronic device, before it was displaced by the transistor in the 1960s.To the world of music, the valve offered not only an infinitely controllable source of pitch creation but – more importantly – for the first time, the power of non-acoustic amplification. And amplification would change everything, not least because it completely overturned the natural order of acoustics, allowing sounds too small to hear and signals too weak to carry to stand their ground against anything the non-electric world could raise against them. In an *acoustical* ecology, every instrument has its natural span of amplitude – and those limits are absolute: no trumpet can play more quietly than a clavichord, and no harp can rise above a wind quintet. What we call orchestration is the recognition and negotiation of these constraints – and they were understood to be constraints that no music could escape; until the invention, by Lee de Forest, of the first valve amplifier, in 1912. After that, you could whisper against an orchestra and still have no problem being heard. All an amplifier requires is an input and an output. That usually means a microphone and a loudspeaker – both of which, in a tidy demonstration of evolution in action, predate the amplifier itself. Indeed the decisive prototype of the microphone was invented several times in a single year – 1876 – by Emile Berliner and Thomas Edison in America and David Edward Hughes in the United Kingdom. Hughes gave his invention to the world while Edison and Berliner fought over the patent rights. But all their designs were based on the way that loosely packed carbon granules compress and relax in response to variations in pressure – in this case pressure exerted by a diaphragm that was mechanically vibrating in sympathy with moving air. Every variation in granule compression causes a parallel change in electrical conduction, thus converting *kinetic* energy into *electrical* energy. And once converted, the electrical data produced is subject not to acoustic but electrical laws – through which it may be modified or made to travel silently through wires before it's eventually reconverted back into sound – all you need is a battery to provide the flow of electrons. Further refinements made in 1886 by Thomas Edison led to the design that then went on to power the world's telephone mouthpieces for the next hundred years.

Loudspeakers, on the other hand, had to pass through many mutations before finally arriving – in 1921 – at a satisfactory basic architecture, although that didn't impede the appearance of public address systems[1] more than a decade earlier[2]. By 1910, for instance, the Automatic Electric Company, whose main

[Ulrich Eller, *Sonambiente, Festival für Hören und Sehen, Berlin*, 1996. Source: https://www.ulricheller.com/en/among-the-circle-of-the-drums]

business was telephony, had unveiled its Automatic Enunciator – a mini public address system that was designed for use in department stores, factories, railway stations and at outdoor events. In 1912, they installed seventy-two speaker horns, set out in pairs at forty-foot intervals to broadcast speech and music at a water carnival in Chicago. They also wired the Chicago baseball stadium – and a similar array was installed in Stockholm for the 1912 Olympics. All of these systems depended on large, directional, acoustic horns whose size and shape determined the amount of amplification that could be achieved – and whose tone was narrow and metallic and decidedly lo-fi. But, even at this primitive stage of development, the new electrical logic created disturbing existential anomalies as it simultaneously *re-scaled space* and *multiplied locations* – by which I mean loudspeakers, by their nature, extend the horizon of acoustic sounds beyond their natural limits – and allow them to originate, impossibly, in many separate locations at once.

[Woodrow Wilson speaks]

[Footnote]

In 1919, president Woodrow Wilson used a standard 25-watt Magnavox PA system to address 50,000 people at the City Stadium in San Diego – and 25 watts remained the standard power rating for all public address systems well into the 1950s. It was the rock generation who upped the stakes. In 1959, the British company, Jennings Industries, created their now famous Vox AC30, specifically at the request of The Shadows – who needed more headroom. Eight years later, Jimi Hendrix was routinely plugging into 200, 400, sometimes 800 watts of Marshall power and, by 1970, The Grateful Dead's touring system – assembled by the pioneering sound engineer Bob Heil – was checking in at 20,000 watts.

