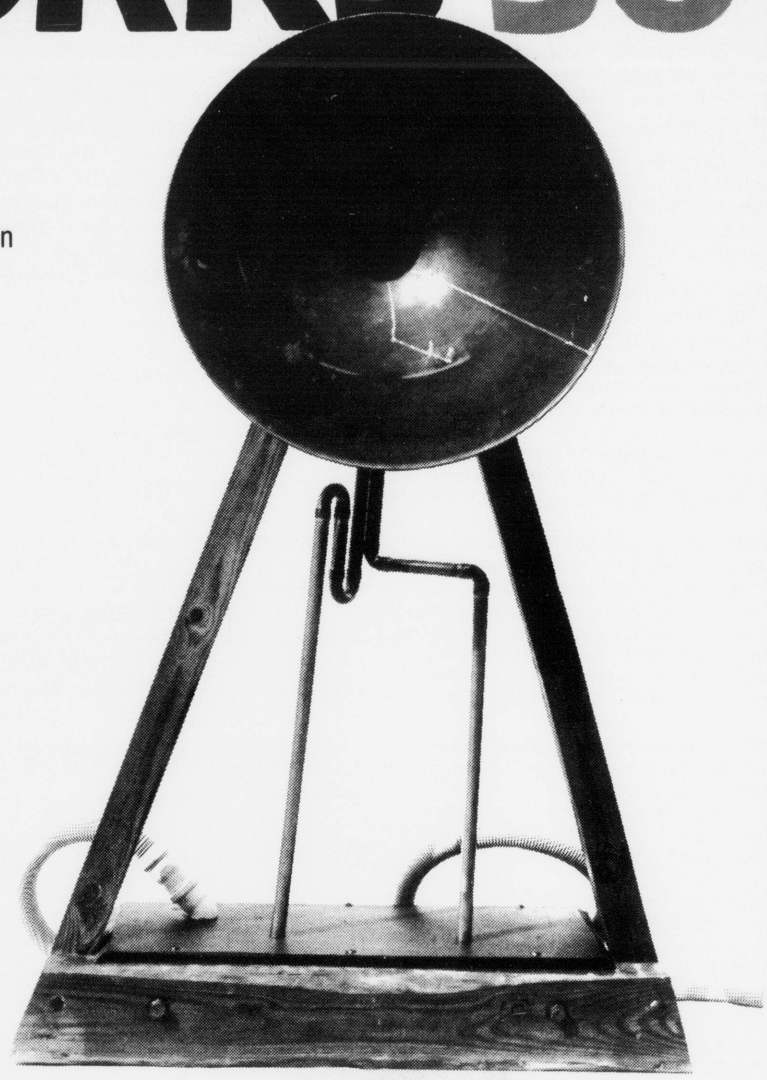
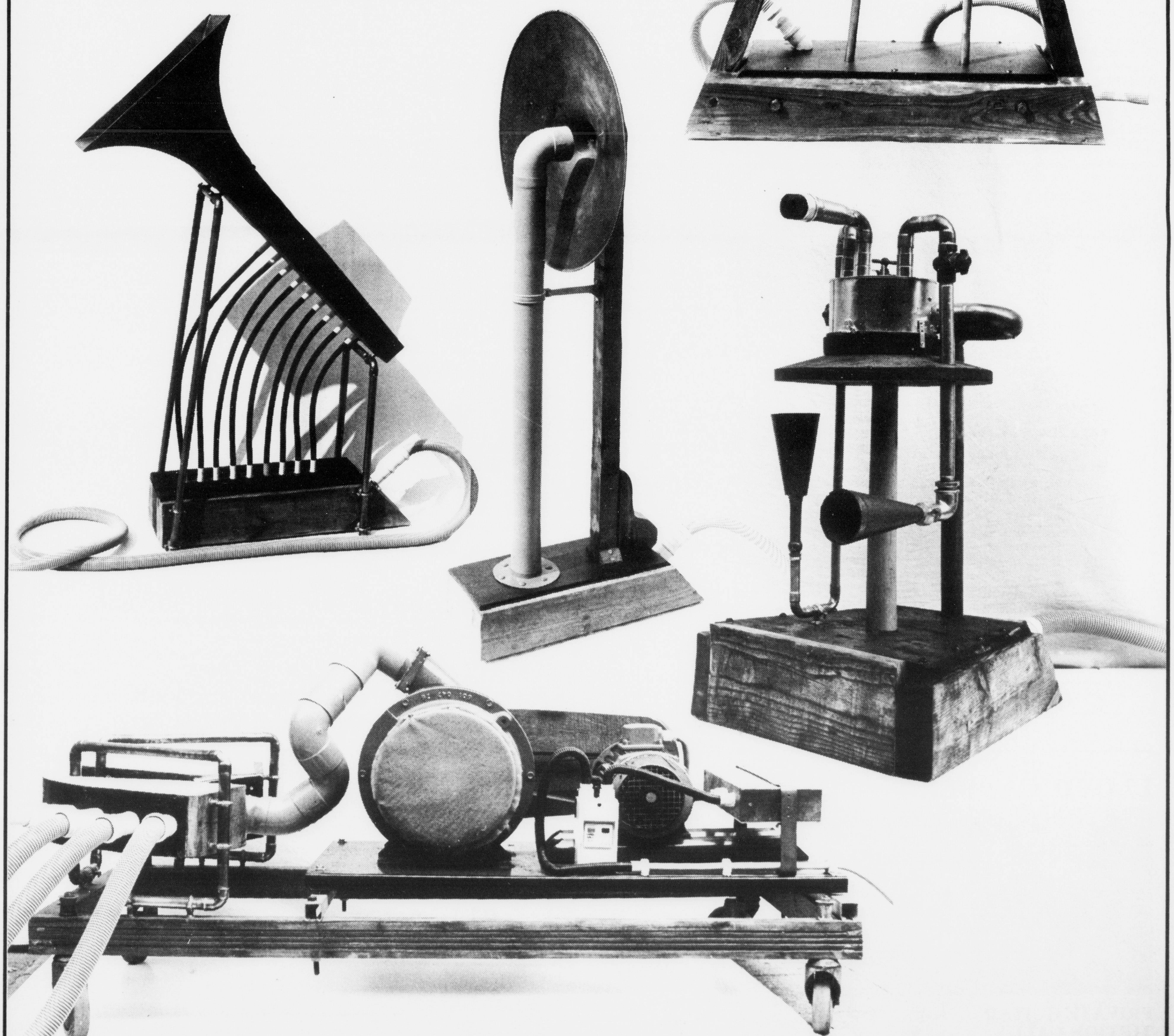
$2. ($6. with cassette in Canada)

MUSICWORKS 30

SOUND CONSTRUCTIONS





PNEUMAFOONS FROM
THE LOGOS FOUNDATION

MUSICWORKS 30

SOUND CONSTRUCTIONS

WINTER 1985

NEW ADDRESS:
1087 Queen Street West
4th Floor
Toronto, CANADA
M6J 1H3
416 522-0192

MUSICWORKS is published quarterly with the financial assistance of the Canada Council for the Arts, The Ontario Arts Council, paid subscription and advertising.

Managing Editor: Tina Pearson
Editor (Musicworks 30): Gordon Monahan
Cassette Editor: John Oswald
Business Manager: Lucy Hogg
Layout: Bob Wilcox
Typesetting: Tanya Mars

Thanks to: Anne Monahan, Andrew Timar, Thaddeus Holownia, Dwight Siegner, Maria Gould, Richard Raymond.

Distribution: Available on newstands across Canada through Canadian Periodicals Publishers Association, Toronto; and Diffusion Parallele, Inc., Montreal. Available outside of Canada on independent newstands. New accounts are welcome. Available internationally by mail subscription.

Letters and unsolicited materials for publication are encouraged. Please send us your scores, tapes, visuals and writings. We would like to hear from you. **Please enclose a S.A.S.E. if you wish to have your material returned.**

Publisher: The Music Gallery.
ISSN 0225-686X

ADVERTISING RATES

FULL PAGE	(15"x10")	$280.00
HALF PAGE	(7"x10")	$140.00
1/4 PAGE	(7"x5")	$75.00
1/2 PAGE	(3 1/2"x5")	$40.00

SOUND CONSTRUCTIONS CASSETTE

This issue's cassette tape includes samples of aeolian harps; sounds recorded from Leif Brush's *Terrain Instruments;* recordings of *stringinstallations* of Paul Panhuysen and Johan Goedhart; and music from the Logos Foundation in Belgium.

UPCOMING ISSUES

MUSICWORKS 31 is being called Women's Voices. It explores the presence and absence of women's voices in the soundscape, and features the music and thoughts of a number of Canadian women who are exploring with sound, ritual, experimental music and electronics, among other things. Some of the women included are Ann Southam, Hildegard Westerkamp, Jan Hammock, Kim Erickson, Tina Pearson, and Inuit throatsingers Allasie Alasuak and Nellie Nunguak.

For MUSICWORKS 32, we are presenting a Summer Score Issue. The issue will feature scores, notations and visuals by Canadian composers who have not yet had scores printed in MUSICWORKS. If you are in this category, please send your scores (with programme notes, explanations, and biography) before July 1st, 1985.

In late 1985, a special event called SYMPOSIUM: SYNERGETICS AND THE ARTS (RE)TUNING HUMANITY will be held in Toronto. MUSICWORKS will be participating in the SYMPOSIUM by publishing a special issue with cassette prior to the event including materials by SYMPOSIUM participants. (John Cage, Pauline Oliveros, Jose Arguelles, Allegra Fuller Snyder, Alvin Lucier, David Dunn, James Tenney, Gayle Young, Deborah Haye, among many others). Stay tuned.

SUBSCRIPTION RATES

PAPER ONLY	WITH CASSETTE			
Individual in Canada				
$8(1 year;4 issues).....	add$12	(4 cassettes)	=	$20
$14 (2 years;8 issues)...	add$24	(8 cassettes)	=	$38
Individual Elsewhere				
$12(1 year;4 issues)....	add$12	(4 cassettes)	=	$24
$22(2 years;8 issues)....	add$24	(8 cassettes)	=	$46
Institution Everywhere				
$15(1 year;4 issues)....	add$18	(4 cassettes)	=	$33
$28(2 years;8 issues)....	add$36	(8 cassettes)	=	$64

ANNOUNCEMENTS

CLEM

Contact List of Electronic Music is a world wide reference source for "underground musicians and sometimes artists working in many different styles of music. These include... industrial, German EM, meditative, new age, improvised, harsh, computer EM, progressive rock, sound poetry, found tapes, popular EM, and new wave." **CLEM** lists addresses and reviews related media. Contact Alex Douglas, P/O Box 86010, North Vancouver, B.C., CANADA, V7L 4J5.

ENVIRONMENTAL TAPE EXCHANGE

The **Environmental Tape Exchange** is a source library of environmental sound from around the world. Tapes are available via exchange or by sending a blank cassette. They are not for sale. The exchange deals only with environmental sound & not artificially constructed sound or 'music'.

In order to take part, simply send an environmental recording and in exchange you will receive a tape containing one or more different environments recorded by other contributors around the world. Your recording then becomes part of the exchange process. Please include as much information as possible about the recorded location (time, date, etc.) with your tape.

ENVIRONMENTAL TAPE EXCHANGE, P.O. Box 493 Broadway Sydney N.S.W. Australia 1007

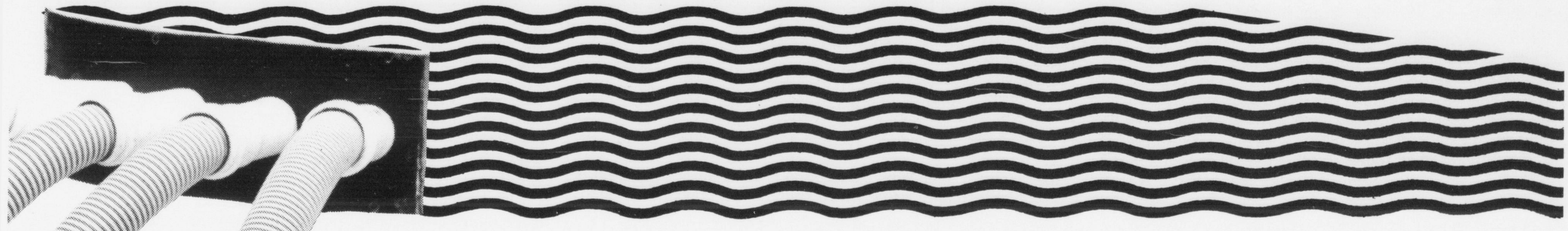
PROPOSALS

STRUTS GALLERY invites proposals for 1985/86 programming of music and sound events. Send letters/tapes and budgets to:

Janet Hammock, Music Programme Committee, STRUTS Gallery, 11 West Main St. Sackville, N.B. Canada E0A 3C0

COMPOSERS CONVERSING

A group of composers in Toronto have organized a bi-weekly meeting to talk about their work, play tapes, look at scores and share ideas about making music. Composers Conversing takes place every second Wednesday, usually at ARRAYMUSIC, 343A Albany Avenue, Toronto. Please call 432-3019 or 924—6060 for more information. Out of town visitors most welcome.



Pneumafoons, Dudafoons, Manipulafoons

An interview with Moniek Darge and Godfried Willem-Raes of Logos Foundation

The Logos Foundation, located in Ghent, Belgium, is an organization devoted to the construction of new instruments, the performance of new music, and the production of many sound projects and events. Their studios consist of an instrument building shop, an electronic music workshop and studio, a performance space, an archive, a retail outlet for publications, and offices.
While on a performance tour of Canada, Logos Directors Godfried Willem-Raes and Moniek Darge were interviewed by Andrew Timar and Gordon Monahan following their performance at the Music Gallery in Toronto, in April 1984.

Andrew: I was very intrigued by your poster. It has pictures of some of your pneumatic instruments. What is the principle behind these instruments? For instance, I noticed they have horns.

Godfried: That's only what they look like on the outside. You have horns because the actual thing that sounds is much smaller, so we attach a horn to everything, which is a general acoustic principle for all wind instruments. But the mechanism from one *Pneumaphone* to another is very different. Some might have organ pipes, but then generally not with one tone, but the pitch will be dependent on the pressure, which is a non-conventional method that's realized either by having water columns on the other side of the pipe (from the diaphragm) so when the pressure is higher the water column will make the pipe either longer or shorter, depending on the design of that particular instrument; or, there will be balls of styrofoam inside the tube and when the pressure gets higher the ball will go up and down, and so do all the harmonics of the pipe. So it's never a straightforward organ pipe or anything like that, it's just a little bit further.

Gord: So you've adapted organ pipes?

Godfried: No, we've made everything. There are no readymades in the mechanisms. There are some readymades in some horns which we took from an old gramophone or even from a lamp, or things like that.

Andrew: You mentioned that you have water columns or styrofoam balls which change the relative length of the tubes by responding to changes in air pressure. How do you vary the air pressure?

Moniek: We have a big compressor, and from the big compressor there go tubes to cushions that are filled with air and all the public is going to sit down on those cushions and when they move and jump, they change the air pressure. And then you have tubes from the cushions again to the instruments. So in just all-moving, they can make a kind of music with it, so you end up with a whole spaghetti of people turning and rolling and jumping. We do it outside on the street so there is actually not a preselected audience, but everybody can come and play with it.

Andrews: So in a performance situation you would have a number of these structures?

Godfried: There is a minimum of 12 but we are going to make it just 14 now. We will make them into 24, maybe even more. There will be more than one compressor, actually.

Gord: You mentioned it was outdoors. In what sort of environment do you install it?

Moniek: In walking and shopping streets. You know those streets without cars?

Godfried: You could have it in nature too but we haven't done it, so far.

Moniek: Or we don't have too much nature around, that's why.

Gord: Is the compressor portable?

Godfried: No, it's not really portable.

Moniek: It's on wheels and we put it outside of a van.

Andrew: Is it gasoline or electric?

Godfried: Electric, on three-phase current, so you need some kind of industrial electric connection.

Andrew: Can you use a portable generator for electricity?

Godfried: No, it's too noisy.

Moniek: Mostly the places we can do it in are those walking streets because sometimes they have special equipment there, like when they make fries and things like that, and they need three phase current, also. So you just need an extension cord.

Andrew: So you have the resonant tubes which were mentioned; also air pressure, which you mentioned; how do you set the air into vibration?

Godfried: Well, with a variety of things. We've used membranes that are also used in car horns, but in a very un-gentle way. You have the air coming through a tube and hitting the membrane which is normally shut, but as soon as you put pressure on it, the membrane will leave a little bit of air open, and then all of a sudden the membrane will start vibrating as a whole surface. Now the horn is attached to the other end, so the wind doesn't come through the horn, but the wind goes back. We've been working a lot along this principle: by changing the shape of the membrane and making it from very flexible latex, or artificial rubber, you have membranes that will do *bpouhroauwwwwoohaahhh.* These kinds of sounds.

Andrew: Sounds like a very Dada-istic membrane.

Godfried: Ja, ja. That's the principle, then we also made brass reeds that we shaped completely ourselves and soldered together.

Andrew: Double or single reeds?

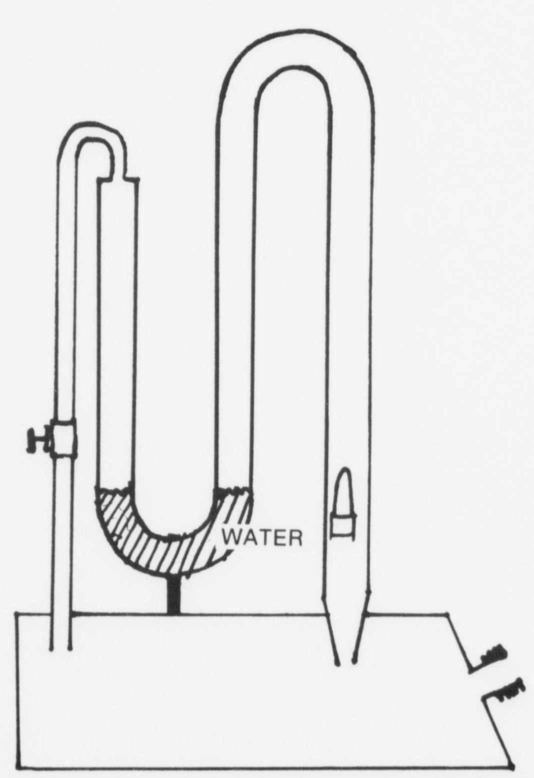
Godfried: These are all single. Double reeds seem to be harder to get working. What we do is that we have for instance a reed a few centimetres long, and instead of making the material homogeneous, we put solder stripes on it at particular spots so that at a low pressure it will give one particular note — generally it will be a percussive sound — *taktaktaktaktaktaktak* or something. But as soon as you increase the pressure it will start vibrating in another wave that has nothing to do with the original fundamental, so it's not just an instrument that will do overtones all the time over and over.

Andrew: So it's a multi-mode reed. That's interesting. So you have a metal reed which you solder on?

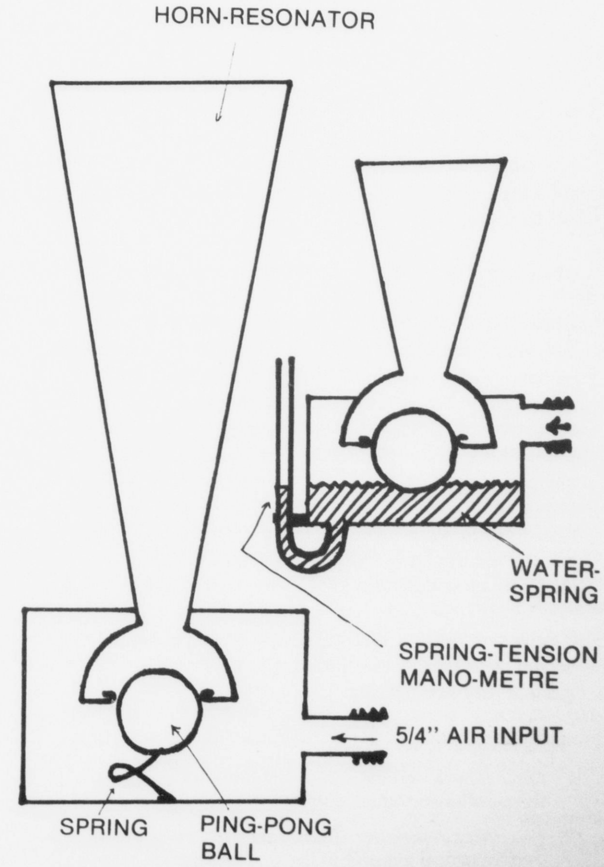
Godfried: We use very thin brass with a thickness of about 0.2 mm., which is very easy to solder on and to experiment with because you can put solder on it and if it is wrong, well, just heat it again to remove it and do it over again, no problem. It's just time consuming, of course.

Andrew: Did you ever try cane reeds, or are they too impractical?

Godfried: In this kind of situation you can't use them because of the air pressure. First of all, this instrument is intended to work 18 hours a day. Try that with the cane reeds. It's not exposed to human air pressure, but this is a machine that's driving it. So you have to take some kind of industrial norms if you don't want to replace the reeds every half an hour or something.



GLIDING PITCH-PIPE SYSTEM



Andrew: Do you have the typical fipple-flute aperture[1] as well?

Godfried: Ja. What else do we have? Oh, the wild things: you know these electricity insulating tubes that are ribbed? If you blow in them they have all these whistling tones. *Whooowhseeeou.*

Moniek: So just by the air passing through you have the sounds. We have in some instruments the very long tubes and in others, small tubes; so you have different pitches.

Andrew: What are these used for in industry?

Godfried: Insulation for electricity, in Europe, at least. But they aren't spiral. Here I see most of it is spiral, but if it's spiral it doesn't work. It has to have parallel cavities, then it works wonderfully. You just blow in it. It's the edges on the inside that cause it to leaps of lengths of repeats of the same cavities over and over.

Andrew: And so it sets the air into vibration by having rarifications and setting up a mode?

Godfried: You don't get pure tones. The interesting thing with this is that you get noise-bands similar to the ones you get with these whistling kettles here. You boil water, and when it boils it goes *fueeettt*! You know how that's made? It's just tubes or cylinder plates with holes and a cavity in between. Take two coins for instance, with holes in them, and bump them a bit so that they would form a sort of cavity between them and blow through them so you get whistles. These whistles are not tuneable to one particular pitch; note that the pitch which results is dependable on the pressure. They go *frrrieeeeee*?!

