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Hybrid Resonant Assemblages: Rethinking Instruments, Touch and Performance in New Interfaces for Musical Expression

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ABSTRACT

This paper outlines a concept of hybrid resonant assemblages, combinations of varied materials excited by sound transducers, feeding back to themselves via digital signal processing. We ground our concept as an extension of work by David Tudor, Nicolas Collins and Bowers and Archer [NIME 2005] and draw on a variety of critical perspectives in the social sciences and philosophy to explore such assemblages as an alternative to more familiar ideas of instruments and interfaces. We lay out a conceptual framework for the exploration of hybrid resonant assemblages and describe how we have approached implementing them. Our performance experience is presented and implications for future work are discussed. In the light of our work, we urge a reconsideration of the implicit norms of performance which underlie much research in NIME. In particular, drawing on the philosophical work of Jean-Luc Nancy, we commend a wider notion of touch that also recognises the performative value of withholding contact.

Keywords

Hybrid resonant assemblages, performance, touch, instrumentality, infra-instruments, speaker-objects.

1. INTRODUCTION

In this paper we present an initial exploration of *hybrid resonant assemblages*, describe some of our design and performance experience working with this concept, and discuss its potential implications for a number of issues of relevance to New Interfaces for Musical Expression. In particular, we show how our work casts a critical light on the primacy often accorded touch in the design of musical interfaces. Our concept of hybrid resonant assemblages has a number of sources of inspiration, some drawn from work in music, some drawn from the social sciences, some drawn from philosophy. Let us introduce these in turn.

1.1 David Tudor and *Rainforest*

Famously, David Tudor explored resonant 'speaker objects' in a number of works, most particularly the *Rainforest* series of compositions/installations (1968-). In these pieces, a transducer is attached to a selected object or material and driven by a sound source. Tudor typically used Rolan Star transducers which were initially marketed in the 1960s as enabling the user

to make the walls of a room into loudspeakers so as to give the impression of the listener being immersed in their domestic 'hi-fi'. Rolan Star transducers can be screwed into materials or bolted on. *Rainforest* performers today (and there have been a proliferation of revisitings of this series in recent festivals) have a number of transducer/audio actuators to explore including the Dayton NXT, Mighty Dwarf and, for low bass emphasis, ButtKickers, amongst others.

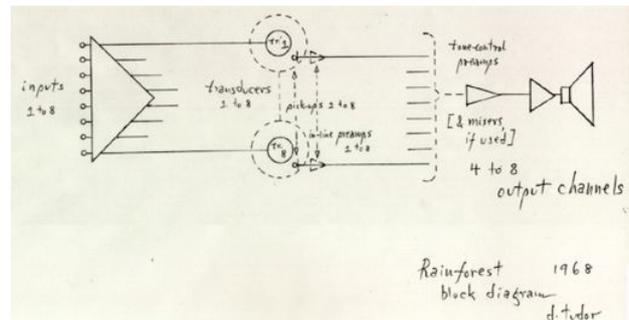


Figure 1: *Rainforest I* block diagram: sound sources are played via transducers into speaker objects which heard front of house via attached contact microphones, eight such objects is the typical number.



Figure 2: *Rainforest I* in rehearsal at the Rambert Dance Studios (2009), assorted speaker objects (plastic bin, slinky, wooden box, panettone tin, metal rolling pin, copper sheet, plastic mixing bowl, grille).

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One of the authors (JB) extensively worked with Tudor's techniques in collaboration with the Rambert Dance Company in their 2009-11 revival of Merce Cunningham's *RainForest*

(1968), Tudor’s music to this comprising the first in his *Rainforest* series, as well as in a 2009 realisation of *Rainforest IV*, a large-scale, multi-participant, installation variant. This experience prompted us to investigate extensions of Tudor’s ideas.

1.2 Nicolas Collins and *Pea Soup*

As originally realised in 1974, Collins’ *Pea Soup* employed an amplitude envelope follower to vary phase delay in an all-analogue feedback circuit between microphone(s) and loudspeaker(s). Omni-directional microphones pick up the sounds in the performance space. As these sounds increase in amplitude, so the phase delay on them is increased before they are amplified back into the performance space. Collins intended this variation of phase delay to mimic the effect of manually placing a microphone near a loudspeaker and withdrawing it, so as to obtain a self-modifying feedback circuit with modes unique to each performance architecture and sensitive to the movement of performers or audience or, on occasion, disturbed by the contributions of an instrumental player.