[End footnote]

Of course these huge acoustic horns, although effective enough in parks and stadia, were hardly practical for domestic use – and by the 1920s more and more people were buying radios and gramophones and they wanted better quality sound reproduction in their homes. Help came at last in 1924, when Chester Rice and Edward Kellogg patented an improved version of the moving coil loudspeaker, replacing the acoustic horn with a specially mounted paper membrane. Not only did this look better, but its reproductive quality was far superior – and it took up much less space. Although the basic design has been tweaked since then, its architecture remains the universal standard. In daily speech, when someone says loudspeaker, this is what they mean.

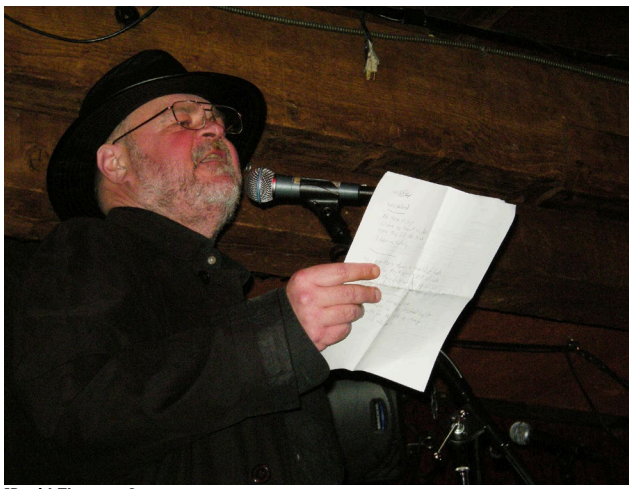
[Footnote]

A moving coil – or dynamic – loudspeaker works like this: a coil of wire is wrapped around an electromagnet suspended in the circular gap between the two poles of a permanent magnet. The fluctuating electron flow that arrives from the broadcast end induces corresponding electronic fluctuations in the coil, and these cause the alignment of the magnetic poles to switch rapidly between attract and repel. As the magnets switch they move the speaker membrane in and out, very rapidly, creating patterns of air pressure that we perceive as sound.3

[End footnote]

A loudspeaker is a gateway to another world – I mean that literally, because *only* a loudspeaker can grant us access to the boundless universe of electrically mediated sound – and that now includes almost all of the music and a great deal of the verbal information we encounter daily, from recordings, radios or concert stages. In fact, almost everything that isn't conversation or a natural environmental sound arrives to our ears through a loudspeaker. They are everywhere; so universal we don't even notice them. Yet a speaker is a miniature miracle – a distant cousin to Jorge Luis Borges' Aleph – that impossible point in space that contains all other points, or in the case of speakers, is able to contain. But imagine a world without them: our extensive access to the audio past would disappear while our sound horizons shrank from *planet-wide* to *immediate vicinity*.

[Digital silence]



[David Thomas. Source: https://en.wikipedia.org/wiki/David_Thomas_%28musician%29#/media/File:David_Thomas_02.jpg]

Given the importance of loudspeakers, it was inevitable that musicians and composers would eventually explore their unique affordances – or what you might call the nature of their being beyond their function as a portal or a conduit for something else. And amongst these affordances one would have to count the way in which speakers disruptively reconfigure scale and space. In an *acoustic* space a thing is reliably where it is; in an *electric* space it appears to be wherever a loudspeaker is. In the Athenian agora, Woodrow Wilson would have spoken from where he stood – and he would have been heard only by whoever was in earshot; but at the City Stadium in San Diego he was magically multiplied and now appeared to speak simultaneously from every position in which a loudspeaker had been placed. Of course, many of his audience could see him on the stage, so at least the eye, if not the ear, could hold to a sense of where he actually was. But if those same loudspeakers had been plugged into a radio set, then Wilson might have been anywhere on the planet. And if they'd been connected to a phonograph record, he wouldn't have been speaking at all – except, impossibly, from the past. And a loudspeaker alone can't tell you if that's Woodrow or a recording of finally arriving – in 1921 – at a satisfactory basic architecture, although that Woodrow. So suddenly there's no saying where he is, or even if he's still alive. That has to be – at some deep experiential level – disorientating. Suddenly, the laws of natural acoustics no longer apply. When loudspeakers dominate the soundscape, the human ear can no longer be trusted to tell us the truth about the world we experience. And this is not so much a sort of ventriloquism as it is an eerie analogue of Descartes' conception of the pineal gland – the sole organ through which a corporeal body can communicate with an incorporeal mind. Or, in the case of the loudspeaker, the sole means by which the world of electricity can interface aurally with the world of natural acoustics.