Andrew: Did you ever use steam pipes?

Godfried: Well, whether you use steam or air it's acoustically the same. I thought of using steam in the whole procedure of going to the *Pneumaphones*, but we had problems with condensation. When you have air passing through a whistle, it drips. Also, with cushions it wouldn't work. There's a decompression in the cushions, and there you would immediately get distillation and condensation of water. That doesn't work so well.

Sirens we use also, but the other way. Normally, a siren is driven by a motor or mechanical force. Here, we have wind to operate the siren.

Andrew: So these are rotating disks?

Godfried: They are called a sort of drum, with segments instead of a disc. You have to orient the wind on it so that it's like a ventilator. Imagine a ventilator, a blower, but not a fan because that's in one plane; you have two parallel cylindrical plates with ribs on them. If you have a closed container, and then you make holes in the container and you blow at one end, it then operates as a siren. It also sounds like a siren. It's magnificent.

We also have artificial lips: *Bwuwwwwhh*. We made them from latex also. Like brass instruments, but only the lips. And these we connect always to exponential horns, not to concial or cylindrical parts. Because as soon as you have cylindrical parts, you get specific pitches and you can't change them. An exponential horn has this property that it amplifies equally all the frequencies from a bass which is determined by the surface of the mouth of the exponential horn, where it stops. It determines the lowest note I want.

Andrew: Are there optimal apertures that you use based on the lips?

Godfried: Yes. If you want to have a bass sound, you have to have a very large mouth.

Andrew: Of course if you have a very long tube, then you can go lower.

Godfried: Yes, but acoustical impedance[2] will not be ideally coupled. And that's an important principle that you have to take care of whenever you're working with acoustical instruments: the impedance question. Of course you can always put things together and still get a sound, but that's not the point.

Andrew: Yes, but you could use microphones.

Godfried: But that's another principle. When we use acoustical instruments, I do not want to amplify them, because that would be a trick. It's an ideological point for me actually. So, all of these *Pneumaphones* are purely acoustical. Although the compressor is electrical, but it's got nothing to do with the acoustical principle: it's just making wind, like an organ, and nobody speaks of an organ as an electric instrument. The whole set of these *Pneumaphones* is basically an organ, but the principles are just upside down. Instead of constant air, we have moving air; instead of constant pipes, we have moving principles.

Andrew: So you are working towards complexity of sound, and you're also looking for something that's not particularly predictable.

Godfried: Really, we're looking for discontinuity, and this is predictable after a time. I know the *Pneumaphone Project* so well that for me it's very predictable. I can change it, and I mastered it, and I know what to do to get certain results.

Moniek: It's important that you have the unpredictable things in it because when the audience goes and plays with it, they need some time before they figure it out for each sculpture, so it keeps their attention going.

Godfried: This way, they can at least spend half an hour on it before they know which sound is coming from what thing, and what causes what, you see; all the relations. It's nowhere obvious.

Andrew: Are you busy during a performance or can you just leave it? Do you have to be there to work the various aspects of the structures?

Godfried: The instruments are safe, but it's the cushions. People get so crazy about this project that they start running and they jump . . . *vvrruuppbamm*! on the cushions.

Moniek: And they throw the cushions because they are so excited by them.

Godfried: We always bring a sewing machine because we have to do repairs on the cushions all the time.

Moniek: And also we have to be around because some people are really crazy, they jump on it and they could fall with their head on the floor or on other people.

Once we had it in Germany for about a week. The moment you switched it on, it was early in the morning, 'til the moment you switched it off, children were waiting. There was no way to get 5 minutes rest.

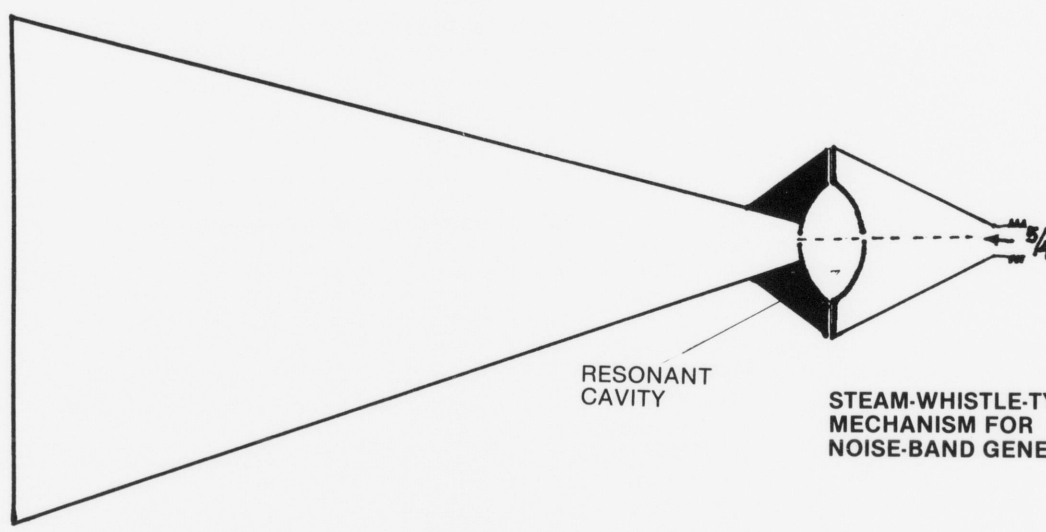
Andrew: Children especially like it?

Godfried: Well it's either children on the project, or adults, but never together. As soon as you get a bunch of children on it, the adults that will come along will just say, OK it's a children's game. But if it's alone for a time and some adults come along, they all take it very seriously, and they behave with it in a very different way. Children will first jump on it, roll, and then discover that it actually sounds. But adults will first follow the line, oh, this tube goes there, and then it goes there, oh yeah, if I sit here I should expect the sound to happen there. This kind of idea. And then they will seat themselves.

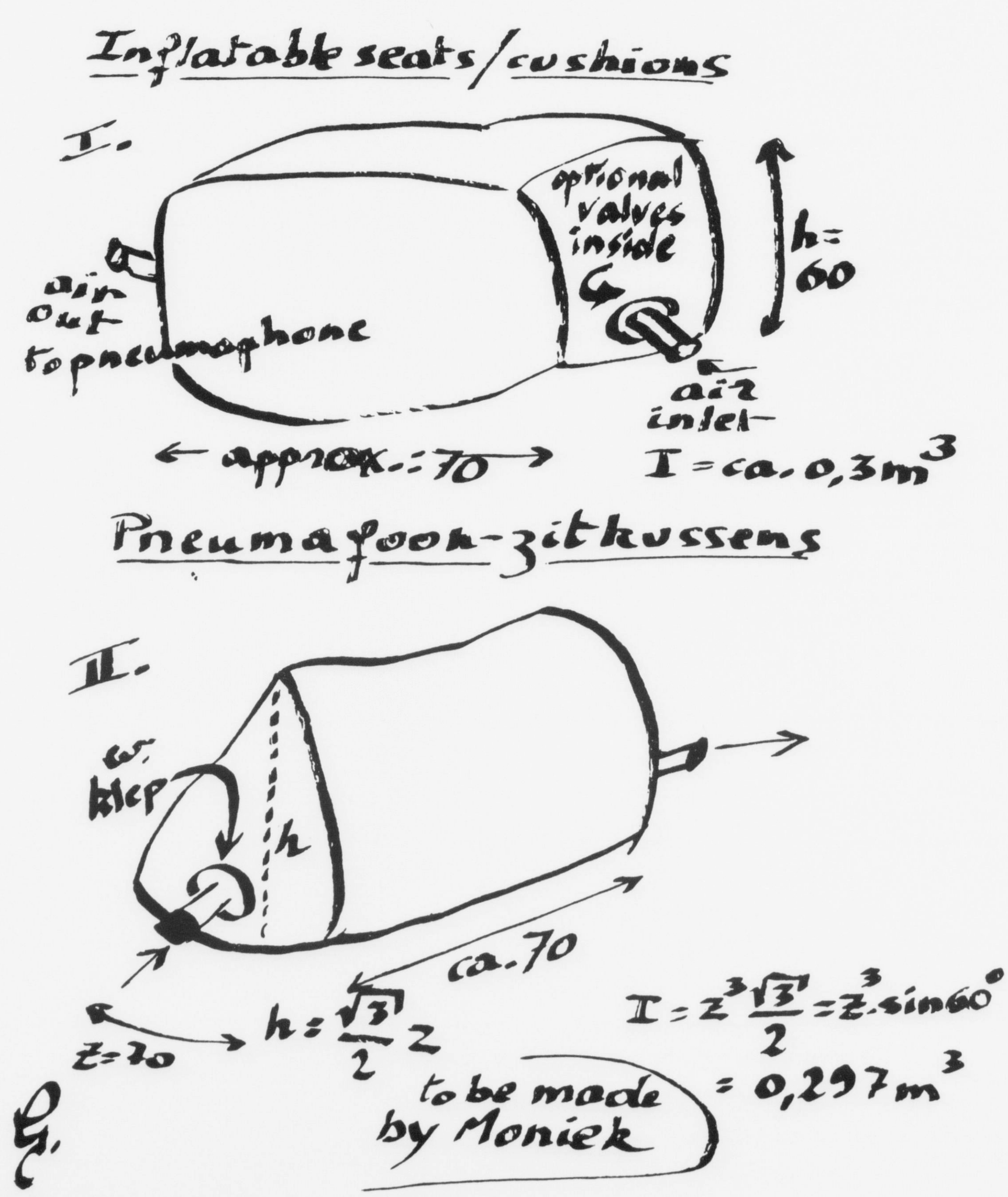
Andrew: And then they will roll around.

Godfried: And then they will roll all around because then they are lost in a way, because these cushions do not hold a person in any stable way. As soon as you sit, it loses air. It's not like a comfortable seat.

Andrew: The cushions are large?



STEAM-WHISTLE-TYPE MECHANISM FOR NOISE-BAND GENERATION.



1. *fipple flute*: a vertical end-blown flute, with a plug (fipple) in the mouthpiece which diverts the breath to produce a tone.
2. *acoustical impedance*: the complex ratio of acoustical force and acoustical velocity in the transmission of sound.

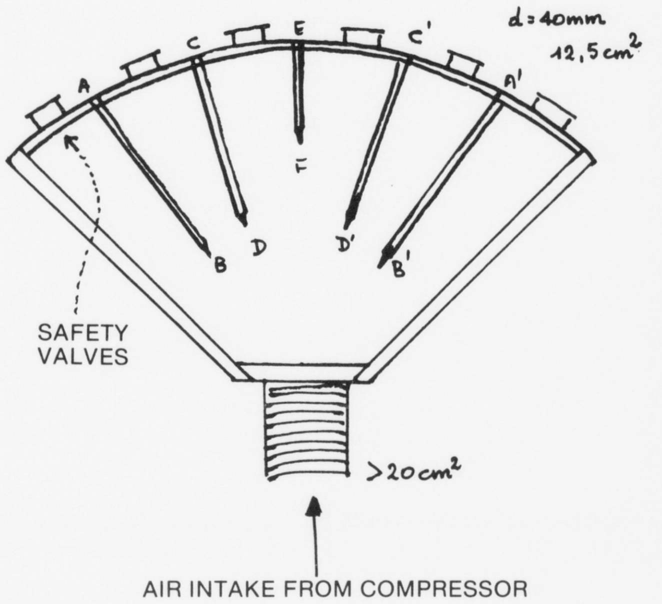
Godfried: Yes, this size. (one or two metres in dimension)

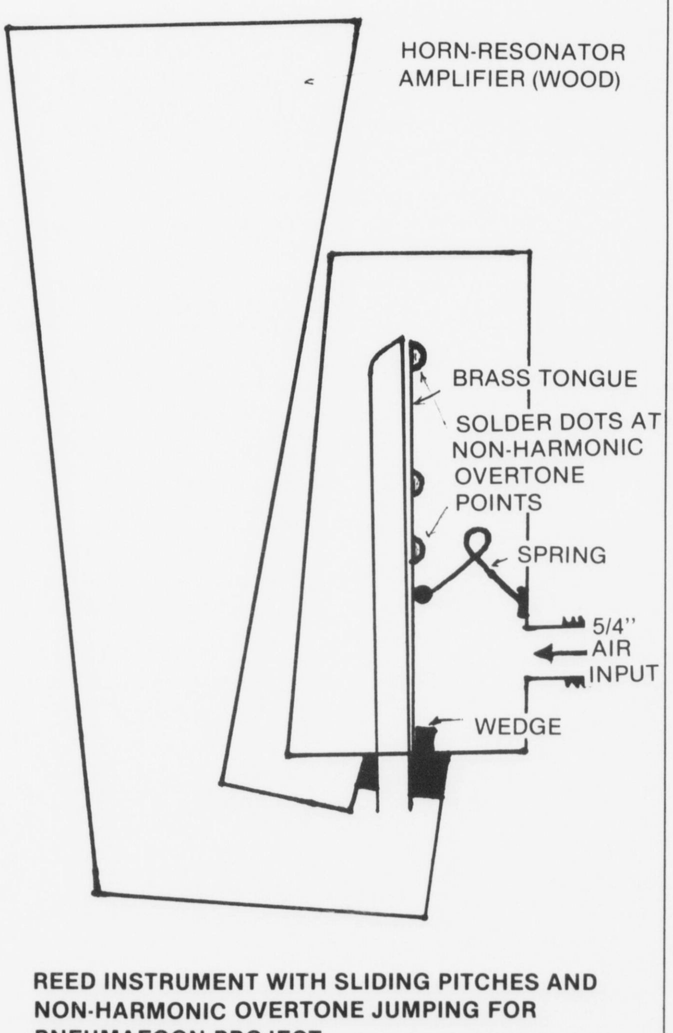
Moniek: Also the cushions are very bright colours, so that affects people, and they like to jump on it. And they have different forms; one is like a triangle; the other is a rectangle; or a circle.

Gord: You've built a number of other instruments, and some are portable which you take on the road touring with you. Could you describe one instrument that you had with you tonight, for instance, the one with the springs?

Godfried: That's the set-up for *Timeframes*. That's a piece, and actually an important part of my work. See, what I try to do very often for our performance pieces, is instead of writing a score, I would rather make a machine, or imagine a set-up for producing very characteristic and specific sounds, and only capable of doing that single piece, because everything is made for that. So there is no score, but actually an instrument and a piece all together. I like this kind of idea, it's very apparative.

So, it consists of, first, a *Manipulaphone*. This is a device that consists of two tape playback heads, with some arms so that you can feed tape that's being recorded in the performance. You feed the tape by hand, by moving it at the heads. The tape has two channels, so that every sound that you bring for the one head will first be heard left channel, and then go to the right channel. There are some





REED INSTRUMENT WITH SLIDING PITCHES AND NON-HARMONIC OVERTONE JUMPING FOR PNEUMAFOON PROJECT.

switches so you can change the order of the events, so you have sterophonic affects, or rather, ambiophonic effects. Then these sounds feed a small amplifier, a very, very small amplifier — half a watt — and that's connected to loudspeakers which you do not notice in the performance but they drive long springs, or any three-dimensional object, actually. The speaker is attached from the magnet to a spring, so it sets the spring into motion.

Gord: A spring like a slinky?

Godfried: Ja, slinkies, or all kinds of things. At the other end I have microphones, which are electromagnetic transducers that I have taken and modified from Morse headphone sets from the army. They're inexpensive army surplus things that we use as pickups. These feed back to my amplifier, so I have standing waves which are originated by the tape system. This kind of set-up is an interactive system. I started doing these things because I was highly bored with electronic instruments at a particular point. At some point I felt stuck with them. I've been developing synthesizers for a long time, so I'm not refusing it because I don't know it. But the one-dimensionality of the sounds has struck me very, very strongly. In electronic instruments, you only have voltages that go up and down: their origin is a one-dimensional phenomenon, to change voltage on one level only. Whereas any physical object you can think of has at least three dimensions; three degrees of freedom, as you would physically call it. You

Testing the Pneumafoons

cannot imagine a string without it having a thickness. Well, a string for instance, in acoustical theory, is considered to move like in all these drawings of overtones, and that's just bullshit. That's theorization that has nothing to do with the physical reality, with the acoustical reality. It's a simplification for matters of ideology, I think, of tonality. People have always wanted to find foundations for the actual aesthetics of tonal music in nature. It's like looking in nature for a moral truth or something like that, it's as bad. I think it's non-sensical, anyway.

Andrew: So how do you see it? You must have a theoretical perspective.

Godfried: It's a choice of people. It's just like morals: there are no absolute morals, and certainly you're not going to look for them in nature, because you're the creator of nature; you make it by distinguishing objects.

Andrew: So what you're saying is that the schematic explanation for the vibrational modes of a string is not true to reality. Is that what you're suggesting?

Godfried: Yes. There's never been an attempt at synthesizing an acoustical sound that has been proven successful, so far. That's very odd, because the actual electronic apparatus that we are using now in synthesizers is based on acoustical theory — on the Helmholtz Theory; on the Fourier Analysis of overtones. But by adding overtones, no matter how complex you make it, you will never achieve this thing because the electronic sound you are starting from is one-dimensional, and the harmonic overtone series just doesn't work. It's like a momentary picture of one state of movement of an object — and you extend that to a long period of time, and it's just boring. I think of electronic sound as being a caricature of real sound. I'm interested in that, in its quality of being a caricature. I like that kind of quality just like I like animated cartoons and movies — I have nothing against it, so don't misunderstand me in what I say about electronics: I only refer to it as being one-dimensional. But to go back to what I am trying to do with it . . . First, I try unreliable electronic circuits, because electronic circuits sometimes offer very interesting sounds, too, but sounds that escape from electronic theory: like the switch-on surges that you get when you switch on an electronic device. You get this *Clack*! Well, this is definitely almost an acoustic sound. It's electroniç, but what **happens** is no longer linear. You cannot describe it — it's the phenomenon of discontinuity. Now, Fourier Analysis refuses to integrate discontinuity: you cannot analyse the start of a sound wave with Fourier Analysis. Ask any mathematician, he'll agree with that.

So you have this with every system that goes from 'static' into 'dynamic'. To get into this dynamic stage it goes through a whole lot of processes which you can regard as noises. But that's theorization, and I refuse to accept that these noise processes are chance operations.

Andrew: But how do you explain it?

Godfried: I have no explanation. If I had a perfect explanation, a perfect model for this thing, I would have developed a dynamic logic. But a dialectical, dynamic logic doesn't exist. We do not have the mathematical apparatus for describing this degree of complexity, that's the trouble. We have mathematics to describe linear systems and the way they operate, but we do not have an apparatus to describe systems that change their own norms and values.

Andrew: So we don't really have a way of discussing or communicating, or even understanding transitional states? That's what we're talking about?

Godfried: We can do it because we can imitate. It's the way we function ourselves. It's the way society works and evolves.

Andrew: How do you refer this to society?

Godfried: It's because I'm talking in the scope of general systems theory now. What is an electronic system, a social system, an animal, or whatever. It's a system.

Andrew: So you're making an analogy from an electrical system to a social system. Are you referring to something specific or just in general?

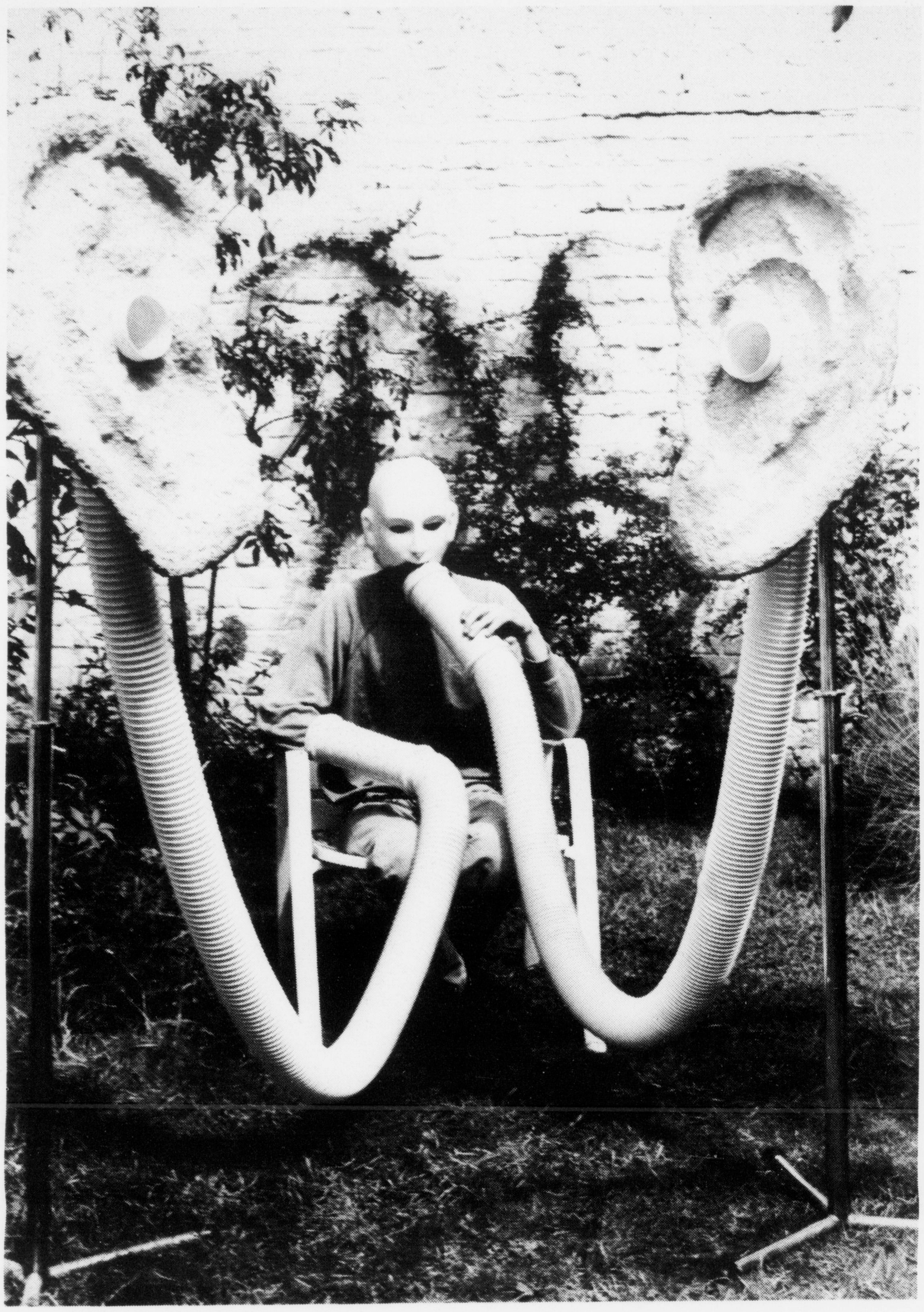
Godfried: No, in general. Any kind of way of predicting on a linear basis will always be wrong, as soon as you deal with systems that have a certain degree of complexity. On the other hand, I refuse infinity, so . . .