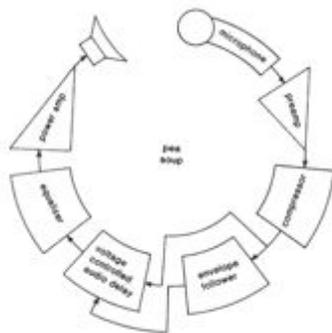


Figure 3: Nicolas Collins’ *Pea Soup* functional diagram.

Revisions of *Pea Soup* in the period 2002-11 have explored the use of digital technologies to perform envelope following and modulate phase delay. Collins’ current Max/MSP patch for *Pea Soup* contains lots of performance refinements including support for three channels, input limiting and equalization, an FFT based filter which can duck current feedback frequencies so as to excite new modes. As we shall shortly make clear, an important component of our work is to combine Tudor’s interest in speaker objects with Collins’ concern to put a self-modulating delay in the feedback loop to excite resonances.

1.3 Infra-Instruments, Objects, Things and Assemblages

In NIME 2005, Bowers and Archer [1] outlined a concept of *infra-instruments* as an alternative to hyper-, cyber- and meta-instruments. While hyper- and the rest seek to add functionality to an instrument (e.g. through sensor augmentation), an *infra-instrument* is something simpler, restricted in functionality, shantly built, closer to its materials of construction. Bowers and Archer was an early attempt to bring some of the maker-hacker spirit to NIME as well as critically and playfully questioning what the NIME design space should be. Developing the account in the 2005 paper, we can situate *infra-instruments* at a number of key moments in what we can think of as the lifecycle of instruments (see Figure 4).

Infra-instruments exist at the interstices between raw materials and instruments (cf. as depicted, *The Strandline Guitar* [1] made from material scavenged from the ‘strandline’, where the tide deposits materials at the sea shore), and between instruments and garbage (cf. as depicted, a broken and partially

reconstructed violin from Bowers’ *Atonement for Violin Quartet*). Naturally, such constructions/de(con)structions do not have the functional capability of a sensor-augmented cello (to cite a hyper-instrument ‘classic’ [5]) but their restricted sonic capabilities and material aesthetic may be just right in other performance contexts.



Figure 4: *Infra-instruments* in the life-cycle of instruments.

In a related spirit, through a critical engagement with anthropology, archeology, architecture and various other disciplines, Ingold [e.g. 4] has done much to reemphasise the importance of ‘following the materials’ in creative work. Ingold’s work is replete with examples of ‘makers’ of all sorts incrementally interrogating materials, working up artefacts into a (relatively, provisionally) finalised form in a give-and-take of action and response. Ingold contrasts this to-ing and fro-ing with the alleged ‘hylo-morphism’ that is often supposed to underlie creative work as the creator imposes a pre-formed idea onto the yet-to-be-formed materials. Often, however, we are just presented with ready-made objects without access to the means by which they were produced because, say, they are part of an archeological record or they are part of an industrial production process we cannot inspect. In contrast, for Ingold, we should turn from objects to ‘things’. Drawing on Heidegger’s essay *The Thing*, Ingold [4, p85] argues that the object is “complete in itself... We may look at it or even touch it, but we cannot join *with* it in the process of its formation... But if objects are *against* us, things are *with* us. Every thing, for Heidegger, is a coming together of materials in movement. To touch it, or observe it, is to bring [ourselves] into affective correspondence with... its constituent materials.” It is often remarked that the etymology of the word thing lies in ‘ting’ meaning a gathering or an assembly. Ingold [4, p85]: “To witness a thing is not to be locked out but to be invited in to the gathering”.

We are interested in pursuing this idea of thinghood to see if a musical performance setting (our gatherings) and instruments within it could have some of these qualities. Rather than work with pre-formed instrument-objects, we want to explore *infra-instrument-things*: assemblies or assemblages (cf. Deleuze and Guattari [3]) of materials-in-movement/resonance whose material formation/deformation is in play in the performance itself.

2. HYBRID RESONANT ASSEMBLAGES

This is the musical, social scientific, philosophical and critical background to our notion of *hybrid resonant assemblage*. To be more specific, we see such ‘things’ in terms of five critical features.