Neither microphones nor loudspeakers are neutral; each has its own characteristics and imparts its own way of uttering or hearing to the listener. And, although, rhetorically, the history of both devices has always been directed toward ever-greater fidelity, ever-greater clarity and ever-greater separation and transparency, out in the real world it's the manufacture of hyper reality that has served them better – that is to say, the quest for *more*: more volume, more bass, more high frequencies, more separation, more contrast – with the result that loudspeakers – like blockbuster movies – increasingly deliver a world of artifice which, although it presents itself as the documentation of high-definition, reality is, in fact, entirely fake.

[David Thomas, soundcheck (excerpt)]

A microphone is not an ear; it's not connected to a brain; it doesn't have experiences and it isn't equipped with any other senses with which it can contextualise the things it hears. Nor can it focus, as we do, on what's important – or suppress what's unimportant; it's not like us. It hears technically, not subjectively. On the other hand it's able to listen in ways and places that no ear can match – and then it can put *our* ears right there beside it. As Marshall McLuhan said, it's an electrical extension of the biological human sensorium – in other words, a tool with which we can do previously impossible things.

[Frank Sinatra, 'In the Wee Small Hours of the Morning', 1955]

Crooning, for instance, was a direct product of the microphone; and it was born, not in a public context but out of the microphone-amplifier-loudspeaker complex. To sing on a stage, except with the smallest ensemble, is a battle for audibility; that's why the operatic voice is so stentorian and artificial: it's trying to be a trumpet. But, under studio conditions, acoustic reality can be discounted, because amplitude is made relative and a singer can be as intimate or relaxed or nuanced as emotion demands, allowing *personality* rather than *projection* to dominate. Because speaking to a microphone is speaking directly to a listener's ear.[4]

[Gary Kellgren's (censored) whispering that was meant to be on Frank Zappa's 'Only in It for the Money' (excerpt), 1967]

I suspect this understanding arose first in radio studios, where one quickly learns that when one is close to a microphone, the warm, low frequencies are boosted, and as you draw away, thinner, higher frequencies predominate. This gives you control over parameters that were out of reach – that, in fact, didn't exist –

[Blossom Dearie. Source: https://en.wikipedia.org/wiki/Blossom_Dearie#/media/File:Blossom_Dearie.jpg]

before. So good singers quickly learn to play their microphones – especially once they're working with headphones – because hearing one's own voice, as it were, from outside, is a very different thing from experiencing it from the inside which – before the age of sound recording – was the *only* way we could hear it. Indeed, what reason would we have even to imagine that we might sound different to other ears – until we can become those ears ourselves. Obviously, our amplified or recorded voice should never be mistaken for our 'real' voice – it's just a new voice that we didn't have before. And it's a voice that offers us novel powers and dimensions. Once discovered, these can move from the studio to the stage – or vice versa. For this reason I was immediately convinced by Philip Tagg's suggestion that Lemmy Kilmister's strained vocal delivery was in large part a product of his having physically to stretch his head upward to sing into a microphone that was always mounted over his head, pointing down at 45 degrees. Try crooning in that position; it's impossible.[5]

[Motörhead, 'The Hammer (live in Newcastle)' (excerpt), 1981]

And compare:

[Blossom Dearie, 'Someone to Watch Over Me' (excerpts), 1959][6]