Andrew: You refuse infinity?

Godfried: Ja — I am a finitist, pretty much. I don't believe in the concept of a non-rational theory. I regard myself as trying to be very, very rational about things. This doesn't mean that I accept everything of modern industry and modern technology the way it is, but whatever you think of acoustics or society, the patterns of reasoning should be the same. But we have to look for rational patterns.

Andrew: You've developed instruments which have a certain amount of complexity and unpredictability and yet you're saying that you're still a rationalist, somehow.

Godfried: Yes. I'm objecting a bit to the term **unpredictability**. I cannot literally predict them, but I can live with them, and by doing so I can master them. When you play



Ohre Projekt

a clarinet, for instance, that's not unpredictable, but it's not completely foreseeable, either. There is an interaction between me and my instrument. I have this reed, and I know I push here and I get this *wooooaaap* sound, for instance. Now there's no way of absolutely knowing that I'm going to get that exact sound because it depends on which reed I have, and every time it will be another kind of pressure that I need. So in a sense, I master it. It's not unpredictable, but this interaction causes me to control the instrument at every moment and from an expressive point of view, this makes it very interesting to work with. The same for electronics, although they are not yet at that stage, except for some very experimental set-ups. I've done a couple of those, in which you really work with your fingers in the circuitry in order to produce certain things.

Gord: Could you describe some of that?

Godfried: If you take just a broken down transistor radio and you play in it with your fingers you will cause feedbacks. You will get very interesting effects which were not foreseen by the manufacturer of the device, of course, and eventually you will ruin the radio sets. I actually build them now this way, especially for that purpose.

Andrew: So you short-circuit certain parts?

Godfried: Well, you over-bridge things. You see, your fingers, because of humidity, form resistance, so you actually add extra components at spaces which are not meant for them. But all electronic systems are actually amplifiers. There's hardly anything else besides amplifiers and passive components. If you put your hands on a circuit board you will always happen to connect an output and an input, and you will lower the resistance between both so you will get a feedbacking system. But it's very likely that you will have many more than one amplifying system in there. If you start short-circuiting the outputs of one amplifier to the inputs of another one and the output of that one to the input of yet another one — a third one — and then that again to the input of the first one, then we have an interesting system that's no longer very predictable.

I did not invent this kind of thing — actually, a friend of mine has worked a lot with these, and he called them *Crackle-boxes*. Maybe you have heard of Michel Waisvisz?

Andrew: Yes. He's been here and a number of people have his *Crackle-boxes*.

Godfried: Ja, he has been one of the first. What he does with them now is another thing, because he's started tuning them.

Andrew: How does that work?

Godfried: He makes organs out of them. It is ironic actually, but all his work is, in a sense. We've been very similar at certain points in having this love-hate relationship towards electronics: I am absolutely convinced he hates electronics just as I do, but still he loves to work with it. His musical career is going in a direction other than mine, because what he is doing now is making ironical music, sort of *metamusic*. He will have funny melodies coming out, playing **against** the instruments rather than with the instruments, so that eventually they will burn up, or smoke will be coming out of them. Did you ever see him break his instrument down or have explosives in the thing? He used to do that a lot, but maybe not when he's on tour.

Andrew: No, because he needs them. That would be very complicated.

Godfried: He is very destructive, very often.

Andrew: So he builds that into his instruments?

Godfried: Ja.

Andrew: His *Crackle-box* is very reliable, the little ones, anyway. They're very good.

Godfried: They depend on the battery, though.

Andrew: It's more interesting when the battery's low.

Godfried: Ja, exactly. See, this is the kind of reliability: it's not absolutely reliable, it's very conditionally reliable.

Andrew: Now he's making more complicated ones?

Godfried: Ja, with pre-sets on them just as on synthesizers. He has tonal melodies, waltzes and tangos for *crackle-box*.

Gord: Could you describe these *Crackle-boxes* for someone who wouldn't know what they are?

Godfried: I can't describe them visually, but electronically the principle is just one operational amplifier, which is a device costing 25 cents in any surplus store or any electronics store, that amplifies the signal — a voltage. It has two inputs and one output. One is an inverting, and the other one is a non-inverting input. What it basically does is this: The stable state of the *Crackle-box* is so that it does nothing at all; now the different points of input and output across a very small number of capacitors and resistors are brought out on a part of a printed circuit material such as epoxy or anything. It's etched in little squares with solder which you can over-bridge with your fingers. By doing so you create all different configurations around the operational amplifier. You can cause it to feedback; you can have one finger on the inverting input and then on the output: This will be a contradictory situation, will block it off so that it will go *glllpm*. And then at the same time if you have the plus input on your finger, you will cause it to give a higher voltage at the output. See, things like that. So it's always interactive with whatever you do. The problem with it is that you get only one sound at a time, generally. Generally, I say, because there are some exceptions, and there is the unreliability of the device, which is the good thing about it.

Andrew: Really the small ones are very nice, because they're only slightly bigger than a packet of king-sized cigarettes, and they have a small speaker. And of course he has larger ones with horns which he uses in performance.

Gord: Could you describe some of the larger instruments you've built back home, in Belgium?

Moniek: There are two main groups of instruments. In one sense you have the smaller instruments or the instruments that are really made to use during performance, and then you have a whole group of more or less sound sculptures that are not suitable to performance. Within the instruments for concert you have many differences: You have acoustical ones, and then the electro-acoustical ones. Some of these are pretty interesting. When you use springs on different materials as resonators, or when you use oil-cans for resonators instead of wooden boxes, these resonators influence the timbre of the strings you are using and you can make a whole variety by going to different lengths of the string; we make a kind of harp but fixed upon different resonators than classically used; or we just have the small tones of one string and we amplify them; Or like the *Clavimonochord*: It has the keyboard of a piano, but there is just one string stretched across behind the keyboard. There are little metal bars on the tangents of each key, so if you play the keyboard they hit the string and you have the sound coming both on the right and on the left side from where you are pushing, so you have two sounds at the same time.

Andrew: Yes; because the string is divided into ratios.

Moniek: You really have very different results than what you do with a piano.

Godfried: And this is amplified. Actually, you can divide the one length of string into two parts as Moniek describes, but you can also have it in three parts, or in four parts. You can play up to 12 notes in a chord on one string depending just on how many microphones you put on the thing. Electromagnetic microphones of course, not acoustic microphones.

Andrew: Right, so what you pick up is very much dependent on the position of the microphone.

Godfried: Ja, but the pitch is dependent on where the tangents hit the strings, of course. So it's an interesting machine also to work with to compose, because any kind of scale is actually made feasible with it. You can work absolutely microtonally, or with any kind of division of an octave, because the pins, the tangents, are so close to each other over one string.

Andrew: How long is the string?

Godfried: The whole width of a piano; a little longer than the actual keys.

Moniek: Another very interesting acoustical instrument is when you take a can and you fix a spring on the bottom of it. You open the can on one side — a huge can, it's better resonanace — with a heavy spring that is very well fixed in there. When you shout in that can you have an acoustical reverberation that is just great. And you also can hit the can by itself, and every sound gets a reverberation of the spring.

Gord: And that's amplified as well?

Moniek: No. It's incredible. You could not believe it. You see your can there and your spring, and it's making nothing; then you put them together and it's really fabulous, what's coming out.

Godfried: *Clack, clack, clack . . .*

Andrew: How heavy should the spring be? Like a car spring?

Moniek: No, not necessarily.

Godfried: Very flexible, but very thick.

Moniek: If it's not flexible, it's not working.

Godfried: You get them for garage doors. Not the too-heavy ones. The diameter of the coil, more or less, is let's say one inch and a half; the length is three feet long; and the width of the wire is four millimetres.

Moniek: The important thing is that the spring is very well fixed in the can.

Gord: Do you weld it?

Godfried: Yes, that's the best thing. Arc welding. We have special atelier workshops where we can do all these things.

Moniek: We've been experimenting a lot also with flutes; some made out of sanitary tubes, because we do a lot of workshops with children and with people that have no money to build instruments, to make instruments and to buy instruments. Those, we call *Plastic Stragoarchy*. I used one tonight but I don't think you could see it because it was dark during the performance.

Andrew: We could hear it but couldn't see it.

Moniek: You have your tube and you make a notch in the shape of a 'U', and then you make a prop inside with plastic. So it's a very easy, simple construction.

And then there is the more complex range of instruments with very small tones that are amplified with a contact microphone or an electric microphone. You have a board with little things such as springs or any kind of metal thing that you can find: Knobs of doors; locks and all those things; and by amplifying these small tones you really can have some very interesting sounds.

Godfried: And there is an ideological point about this thing: we would never amplify an instrument that could possibly sound acoustically. If there is a way of making it perfect acoustically and making it audible, we do it. We use the acoustical way. But just amplifying for the sake of amplifying, no. I think it is an important thing to say. I love that point. That's why I hate rock music, you see.

Andrew: But this instrument depends on that principle, doesn't it?

Godfried: Ja, but these are tiny objects; inaudible sounds. Like private music: you know when you take any kind of metal object and you take a cord and you put it in your ear, you get to hear it. Now this kind of sound is inaccessible; you cannot communicate it without asking everybody to put in in their ear. So you have to amplify these things. It's intrinsic to the movement, to the vibrations, because we're just using such tiny small objects.

Moniek: We made an open air project on that ideology behind amplification: it's a piece with two big ears made of *papier maché*; and there is a hole in the ear. In that hole you fix a long tube. There are one or two performers, better with masks because then I think the people in the street easily come as an audience. Inside those tubes there are all special little tiny instruments that hardly make any sound so outside the tubes you cannot hear them. So people have to come to listen to the ear, and through the cavity of those tubes, those sounds get a bit amplified. So if you listen carefully . . .

Godfried: There's a lot of resonance . . .

Moniek: You have those sounds coming through with the resonance of those tubes. That's one idea.

Godfried: Intimate music in the street.

Moniek: The other category of instruments I was describing are the sound sculptures; the really huge ones such as the *Dudaphone*. The *Dudaphone*, I think is really a good idea: You have the idea of the small objects in metal but there is also a wheel of a bicycle on top of it with little springs between the spokes and pickups that amplify the sound of the spokes and the sounds of the springs, and when you turn the wheel you have the sound of the air moving which is also going through those microphones. He called it the *Dudaphone*: the **Du** is from **Duchamps**, the **Da** is from **Dadaism** and **Phone** because it's making a sound. So that's a really great one.

Godfried: It's a great one. It's a big thing. It's built on its own loudspeaker enclosure.

Then there are also autonomous sound sculptures which are not instruments. So far it's a triptych of machines, automats — completely automatic music boxes, if you want — built with nothing but alarms, sirens, the most rough kind of sounds you can imagine: horns, all kinds of electrical bells. I've been looking through markets and I've bought every kind of alarm bell you could find — telephone bells, everything; all these things that are explicitly unmusical, that make people move from one place to another; to warn them, to cause odd reactions with people. Now, one of the machines, called the *Bellenorgel*, is programmed in such a way so that it is a self-programming machine: 50% programmed, 50% programming. It will always behave in such a way that the most unexpected sounds will be the next one.

Andrew: How does that work? What do you mean by that?

Godfried: Well, I mean that the programming design is based on contrast, and not homogeneity, so do not expect this machine to sound musical. Actually, the machine doesn't work on the sound output; it works on something that goes parallel with it; on the current conception of the bells. Generally a bell that will take two amps of current will be a louder bell than one that takes 50 milliamps. See, this kind of contrast. But that's the technical side of the thing. The story is that the whole machine works as a computer: It has memories and everything, but it has not one single electronic part. It works with nothing but relays from the telephone company. The things that go *clack, clack, clack, clack*. So for a long time it may be almost silent, but you hear the machine thinking. You hear *clack, clack, clack, clack*: setting of shift registers and all these things; then all of a sudden *BOOOOM ting tong, ting tong poiiing deedeedee!*. . .

Moniek: And it's really loud. It's really loud.

Godfried: But it has the whole dynamic scale: soft and loud.

Andrew: Seems like one of those very, very early computers.

Godfried: That was the idea actually: using old-fashioned technology and showing what you can make it do.

Moniek: What's great about it is that there are always sounds that you recognize as the doorbell, your telephone bell, the alarm, or the ambulance coming along; and so each time when such a sound occurs you have the feeling like: I have to do something, I have to open the door; and it makes people very nervous. It makes you think about those sounds that you hear each time. Everybody knows the sound of the telephone but in a totally different context you start listening to them again.

Andrew: What did you call that?

Godfried: The machine is called the *Bellenorgel*: from **bell** and **organ**. It's Dutch.

Moniek: There are three of them: the *Bellenorgel* is completely automatic, and then there is the *Bell Telephone* where you dial numbers to . . .

Godfried: Bell Telephone.

Moniek: . . . to make a choice of different bells, and the other one is the *Bell Totem*, because it's on a very high pole. There is a microphone attached to it and when you speak through the microphone, the louder you speak the more bells you have so you can never be louder than the instrument.

Godfried: That's a triptych so far. I will make a fourth one with 12 sirens: electrical sirens that go on all different velocities and things like that, but it is not yet finished.

Andrew: So with the *Bell Totem* you have a microphone, and there's also a speaker?

Godfried: No, there is no speaker. It's going to an amplifier and this amplifier drives bells. Not straight, but over some shift register things. It's a little more complicated, but take that as a principle.

Gord: So the amplitude of your voice sets a certain voltage . . .

Godfried: Ja, but it jumps in such a way that the level that it reads is higher than the level that it causes.

Moniek: We once used it during a concert for radio in Belgium, and normally they have a very official speaker announcing the programme and presenting the concert. So we changed the microphones and we put that one in front of her and she went really crazy because each time she wanted to be louder those bells were going up. So that was part of the performance but she didn't like it very much.

Godfried: So now nobody at the Belgian radio wants to present us anymore. The last time we gave a concert for them we had to present ourselves.

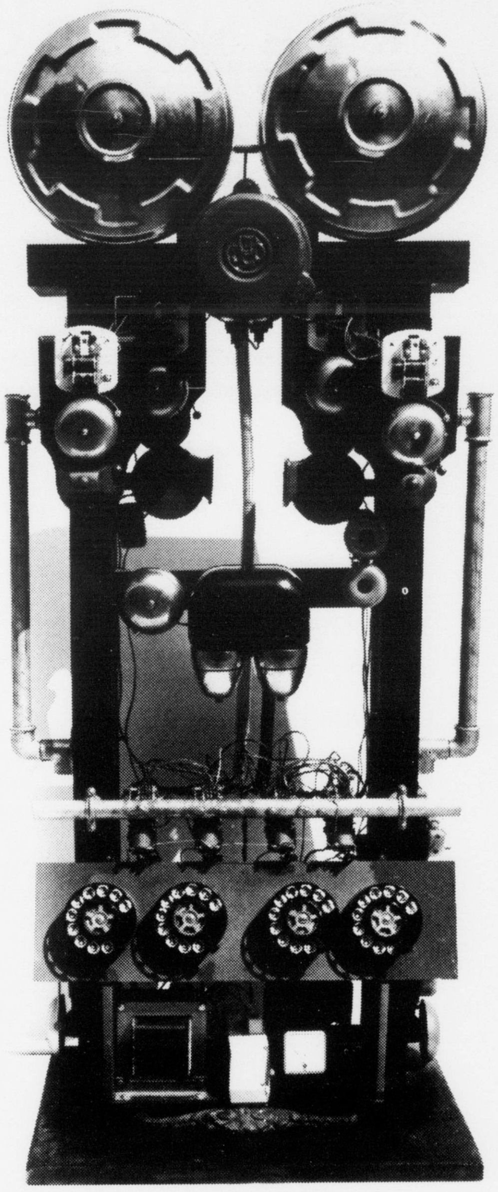
Andrew: They didn't find it amusing?

Moniek: No, because those speakers are trained to speak very well and pronounce everything.

Godfried: Symphony number so and so much andante, moderato, et allegro.

And then there are other things. Like the *Singing Bicycle Symphony*: a piece that I made and that we realized not so long ago. You know in Europe all the bicycles have dynamos: a sort of device to make electricity. Now in North America it's not very common. You see people use batteries here. Shit. I can't do this piece here because I cannot do this piece with batteries.

Andrew: I guess the feeling is that a generator adds weight and resistance.



The Bel Telefoon

Godfried: Sure, it definitely does that, but that's why I wanted to use it. I have always been interested in making sounds dependent on bodily efforts; maintaining this kind of physical relationship to the instrument. That's why I'm against amplification: It should have a physical relation. But in this bicycle proejct there's at least 12 or more people that drive bicycles, and the dynamo is connected to a loudspeaker. Now the dynamo gives AC current, and the loudspeaker is connected to a tube; plastic tubes of large diameter, fitting to the loudspeaker. The tubes are tuned to a specific frequency. For every bicycle we'll get another specific frequency. Now, when the bicycles are standing still there is no electricity, so no sound. As soon as it moves, the frequency of the sounds — of the electricity, and so of the sounds — will go higher, until at a certain point it reaches resonance, so you get every bicycle speeding up and going *whhhhhoooooooo?* This kind of thing. And the *whhhhhoooooooo?* will be specific for every bike. Now the score says the people that are involved in the project have to prepare this whole thing; make all these tubes; fit in the loudspeaker; it's a workshop in itself. Then all these people drive down the road, and the one that's last has to go faster than the others and come in front and then slow down again. That's the way it goes all through town. We make a route where it's bumpy through town. It adds a sort of special character to a town because you have all these resonances between the buildings. Not particularly very loud, it's as loud as the people want because it depends on their velocity, but it's a big cluster moving through town. It's a very mysterious sound.

Andrew: How do you mount those tubes on the bikes?

Godfried: Either vertical like a chimney, or horizontal, or any shape.

Moniek: Also there's an interesting aspect when you have cobblestones. You have *yooouuiiiiyoooouuuii*.

Godfried: That tremolo effect.

Moniek: When you are living in Belgium there are many cobblestone streets, and when you have small streets you have different resonsances than when you have big streets.

What's great about when you do it in a town is that the people in the street aren't asking that kind of stupid question: Is this music or not? and Is it art?; they just enjoy it as it is: Ha? What's going here?, and that's a different attitude.

For further information, write: Logos Foundation, Kongostraat 35, B-9000, Belgium.

KLANKSPOOR
SOUNDTRACK

A Logos Soundscape Project
By Moniek Darge and Godfried Willem-Raes

no century but the 20th has heard as many sounds.

nor has any other century ever provided the technical means to record these sounds

sound has been unpalpably and invisibly present for millennia

today, though, we can imprison it

therefore, this soundtrack project

to congeal the sound of a city and to confront its inhabitants with it, in a palpable and visible shape

to intercept sounds which rise and evaporate between walls of stone and brick, to record them and to leave them behind, as a track, through the city

and there where the soil still is permeable, to bury them and thus return them to the earth, which originated them.

Phill Niblock

Phill Niblock

Description of the Soundtrack Project

A path, running from north to south, which cuts the chosen city in two halves, is outlined upon the city map.

The sounds are recorded, by performers who follow the path by foot, on a magnetic tape as long as the route (ca. 3km/2 miles), though not at the speed of any standard tape-recorder, but according to the rhythm of the performers' motion through the city.

Instead of being wound on a reel, the recorded tape is stuck to the surface of the road, or buried where it meets with soft soil (e.g. in parks); thus a long track of coagulated sounds, which is to be followed throughout the whole city, is left behind over several miles.
A videocamera, following the performers on their route, is recording the happening visually as well as audibly. The video-soundtrack is directly connected to the audio-machinery, thus, here also, it is the performers' rhythm which regulates the speed of the sound-recording.
The videotape as well as the audio-recording are delaying the erosion of the happening and of the sound to that of the matter which bears them.

Recording-Equipment

A machine, composed of a mono full-track recording head and a similar recording amplifier plus oscillator without corrections of the frequency-characteristics (these are superfluous due to the high speed recording) and a playback head with a playback amplifier, connected to headphones and supplied with a line output to provide the video soundtrack (a wireless radio is herefore used).
The machine is supplied with a tape transport system composed of freewheels and tape transport ball bearings.
A tape of the same length as the route which is to be followed is wound upon an exceptionally giant reel (the maximum length of the route is limited only by the capacity of this reel, about 5 km/3.10 miles).
No reel is supplied for winding the recorded tape, as this will end up on the road-surface and in the earth.

The Recording

The tape is inserted into the recording-machine, while its other end is fastened to the street (to this end stickers are designed which bear the title of the project, *Soundtrack*, as well as notations of the exact time and location of that particular bit of recording).
The machine is carried by one of the performers who follows the route, recording at the speed of his own motion with a hand-held microphone.
In effect, the audible result depends on the speed of the machine-bearer; thus this person provides a truly individualistic work, which only he will be able to listen to authentically. Each other person who would follow the whole route again shall always move at a speed — however minimally — different from the original performer's.
Control of the recording is monitored through headphones.
All of the sounds which cannot directly reach the performer's ears through the headphones, reach them, as well as the video-soundtrack, delayed and modulated by the varying speed at which he moves, via the tape.
(this way the videotape becomes a means to the democratization of this unique work, as everyone shall afterwards have the opportunity to listen to the original sound)
From the start, all of the recorded tape is fastened to the street or buried whenever possible. This way the sound of each specific area remains at the place where it was originated.

