A Guide for working with Piezo Electric Disks to introduce Children to Issues of Acoustic Ecology and Sonic Creativity

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The proliferation of COMMERCIAL MUSIC makes it difficult, if not impossible for children to appreciate issues of ACOUSTIC ECOLOGY, or even become exposed to contemporary music and sound art. Teaching strategies and processes must be developed that encourage children and teenagers to explore their own sonic creativity. While enabling them to 'discover' acoustic ecology, and newer forms of music, they will also explore relationships between the Arts and the Sciences. This paper suggests a practical approach to initiate Study Units in the schools which combine Audio Art and Science that will engage students in making their own transducers. Students will use these to explore their own sonic creativity, which will lead them to a beginning intuitive understanding of some issues in acoustic ecology. The four study units are deliberately open ended allowing students to begin to engage the process of working with sound.

Since the mid 1960's I have worked with many different kinds of contact microphones. In 1977, I began to work more specifically with piezo electric disks to make my own transducers and microphones. I have deployed them to record sounds and vibrations in bicycles (my piece **Travelon Gamelon**), wind harps, plants, boat anchor ropes, rocks, cactus thorns, heat expansion in metal, spider webs (with limited success), attached them to many kinds of self-built and traditional musical instruments, and even used them as loudspeaker drivers to induce sound into metal and glass sculpture. I have conducted workshops with children who have developed their own sound sculpture using these devices. I believe there are still many yet-to-be discovered sonic possibilities using these materials and that children would find these intriguing devices to explore sound.

There are three primary virtues of piezo electric disks:

1. they are their very sensitive & because they are high impedance, they work well in a wide variety of equipment.
2. they are rugged
3. they are inexpensive (less than $1 US each)

This paper outlines a process whereby students can learn to:

1. make these devices,
2. deploy these to make their own recordings using a wide variety of recording devices ranging from cassette recorders/boom boxes to DAT recorders, and from consumer video camcorders to more professional video cameras.

These recordings can be used to support student based projects on acoustic ecology or sound mapping, to generate student created libraries of sound samples for music or media projects, and/or provide the raw material for making sound collages. While there is not sufficient space here to elaborate on how to make electronic equipment to support these devices, it is a logical next step and doing so will engage students in simple mathematics which has the added benefit of making these mathematical concepts less theoretical. I am happy to email these schematics along, should persons be interested.

For older children, it is possible to engage them in soldering activities (there are non-lead based solders available) but for younger children and those not wishing to solder, I have developed a way to use inexpensive hardware to attach a shielded audio wire to the piezo disks. Also note that for small children, the piezo disks can be operated directly into small battery powered amplifiers with minimal audio feedback problems. This will allow them to explore 'sonic' and 'physical' textures simultaneously, without making recordings.

Following is a beginning 4 class unit of sound exploration, which provides construction diagrams for making contact microphone devices (one using solder and one solder free). Sources for the piezo electric disks are also given. Classes are assumed to be about 45 minutes to one hour in length.

Unit One

I will use for this model children aged 11-14. This is the age of Middle School in the US. I taught this age group for 3 years from 1969-1972. I found them to be curious, energetic and very eager to engage in the process of exploring and making things. They are also old enough to work with tools and wires. Given the right kind of equipment, they could also construct battery powered amplifiers.

I. It is important to raise children's curiosity about Piezo electric materials. And This can be done with great effect by playing for students some video and audio clips. This should immediately be followed by a discussion offering a few simple facts, which will then raise further questions. I would begin by playing some sounds and having them guess what they are (by writing down their answers, and then showing video tapes, first silent and then with the audio.

Here, several examples of about 1 1/2 minutes from my work I would play:

1. a windharp in the rain in Newfoundland, Canada
2. ants with piezo disk on the Sonoran Desert
3. South Point (Hawaii), boat launch in the wind
4. grass at South Point
5. Cactus in the rain on the Sonoran Desert

The discussion for this first unit would then begin and consider what sounds they thought they heard, and what kinds of sounds they expected to hear after seeing the video tapes played silent. The teacher should then mention that these sounds were all recorded with a simple electronic device that costs about $1 US. This material is called a PIEZO ELECTRIC DISK. The teacher should add something like, "And we will use them to explore sound."

Some facts about piezo disks follow:

a. They have the same internal crystalline structure as magnets, but they behave differently
b. We hear them almost every day--They are used in contemporary life in most beepers, alarm clocks, phone 'ringers' and buzzers. They also can be made into special small cooling fans. Many musicians use these kinds of materials to amplify their instruments.

c. when they are used to record with, they are similar to our ears. The human ear drum gathers sounds because of vibrations in the air. Piezo disks do the same, but they work better when they directly touch a material that vibrates.