- *Assemblages*. We are concerned with things that are multi-part, drawn together from a variety of materials and structured loosely. Elements are commonly rested against one another, rather than firmly fixed or bolted down.
- *Hybrid*. The material variety should cross between different material ‘idioms’. We are interested in how light and sound might interplay, how the electrical, the electronic and the computational might interfere, and so forth. Much as in Collins’ latest versions of *Pea Soup*, we are interested in how the analogue and the digital might work together.
- *Resonant*. Naturally, as sound artists, we are interested in specifically resonant assemblages but, furthermore, we want to explore what might be called...
- *Immanence* – ways of making the self-generated resonances of the assemblages we work with the most prominent concern. In particular, through feedback, we explore assemblages without a necessary ‘external’ sound source.
- *Transience*. The loose structuring of our assemblages means that their construction/de(con)struction can be a performable gesture. Indeed, more than this, we regard the making and unmaking of a hybrid resonant assemblage the preferred arc of performance. This emphasizes the transience of the assemblage and the concern to allow, in Ingoldian terms, co-invitees to the gathering.

3. IMPLEMENTATION FRAMEWORK

As outlined, of course, our notion of hybrid resonant assemblages allows for many, many different manifestations. This openness is part of the point. However, in our explorations we have worked with a more specific implementation framework. This consists of five parts.

- *Tudorian sounding-elements*. Here we want to particularize the David Tudor notion of a ‘speaker object’ and give it potentially a finer grain. In our assemblages, transducers can be attached to something relatively large and evocative of a sound sculptural element as in Tudor’s work. But they can also be attached to smaller things or be left free and manually positioned. The point is to allow the performer to bring resonant elements into contact with one another potentially ad hoc. Thus, a transducer may be attached to a metal plate (say 3 inches square) but this plate may in turn be rested against a membrane upon which a number of screws bounce around or be placed edge on to another plate or a lump of wood or a tin can or whatever. Except in the limiting case of a manually held transducer, the bounds of a Tudorian sounding-element, in our terms, is given by the extent of its rigid connection. We have experimented with a variety of transducers to drive materials in sounding-elements. We have found the Mighty Dwarf to be most flexible and convenient for experimentation as it integrates a USB-powered amplifier in a small footprint. A wider range of frequency response can be had using Dayton NXT transducers though these require a separate power amp and a larger area of attachment.
- *Tudorian microphones*. Classically, in Tudor’s work, a contact microphone (usually a brass and ceramic piezo-electric pickup) is placed on a speaker object so as to pick up the sound source ‘filtered through’ the object. Again, we wished to particularize and mobilize this notion by creating Tudorian microphones in which the pickup is pre-attached to a smaller manipulable element which can enter into combination ad hoc with other elements in an assemblage. We have also experimented with microphone elements (e.g. electrets) suspended or cushioned in particular housings (e.g. in a glass jar, against which sounding-elements might be placed). In this sense, we are separating out what is rigidly affixed in most performances of *Rainforest* (a single

transducer and pickup attached to a single speaker object) to allow more varied transient combinations.

- *Free materials*. These are other materials brought to the scene to resonate, rattle or otherwise respond – driven by Tudorian sounding-elements.
- *Processing in the loop*. Our Tudorian microphones are pre-amplified and sent via a multi-channel ADC to a laptop. There the digitized signals are processed before being sent to the DAC and on to the Tudorian sounding-elements. We have experimented with a variety of digital signal processing algorithms in the loop (various filters, equalizers, spectral FFT manipulations, versions of classic ‘stomp box’ style processing such as chorusing and distortion) and, while this is a wide-open area for experimentation, we have tended to focus on delays and phase-delays which vary as a function of input amplitude in the style of Collins. In addition, we have designed an adaptive ‘super-limiter’ which disciplines extremes of amplitude variation and, as a byproduct, helps avoid the sound getting trapped in uninteresting continuous unvarying feedback pitches. All digital signal processing experimentation has been conducted using Pure Data.
- *Mixing and front of house*. Our assemblages tend to make a clear acoustic sound without further amplification. However, for performances in concert halls and more flexibility, one can experiment with different mixer-routings and varied selections for what goes ‘front of house’ (FOH). This again is an area for wide experimentation. The loop through the assemblage/signal processing can be tapped at various stages: direct from Tudorian mics, post-ADC, post-processing, and so forth. Different mix matrices can exist for routing Tudorian mics to ADC inputs, ADC inputs to processes, processes to DAC outputs, DAC outputs to Tudorian sounding-elements, taps to FOH channels. In addition, conventional air microphones might be positioned to reinforce the direct acoustic sound of the assemblage. These can also add to the mix. In our work we have tended to simplify the routings so that, for the most part, a feedback loop is a single chain of 1:1 routings, and FOH is a mixture of what is picked up by the Tudorian microphones reinforced by one or two air microphones which do not get processed further.