Generally, on stages, microphones are static, while a singer or an instrumentalist moves in relation to them, controlling their tone and amplitude through movement. But there's no rule that says a microphone can't be an active participant in a performance – a technique brilliantly exploited by Karlheinz Stockhausen in his visionary 'Mikrophone I', premiered in Brussels in 1964, and scored for tam tam, two microphones, two filters and two potentiometers. It has an instructive history: in 1964, Stockhausen had acquired a huge tam-tam which, when not in use, was set up in his garden.[7] Using objects gathered from around his house – made of metal, glass, wood, rubber and plastic, and also a set of cardboard tubes – Stockhausen began to experiment with the tam-tam, building up a repertory of novel sounds and techniques. Then, with a highly directional microphone, he began – as he expressed it – to 'probe the surface [of the tam-tam], the way a doctor probes a body with a stethoscope.' Out of all this experience, he assembled a catalogue of sounds, categorized according to their associative qualities, these included: 'groaning, trumpeting, whirring, hooting, roaring, grating, chattering, wailing, sawing, ringing, choking, cawing, clacking, snorting, chirping, hissing, grunting, crunching, clinking, tromboning, and scraping'[8]. Out of these he derived a kind of scale that consisted of 36 steps, calibrated from the darkest and lowest to the brightest and highest. Only then did he write the piece. In the final score two musicians play the tam-tam, two move the microphones – following choreographed instructions – and two process the information delivered by the microphones using filters and potentiometers. It's a 27-minute tour-de-force and I can only play a very short excerpt; but I do recommend you search out the full recording.

[Karlheinz Stockhausen, 'Mikrophonie I' (excerpts), 1964]

When he was asked 'must it be a tam-tam?'. Stockhausen said, 'No, I can imagine this score being used to musically examine an old Volkswagen.'
And here's another microphone on the move, this one is attached to a recording device that was packed in a parcel and mailed from London to Rome by the sound artist Daniela de Paulis. The forty-one and a half hour journey was released as a data CD sound edition of 250, in 2008. I'll play two short excerpts – the first sounds rather like a station, the second is probably on a plane.

[Daniela de Paulis, 'London to Rome' (excerpts), 2008]

And here's another – this one has been swallowed by the French sound poet Henri Chopin and is on its way through his digestive system.[9]

[Henri Chopin, 'La Digestion' (excerpt), 1974]

But, in the main, just as microphones are imagined as passive and expressively neutral devices, so are loudspeakers. They just sit where they're put. That's especially relevant when stereophonic, quadraphonic and surround sound illusions of dimensionality and motion are created – because these are dependent

[Karlheinz Stockhausen, *Mikrophonie i · mikrophonie ii*, 1975]

precisely on there *not* being any actual dimensionality or motion. This a relatively new idea because, until the 1950s, a loudspeaker could only project point source information into the world: that is to say, wherever the speaker was, that's where the sound was. It was only with the advent of stereophony that spatiality was able to move out of the acoustic world and into the psychoacoustic world – a domain in which sounds are no longer where they actually are, but were where they *appear* to be. By feeding different information to the left and right ears, an illusion of depth, movement and lateral position can be reliably induced, as a diligent brain, trained and familiar only with the behaviour of sound in the real world, struggles to interpret audio illusions (trompes d'oreilles*)* as if they were actually valid spatial information. To create this illusion, it's essential that the loudspeakers themselves do not move, and also that they are not heard as individual sound sources – rather, they become a sort of frame, like a picture frame*,* that contains a three-dimensional illusion.

[Jimi Hendrix, 'And The Gods Made Love' (excerpt), 1968]