This piece was premiered in Ghent, Belgium on July 16, 1982. The route on this occasion was 3 km (2 miles) long, starting at the Logos-Foundation and ending at the Museum of Contemporary Art.
Collaborators/Performers were:
Moniek Darge (T-shirt design, sticking & burying)
Johan Neyt (sticking)
Didier Leroy (video-camera)
Guy Van Belle (sticking)
Godfried-Willem Raes (soundtracker)
Phill Niblock (pictures)
Johan Grimonprez (information)
Jan Van Imschoot (public-interviews)
and many others

An alternative version of this Soundtrack event uses live broadcast on a local television station of the video-images, along with the sound derived from the Soundtracker.

snareninstallaties

stringinstallations

By Paul Panhuysen
and Johan Goedhart

I have always considered art as an attitude, as a way of life, as a method of exploring, experiencing and understanding the conditions of life. The artwork is a statement expressing the thoughts and feelings of the artist. The artist has to be an independent surveyor not belonging to any social group or powerstructure. His work is made to be discussed, to be accepted or rejected. Art fails if it is not able at all, even on the smallest scale, to provoke public attention and discussion. Art fails too, if it does not present personal ideas and concepts which are of interest to more people.

My work has always been concerned with order. Order seen as a reflection on structuring my world, and not so much as power structure. I see order as a tool to gain more understanding of the world. Order is the result of feeling, intuition, association, and of systematic and rational activities as well. The way that man puts order in his life and environment is very personal and revealing; it shows his vision.

Order can be expressed in music, in visual art, in theatre, in architecture. But the same kind of order works out differently in different media. An artist has to find the adequate medium for a concept or idea. This means that a painter cannot naturally express all his ideas in paintings. Sometimes it is better to write, to compose, or to make a piece of theatre.

Since 1971, I have been concerned with the environment. It all started with a design to improve the quality of life on the street where I lived, by the action of the people who lived there. Later on, I was invited to be a member of urban planning teams. As a consulting artist I was able to present my ideas, but my proposals were not realized very often. The introduction of art in this context was always problematic. The **stringinstallations** *are a reaction to this experience. They offer a temporary vision on architectural order; on interpreting the meaning of a given space and revealing its character in sound.*

-Paul Panhuysen

In the last two years the artists Paul Panhuysen and Johan Goedhart have built a considerable number of *stringinstallations* in various rooms of different characters. On most occasions the artists did a concert on these instruments. On other occasions the instruments produced their sounds automatically. *Stringinstallations* are seen by the artists as an intervention that changes the environment into an artwork and at the same time into a musical instrument. By stretching a number of strings in a space according to its architectural features, an instrument comes into existence which is able to produce sounds highly influenced by the given space. The *stringinstallations* are playing a stystematic game with the visual and acoustical qualities of the spaces where they are built. The atmosphere evoked by each building found expression in these works. Various materials are used for the strings such as steel, brass, chord, sisal hemp, twine, nylon, dental floss, fishing line. When the instrument is built, the artists rehearse some hours on it, then a concert is given. After the concert the instrument is pulled down.

A recent version of the installation is the automatized instrument, where small hammers hit the strings. If a certain level of sound is reached the hammers stop hitting, and if the sound goes under the programmed level the hammering starts again. This type of automat allows visitors themselves to perform and interfere in the sound-patterns. An apparent quality of the *stringinstallations* is the contrast between image and sound. The strings, sometimes almost invisible, always refer to the formal and geometric order of the space, to its architectural structure and meaning. The visual intervention is modest and minimal. The amplified sounds permeate the whole space, reflect on the walls and make the building resound and drone. The *stringinstallation* evokes the voice of the building. The concert on the instrument is a competition between the musicians and the stubborn character of a building, full of coincidences and unpredictable surprises and unimaginable experiences of sounds. Every concert is different, because every building is different.

The *stringinstallations* may be seen as an elaboration on the ideas of earlier visual art works by both artists, in which they have cooperated over the last ten years. In the middle of the seventies they produced an extensive series of drawings which reflected their systematic study in visual order. The results of this cooperation were drawings, paintings, and objects based on simple geometric proportions, modulations on systems of numbers, magic squares and integer sequences. Later on, the parameter of chance was introduced into these works.

The results of this research were put into practice in urban planning and environmental design and are applied to the *stringinstallations*. Both artists are invited to join architectural or urban planning teams. In this kind of commission, an analysis of the given architectural or urban structure and design is normally the artists' first step in preparing their proposals. Art has to connect with, to work out or to give another turn to the given situation. However, in this kind of commission artistic freedom is limited, because the results arise from an agreement in which many parties and interests are involved. Proposals and realized projects of Panhuysen and Goedhart demonstrate a growing need to give art an independent position in the constructed environment, and an expression of its own. The temporariness of the *stringinstallations* makes complicated deliberations superfluous and brings into reach artistic interventions which demonstrate the ideas of the artists on the relation between art and the environment in a much more radical way. The *stringinstallations* offer freedom to realise an autonomous intervention in the given space and an independent interpretation of the relation between art and the environment.

In commissions, art mostly adapts itself to the environment. In this case the environment is adapted to the work of art.

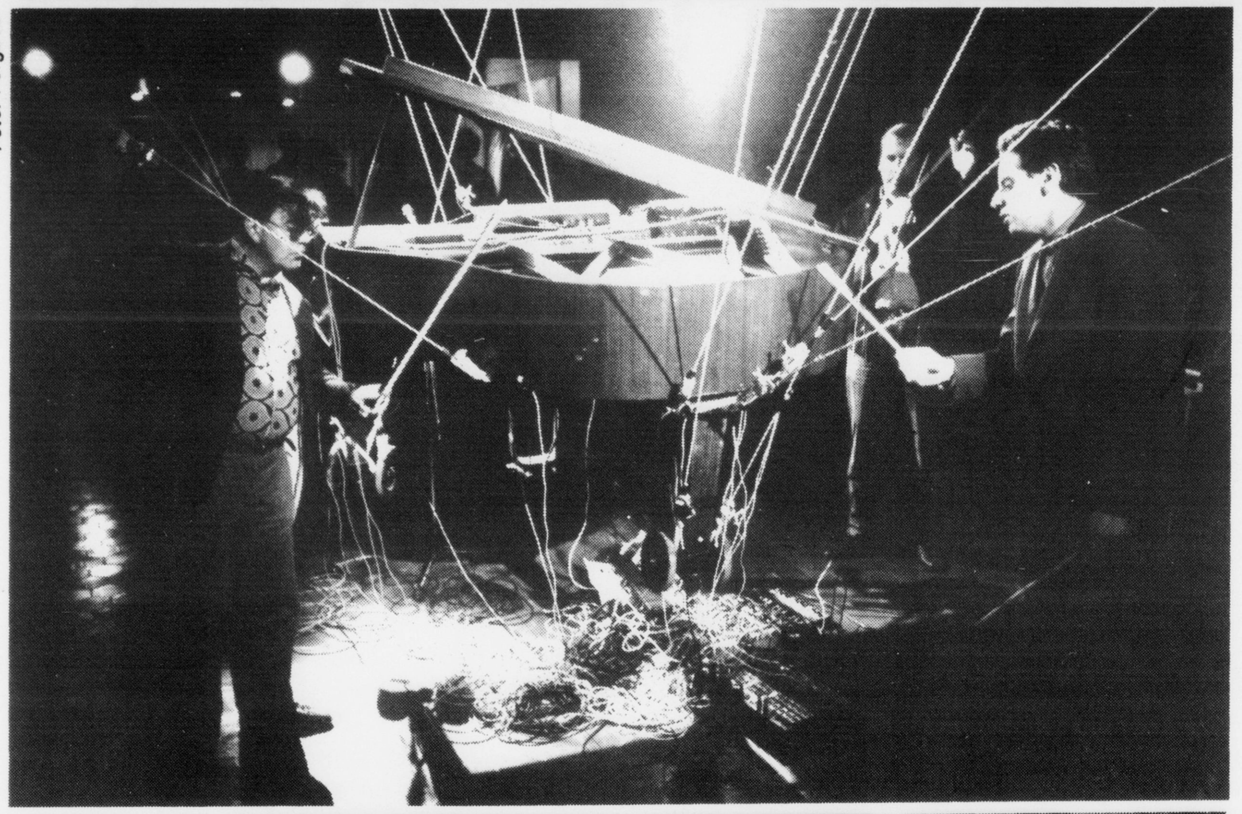
A *stringinstallation* is as much an artwork as a musical instrument. The proportion between meaning and function has to be defined again in every new design. Each time, there is a spectrum of choices between function and meaning. This process may be compared with designing a seat that could become either a kitchen chair, or a royal throne. The opinion of many people that the meaning of a work of art is its profit and utility, is under discussion in the *stringinstallations*, which are at the same time a work of art and an instrument. They represent an artform which is, at the same time, autonomous and applied art; where design and function both refer to meaning. The artists' stand is that meaning is the only relevant function of art.

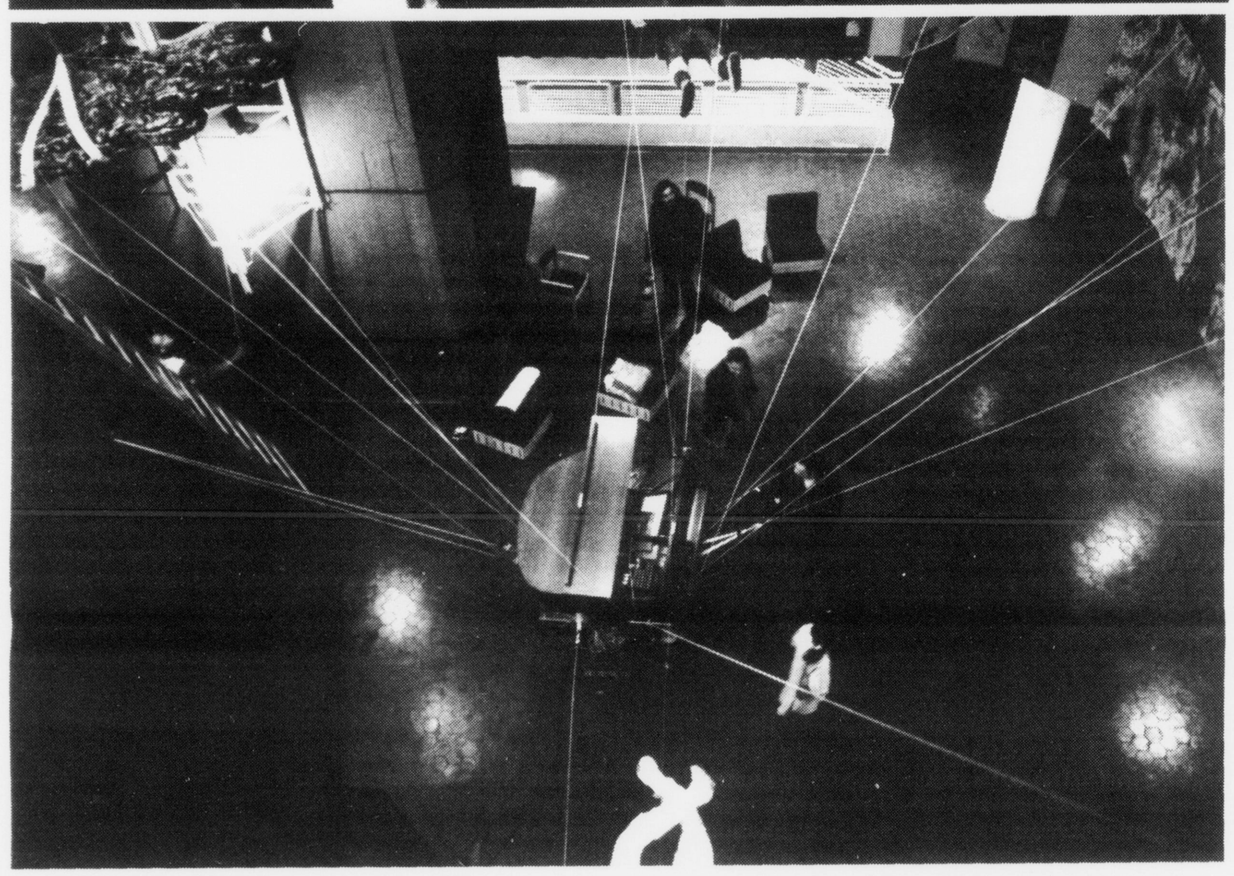
The *stringinstallations* are usually presented in the form of a concert which sometimes involves theatrical features. The concert is an exploration of the qualities of the instrument. Every instrument is different. Big instruments are stubborn and generate undertones, tones, and overtones at the same time. They produce noise, scratches, wah-wah-effects, reverb, tremolo, echo, rhythmic patterns, choruses, voices, squeezed and sonorous sounds.

The combination of image and sound produces an artform that may be interpreted on many different levels, to an artform which comes up to the conception of Oyvind Fahlström: "Consider art as a way of experiencing a fusion of pleasure and insight. Reach this by impurity, or multiplicity of levels, rather than by reduction." The combination of a concert and visual art offers practical advantages too. The audience is persuaded to contemplate the visual artwork for a longer period of time than is usual in visual art. The way of seeing is influenced by the sound. The imagery of the instruments brings more perception to the character of the music. The whole performance withdraws from the traditional context of music and visual art and opens up a perspective of new opportunities to art. The artist becomes an actor in his own work and comes in direct touch with his audience.

Paul Panhuysen and Johan Goedhart are artists living and working in Eindhoven, The Netherlands. They are presently preparing a three-record set and a book on the **stringinstallations**. *For further information, write: Het Apollonhuis, Tongelressestraat 81, 5613 DB, Eindhoven, The Netherlands.*

Peter Forgacs





PARAPHRASE (Homage to Franz Liszt)

snareninstallaties
stringinstallations

By Paul Panhuysen and Johan Goedhart

BARCAROLE
13 March, 1983
De vleeshal, Middelburg, The Netherlands (Gothic meatmarket)
12 parallel strings of sisal hemp were stretched over the floor. Each string had a bridge. The bridges were placed in a serial sequence. The concert was performed by Paul Panhuysen (strings and vocals) and Johan Goedhart (strings). This was the first concert in which a digital delay was used.

DIE GROSSE VIOLINE
29 May, 1982
Mainz, Germany; Die Halle. (factory-building)
Six strings of swedish music wire varying in length between 20 feet and 60 feet. Electric amplification. The concert was performed by Paul Panhuysen, Jan van Reit, Leon van Noorden and Herbert Hertling.

PILLAR KOTO
13 June, 1982
Frankfurt, Germany; factory-building.
12 strings of different materials (swedish music wire, chord, twine, dental-floss, fishingline and ironwire) varying in length between 15 and 40 feet were stretched between 8 pillars. Electric amplification. On the crossings the strings were attached to each other with small wooden blocks. The concert was performed by Paul Panhuysen and Johan Goedhart.

MIKADO
5 March, 1983
Art and behaviour, Amsterdam. (factory-building)
Twelve strings of sisal hemp form a circle on the floor to random points at the ceiling. The strings varied in length between 20 and 90 feet. The concert was performed by Paul Panhuysen (strings and vocals) and Johan Goedhart (sound-mix).

VICTORIA
3 June, 1983, Holland Festival, Victoria Factory, Dordrecht, The Netherlands
A *stringinstallation* in the open air, attached to an old factory building. Ten strings of twisted steel came from both sides of the floor together to one point on the ground at a distance of 30 metres on a somewhat oblique axis from the building. The average length of the strings was about 50 metres. Paul Panhuysen and Johan Goedhart performed two times on this instrument, a concert by day and a concert by night. The strings were not tuned; the building was used as a resonator for the loudspeaker boxes.

CARILLON
10 March - 24 April, 1984
De Kijkschuur, Acquoy, The Netherlands
This installation consisted of 12 steel strings forming an elliptical cylinder and making an angle of 45° with floor and wall. The strings were attached around a circular window in the wall to a circle on the floor. The tuning was based on just intonation; the strings were interrupted with sugar-tins, which served as resonators. 12 motors with retardation hitting the strings with a tongue of steel produced a slow music with gradually changing patterns.

SANGUINE
20 February, 1983
Aorta, Amsterdam. (old printing office)
Two crossing sets of six strings each were stretched over an open part of the floor. Six strings were of twisted nylon fishing line and 23 feet long, the other six strings were of swedish music wire and 50 feet long. Where the strings crossed was a diagonal of wooden blocks which connected the strings. The concert was performed by Paul Panhuysen (strings and vocals) and Johan Goedhart (sound-mix).

EEN STRALENDE ZON IN GOUDEN (THE SUN RISES WITH GOLDEN BEAMS)
27 November, 1982
De Fabriek, Eindhoven, The Netherlands. (factory-building)
8 strings, 4 of swedish music wire and 4 of twisted nylon fishingline varying in length between 130 and 160 feet. Electric amplification. The concert was performed by Paul Panhuysen.

PARAPHRASE
(Homage to Franz Liszt)
Festival Planum '84, 9-10 November, 1984
Cultural Centre, Almassy Ter, Budapest, Hungary
A grand piano was hung on strings of chord, attached to the ceiling and the balustrades of the different floors in the main hall of the building. The keyboard lid was shut and on it were placed three walkmans, which played a fragment of one of the Hungarian Rhapsodies of Liszt. In a systematic way this fragment was repeated and overlapped in a process of gradually growing density until 64 layers were reached. The strings were not tuned. Two concerts were done on this instrument, the first day by Johan Goedhart and Paul Panhuysen; the second day they were joined by Arnold Dreyblatt.

TIPI
22 January, 1983
lokaal 01 Breda, The Netherlands (old classroom with two cast-iron pillars)
Two symmetrical *stringinstallations*, around the pillars. The first installation had six strings of swedish music wire, the other one had six strings of fishing line. The length of the equal strings was about 18 feet. The concert was performed by Paul Panhuysen (strings and vocal) and Johan Goedhart (strings). This was the first time that singing (with octaver) was introduced in the concert.