4. MAKING AND PERFORMING A HYBRID RESONANT ASSEMBLAGE

Over a period of a year up to the time of writing, we have explored a great variety of materials and objects in different kinds of assemblage. There is not space here to review all the work we have done. Rather, in all this range of experimentation, we are going to highlight just one trajectory of development as (a) it concerns the assemblages we have most performance experience with and (b) it manifests an approach to the structuring of assemblages which we think might be instructive.

We typically organise our assemblages around a *base* and a *superstructure*. For the base, just to note a few examples, we have experimented with wooden sheets, metal plates, drums and drum-like membranes. Superstructural elements have included tins, glass jars, wooden and cardboard boxes, polystyrene beakers, rough cut lumps of wood, and, a particular favourite, Petri dishes. The various elements have been more or less loosely attached or adhered to each other by using tape, string, fishing filament, glue, BlueTak, nails, wire or rested against each other. Tiny objects like nuts and bolts, small pieces of glass or plastics, electrical components, sand and so forth might also be added.

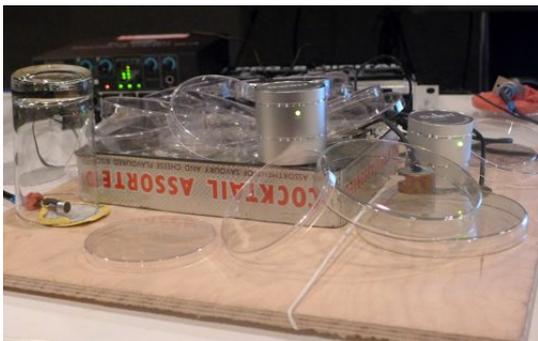
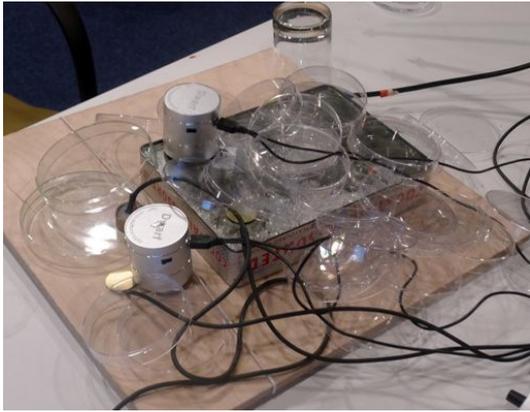


Figure 5: Two views of a hybrid resonant assemblage.

In Figure 5, we see an assemblage with a plywood base (cushioned from the table-top with four BluTak ‘legs’, unseen, below) and a superstructure of a tin and a number of Petri dishes. Both the tin and the base are Tudorian sounding elements (in the sense described above) through the attachment of Mighty Dwarf transducers. A piezo element is attached to one of the Petri dishes and an electret capsule is to be found within an inverted drinking glass, comprising the assemblage’s two Tudorian microphones.



Figure 6: A hybrid resonant assemblage with wire frame, layered base and papier-maché enclosed Tudorian mics.

Figure 6 shows another assemblage. This one has a layered base of two large sheets of wood with a centimeter gap between them, a plywood sheet on top, and on that an embroidery hoop holding cotton fabric to make a loose membrane, upon which is placed a transducer. A wire roughly bent above enables Petri dishes to be attached by mono-filament nylon so that they can

swing, turn and bump against each other as the base and wire conduct vibration. Two piezo elements are enclosed in papier-maché to make Tudorian microphones which can be freely applied to various points in the assemblage.

The assemblages in Figures 5 and 6 both permit a variety of performance gestures as the assemblage itself can be manipulated and the sound elements and microphones variably deployed. The introduction of the wire and hanging elements in Figure 6 explore a further degree of *gentle structuring* over the ‘pile’ of elements in Figure 5. While there are still materials which can be freely moved and manipulated, there is also a more relatively fixed structural component from which elements can be attached. This approach to gently structuring an assemblage is taken further in Figure 7.

In Figure 7 we see an assemblage with a thin plywood base, a membrane angled so that its hoop frame makes contact at just one point with the base, bent wire from which mobile elements can be suspended, a variety of materials resting on the membrane, Mighty Dwarf transducers (one attached to base, one freely deployable – at the moment at the rear of the assemblage). Both the base and the membrane are Tudorian microphones and other, variably enclosed and attached piezo elements can be deployed.



Figure 7: A complex hybrid resonant assemblage.