This aspect of loudspeaker sound: that 2, 4, 5, 7 or more of them can be configured to create an enclosed, illusory, space – or rather, a space within a space – or a space superimposed *upon* a space – is something we'll examine more closely in a later programme. Here we'll just restrict ourselves to probes that treat loudspeakers as individual entities – or personalities – rather than as invisible frames used to project tricksy audio illusions.
Based on the notion of an orchestra – that is, a large collection of different instruments, each with its own unique qualities, and each occupying its own unique spatial location – there arose in the electronic music world of the 1960s, what you might call orchestras of loudspeakers – the best known being the French Acousmonium, founded in 1974 by François Bayle.[10] The Acousmonium disposed a variety of different kinds of loudspeakers – between 60 and 100 of them – in varying configurations, sometimes set out like an orchestra on a stage, sometimes placed around – or even below and above – the listening public. These speakers were carefully selected for their individual qualities, and the sounds they relayed were further individuated by their movement from one speaker – or one group of speakers – to another. Conceived as immersive installations, these speaker orchestras were designed to be animated in real time by composers who imposed spatial and dynamic movement onto the playback of two, four or eight tracks of pre-recorded tapes. In such arrays, the speakers are not intended to be neutral or optimal, but are carefully selected for their differences and personalities – to add colour to the listening experience. The claim they lay to the acoustic world is that, as with any live concert, the listener's experience is irreducible and non-reproducible – you have to *be there* in the room with them. The effect can not be recorded. What we might call their phenomenological essence is not so much to do with the music they relay, as it is with the experiential gestalt that they create in a particular space at a particular time. There's nothing I can play you to illustrate this – and that, of course, is the point.

[Johann Sebastian Bach, 'Toccatta and Fugue in D Minor' (excerpt), from Walt Disney's Fantasia, recorded by Leopold Stokowski in Fantasound, a one-off stereo/multi-speaker system launched at vast expense (and quickly mothballed) in 1940, a prescient experiment that had to wait another decade to be followed through (excerpt), 1940]

Even before the normalisation of imaginary spaces – most commonly, stereophonic space – other multi-spatial possibilities had been sketched. Back in 1926, Hugo Gernsback's Pianorad had been designed to send each note of its two-octave keyboard to a different speaker and, although they were all mounted together on top of the instrument, they could have been distributed in any number of ways around an auditorium – or throughout a building.[11] Gernsback himself drew attention to this, although he never actually implemented it – the idea, however, is rich with possibilities; and I must say it surprises me how seldom the world of music has considered them since.[12] Of course, some forms of electronic music use loudspeakers in this distributed way, and it's a common feature of many sound installations – a field in which different ways of working with point source sound are common. An excellent example is Janet Cardiff's 2001 installation, 'The Forty Part Motet'. The motet in question is Thomas Tallis' 'Spem in Alium', a remarkable work written in the late sixteenth century for forty separate musical lines, divided between eight separated five-part choirs. Cardiff duplicates this precisely, by assigning each of the forty voices to its own

[Janet Cardiff & George Bures Miller Bures Miller *The Forty-Part Motet, 2001 (A reworking of Spem in Alium by Thomas Tallis, 1573)*, 2007. MACBA]

loudspeaker and arranging the forty speakers in eight groups of five around the listening public – exactly as Tallis had, with his choirs, almost half a millennium earlier. As with a real choir, the blend of voices happens in the room and each voice is fixed into its own space. The public is left free to move amongst the speakers at will, listening to individuals, groups or the whole ensemble. Again, the experience is unrecordable, but at least I can indicate the nature of the composition – and a little of what a visitor might hear. This excerpt is from a private recording made in the room by a visitor, acting as a visitor might.[13]

[Janet Cardiff, recording of 'The Forty Part Motet', 2001]

Point source sound is always a real world event – no recording can capture it because, obviously, one speaker in one place can't duplicate the spatiality of several speakers in several places. Nor can any stereo or surround sound system, however sophisticated. In a point source set-up, each speaker is an individual entity.

Like a microphone, a loudspeaker can also be an instrument in it's own right, a point brilliantly made by Gordon Monahan in his classic 'Speaker Swinging', first performed in 1982. Its genius is its simplicity – and you get a huge result for a modest input. In essence, three athletes – it's a 25 minute piece and very strenuous – swing three large loudspeakers around their heads on heavy ropes, drawing approximately six or seven metre diameter circles. The speakers themselves are fed by nine sine and square wave oscillators and everything else is the product of room acoustics and the highly complex wave patterns, disturbances, cancellations, doppler effects and reflections of the three independent speaker trajectories and their intersections. Here's a short two-dimensional excerpt from a performance filmed in 1986 – but I do recommend you watch the video – because there's a lot more to this piece than just the sound. I've put the video address in the transcript to this programme.