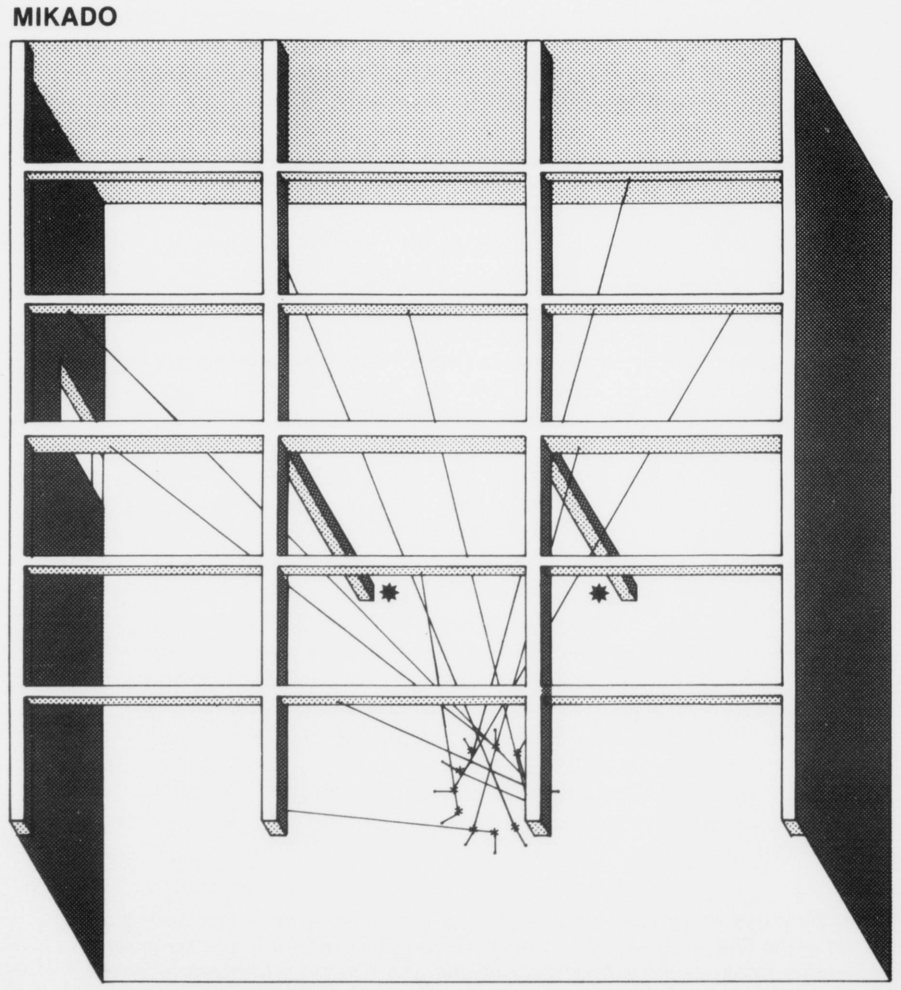
Pieter Boersma

VICTORIA

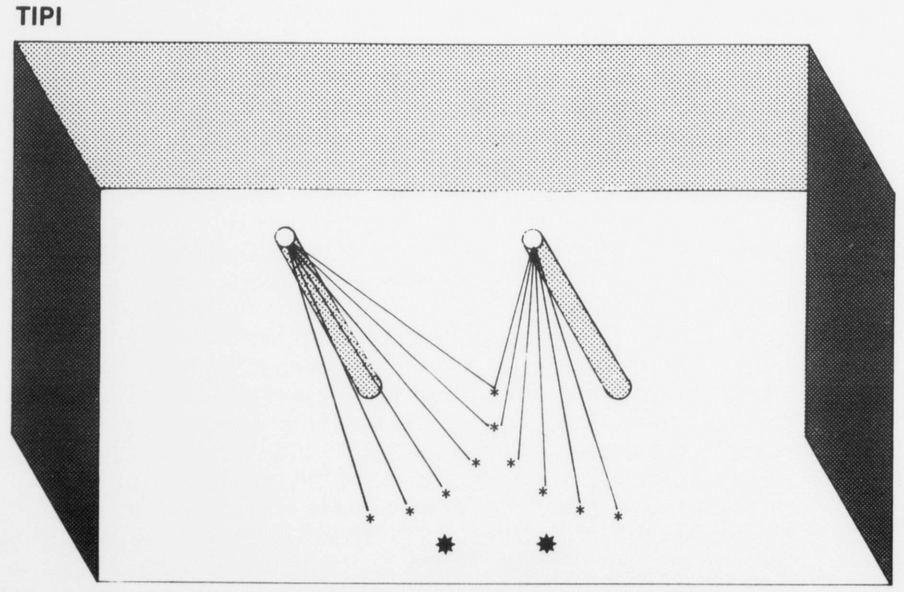
Peter Cox

CARILLON

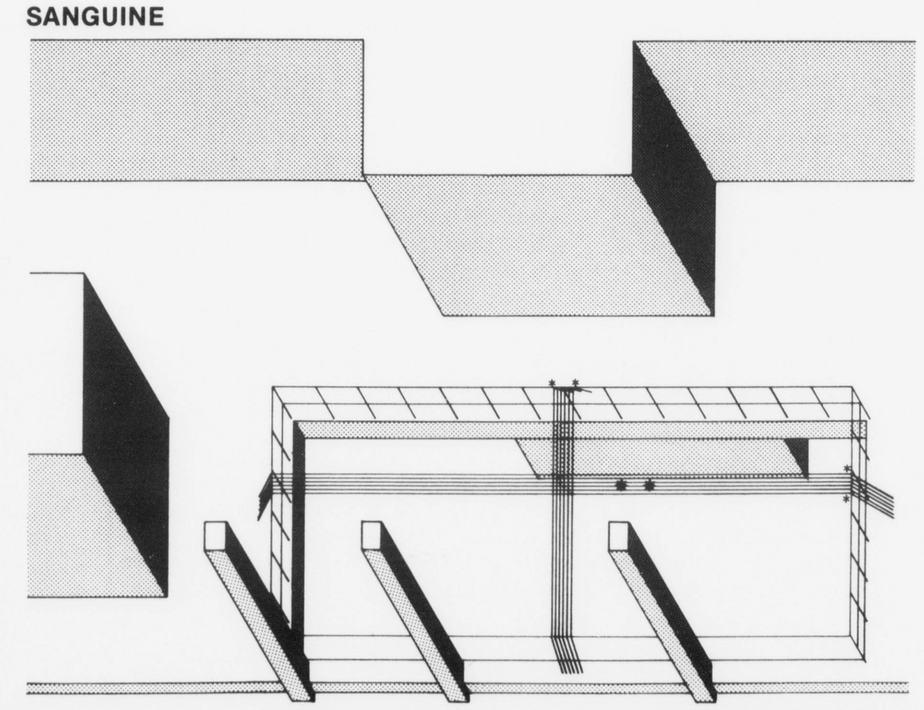
MIKADO



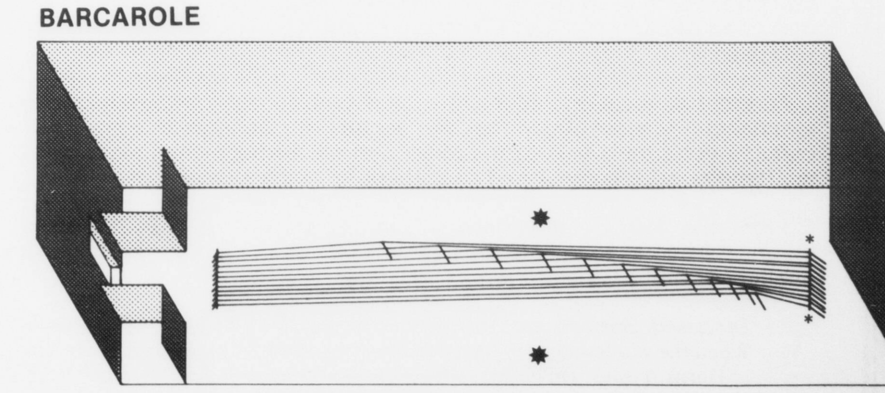
TIPI

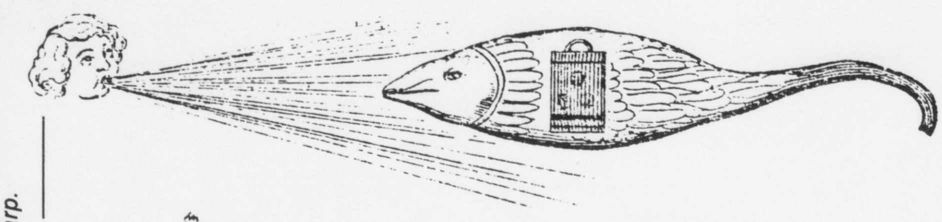


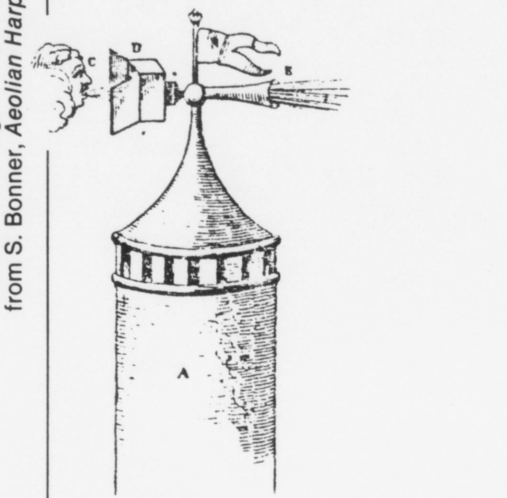
SANGUINE

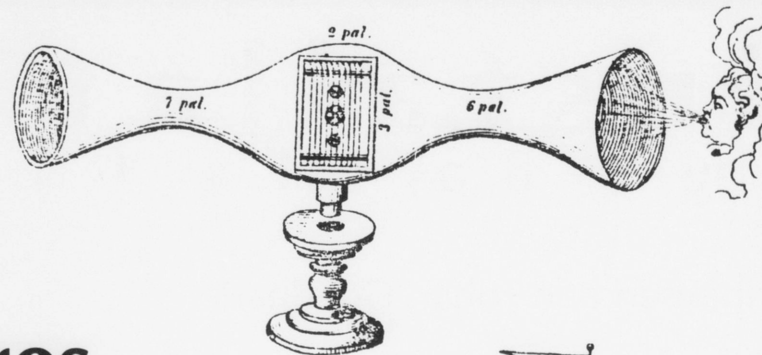


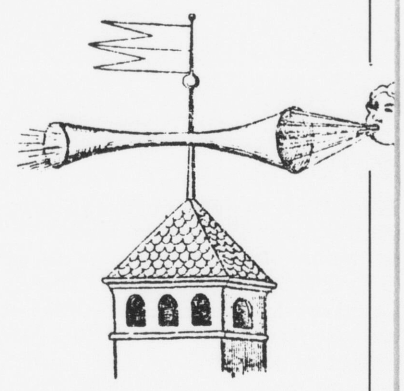
BARCAROLE











Kircher's Drawings of Aeolian Harps, 17th Century; from S. Bonner, *Aeolian Harp*.

Singing Wires

The Music of Aeolian Harps

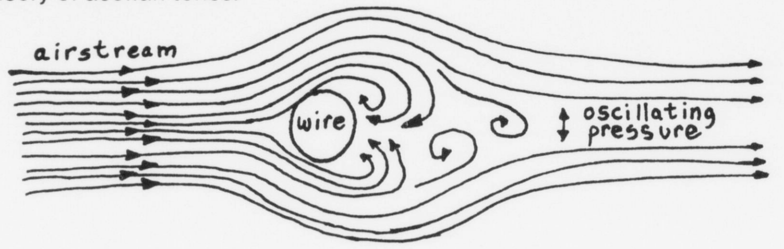
By Gordon Monahan

Consider that the aeolian harp is one of the oldest musical instruments known to man; that it can spontaneously produce an enchanting, mysterious and complex music of its own accord; and yet it remains an obscure, unkwown instrument to the average person — musician and non-musician.

Aeolian harps have assumed a variety of forms in many cultures thoroughout history, ranging from long-wire installations, to various kite harps of Asia, to the conventional aeolian harp of western culture: usually consisting of a horizontal or vertical soundbox of rectangular, triangular or curved shape, 3 to 5 feet long, over which a number of strings are stretched between bridges. An aeolian harp is not played by man, but is placed out of doors to be sounded by the wind.

The sounds produced are known as aeolian tones, named after *Aeolus*, the god of wind in Greek legend. They are characteristically described as being "audible harmonics of a mingled and distant sweetness." (Webster's Dictionary)[1]

It is only recently (over the past century), that science has begun to correctly explain the manner in which aeolian tones are generated. The following is a brief summary of present theory: When the wind blows across a stretched wire, a fluctuating system of wind-eddies arises in the wake of the string, much like the small whirlpools visible when a stick is held in flowing water. When the vortices of the wake vibrate at a frequency which matches a harmonic frequency of the string, a sympathetic vibration of the string is induced, and aeolian tones produced. Often, several pitches may be produced simultaneously on one string, and a complete explanation of this phenomenon escapes the modern theory of aeolian tones.[2]



The vortex-shedding in the wake of a string

While the string's length and tension establish its fundamental pitch and overtone series, it is the velocity of the wind in relation to the diameter of the wire which determines the harmonic frequency(ies) that sound. Essentially, the string's harmonic structure defines a gamut of pitches that may be activated by the vibrations of the vortex-shedding in the wake of the string. However, if the vortex-frequency does not correspond to a natural frequency of the wire, the string will not be sympathetically induced to vibrate, and any previously-sustained tones may die away.

The aeolian vibrations are transmitted through a bridge to an amplifying soundboard, and depending on the efficiency of the particular instrument's design, the aeolian tones, rich in harmonic complexity, may be amplified with great fidelity.

History of Aeolian Instruments

The discovery and construction of aeolian instruments dates back thousands of years. Some of the earliest references, which exist in legends, attribute its beginnings to observations of wind-blown decaying animal carcasses, sounding in the wind. Among them, in the Greek legend *Hymn to Hermes* (Homer, 800 B.C.), the wind is discovered making music on dried sinews stretched across a tortoise shell lying on a beach; and in an undated Turkish legend, music is heard from dried monkey's entrails hanging from a tree branch as they are sounded by the wind. The invention of the Greek lyre and Turkish lute are associated with these legends, respectively. (The Greek and Roman terms for their small lyre — *lyra* and *testudo* — are synonymous with the tortoise carapace.)[3]

Further historical references to aeolian tones usually involve man-made instruments. For example, in the 10th century, St. Dunstan of Canterbury was carrying out a daily task at the request of his Bishop, when his harp, sitting unattended, accidently played an anthem, at which all nearby marvelled.

From the 16th century onwards, more detailed records of aeolian instruments and experiments survive. In 1540, Jean-Baptiste Porta of Naples published his *Magia Naturalis* (*Natural Magick*), in which he wrote:

> To make a Harp or other instrumente be play'd on by the winde do thus: When the windes are very tempestuous set your Instrumente just against it, as Harps, Flutes, Dulcimers, Pipes; the winde will run violently into them, and will run into the holes of the reeds; whence if you stand near and listen, you will hear a most pleasant musick . . .[3]

Following Porta's findings, the 17th century experimenter Athanasius Kircher invented the *musical autophone*, apparently the first string instrument specifically designed to be played by the wind. He was also the first to employ a derivation of the name *Aeolus* in describing the phenomenon of these vibrating strings. In 1650 and 1673 respectively, he published his *Musurgia Universalis* and *Phonurgia Nova*, which collectively contained his theory of aeolian tones: In observing that several pitches may sound from a single string either sequentially or simultaneously, he suggested that the string divides into vibrating sections according to the irregularity of wind intensity along its length, thus producing the various harmonic pitches relating to the divisions of the string.

> Because therefore the wind may at one time strike the whole string, and another time innumerable aliquot divisions, the true cause of diversity of the sounds produced on this instrument is revealed. Suddenly the trembling sound is born, assuredly from no source but the wind, causing wonder to charmed ears. The force is not always directed horizontally, but flows in waves like the string itself, and thus excites that (portion of) the string which is struck.[3]

This marks the beginning of theoretical study of aeolian tones, and Kircher would be used as a basis in future developments of aeolian theory.

In the next century after Kircher, the aeolian harp gradually became known in many European countries. However, there are no historical records that show that manufacturers had been established at this time. It appears that individuals constructed their own harps, and information passed through word of mouth and through publication.

In 1754, an anonymous letter was printed in the *Gentleman's Magazine* (London) with detailed instructions on how to build an aeolian harp:

> Mr Urban,
>
> Having lately been very much entertain'd with an instrument commonly known by the name of Eolus's Harp, and imagining it not to be thoroughly known, I could not but think it would be agreeable to many of your readers to have a description of it, especially as the contrivance is so simple, that the chief part of it may be easily made by a common carpenter.
>
> Procure a box to be made of a thin deal as possible, (Fig. I) the length exactly the width of the sash, where you intend to fix it, the depth of the box 5 or 6 inches, and the width 7 or 8 inches; let there be glued upon it at aa, two pieces of wainscot about half an inch high, and a quarter of an inch thick, and within side let there be glued to the top at each end, under bb, two pieces of beach, about an inch square, and the length the width of the box; then let there be made through the top, and into these pieces, as many small holes as

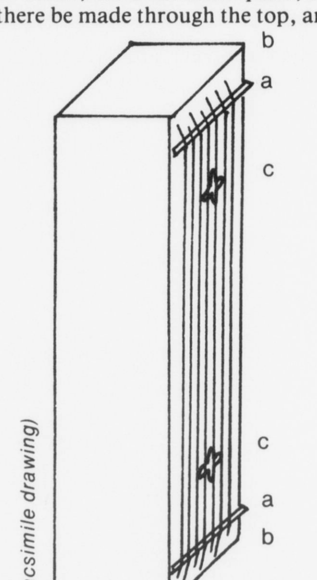


Fig. I

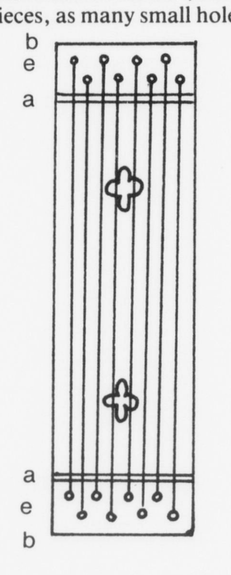


Fig. II

> you would have strings to the instrument, half at one end and half at the other, into which fix the same number of pins, such as are used in harpischords, etc. all that remains now is to string it with small catgut strings, or blue first fiddle strings, fixing one end to a small brass pin as at ee, (Fig. II) and twisting the other round the opposite pin as at bb.
>
> When these strings are tun'd at unisons, and the instrument plac'd with the strings outward, in the window to which it is fitted, provided the wind blows upon the window, it will give a sound like a distant choir, increasing and decreasing according to the strength of the wind.
>
> cc in Fig. I are only sound holes cut in the top of the box, and the thinner the top is, the better will the instrument perform.
>
> I am, sir, yours etc.
> A.Z.[3]

Twenty seven years later, an article *On the Eolian Harp* (Physiological Disquisitions; London, 1781) was published, in which the author, William Jones, relates the following story:

. . . When Mr. Pope was translating Homer, he had frequent occasion to consult the Greek commentary of Eusthasius; where he met with a passage in which it was suggested that the blowing of the wind against musical strings would produce harmonious sounds. This was communicated to Mr. Oswald, a master of the violoncello from North Britain, and an ingenious composer in the Scottish style, who himself gave me the following account many years ago. When he had received the hint of Mr. Pope's discovery in Eusthasius, he determined to try whether he could reduce it to practice. Accordingly he took an old lute, and having put strings on it, he exposed it to the wind in every manner he could think of; but all without effect. When he was about to give up the matter as a mystery or fable, he received some encouragement to a farther trial from an accident which happened to a harper on the Thames; who having his instrument with him in a house-boat, perceived that a favourable stroke of the wind brought some momentary sounds from the strings, as if they had been suddenly touched after that manner, which, from the genius of this instrument is called *arpeggio*. The man was alarmed with the accident, and made many trials to procure a repetition of the same sounds from a like turn of the wind, but could never succeed: the music was vanished like an apparition. Upon this ground, however, Mr. Oswald persevered; and it came at last into his mind, that perhaps the strings ought to be exposed to a more confined current of air. With this view he drew up the sash of his chamber-window, so as to let in a shallow stream of air, and exposed his lute to it. In the middle of the night the wind rose and the instrument sounded; which being heard by the artist, he sprang out of bed to examine the circumstances of its situation, and noted down every thing with the most scrupulous precision; after which, as the principle was now ascertained, he never failed of the effect.[3]

As well, Jones makes this insightful observation:

That the effect of the Eolian harp must often have been heard by accident seems undeniable from what I was lately informed of by Mr. Stanley, composer to his majesty; that two wires stretched across an area before a house at London, had been heard to make very fine music, equal to the best Eolian harp.[3]

So it seems that many more have heard aeolian tones than may be apparent from the small number of historical references that have survived.

Jones goes on to describe the construction of a vertical aeolian harp, and to state his version of aeolian theory. Based on Kircher's theory, Jones suggests that

Upon the whole, the Eolian harp may be considered as an air prism, for the physical separation of musical sounds . . . That as light shews no particular colour but by means of some other intervening body to separate and modify its rays; so the air yields no particular musical tone without the assistance of some sonorous body to separate its parts and put them into vibratory motion.[3]

Perhaps the most intriguing and significant aeolian experiment of this time period was the construction of the *Armonica Meteorologica* by the Reverend Abbot Don Guilo Cesare Gattoni, Canon of Como Cathedral in Milan. In 1783, Gattoni anticipated the work of the 20th century avant-garde by stringing long lengths of wire which stretched from a third floor balcony of his residence to a tower 150 paces away. He used wires of various metals: steel, iron, copper, brass, silver, and gold. Gattoni had been inspired to build his *Armonica* upon hearing from don Pietro Moscati, Professor of Chemistry and Director-General of the Principal Hospital of Milan, who had observed "the long taut wire from (his) electric bar to become spontaneously harmonious in certain kinds of weather." In a letter to Moscati, Gattoni lists a number of experiments, observations and deductions. After an initial experiment with 20 yd. wires strung in his garden met with moderate success, Gattoni decided to continue his investigation on an even large scale.

I chose for experiment a tower 52 feet (?) high, and about 150 paces from my house to make a novel kind of gigantic harp; . . . the columns (of the tower) had been bound with huge pieces of horizontal iron and the wires which were fastened to them were all made from one piece of metal which led to a balcony of the house on the third storey, and they were arranged and placed on the facade of the tower. There I attached to a huge iron frame the other ends of the wires, which were fifteen in number, adapted however in their arrangement — for this would be necessary to produce the seven fundamental notes of music and one group of other semitones increasing and decreasing in intensity, so that the confusion of so many produced simultaneously would be more wonderful to hear; and possibly they could then be followed by something sounding capricious or like beats, like some clumsy psalm, or as with the harp when plucked. To obtain the desired results, since one cannot profit from differing lengths of strings, I used varying diameter and tensions to make a chord in the major mode. To do this I started by setting up three wires of thicker calibre, the first (?)bass, the other two 1-2 mm. larger, the others up to twelve notes following their proper order in the right pitch. I can tell you, Sir, that it made my heart swell with pride to hear the various strings in these first days, playing like a harp and to feel that strange instrument reply to the 'fingers' with such sweet harmony. But I soon realized the sound would not last long, and that this like all the others was on the point of disappearing. The problem of keeping the harp playing became a great weight on my mind, and distracted me from the main aim — for I stretched the strings frequently to keep them in tune. Those detestable periods of rain, snow, hail and wind all put the apparatus out of tune and very often broke the strings. Eventually I gave up the idea of harmony by applying myself solely to observation of those results pertinent to the main aim.[3]

Gattoni supposed that the sounds produced were in response to imminent weather changes in the atmosphere. After extensive observation, he became convinced that he could predict weather changes by observing the responses of his *Armonica*. He asserted that they were foretold by "lively noises, such as the unwanted squeels that issue from an instrument touched by an unskilled hand." Gattoni describes a number of such occasions and summarizes the events as follows:

When the sky is perfectly clear, and distant objects can be seen, and the sky is a very intense blue, and although there is no sign of it, the rain is very near, . . . then the wires start three, four, and even five days previous to the weather change a murmer which grows gradually, and replies in many voices day and night up to the last day, when the sound, becoming more intense and almost continuous, ends with the falling of rain and snow; in this weather there are no longer any indications, and the sound resumes only when there is a change in the atmosphere; but even so no other meteorological instruments are as sensitive: and this follows independently from cold and heat which are supposed to be due to alterations in layers of air, as seems proved by subsequent experience.[3]

Gattoni attempted to explain the cause of the wire vibrations, and put the instrument through tests drawn from his deductions, but he was unable to develop a conclusive argument.

Magnetism and electricity do not appear to have any effect; and no laws known are capable of accounting for the vibrations of the metal related above — on the contrary, with regard to electricity, it was proved to me that by electrifying them heavily . . . that there was not the least response. It is

GATTONI'S ARMONICA METEOROLOGICA

Acoustical Observations, 1783-85 (abridged)

In the year 1785 the first three days of February were fine, and the sun shone brilliantly. The wires could be heard at various pitches during the day, and during the night they sounded sweetly; and then the sound by stages grew so much louder in intensity and so much more frequently that it became intense from the length of time they played. On the 4th February . . . the day was fine, as though the sky were burdened with blue. The harmonious wires on this day never stopped and they seemed to vibrate with an intensity and vigour greater than at other times. After half a day, with the sky very beautiful and all cloud banished from it, under the balcony on which the *Harmonica* was mounted could be found many distinguished persons . . . and some more who had left and were not acquainted with this phenomenon. Some stayed to marvel, and so great a one as Sig. Don Alessandro, who until then had always been sceptical, not believing the accounts of others, thought most highly of that very experiment which the vivid imaginations of some people had made him doubt. He asked me what kind of event was foretold by this continuous music, and I openly hazarded a guess that a great change in the atmosphere was going on, and we would have this proved on the following day. During half the night a very vigorous wind blew, which having blown through all the sky caused snow to fall eleven Milanese ounces deep, and this was repeated over a long period.