As such Figure 7 manifests an assemblage with a variety of structuring principles in play. There is a (relatively fixed) *base* and a (relatively manipulable) *superstructure* and a *frame* from which mobile elements can be suspended. There are variable forms of *attachement/adherence* (from resting to rigid). There are variable *regions of contact* (from point-touching to edge and surface-sharing).

5. Performing Hybrid Resonant Assemblages

In a significant sense, performing (with) hybrid resonant assemblages starts with, and in part consists of, *their making* [cf. 1.3]. This puts emphasis on performance as a process of creating transient, ephemeral situations in contrast to performing a work with pre-existing instruments or interfaces. It becomes a performance choice, and so one which can in principle vary between performers, whether making first happens on stage before an audience (at one extreme) or as a long careful durational activity without an audience in the

workshop or studio (at the other). Even when aiming for the former, we have tended to engage in much prior experimentation to determine a preferred strategy for positioning Tudorian microphones and sounding elements and a preferred palette of different sounding objects and materials that are about to be assembled.

We tend to attach one of the loudspeaker-transducers and a contact-microphone to the *base* to provide a vibrating ‘reservoir’ or ‘environment’ within which to investigate the sound colours that are possible to achieve through manipulating, positioning and assembling other materials and objects. We also tend to set up ADC, DAC and FOH mixing levels and gain structure so as to optimally accommodate a variety of materials and manipulations of them. We pre-select the kind of in-the-loop processing we are interested in exploring and again optimize its paramterisation to encourage a variety of effects to be obtained. The intention here is to make object and material manipulation and other actions with respect to the emerging assemblage the focus and not working a mixer or tweaking a patch.

Within this environment, the *superstructural elements* are now put on the vibrating *base* and re-arranged in various ways. The elements may be juxtaposed, tied together or thrown loosely onto other objects. They may be moved or replaced during a performance. The *base* may be lifted or transformed with tools. It might occur that things fall to the floor, that the assemblage dissolves due to vibration, and that single objects are destroyed. The brittle Petri dishes we favour for their occasional shrieking resonance and dynamic response are especially vulnerable to shattering. From time to time, an assemblage can be created which manifests a kind of super-sensitivity with different touches in different locations enabling different vibrational modes. On other occasions, an assemblage will respond to pressing or squeezing two materials together to facilitate the transmission of vibration between them.

The transience and occasional fragility of assemblages encourages an orientation to performance, and indeed a deportment of the performer’s body, which emphasizes care, deliberation, attentive listening and judicious touching. This form of auditory-tactile exploration makes for a notable performance aesthetic which is often characterized by moments of *withholding* and hesitating to touch the assemblage. We found ourselves confronted with the need/demand to listen to the assemblage and to experience the phenomenon of touch as part of musical expression in a novel way. Beyond considering touch as the means by which physical force is transmitted to actuate an instrument or as an expressive gesture, we rather experienced touch as a matter of *tension* – in particular, a tension between expressive and destructive potentialities.



Figure 8: Performing with a hybrid resonant assemblage depicting stages of tension, withholding touch, and contact.

Our experience with hybrid resonant assemblages has added to our performance vocabulary in a number of ways. Naturally, we anticipated making the act of constructing and manipulating such an assemblage part of our performances with them. Indeed, that was our whole motivation. It has been more of a discovery though that different forms of touch/touching need to be considered in performance including the most important *possibility of ‘non-touch’, of withholding and letting be*, for at

least as long as to let a new sonic behaviour emerge (see Figure 8). Slowly, then, one begins to explore the different tactile qualities of the materials anew.

From an audience’s point of view, the performer’s conduct may not only engender a curiosity as to how the sound is being created but cause a tension as the performer distances and approaches or half-reaches to the assemblage and then stops. Generally, our performances have had a slow pace which some audience members have found, pleasingly, to be enigmatic, tension filled and always on the edge of failure.

6. DISCUSSION

Drawing on a variety of influences from music, critical studies of material culture and philosophy, we have offered the notion of a hybrid resonant assemblage as an affair to investigate for sonic and performance potentiality. Hybrid resonant assemblages are transient, manipulable combinations of varied materials, some of which have the form of (Tudorian) microphones or pseudo-loudspeakers. Together they make up an assemblage which can be made and unmade as a performable affair. We have investigated assemblages which are ‘immanent’ in that carefully configured feedback loops allow sounds to emerge without any further source. Combining our inspiration from David Tudor with Nicolas Collins, we have investigated assemblages which have (digital) processing in the feedback loop to create a variety of autonomously varying sonic behaviours. We have outlined an implementation framework for hybrid resonant assemblages which permits one’s thinking about them to be requisitely organized without eliminating considerable scope for creativity within the concept. We have sketched how our own explorations have been guided by simple ‘structural’ distinctions between base and superstructure. We have given an account of our performance experience with assemblages and, in particular, how this has caused us to rethink and expand our vocabulary of touch in performance to recognise, amongst other matters, how the withholding of touch can both enable an assemblage to sonically evolve and for a certain palpable tension to appear in performance.