[Gordon Monahan, 'Speaker Swinging' (excerpt), 1982]

Though rare amongst musicians, many sound artists have probed moving speakers and point source spatialisation; they also love loudspeakers for their appearance and their kinetic power – filling them with fluids or feathers or sand; or arranging dozens of tiny loudspeakers in blocks or lines or patterns, with sound moving through them; or feeding them with sub bass frequencies to move them silently – or to make Chladni[14] vibration patterns. They may also be employed to make other things move – as they do in Ulrich Eller's 1996 installation 'Circle of Drums', for instance, where inaudible sub-bass frequencies activate multiple snare drums in random bursts, each drum tuned differently, with a speaker pressed invisibly to its underside.

[Ulrich Eller, 'Circle of Drums' (excerpt), 1989]

In the story of amplification, microphone, amplifier and loudspeaker form a co-dependent triad; the microphone turns acoustic sound into a stream of electrical data; the amplifier magnifies it; and the loudspeaker turns the result back into acoustic sound. But before we look at the many applications of this triad we should look first at the phenomenon created by – and unique to – it; an effect completely independent of any intentional content – or actually any content at all – and that's feedback: the purest expression of the microphone, amplifier, speaker triad in which, even with no discernible input, the tiniest disturbance between microphone and loudspeaker, once they are too close to one another, initiates a runaway loop that quickly resolves into a constant howling tone.

[The Beatles, 'I Feel Fine' (excerpt), 1964]

This introduction to The Beatles' 'I Feel Fine' was no accident – it was there on every take – and it marked the first deliberate use of pure feedback on a rock recording. Thinking was changing – in the experimental community too: a few months earlier in America, Robert Ashley had probed the same phenomenon at Charlotte Moorman's Annual Avant Garde Festival of New York, with his highly influential performance work, 'The Wolfman'. This involved setting up the auditorium with a PA system pushed to the edge of feedback, and then having the performer use his mouth, vocal chords and a microphone to modulate the feedback in the room. There's also a tape track of found sounds added to the

[Robert Ashley. Joanne Savio/Courtesy of the artist. Source: https://www.npr.org/sections/deceptivecadence/2014/03/04/285737949/robert-ashley-operas-misunderstood-innovator-dies-at-83]

performance to create further variation. In life, the sound is bouncing off every surface and there is great complexity and directionality so, once again – it's an unrecordable experience. But the recording gives the gist:

[Robert Ashley, 'The Wolfman' (excerpt), 1964]

In similar spirit, four years later, the British composer Hugh Davies premiered his 'Quintet' – for five performers, five microphones and six loudspeakers. Four of the speakers are set at the corners of a square, with one performer facing each; the fifth performer and the last two speakers stand in the centre. The performers are directed only to move their microphones, as indicated in the score, to initiate, modulate and, as far as possible, control, the feedback that is induced between the microphones and speakers.

[Hugh Davies, 'Quintet' (excerpts), 1968]

In the same year the American composer Steve Reich produced his systems music performance piece 'Pendulum Music'. Here, four microphones are suspended by their cables and set in motion to swing above four horizontal loudspeakers that are facing upwards, creating momentary feedback as they cross.

[Steve Reich, 'Pendulum Music' (excerpts), 1968]

And here's Alvin Lucier's 1975 work 'Bird and Person Dyning' – the dyning here refers to heterodyning – which is what happens when two almost identical high frequencies create a third, lower frequency. It's the engine of the theremin, the Ondes Martenot and countless other monophonic electronic instruments.[15] In Lucier's piece, the heterodyning occurs between a novelty electric bird-call and the feedback created between a binaural microphone worn on the head of the solo performer and a pair of loudspeakers set up on the stage. In order to find the phantom tones, the performer has to control the feedback by moving his or her body and head in response to what they hear. Everything that happens in this piece depends entirely on the conditions in the room, so every performance is interactive and experimental – a matter of responding immediately to what emerges in the space, creating a kind of double feedback nexus that mixes electroacoustics with cybernetics.