The noise continued at noon on the 17th (June 1785) up to the moment some drops of rain fell. These scarcely over, the sound started up again. At that moment some immense clouds began to rarefy. The sound shimmered both gently and vigorously, in tones both long and short, as if they assisted the cloud movement, until a north wind opened up the atmosphere and lasted six days. During this time the quiet vibrations did not stop at any particular time, such as day or night; nor did they necessarily cease when the wind dropped — particularly during the third and fifth day. Generally the sounds of the larger wires come first, and the languishing of these forces the other to vibrate, so for three and a half hours thirds, fifths, and octaves could be distinguished with organ-like harmony as though by human hand. Indeed, on the evening of 29th June 1785 the wires of the apparatus could be heard so loudly and so far off that many people conversing nearby went out into the street to discover the cause of so great a vibration. An hour after midday a storm appeared which precipitated much rain with lightning and hailstones; the sound ceased with the first few clouds and drops of rain, and this happened again at various times up to 2nd July.

. . . in some of the wires a blow is felt which rapidly decays, making a sound more like keyboard instrument. More than thirty times I encountered this in two years, without precisely being able to determine the cause; but examining the phenomenon thoroughly, I could detect an accidental blow from a sparrow or bat flying through the wires.

It appears the more the wires are exposed to the air, the better-sounding they become, for the oldest and most rusty are always the first to hum;...

The murmur is not felt at times when the wind is at its gustiest, and the sound more like a keyboard instrument. More than thirty times I en- . . . (the wires) were heard 200 yards away, suggesting to some the idea of a very distant concert of bells, and to other a church organ.

A greater sound from the wires is sensed when they are of one piece, and when their ends are attached to elastic bodies — such as iron spears set into a wooden attic, or better still into a large chest of old wood bolted down with male and female screws.

When the sound first begins, the balls of the finger placed above the wire detect a slight beat like the pulsations in the arteries of an animal; from there the vibrations become gradually broader, and occur more frequently, like feverish burning. In the end, they beat so fast that they cannot follow each other: with assiduous reflection, and so the sound commences by this cause a humming of the metal wire — and the sound grows to a state at which the diameter, length, and tension of the wire, and the degree of heat sustained by it from the furnace (the furnace of life?), become all significant factors. From there, just as the different wires are of various kinds, so likewise are the effects produced by variations in intensity, their promptitude, and duration.

from *'Sopra una nuova maniera . . .'* in *Opuscoli Scelti di Milano* (1785); quoted in S. Bonner *Aeolian Harp*, Vol. 4, pp. 82-95.

not directly the force of the winds, since the loudest and most vibrant noises are produced not when the wires are shocked and agitated, but when the air surrounding them seems calm and tranquil. Some think that an immediate cause of the vibrations may be the continual variation of cold and hot in layers of air in contact with the wires, which would produce continual dilations and condensations in the metal . . . to make fully sure that not even a violent and uncompromising passage of heat and cold could co-operate in producing sound, I stretched a long wire half a foot above the ground, maintaining a similar curve to other horizontal wires. I lit a line of gunpowder parallel with the wire several times, and at the time of the final burning some people moved in quickly with full water pots, to cool it down, but to no purpose, because there could be no diminishing a sound that was never there in the first place, insensitive as it was to the firing process.

So what is there left to say? Are these wires a hygrometer, sensitive to greater or lesser quantities of vapour in the air? Or a barometer more sensitive to the various columns of air and their amounts than conventional ones? Or do the wires indicate only the movement of the air of a slightness not otherwise traceable, and, if so, what are the other causes? All these ideas are equally possible. I do not strive to make a judgement: new revelations which will be obtained from repeated experiments will discover the true cause of a phenomenon which is still not thoroughly investigated . . . [3]

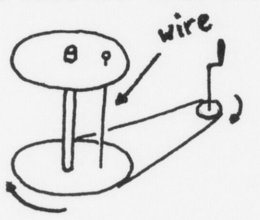
Gattoni's proposition that perhaps "the wires indicate only the movement of air of a slightness not otherwise traceable" is not really far off, as this is really the essence of vortex shedding in the wake of the string, which is now known to cause the aeolian vibrations. And whereas Gattoni suggests that the wind does not cause the vibrations because "the loudest and most vibrant noises are produced not when the wires are shocked and agitated, but when the air surrounding them seems calm and tranquil", two centuries later the Victorian scientist Lord Rayleigh showed this to be a requisite condition for a strong aeolian tone to be produced, as he carried out the following experiment:

The best draught is that obtained from a chimney. In my later experiments, a fireplace was fitted with a structure of wood and paper, which could prevent all access of air to the chimney, except through an elongated horizontal aperture in the front (vertical) wall. The length of the aperture was 26 inches, and the width 4 inches; and along its middle a gut string was stretched over bridges. The strength of the draught could be regulated by slightly withdrawing the framework from the fireplace, so as to allow the passage of air to the chimney otherwise than through the slit . . . . . . On a still night, and with a regular fire, the sound is sometimes steady for a long time, but it is wonderfully sensitive to the slightest changes in the draught. On one occasion it was found impossible to open a distant door so slightly as not to stop the sound, which would revive in a few seconds after the door was closed again. A piece of paper no larger than the hand thrown upon the fire (which was burning without flame) altered the draught sufficiently to stop the sound until the heated air due to its combustion had passed up the chimney. It is the irregularity, and not, as has been asserted, the insufficient intensity, of the wind which prevents the satisfactory performance of the harp in the open air.[4]

Terling Place, Witham,
Feb. 8, 1879

Thus, a regular, calm breeze is best for producing a strong aeolian tone. This is analogous to the proper playing of most musical instruments: it is not a forced pressure, but rather a gentle, even pressure which often produces the best musical tone.

At this same time, in 1878, experiments were being carried out by V. Strouhal, who was the first to demonstrate that the pitch of an aeolian tone was dependent on the wind velocity in relation to the width of the wire. Strouhal constructed a rotating apparatus which could be fitted with wires of various gauges and materials, glass rods, and glass tubes, such that they were rotated through the air at a controlled velocity. Strouhal was thus able to control the wind velocity crossing the vibrating section, and through observations, he deduced that the pitch of an aeolian tone was indeed dependent on the variables of wind velocity and wire thickness. He also found that the length of the wire influenced the intensity of the sound: "the longer the wire, the greater the intensity."[4] However, Strouhal incorrectly concluded that the length and tension of the wire did not influence the pitch of the aeolian tone produced. This assumption was negated in 1924 by the British acoustician E.G. Richardson, who, experimenting with a similar rotating apparatus as well as with a wire stretched in a wind tunnel, observed sound intensity drop-outs between harmonic frequencies of the wire, and suggested that "To this extent the tones are dependent on the tension of the wire, in that they are all harmonics of the fundamental tone of the wire, which is regulated by the tension."[5] Therefore, Strouhal's assumption should be addended to read: while the frequency of the vortex-shedding is determined by the wind velocity in relation to the wire tension and is independent of the length and tension of the wire, all aeolian pitches which sound due to sympathetic vibrations of the wire are in fact dependent on the length and tension of that wire. To this end, Strouhal's equation for determining the vortex-frequency behind the wire ($f = 0.185\ V/d$; where f = vortex frequency, V = wind velocity, d = wire diameter, and 0.185 is a constant known as the Strouhal number) certainly holds true. If this vortex frequency is plotted against the harmonic frequencies of the wire to determine potentially sounding pitches, then wind velocity and wire diameter can then be used to predict which aeolian tones may sound (or remain silent) in any given circumstance.



Strouhal's aeolian contraption.

(facsimile drawing)

Other scientists over the past century have examined various aspects of aeolian tones, with particular attention in the 1950's paid to the study of aerodynamic noise issuing from the vortices of a wake behind a motionless cylinder. However, there does not appear to have been any comprehensive scientific study of aeolian tones since this time, and a complete scientific theory has yet to be stated.

Variations in Design

Aeolian harp design has been as varied as the number of people building them. Over the past few centuries, few design aspects have been standardized. As the aeolian harp gained popularity in 19th century Europe, small manufacturers established themselves. It seems that most harps were purchased by the aristocracy and kept in private homes and gardens, although an 1854 Berlin article recommends it for use in public parks.

The most common harp seemed to be a rectangular model which lay horizontally or stood vertically. Small harps were often designed to fit into a window sash. Also common was a wooden attachment which fits over the strings and is designed to concentrate the intensity of the wind into a channel blowing across the strings.

In 1845, the French composer and harpsichord builder Ignace Pleyel constructed a vertically standing triangular harp. This harp allowed for changes in wind direction: regardless of which way the wind blows, it strikes at least one set of strings; but most importantly, the wind will also strike the strings at an oblique angle, as Pleyel noted this to be the most ideal circumstance for best sound results. There have also been curved, cylindrically-shaped harps built on this same principle.

In addition to the conventional aeolian harp, some ingenious aeolian instruments were invented in the 18th and 19th centuries. Among them, the *Anémocorde*, which goes by the following description:

Stringed keyboard instrument invented by Johann Jacob Schnell of Paris in 1789, actually an aeolian harp controlled by a keyboard. When the corresponding key was depressed, the tri-chord strings were set in vibration by wind conducted through tubes leading from the bellows. Dynamic variations were made possible by registers, but the tone remained soft and required a slow tempo. In 1803 the instrument was purchased by the British physicist Robertson. Compass 5 octaves. Also known as *aero-clavicorde* and *aero-clavicordio* (in Italy).[6]

Also similar in concept, and perhaps inspired by the *Anémocorde*, is the *Aeolian attachment* (inventor and date unknown), which is "a contrivance attached to a piano, which prolongs the vibrations and increases the volume of sound, by forcing a stream of air upon the strings." Also, Isouard's *Piano éolian* (Paris, 1837), which I could not find a description of.

Aeolian harp building has continued in relative obscurity through the 20th century, as they continue to be built mostly by individuals working in isolation from each other. Information is scarce on these builders and what designs their harps take. Stephen Bonner makes a reference to T. Ward McCain, who constructed an 80-string, 23-foot high harp-shaped harp out of California redwood with maple, holly, and ebony inlays, and high-tension airplane wire. Built on a hill overlooking Chelsea, USA, the harp was subsequently abandoned, with McCain commenting 'I enjoy it just standing there and singing joyously, and then rotting and falling when it is right.' The harp became something of a tourist attraction, and a record album was released (United Artists UAS-9963). Then, on 19 November 1973, the Portsmouth Herald noted that it 'has fallen victim to its partner, the wind', and that 'the owner did not want it rebuilt in its present location.[3]

The Obscurity of Aeolian Harps

In subjective analysis, the relative obscurity of aeolian harps may be due to two main reasons: (i) that published material on aeolian harps is largely unavailable. The material that has been published over several centuries has either been destroyed or lost, is out of print, or has been inadequately distributed. Actually, an excellent 5-volume edition outlining aeolian harp history, acoustics, literature, and instrument design, written by Stephen Bonner and Jonathan Mansfield, published in Britain from 1970-74, is in a limited edition of 180 copies and thus only available in rare book libraries (these volumes provided much of the historical source material for this article.); and, (ii) it seems that the musical status quo has not fully accepted the aeolian harp as a musical instrument. In fact, the British acoustician E.G. Richardson even goes so far as to refer to it as a toy. However, established composers in the past have built and kept aeolian harps (Pleyel constructed his triangular version in 1845; and Sir Edward Elgar, having received an aeolian harp as a gift from a friend, constructed another one as well.)

It may be obvious why the traditional musical establishment has tended to reject or ignore the aeolian harp: firstly, that there is no standardized tuning system for the aeolian harp, and because the instrument may be sounding virtually 24 hours a day, the strings' tuning is difficult to control and maintain; secondly, the wind intensity will fluctuate without warning, giving rise to noise elements that may predominate in the timbre, over-riding the more 'desirable' or 'pleasant' tonal sounds of the strings; and thirdly, that the control of the harp is out of human hands, and is placed at the will of the wind. Perhaps this contradiction to the standard approach to orchestral instruments is too strong.

However, many musicians would consider these to be useful and desirable elements in performance and listening practice. Consequently, there seems to be a current revival in interest in aeolian harps, but, as John Cage says, "There should be one in every city in the world."[7] Such enthusiasm is shared by R. Murray Schafer, whose proposed *Soniferous Garden* features an aeolian harp. Schafer feels that a *Soniferous Garden* should be an integral part of every city, where people can come to hear exotic sounds on display in a hi-fidelity soundscape.[8]

Aeolian Tones on Telephone and Telegraph Wires

My first exposure to aeolian tones was an experience common among many people: hearing the aeolian tones along a telephone wire. It seems that communication and power line systems fulfill the basic criteria for a functioning aeolian harp: wires stretched under tension and exposed to the wind, suspended between bridges in contact with a wooden or metal amplifying system. Aeolian tones have been a hazardous problem for overhead line engineers ever since the invention of electric line transmission. Aeolian tones may cause stress fractures at harmonic points along the wire, thereby making it susceptible to failure or accident.[9] Certain preventive measures are generally undertaken to silence these vibrations: adding slack to the wire; and installing rubber dampening devices along the wire.[10] In some cases, however, the aeolian vibrations can only be minimized. Whether by error or by accident, a small percentage of overhead line sections produce audible aeolian tones. Considering the extensive layout of transmission lines world-wide, this small unknown percentage may account for a vast number of locations where aeolian tones are audible in the public environment.

In discussing aeolian tones, many people speak of well-remembered locations where they have heard the telephone or power lines sing. The writer Henry David Thoreau often made entries in his journal about a place near Walden Pond, where he would go to listen to the telegraph wire.

Sept. 3 (1851)

As I went under the new telegraph wire, I heard it vibrating like a harp high overhead. It was as the sound of a far-off glorious life, a supernal life, which came down to us, and vibrated the lattice-work of this life of ours.[11]

In thinking of the telephone wires singing, one may easily associate a vocal

THOREAU AND THE TELEGRAPH HARP

(excerpts from Thoreau's Journals)

Sept. 12 (1851)

At the entrance to the Deep Cut, I heard the telegraph wire vibrating like an aeolian harp. It reminded me suddenly — reservedly, with a beautiful paucity of communication, even silently, such was its effect on my thoughts—it reminded me, I say, with a certain pathetic moderation, of what finer and deeper stirrings I was susceptible, which grandly set all argument and dispute aside, a triumphant though transient exhibition of the truth. It told me by the faintest imaginable strain, it told me by the finest strain that a human ear can hear, yet conclusively and past all refutation, that there were higher, infinitely higher, planes of life which it behooved me never to forget. As I was entering the Deep Cut, the wind, which was conveying a message to me from heaven, dropped it on the wire of the telegraph which it vibrated as it passed. I instantly sat down on a stone at the foot of the telegraph pole, and attended to the communication. It merely said: "Bear in mind, Child, and never for an instant forget, that there are higher planes, infinitely higher planes, of life than this thou art now travelling on. Know that the goal is distant, and is upward, and is worthy of all your life's effort to attain to." And then it ceased, and though I sat some minutes longer I heard nothing more.

Sept. 22

Yesterday and today the stronger winds of autumn have begun to blow, and the telegraph harp has sounded loudly. I heard it especially in the Deep Cut this afternoon, the tone varying with the tension of different parts of the wire. The sound proceeds from near the posts, where the vibration is apparently more rapid. I put my ear to one of the posts, and it seemed to me as if every pore of the wood was filled with music, labored with the strain — as if every fibre was affected and being seasoned or timed, rearranged according to a new and more harmonious law. Every swell and change or inflection of tone pervaded and seemed to proceed from the wood, the devine tree or wood, as if its very substance was transmuted. What a recipe for preserving wood, perchance — to keep it from rotting — to fill its pores with music! How this wild tree from the forest, stripped of its bark and set up here, rejoices to transmit this music! When no music proceeds from the wire, on applying my ear I hear the hum within the entrails of the wood—the oracular tree acquiring, accumulating, the prophetic fury.

The resounding wood! how much the ancients would have made of it! To have a harp on so great a scale, girdling the very earth, and layed on by the winds of every latitude and longitude, and that harp were, as it were, the manifest blessing of heaven on a work of man's! Shall we not add a tenth Muse to the immortal Nine? And that the invention thus divinely honored and distinguished — on which the Muse has condescended to smile — is this magic medium of communication for mankind!

Sept. 23

The telegraph harp sounds strongly today, in the midst of the rain. I put my ear to the trees and I hear it working terribly within, and anon it swells into a clear tone, which seems to concentrate in the core of the tree, for all the sound seems to proceed from the wood. It is as if you had entered some world-famous cathedral, resounding to some vast organ. The fibres of all things have their tension, and are strained like the strings of a lyre. I feel the very ground tremble under my feet as I stand near the post. This wire vibrates with great power, as if it would strain and rend the wood. What an awful and fateful music it must be to the worms in the wood. No better vermifuge were needed. No danger that worms will attack this wood; such vibrating music would thrill them to death.

from **The Heart of Thoreau's Journals**. *Edited by Odell Shepard; Dover Publications, Inc., New York, 1961.*

quality to the sound. The wind is really like a breathing system, voicing itself on these wires. On my first conscious listening to aeolian tones along a telephone wire, I associated the sound of the aeolian tones to that of the collective conversations being transmitted along the telephone lines at that moment. It was a though there was an electronic chatter being amplified and broadcast from atop this telephone pole, in the middle of an empty field. This inspiration eventually led to the construction of a long-wire aeolian harp in July 1984 (in collaboration with Thaddeus Holownia, and after hearing of Gattoni's *Armonica Meteorologica*; with design consultation from Leif Brush of Duluth, Minnesota, USA.)

Gigantic Aeolian Harp

This gigantic aeolian harp has 60-foot long vibrating sections of piano wire stretched between wood structures. Presently, there are 8 strings of various gauges on the instrument, with an allowance for a total of 15 strings. The lowest gauge string is a no. 8 piano wire; lighter gauges snap under tension. The heaviest gauge piano wire presently used is a no. 26 wire. Fencing wire is also strung on the harp, and it gives a very beautiful sound. The fencing wire is galvanized and rustproof, whereas the piano wire rusts. There is not an appreciable timbral difference between clean piano wire and rusted piano wire.

The wires are strung parallel between two wooden bridges (1" x 12" x 48" pine board) 60 feet apart, that also serve as the sole amplifying soundboards. Each soundboard is bolted to a pair of 4" x 4" posts anchored into the ground. There is no soundbox. The wires cross the soundboards and angle downwards to turnbuckles which are connected to each pegboard, which in turn are bolted to additional 4" x 4" posts. The turnbuckles at both ends of each string allow for fine tuning. The structure at each end is connected to concrete anchors with guy wires, to sustain additional tension. These guy wires may be pushed and pulled to modulate the pitches of the entire set of strings simultaneously. The harp is constructed in an open field at the head of the Bay of Fundy, at Jolicure, New Brunswick, Canada. It is expected to stand for many years.

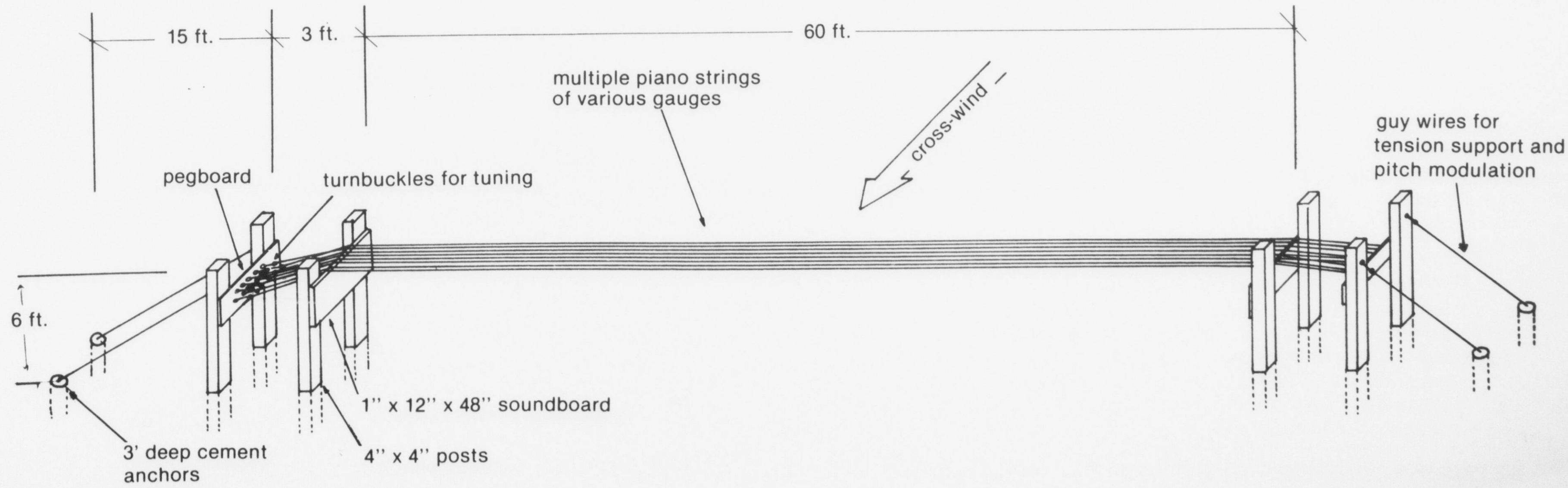
The aeolian sound can be heard several hundred feet away. At this distance, one might think that they are hearing the sound of a far-away machine, but as the instrument is approached, you gain the rather distinct impression that you are listening to a thick electronically produced sound that is emanating from some sophisticated sound synthesis equipment. Indeed, one's initial reaction upon arriving at the site is to look for the electrical wires and amplifiers. The paradox of course, is that, in design and materials, this instrument precedes the modern age of electronics, and similar sounds were heard on Gattoni's *Armonica Meteorologica* of 1783.

The long-wire harp has a sound of its own, distinct from the small aeolian harp. The small harp has short strings of about 3 or 4 feet in length, usually tuned in unison. The first few overtones of these strings generally share the same frequency range as the vortex-shedding vibrations in the wake of the string. Therefore, the aeolian music produced on a small aeolian harp will be distinctly 'tonal' in character. As well, because wider intervals are found between pitches at the low end of the overtone series, there will be a substantial number of occasions when a sympathetic vibration of the string will **not** be induced, as when the vortex vibration frequency falls between the natural frequencies of the wire. This will result in a music with a substantial number of silences, interspersed with sustained tones.