6.1 Assemblages, *Struktion*, Things

Alongside some of the other philosophical and aesthetic forebears of our notion of assemblage (notably Deleuze and Guattari), it is worth noting Jean-Luc Nancy’s concept of *Struktion*. Nancy draws attention to the etymological fact that many of our English words related to ‘structure’ derive from the Latin word *struo* meaning to pile something up haphazardly. The neologism of *Struktion* is an attempt to keep the etymological echo alive and to denote a process rather than an object. So instead of a construction plan or list of instructions, the concept of hybrid resonant assemblages is the paradoxical attempt to (un-) create something with no firmly fixed order, or mode or principle of organization. Instead, emphasis lies on the contingent co-presence of parts that are not absorbed or subsumed in an integrated entity or object. Everything is at once and together, not juxtaposed one after another, without linearity or (final) cause and (resultant) effects – as, indeed, feedback insists it should be. While we might orient ourselves with ideas of base and superstructure, this is as far as it goes.

The transience of an assemblage and the challenge of researching (perhaps before an audience) different materials, combinations and sonic potentialities creates a very different performance situation and sense of instrument than if a ‘structure’ was actuated by gestural force. It is through this that we try and honour Ingold’s [4] Heideggerian concern for ‘things’ and creating ‘gatherings’ of ‘co-invitees’. Rather than

objects-manifesting-structure, our hybrid resonant assemblages are *things-undergoing-Struktion*.

6.2 Rethinking Touch

The tension and uncertainty that is characteristic of our minimalistic, less activity or gesture-oriented performance style suggests that a wider notion of touch in the context of musical interaction is worth considering. Nancy's writings on touch provide some more nuances that have resonance with our performance experience. He writes colourfully of, e.g. 'the superlative movement of proximity', of 'stroking' or 'setting in motion' [6]. From this perspective, clashing objects against each other or bumping the assemblage in a heavily physical and haptic manner appears as a very harsh form of touching that can be contrasted with all the ways in which touch indexes moments of *tension* between a body and an assemblage, including those moments when *contact is withheld*.

Indeed, we would like to emphasize especially the importance of withholding touch to certain minimalistic styles of performance, especially when considering means of musical expression that implement generative sound processes and electro-acoustics that do not necessarily have to be excited by the physical energy of touching – such as our assemblages and, for that matter, *Pea Soup* and some realizations of *Rainforest*. From this perspective, we support a broader notion of touch that considers it to be a movement of the whole body in relation and in tension with the things we perform with and that our body is, in a sense, *exposed* to. Touch implies "a permanent movement, an undulation [...] an air of continual change [...] in contact with all that comes near and all that is approached" [6]. The performance palette/vocabulary of touch as a movement of "motion and emotion" [6] consequently also includes the listener, the listening 'sonorous' body that resonates to the sounds it is exposed to – comparable to the resonant body of a drum [7]. So not to touch does not mean not to perform. Referring to Nancy, Arno Böhler emphasizes that "[...] touching always implies a moment of dispense; a withdrawal; a step backward; a dance of difference; of separation and 'dis-dance'" [2].

6.3 Rethinking Instruments

It is in these complex fields of tension that we would like also to rethink the notion of instrument. An artefact that we can relate to haptically, that we can transmit energy to through touch or gesture, that transduces this energy into sound (either acoustically, electro-mechanically, electronically or digitally), and that stays effectively rigid and maintains its structure in the process is a limit case of instrumenthood – a particular way in which the tensions of body, artefact and touch can be articulated. But our investigations of hybrid resonant assemblages have convinced us that there is a wider field of instrumenthood and 'instrumenting', a field of *Struktion* as much as construction, a field of things and gatherings rather than objects and their demonstration [4], a field in which many forms of touch can be mobilised, a field in which the body can perform in very many ways. Much as Bowers and Archer [1] wished to enlarge the design space of NIME with their notions of infra-instrument, we wish to suggest possibilities which are open to many forms of touching, many performance aesthetics, and many new ways in which instrumenting and interfacing can be done.

7. ACKNOWLEDGEMENTS

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