The unit might end with the teacher saying something like, "If you have ever wanted to listen to sounds around us that are often too small for us to hear with our ears alone, you can do so with a piezo disk. We will learn to make a piezo disk into your own recording device."

BELOW IS A DIAGRAM WITH SOLDERING INSTRUCTIONS FOR MAKING A CONTACT MICROPHONE

How to Solder a Piezo Disk and make a Contact Microphone

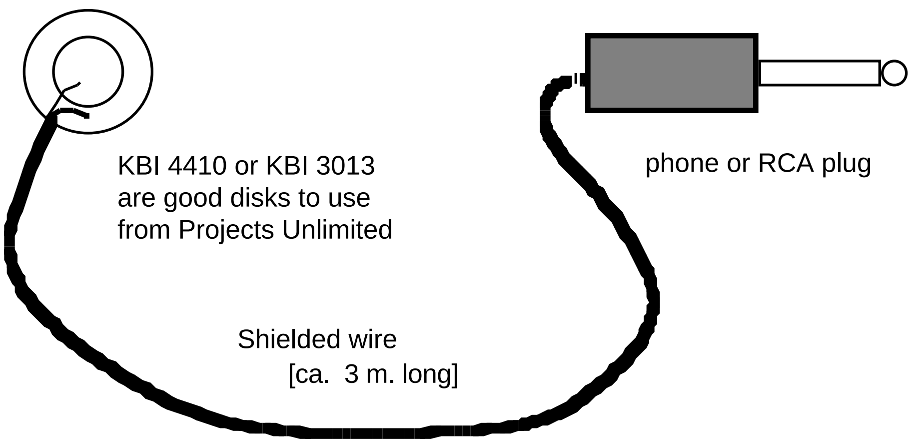
Richard Lerman

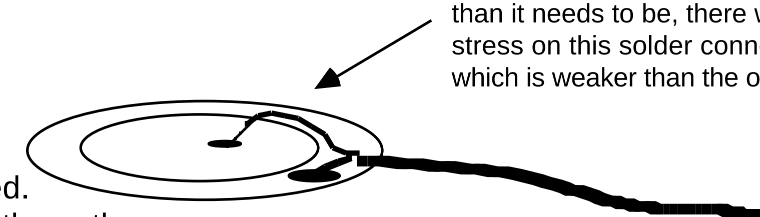
Note: Piezo Brass Disks or 'benders' are available as surplus

In the US, the best current source is:

Projects Unlimited
3680 Wyse Road
Dayton, OH 45414
513-890.1918

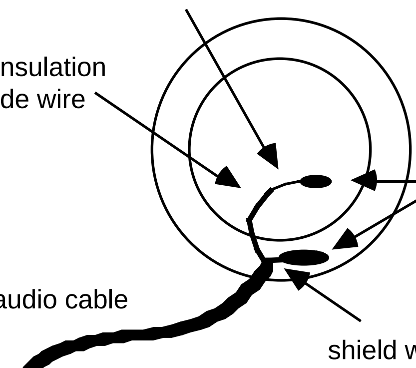
other sources are All Electonics in L.A. & Radio Shack/Tandy





SOLDERING DETAILS

1. Tin both the inside or "hot" wire and shield
2. Apply a small pool of solder about 12mm x 4 mm (1/2" x 1/4") to the brass for the shield wire
3. Hold tinned shield wire on this pool with soldering iron. Tinned shield will flow into the solder pool making both a very strong solder connection and strain relief
4. To solder onto piezo ceramic, you must use a very clean soldering iron--about 20 watts maximum
5. Apply very small pool of solder to the piezo disk
6. While holding insulated wire, reheat solder pool and put tinned end of wire into pool.



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Students should work in groups of 3-4. They should be instructed to wear older clothing, and if working with lead based solders, to keep their hands away from their mouths. After the class, they should wash their hands. They must also be informed that the soldering irons are very HOT.

Each student will need the following:

1. a piezo disk
2. a 1 - 2 meter long piece of shielded wire
3. an RCA (CINCH) or 1/4" phone plug. (It has been my experience that RCA plugs work well, and then one can purchase an adapter that goes from RCA to 1/4" phone or from RCA to Mini phone for about $1 US.)
4. a piece of thin rosin core solder about 9 inches (25 cm.) long

The 20 watt soldering irons and wire stripping tools can be shared. When students are stripping the wires, it is important to demonstrate to them that they should not cut too deeply into the wires, which will weaken them.