Since the fundamental pitches of strings on long-wire harps are much lower in frequency, the corresponding upper harmonic spectrum of the strings falls within the frequency range of the vortex-shedding. As the intervals between pitches are much smaller at the high end of the harmonic spectrum, there are a greater proportion of matching frequencies between long wires and the corresponding vortex-shedding in their wake. Essentially, the high harmonics are so closely arranged, that a continuous music is thus induced on these wires, and silences only occur when the wind dies away completely, or when it rains and the system becomes dampened. The aeolian music of a long-wire harp has a characterisically dense texture of high harmonics, phasing and beating tones.

As with Gattoni's *Armonica*, this harp changes expression from one type of weather to another. On a clear, dry day with a gentle breeze blowing, it will respond with sensitive crescendi and decrescendi, always on the order of several seconds delay to the ebb and flow of the wind. A crescendo will be long and drawn out, a decrescendo will be much quicker, sometimes dropping off rapidly. On a day with a substantial wind, the harp will seem to howl with distortion; on a day of rain the aeolian vibrations will literally be dampened from sounding due to wetness on the bridges; and during the winter months, contraction due to cold can create such tension, that on one occasion, a 1/4" thick metal S-hook attaching a guy-wire to the structure was straightened out in an explosive release of tension by the harp.

The aeolian harp certainly offers a dramatic performance which incorporates many elements defined in traditional music: a wide dynamic range from silence to overblown distortion, with an infinitely smooth modulation between these ranges; an infinite range of rhythmic and phasing patterns; melodies arising from fluctuations in the harmonic structure of each individual string, and of the strings as a whole; a breathing texture that is continually evolving;and, even the musical form may perhaps be seen as an endless variation that lasts for years.



Aeolian Phenomena

Yet these vibrations may be seen as more than music. The vibrations that give rise to aeolian tones also create movement in the environment and physical deposits in the land. The term *aeolian* may be used to describe many wind-related phenomena. For instance, *aeolian deposits* is a scientific term whose definition reads:

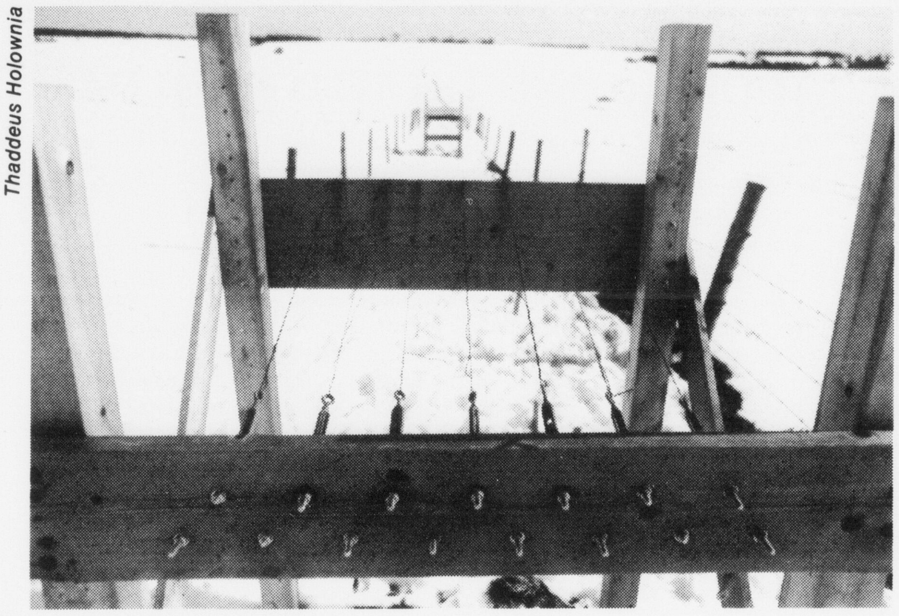
> Sediments and sedimentary rocks which are largely if not entirely, composed of wind-blown material. Desert sands are typical aeolian sediments, characterized by relatively uniform, well-rounded particles whose surfaces are usually covered with microscopic pits due to their mutual bombardment during transportation. This pitting gives each grain a frosted appearance. Wind-blown sediments frequently show characteristic cross-bedding, ripple marks (miniature dunes) and wind-faceted pebbles (*glyptoliths*). Further evidence of their origin is the absence of fossils . . . [12]

As well, Strouhal's experiments with aeolian tones also led him to investigate the whistling of wind among trees, under the name of *Reibüngstone*.[13]

Thus, the sound of wind whistling through trees, between city buildings and other structures; the movement of trees, grass, and objects in wind-eddies and wind streams; drifting sand and snow; these are aeolian phenomena. So, as a wire installation exposed to the wind gives a conscious voice to the minute aeolian vibrations which we would otherwise fail to detect, the geography of sand dunes, for instance, expresses sculptural qualities of those same aeolian vibrations. Particles of sand accumulate to form ripple waves in the image of the wind currents which displace them, and in turn, these dune formations, these *aeolian deposits*, serve to influence the contour and the form of those air streams.

To bring such perceptions to light, man builds temporary structures which interact with nature. These structures must assume forms integral with the very vibrations they articulate, and as such, they exist within the natural processes of growth and decay, and will inevitably disintegrate by the very vibrations they express. In this manner, all of man's forms derive from nature, exist within nature, and return to nature. Their structures assume a (dis)integrating form with nature, as they are consumed by nature's own expression in the aesthetic realms of music, dance and sculpture.

Thaddeus Holownia



Gigantic aeolian harp constructed at Jolicure, New Brunswick by Thaddeus Holownia and Gordon Monahan, July 1984.

1. *Webster's Dictionary*, 2nd edition, 1961.
2. However, this may be a matter more properly addressed by a general theory of string vibration.
3. Stephen Bonner, M.G. Davies and Jonathan Mansfield, *Aeolian Harp,* Bois de Boulogne, Duxford, Cambridge, 1968-74. This five-volume set provided much of the historical information found in this article, including quotations from the following: Porta, *Magia Naturalis* (Rome, 1540); A. Kircher, *Phonurgiae* (Campidonae, 1673); anonymous letter, Gentleman's Magazine (London, 1754); W. Jones, *On the Eolian Harp* (Physiological Disquisitions), London, 1781); Gattoni, *Sopra una nuova maniera* (Milan, 1785) translated by Christopher Bullen; V. Strouhal observations (1878); Portsmouth Herald (1973) on abandoned harp by T. Ward McCain.
4. Lord Rayleigh, *Acoustical Observations*, Philosophical Magazine, London, March 1879, pp. 161-2.
5. E.G. Richardson, *Aeolian Tones*, Proceedings of the Physical Society of London, Vol. 36, 1924, p. 157f.
6. Sybil Marcuse, *Musical Instruments: a Comprehensive Dictionary,* W.W. Norton & co., New York, 1975.
7. Private conversation with the author.
8. R. Murray Schafer, *The Tuning of the World*, McClelland and Stewart, Toronto, 1977, pp. 246-52.
9. G.C. Gracey, *Overhead Electric Power Lines*, Ernest Benn Ltd., London, 1963. p. 229.
10. Herbert, T.E., *Telegraphy*, Whittaker & Co., London, 1906, pp. 733-35.
11. H.D. Thoreau, Journals. (*The Heart of Thoreau's Journals*, O. Shepard, Ed., Dover Publications, New York, 1961, p. 57.)
12. *Complete Book of Science*, Little and Ives, New York 1961.
13. friction tones.

ADDITIONAL BIBLIOGRAPHY

J.H. Gerrard, *Measurements of the Sound from Circular Cylinders in an Air Stream,* Proceedings of the Physical Society, London, 1955.

E.F. Relf, *On the Sound Emitted by Wires of Circular Section when exposed to an Air-Current*, Philosophical Magazine, Vol. 42, London, 1921.

Lord Rayleigh , *Aeolian Tones*, Philosophical Magazine , Vol. 29, London, 1915.

B. Etkin, G.K. Korbacher, R. T. Keefe, *Acoustic Radiation from a Stationary Cylinder in a Fluid Stream (Aeolian Tones)*, Journal of the Acoustical Society of America, Volume 29, No. 1, 1957.

Grove's Dictionary of Music and Musicians.

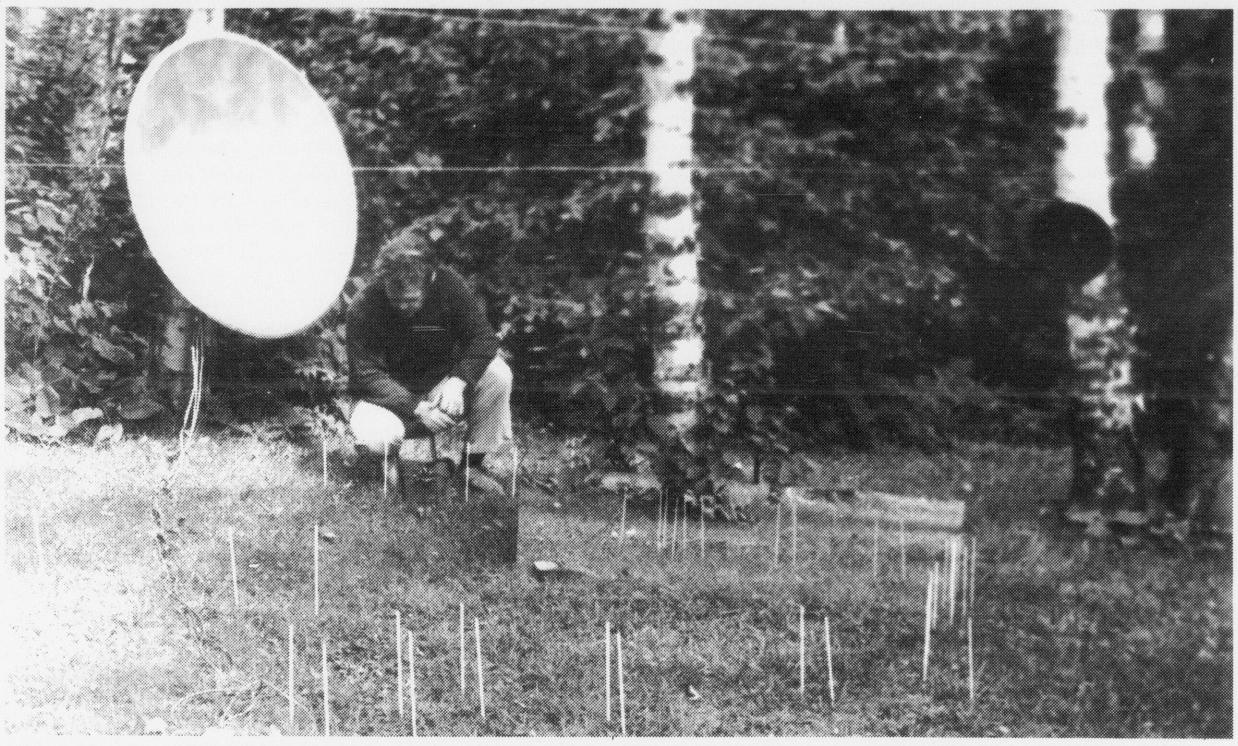
Magasin Pittoresque, Paris, 1845.

Encyclopedia Britannica, Vol. I, 1972.

PRIVATE MAKERS

Christopher Dyer (Austin, Texas)
George Fleming (Philadelphia, Pa.)
Peter Graham (worthing, England)
Jonathan Mansfield (Liverpool, England)
Robert Morley Ltd. (manufacturer), 4 Belmont Hill, London SE 13, England
Doug Holis (San Francisco, Ca.)
John Oughton, 491 Palmerston Blvd., Toronto M6G 2P2
Richard L. Raymond, Boscobel, Boulderwood, Halifax, N.S. B3P 2J2
Greg P. Joly, 2656 Mt. Stephen Ave., Victoria, B.C. V8T 3L6 (manufacturer)

Gloria DeFilipps Brush



Edge Playing, 1977 (detail). Glass rods barely touching the near-surface roots with vibrations being sensed by femto-ampere amplifiers. Main tree trunk vibrations meander down to the roots.

Music from Trees, Icefloes and Other Natural Phenomena

An Interview with Leif Brush

*Leif Brush is an investigative sound artist and teacher who has developed outdoor constructions which respond to natural phenomena. He has installed sensing devices in trees to amplify their metabolic processes and interior sounds; constructed **Terrain Instruments** sensitive to raindrops, snowflakes, air currents, and other environmental phenomena; and presented situations where audiences may interact with these devices via satellite pick-up. He is currently investigating the use of sound holography in his work. He was interviewed by Gordon Monahan at New Music America, Hartford, Connecticut, in July 1984.*

Gord: Could you explain your work with trees, and how it developed?

Leif: I don't really know where my interest in trees came from, but I've been dropping in and out of that interest for long, long time. I planted a lot of trees in Minnesota and I guess everyone does who likes that sort of thing; but until I made my first listen to a sensor that was in the main trunk of a tree, the act of actually hearing it live on the headphones bridged a gap that I wasn't able to bridge in my thinking about trees, or reading about trees or walking about trees. I wasn't able to gain an insight into trees until I heard sap-gurgles and so forth. I've been experimenting with trees for a long time now, and it seems to be culminating in a large piece that I'd like to put together. To do it I would use my 200 speaker system, where the computer is used to construct a tree with the 200 speakers. The speakers would be on the floor, the walls and the ceiling. And where the computer helps me fill in the gaps is that certain sounds from the tree can be made to appear simultaneously, faster than the ear can think, in different spots. So I can construct a tree with that technology and use all, pure tree sound, nothing else.

Gord: Before we get into more detail about that, could you explain how you're actually amplifying the tree?

Leif: Well, that developed through a series of experiments. First, it started with a stainless steel pin inserted in the cambium layer, the live layer of the bark, the living bark that rejuvenates itself. That's a straight pin that went right to an op-amp[1] that was a pre-amp. The sounds you hear there are the sounds that you can imagine. You hear a living tissue. It stretches; you hear expansion of the heat on the bark. It's a living tissue. Then I went into the main trunk itself, with advice from the Tree Reading Research Centre in Arizona on how to core a tree. This means boring a hole in the trunk and pulling out the core, and implanting a pencil-like stainless steel sensor which has pressure gauges and temperature gauges and vibration gauges. These are surgically cleaned and put into the trunk of the tree. Then the outer layer of the trunk is closed over it to protect it from insects, so there is no injury to the tree. That gave me the first interior sounds of the tree: Vibration of the tree when it was blown by the wind; the sap pressure and so on. The sap pressure is enormous in the cells of a tree when the sun starts drawing the water up through the tree. That produces a constant kind of voltage which I monitor with a pressure transducer. So you have vibration, pressure and temperature, and the temperature produces an ascending and descending kind of a scale. The sun may heat up the bark and it may reach the centre of the tree, and it may not. So that was very exciting. That was where I first heard my sap-gurgles and that was where I made a very close connection between the human body and the tree itself. Many things that I heard you can hear in your own abdomen, in your body cavity, and so forth. And then I went from the trunk of the tree to the top of the tree, thinking that there would be a frequency in the tree. I mean, the tree oscillates in the wind, so there is a frequency with all the trees so far that I've listened to. It really takes a sharp ear to spot a birch from a pine tree, but that sense came later. At first, I wasn't disappointed that a tree sounded like a tree. As my excitement grew for the tree I set about a plan to listen to the primary branches, in which I fixed string gauges and other transducers, which still amounted to making a sterilized entry into the tissue of the tree. And so I had transducers in the full length of the primary limbs. I was listening to the limbs, and then I went into the secondary and the tertiary branches, which are even smaller. Smallness has to do with pitch and frequency changes, you know: smaller, higher frequency; and then the middle range of frequencies for the secondary; and then the main trunk is the low frequency. And then out of that grew a desire to go all out, to cover the tree entirely with sensors, to hear it. That's where I ended, because I can't afford to do it.

It's almost like acupuncture. You have to have a sterilized sensor to get into the cells, and then keep that clean so it won't be electronically contaminated. To do it in the purest way you have to go through an iodized salt solution. So what you're hearing is actual tissue: tree vibrational sound; and you're not hearing any amplifying sound. And that's where it gets kind of tricky. You don't want to hear op-amp noise or wind blowing on the sensor or something. So to get the tree vibration you have to isolate the signal so there's no contamination electronically, and no contamination for the tree itself.

Gord: You mentioned that you're reading voltage levels. Are you hearing the actual sounds of the tree, or are you processing those voltage levels?

Leif: Both. You can put your ear up to a root, lay it on a root, and you can put your ear on a branch or a limb and you can hear that vibration. That's one kind of vibration. Then there's another kind which gives more sounds from a tree, and that's the voltages. Some of the frequencies in the roots require conversion to the audio range because they're 5 or 10 Hz. So there is a transformation that has to happen to some frequencies. So you get voltages as well as actual vibrational sound.

There is one experiment that I wasn't able to carry out and that is a chemical experiment: Monitoring when the sap chemistry changes. The sap chemistry can be subjected to a sensor which converts it into a voltage, and that I have not been able to do, although I know of it. And then I have that big piece for the tree which I have not done because I can't afford to do it. I just have it in my mind. It would be a full tree sound, a hundred year old oak. I would hire those cranes, where you get in a bucket, and put the electronics all over the tree, and go through a complete cycle: fall, winter, spring, summer. Then I think I would be fulfilled as far as the tree is concerned and then I think I'd leave the tree alone.

The tree connection to the human being is I think very important. I used to have an idea that if you used acupuncture, I think you could make a voltage connection between the tree and human beings, but I never investigated it any further. Connecting the tree to people with acupuncture. I used to spend quite a bit of thinking about that but that's faded from my mind. But before the tree fades from my mind I will be fulfilled, I think, if I am able to do that large thing.

Gord: Would the prohibitive cost not only be in renting a crane, but also in purchasing the sensing devices? Are they expensive?

Leif: Yeah, because I'd like to have **tree** sound. Superficially it would be inexpensive because you could use something like a crystal pick-up, but that so contaminates the sound. You hear crystal, you don't hear a moan and a groan. You don't hear the tortional twists and the sense of the tree, of getting inside the tree. **That** would be expensive.

Gord: How long have you worked with trees?

Leif: All my life. Climbing and picking cherries, swinging . . .

Gord: Similar to your work with tree-sensing, you've also listened to icefloes.

Leif: Yeah, that's very easy. Actually, I lost two hydrophones that I dropped in the water early in the season. I was thinking that they would be frozen in place and I would be able to find the connector, connect it and have a nice time, but I didn't.

Gord: Was this in a lake?

Leif: This was in Lake Superior. I walked out and out and out to get on the icefloe. What I had to do was to bore two holes, put transducers in one hole and cable myself back to the Nagra[2] and then go way over there to another hole and again cable myself back to the Nagra. And I had two international red flags because I had a steel wire suspended above the icefloe to catch beautiful blown snow. *Boom boom t-t-t-t* on it. And so the recording began, and it was just phenomenal. If you could hear the process of freezing, of contraction. If you could hear the amplification of slushing, water movement. It's all there. It's a visual image that someone who knows ice, icecubes, can relate to slushing water, can relate to tortional bend, can relate to the phenomenal, frightening icecracks which are just like ligntning. It's a *Crrrhaa*! And they just splinter out.

Gord: You say that you lost some hydrophones? What happened?

Leif: Well, in entering into Lake Superior you can go out on rocks and then there's a drop-off and at one particular place I put the hydrophone, and suspended it with a buoy. The icefloe is roughly something like a foot thick and I dropped it in about six inches, thinking that it would be frozen in place when I came back in March. I lost it, but I got the recordings I went for. I'd like to do it again,perhaps in Baffin Islands, where I've been before. Now I know how to do it. You have to drill a hole with an auger and then put the transducer in there and fill it with ice and figure out some way to keep the snowmobilers off of it, and then get away from it, sit down in your tent and let the Nagra roll. And you have some spectacular recordings. They're coming off the horizontal icefloe but they relate to a lot of other sounds that we're so familar with. I have found a lot in nature. Now I have to find ways of producing it, coalescing it, getting it together. Or in some cases, I'm very much interested in substitute sounds because sometimes you're looking for

1. *Op-amp*: operational amplifier.

2. *Nagra*: a portable open-reel tape recorder.

something and you can't find it. There's a whole repertoire of substitute sounds. If I'm interested in cobblestone-road-sound, I could very easily think up a substitute sound that will suffice. So I also spend a lot of time with substitute sounds. One sound sounds similar, is in the family of another sound.

Gord: So you really are in a period now, where you're interested in creating sound pieces?

Leif: Yes. I've tried the natural sound, the man-produced sound, and the artificial or the synthesized sound in various performance spaces. I'm familiar with collecting them, what they sound like and how to get them and whether to incorporate dance or theatrics, and whatever other ingredients are there. And I guess I'm heading for more cohesive works. On one occasion, I tried presenting the tree in a lasar soundpiece in Chicago. However, it was really a disservice to my own discovery about the tree. All my experiments with tree limbs, and mixing a limb sound in with some other *Terrain Instrument* sound is really off in the wrong direction. And so I'm concluding that I can't mix the tree with anything else but trees. If there's some particular sound from the tree or limb or leaf or branch I can turn to it, but to do something which involves the tree in a major way, I would really like to present just the tree.

In other situations, I would just shop around for the sound that would satisfy a particular piece that I have in mind. It could be a thunder and a percussive piece combined, and then from my experience of how to get thunder, from my experience of how to transduce the skin of a drum, I would put all that experience together and I would tailor-make these sounds that I've been shopping around for, and discovering and experimenting with for ten or eleven years, and put them to some real hard use. Performance pieces that begin and end, and that's it.

I've always been on the make for sound and been on the lookout, but now I know what's there. I know what's in nature. I know how to get it. I know how to modify the instruments. I know how to make instruments. And I know who to contact if I don't have the sound and they have the sound. And I know that any piece that I will do, whether it's a 'begin and end piece' — and they must — I know that it will have the ingredient which I feel is essential in a piece: that it gives up where it came from, it gives up where it's going, and it also gives up what it is. It has those three ingredients in it. And I'm convinced that works that I do, that I commit to begin, and I commit to end, they'll still sound like running water. I mean they'll still sound the flow. They'll still sound like they're connected. They won't be isolated. That's a very tough challenge that I have for myself, but it's ingrained in me and I think I do that automatically. That's how I judge any piece, putting these things together.

Gord: You mentioned the *Terrain Instruments*. Does that include the one with the large pane of glass with sensors on it?