[Alvin Lucier, 'Bird and Person Dyning', live performance in Berlin in 2009 by Yvonne Harder (excerpt), 1975]

But it was when the microphone's place in the generative triad was taken by the newly invented magnetic pick-up that feedback became fully integrated into musical discourse...

[Gregorio Paniagua, 'Anakrousis', 1978]

1 Yet another offshoot of telephony.
2 And sporadic experiments with cinema sound, using compressed air.
3 This conversion of air currents into electrical currents is called transduction. That's what microphones do. Loudspeakers reverse the process, using magnetism rather that kinetic energy. That's why microphones and loudspeakers are essentially reversible, both mediate between air pressure and electrical information.
4 It's what distinguishes stage acting from film acting.
5 I'm afraid I can't quote a source, I heard him explain this in a lecture decades ago but I've searched his writings – on his invaluable website https://www.tagg.org – and this observation doesn't seem to appear anywhere I can refer you to. But I remember.
6 George and Ira Gershwin, 1926.
7 It was over a metre and a half in diameter and was first used in his composition 'Momente'.
8 Compare Luigi Russolo's catalogue of noises, which I listed in Probes #31.
9 'In 1974 I put into my stomach a very small microphone and it was a discovery – the body is always like a factory? It never stops – there's no silence' (Chopin). But listening with the benefit of the doubt given, there's clearly a lot of processing going on here, it's not just a microphone on its way through the body.
10 The first of these 'non-standard multi-loudspeaker diffusion systems' (NMDL systems) was probably The Audium, set up in the University of California by Stan Shaff and Doug McEachern, in 1960, though Pierre Schaeffer's group at GRM in Paris was working in a similar way, finally consolidating in François Bayle's Acousmonium, in 1974.

[Robert Ashley. Source: https://es.wikipedia.org/wiki/Alvin_Lucier#/media/Archivo:Alvin_Lucier_(25536346088).jpg]

11 In the same year Theremin's Keyboard Harmonium appeared, also with a separate amplifier and speaker for each note, but no spatial speculations as far as I've been able to discover.
12 Very early tape pieces, such as John Cage's 'Williams Mix' (1951) and some musique concrète concerts experimented with different configurations of individual sets of mono tape recorder, amplifier and loudspeaker place around a room. Or Morton Feldman's 1953 'Intersections', for eight dispersed speakers each carrying different information.
13 With thanks to Dr. Kersten Glandien, who made the recording for her students and has allowed us to use it.
14 See PROBES #32.
15 See PROBES #33.

02. Notes

On length and edits.
The purpose of these programmes is to give some practical impression of the probes we discuss. This necessitates for the most part extracting short stretches of music from longer wholes, which, of course, compromises the integrity and disrupts the context inherent in the original works. I have also, on occasion, edited different sections of a longer work together, better to illustrate the pointsunder discussion. So the examples played in the programmes should not be confused with the works themselves. Wherever the word (excerpt) appears after a title in the programme transcript, this indicates that what follows is an illustration, not a composition as it was conceived or intended. If something catches your ear, please do go back to the source.

Notification and farewell
PROBES #37. Auxiliaries will be the last podcast hosted by Radio Web MACBA, but I do plan to continue the series, at least until I reach the end of the first topic. I'm not sure who might take us on yet, but if you want to be informed when we resume, please mail me at ccutler@clara.co.uk with subject: Probe Me.
This is my chance too, to thank my editor of eleven years, Anna Ramos, without whom this series would never have existed - and, of course both my co-conspirator in the studio, Bob Drake and Peter Blegvad, the stoical Voice of Footnote. We'll meet next – if all goes well – at PROBES #38, the first of four chapters in which we'll unpick the life and times of the electric guitar.

03. Acknowledgments

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*Author of *Electronic and Experimental Music*, Routledge 2008 (3rd Edition) and curator of Noise and Annotations: www.thomholmes.com

04. Copyright note