Leif: Yes. That's another way of getting sounds from the forest. Instead of taking a microphone, you can remove a large pane of glass from a window, set it out, and carefully suspend it so it's isolated as much as possible, and it's an alternative to a microphone.

Gord: Are you planting sensors on the edge of the glass, or in the middle?

Leif: Right on the edge.

Gord: And the glass becomes a diaphragm, a sounding diaphragm?

Leif: Yes, you could use it as a microphone or as a low frequency speaker. You can't fire up the speaker too much or you'll break it, but you could set up a rumble. The largest pane of glass I used, believe it or not, I abandoned and left outside suspended in between trees. It went through all kinds of rain and the only thing that did it in was the tree dipped, low, one time and it hit a rock and it splattered. But it had been up almost six months. It was just amazing. I just got so used to that pane of glass hanging out there. Mosquitoes, insects hitting it; no birds though, because they could see the reflection.

Gord: What kind of sound did you get from it?

Leif: You get the resonance of the glass itself, and any body: insect, mosquito, ligntning bug, that passes or hits it, that activates the pitch of the glass. So you may be a glass-lover and like it and use it. But it's glass. It's a glass sound. Then you have vibrations, too: Birds nearby; No airplanes though. So it discriminates, fortunately, against jet planes and car traffic and this kind of thing. Just proximity sounds.

Gord: Could you describe how your *Terrain Instruments* developed?

Leif: Well, I started out thinking that all my sounds were going to come from nature. And I tried as many artforms as I could to test and to use those sounds: dancers in the landscape; nature being amplified and fed back to nature through speakers in the trees; transmitting nature, like that icefloe across country from Minnesota to the University of Chicago via satellite and presenting those sounds in a concert. And then from that I moved into making instruments that I put in the forest. And so I made a jump from natural sounds, and the *Terrain Instruments* were born. There are many kinds of configurations, they are primarily interceptors of nature. They are instruments that can be played by either the wind, by rain, or by people. The *Terrain Instruments* are passive instruments, for listening for wind or snow, and all the natural phenomena. There have been many varieties for wind, rain and snow and they became instruments while the wind was blowing. They could be played by two people with some grass stalks. They could hum or touch the surfaces. So they could play along with the wind. so those are both passive and participatory kinds of instruments. Those are the ones that were used in a piece where there were sound artists in the wind, playing these instruments in Duluth, and then David Garland and some other musicians in New York had their own homemade instruments and their electronic gear, and they had earphones on, and so they were interacting with this. That was a satellite piece. And so the instruments, while dumb, served a purpose. But they were limited by being metallic, and limited in so many other ways, so I'm recycling those now. They've been recycled many, many times and been re-used in different configurations. Now, I think I will concentrate on more intelligent machines that will do things; that will be solar powered, battery-standup-backup-powered. Commands could be given to them. Commanding such and such an instrument: Do something; turn on; turn off. So I'm going to more intelligence. Intelligence which is manipulated by myself and by someone else with a telephone, and that's where the satelitte thing comes in. I'm tired of doing these things myself. I would like to make them available to other people to do. The instruments are large public-work pieces. They could be monuments, taking the place of monuments. They could be up for ten years. I don't think they should be up for any longer than that because that cuts across generations, and one generation doesn't like the succeeding generation's stuff. So they should have a limited lifespan. But they should be public monuments that people can turn on from their telephones at home, feed their hi-fi's, make recordings, whatever. So my thinking once again goes back to large-scale pieces that are public pieces that people can pirate stuff from, that people can try, and that people can understand. Because a lot of sculpture, a lot of new music, a lot of sound that's being produced, no one has access to. By not having access to it they don't participate in it and they don't believe it. And so participatory pieces, like the one I did in May 1984, where the audience had a microprocessor and a keyboard and little speakers during the performance. They could, with the instructions from a xerox sheet, pull one sound that they liked and put it right there; pull another sound and put it right here in front of them. That's the direction I'm moving in, is audience participation.

Gord: So in that particular case the audience had a gamut of sounds that they could choose from?

Leif: The sounds were on the floor, the ceiling and the walls, and they could pull in any sound, and put it right there in front of them, and it was right in their lap.

Gord: So without moving they could focus in on different parts of the sound by bringing it to them?

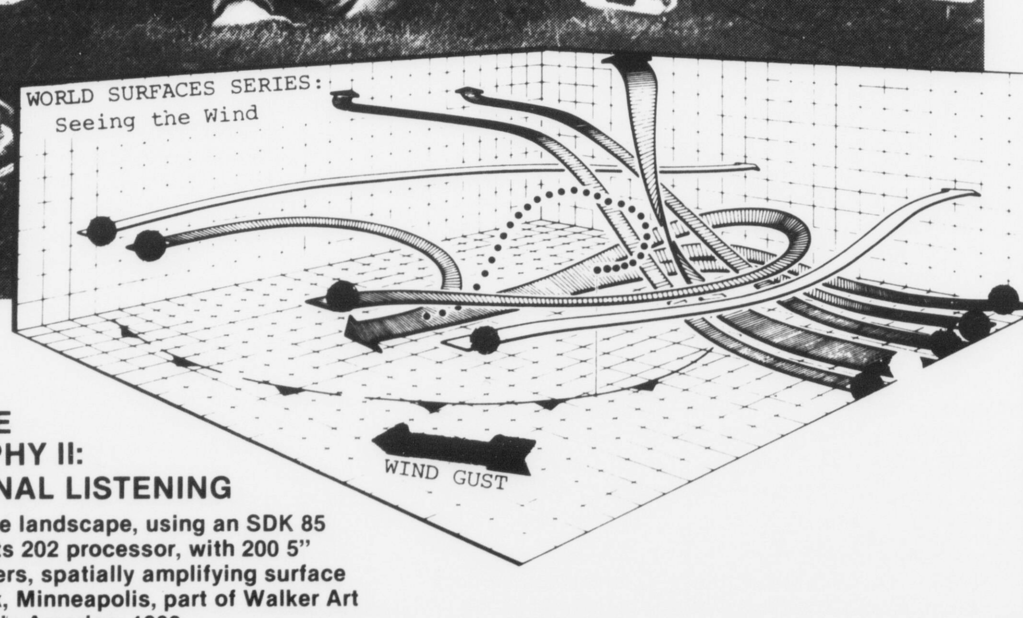
Leif: They could examine the sound, and in effect, compose, right there from it. And that's the most exciting thing. Audience participation has been a question for me for a long time, and this is my solution. It's a tricky and touchy question for performers, as a lot of people could care less about turning it over to the audience. But I'm not turning it over to the audience, because I have an over-ride control. If someone is sabotaging it, I can just cut him off. But if someone is making a contribution, if someone is learning, if someone is helping out and participating, then that's a connection that a lot of performances don't make.

Gord: Could you describe your satellite broadcasts?

Leif: The first piece was the icefloe in Chicago, and that one used Oscar 4 satellite which is a ham radio operated satellite.

Gord: And was that the icefloe that you had the hydrophones in on Lake Superior?

Leif: Yeah. That was the one. That was the first one. I'd never used it before and so transmitting a known kind of sound-body, which everyone could identify, was easy to transmit. But then when I started the trees, the nature, and the *Terrain Instruments*, they got a little more complicated. You had to structure it different. But each of the satellite pieces had specific challenges. One was the transmittal of the body of ice. Then I went into dancers in the landscape. Then I went into transmitting and mixing trees from Duluth with trees from Loring Park in Minneapolis. So the performances have examined the feasibility and the difficulties that are inherent in transmitting a simple pattern of



TERRAPLANE CHOROGRAPHY II: INTERNATIONAL LISTENING

A soundwork in the landscape, using an SDK 85 Terrain Instruments 202 processor, with 200 5" paper cone speakers, spatially amplifying surface winds. Loring Park, Minneapolis, part of Walker Art Center's New Music America, 1980.

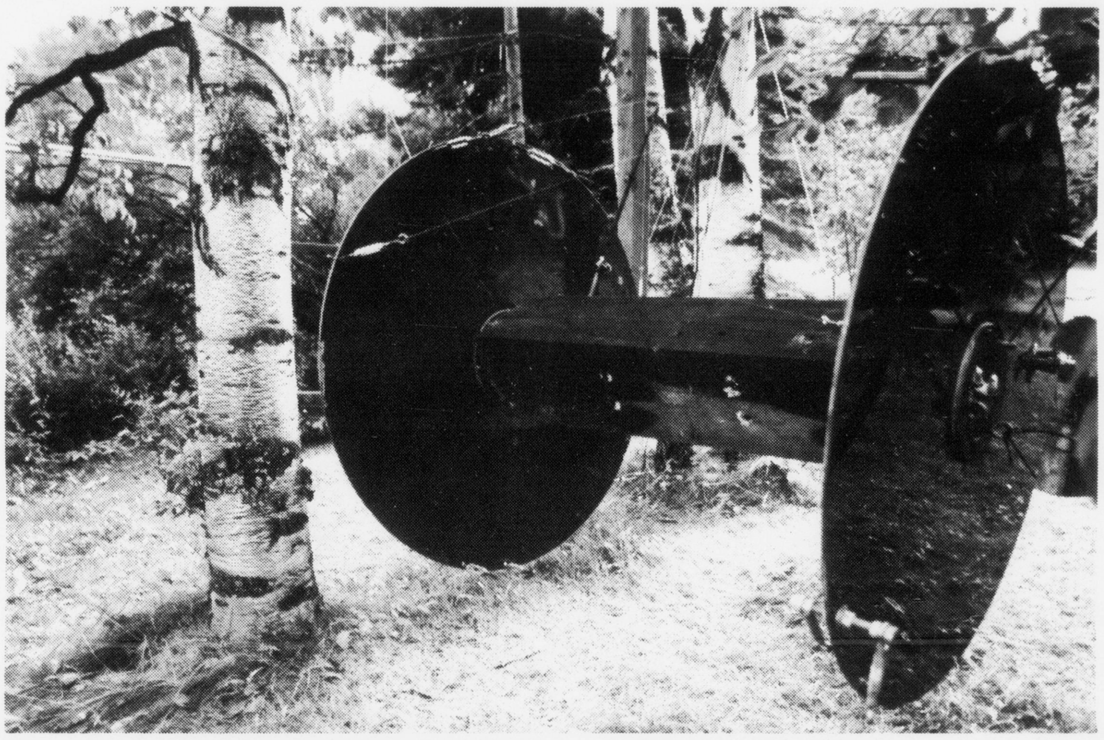
sound, complex patterns, and mixing nature and instruments. And concluding with this piece here (at New Music America 1984, Hartford, Ct.), where semi-intelligent, simplified commands are sent to the transmit site: to turn on certain functions, feed the synthesizer, tape-recorders cued, tape recorders start and stop and fade and turn up the volume, turn off the volume, stop, and switch to the next one; concluded my series of robotically controlling sound sources from one part of the world and sending them to another part of the world.

Gord: As an artist who uses science and technology, how do you feel about the separation that has evolved between science and art, and do you think that art and science are merging together again?

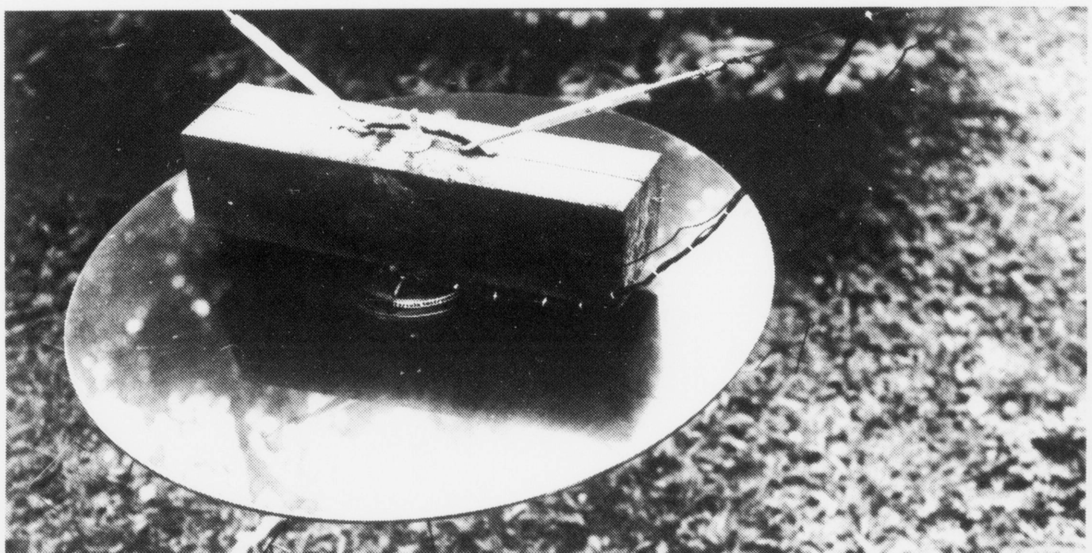
Leif: I think the visual arts have been very foolish in separating in the first place, and not recognizing that investigation is extremely beneficial if there are two heads, three heads. To treat things in a strictly visual art way or a science way is really stupid, and so I'm just acting in the way any curious individual would. If the resources aren't in the visual arts, you go where they are. There are connections. If a road leads someplace — even it it's not a road — if a field leads some place, the two different disciplines are there anyhow, but everyone is doing their damndest to keep three separate doors, when the doors should never have been created in the first place. It's really a downfall. It's one of the problems that has kept art in a stalemate for years. Because they're content to just be happy with investments and to protect the investments, the 30 million dollar sculptures, and the 10 million dollar paintings and say, That's it. Let's collect no more. That's art. This is it, this is your heritage, new generations. This is your heritage. But it ain't. And the new generations: even in the sixties, they didn't stir up very much. Generations are still eating a lot of unprocessed raw sewage. And there's not oxygen being supplied to the system, and you know what happens with that? It's decay, it's rot, it's incest, it's contamination and it's robotics. People can wear different kinds of shirts, but inside they're all the same. And closed doors cause that kind of stuff. Yeah, it's been a real pain, because I have to defend lots of times, why I'm doing it. I say well hell, you **should** be doing it, if **you** don't have any answer there are dozens of other people around. Who cares what the category is. If you need it, seek it out.

Leif Brush is a teacher in the Art Department, University of Minnesota-Duluth School of Fine Arts, 317 Humanities Building, Duluth, MN, 55812, U.S.A.

Terrain Instruments
By Leif Brush



Treesway Cluster (detail: Vertical Treesway). This may be played by one person standing on either side of the discs. They may wear headphones or choose to be enveloped in the magnesium disc's vibrations.



Terrain Instrument Signal Disc (detail). May be played but is reserved for rain, filtered by the overhead birch leaves.

The *Terrain Instruments* began as prototypes in 1968 and have appeared as more conceptually complex outdoor installations since 1975. The *Permanent Forest Terrain Instrument* in Duluth, Minnesota, functions as a primary research site. It encompasses various sound events within 400 square feet of space through a series of detailed electronic monitoring configurations and physical constructions. Many of these instruments are meshed and woven in the air through a variety of types and gauges of tunable brass and steel wire strands suspended between tree clusters.

The *Signal Disc, Treeharps Networking, Treesways, Wind Ribbons, Rainpattern Tree Filters, Snow Pixel, Groundswell (modulated) Laser,* and *Whistlers* each occupy a portion of the total forest space to pick up the intermittent phenomena. For example, the *Whistlers* are made of six aluminum and copper tubes, from five to twenty feet in length, with diameters varying from one-half to two inches. Four are freely suspended in proximity to one another by plastic-coated, braided cables, which are anchored from trees approximately fifty feet apart. Two additional tubes are attached with I-bolts to a five-by-six-foot pine block, also suspended between trees. Several wire pigtails of 0- and 22-gauge steel are securely bolted to the wood. They serve, with the tubing, as principal collection points for sound. The circularly twisted pigtails allow more raindrops or snowflakes, already influenced in their fall patterns by branch and leaf cover higher above ground, to produce sound.

The electronics used to hear the *Whistlers,* primarily a wind monitor, include a variety of force, vibration, acceleration and strain-gauge sensors, positioned in selected locations on both wooden and metal parts. The transducers are affixed to these surfaces with silicone rubber adhesive as weatherproofing, and the wooden parts are given an initial hot wax protective coating. The output of these sensors is connected directly to femtoampere, differential or op-amp amplifiers.

Another configuration, the *Signal Disc,* couples a similar pine block with a magnesium computer storage disc. Suspended together between trees, the entire assembly is about five feet above ground. Five wire pigtails are bolted to the underside of the disc and extend beyond its periphery.

Precipitation first passes through the filter of the forest tree cover, then reaches the broad magnesium disc surface, and occasionally reaches the pigtails. Accelerometers and strain gauges monitor the concussive precipitation; the amiplifiers are similar to those used on the *Whistlers.*

An unusual feature of the *Treeharps Networking* is a splayed array of gauges of strands that move off several horizontal blocks, positioned high in trees, to other blocks, nearer the trunks of neighboring trees. Wind then oscillates both the strands and the opposing trees, causing the instrument to 'play' itself. In the *Snow Pixel,* ultrasonic transceivers detect snow and rainfall, and helium-neon laser transceivers detect earth movements. Fluffy, slower snowflakes produce sounds that differ from the harder crystals.

Each *Terrain Instrument* configuration is designed to respond to specific environmental phenomena. The individual insrument arrays themselves change, subject to my periodic restructuring, recycling of parts, and extensions of purpose. The constructions are functional but harmonious with the larger natural environment — nonobtrusive linear and massed detailings of wood and steel. Heavy, clear plastic tubing is used to shield the cable support systems to minimize any damage to the trees.

excerpt from *Monitoring Nature's Sounds with Terrain-Based Constructions*, by Leif Brush, printed in *Leonardo*, Vol. 17, No. 1, pp. 4-7, 1984.

Dreams of an Instrument Maker

By David Rokeby

Instruments have always been, to some degree, an important part of the compositional process. In writing music for the guitar, one must take into account the nature of the guitar. Each instrument encourages different approaches. To some degree, all guitar compositions have drawn on something that has always and only been potential within the nature of that instrument.

Three cameras are set up in a room in a triangle facing inwards.

The instrument maker dreams . . . During the day, as he designs and makes his instruments, he dreams of the music that they will play . . . feels their potential as they sit silent on his racks.

He wanted to be a composer. His head was full of musical ideas but he had difficulty translating what was in his head into music. After several years of struggle, he gave in to the urgings of his friends, who had always admired the instruments that he made as a hobby, and he became an instrument maker.

Digital synthesizers and the computers that control them have given composers previously inconceivable control over sound.

The cameras are connected to a computer.

These instruments present new kinds of problems.

The instrument maker dreams. At night he dreams of instruments. Fantastic extensions of his thoughts and musings, these instruments weave their musics around his dreams. He wakes up with his heart beating furiously . . .

Technology encourages the exploration of entirely interior universes. Computers are an odd sort of rational dream machine.

The computer analyzes any movements that take place in the field of vision of the cameras.

The first dream of the instrument maker: He dreamt that he had created an instrument that sat on the head, a bit like a large crown. It was capable of producing any imaginable sound. Any sound that occurred to him would instantly be played by the instrument, any combination of sounds . . . any music.

Unlimited control can be distracting. Trivialities can become obsessions. Structures can very quickly and easily become complicated, obscure and self-referential. New sounds are created in profusion but lose their meaning. Power corrupts . . . Somehow, some of this control must be given away.

The computer perceives the location of people; it perceives how much of their body is in motion; the relative intensity, suddenness, or continuity of their movements; and the locations of greatest activity.

Unless one has an absolutely clear idea of what one is trying to create, it all becomes a meaningless game played in an electronic playground.

The second dream of the instrument maker:

The easiest solution to these problems is to fall back on conventional approaches to writing and producing music, but this ignores the exciting challenges which these new instruments present.

In this dream he holed himself up into his studio for weeks in an attempt to complete a new instrument. As he worked, he whistled a tune which he had always intended to develop into a musical composition.

He used patches of his own skin, locks of his hair and sections of bone from his limbs as sound sources. When it was finished, he took it and presented it to a local composer. The composer began to pluck, scratch and hit it in order to discover how to play it. But no matter what he did, the instrument played variations of the piece the instrument maker had been whistling.

The unique abilities of these instruments seem to propose a new approach to music, which would use to full advantage their unique potential. By this I do not mean the invention of new structural systems, or complex mathematical tunings, but a renovation of the relationship between music, the composer, and time.

The computer interprets the movements in the room and translates its impressions into sound using a specially configured digital synthesizer.

For me, the composition of music has always been an affectionate struggle with time. But digital synthesizers have changed one's relationship with time, by turning it into a freely manipulable substance. This dissolves much of the creative tension involved in the act of composing. At the same time, it creates a new challenge, but this challenge must be approached from a new direction.

He dreamt again: he dreamt that his wife was pregnant, but what she gave birth to was an instrument. Playing this instrument was rather strange. It did not seem to require any technical skills, yet it was not an easy instrument to play. Like a snake, it would coil itself around the hands that tried to play it . . . You had to wrestle the music out of it.

An instrument contains a large number of simultaneous sound possibilities. Conventionally, music is an established sequence of these possibilities strung out through time. Somewhere between music and instrument there exists the possibility for a kind of labyrinth of sound, where there are many possible paths through one composition . . .

The music is created and played simultaneously with the movements it is related to.

The challenge ceases to be the molding of sound as it flows through time. The challenge becomes the creation of a music outside of time . . . a music of suspense, of potential sounds waiting to be drawn into time by functions of time (such as motion).

The instrument maker dreams. As his dreams expand, his instruments begin to reflect those dreams. Just as music sat in potential in his head, it sat in potential in his instruments. And as this process developed, the potential for music that existed in his instruments resembled more and more closely the galaxy of possibilities that swam in his head.

The instrument becomes a volatile composition which is revealed through exploration and changes within its character in response to external forces. The lines between composer and instrument maker, between listener and performer, become blurred.

This installation is a composition of musical potential . . . both an instrument, and a musical composition which exists outside of time. The composition is transformed into music through physical exploration of the space. In a sense, the installation is music experienced through space as well as time.

The music becomes a function of both the inner world of the creator's personal vision and the outer world of physical reality. Each are drawn into a creative relationship with the other through the mechanism of the instrument/composition.