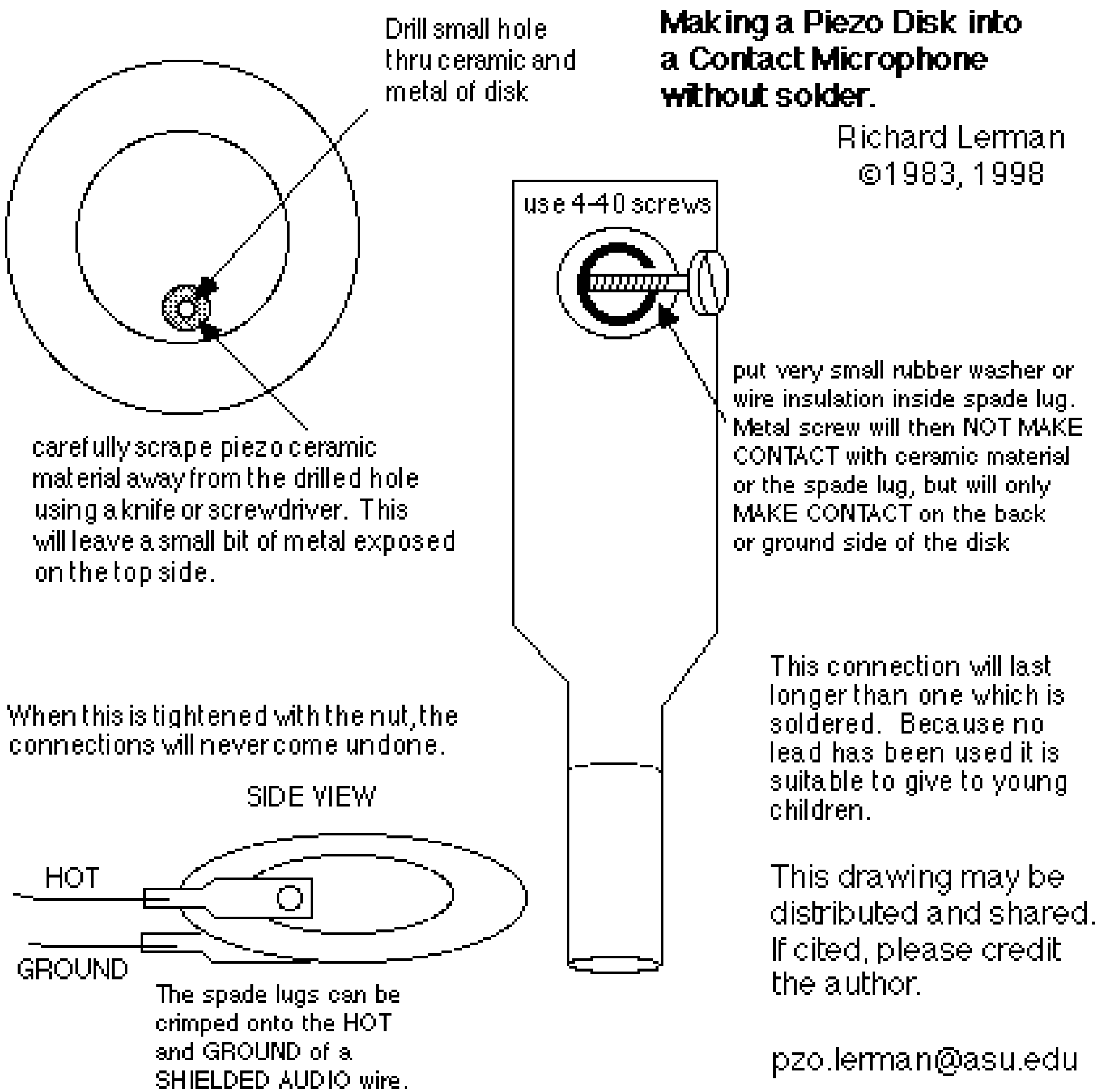
Adult supervision is needed, and/or the teacher must identify those students (or older children) who know how to solder to assist. Plan on this being somewhat chaotic, but it ought to be treated as any other art project or science lab. This workspace must also have some kind of audio playback system so that the disks can be checked out when soldering is completed.

> IMPORTANT: Piezo disks when amplified can be very loud, so the volume on this system should be kept low. My suggestion is to run the disks into the amplifier at LINE LEVEL. This will be enough gain to insure that the work is being done correctly. There are 3 possible results.
>
> 1. No sound at all, denotes a short. Either there has been a short in the soldering or wire stripping process. Go back and check the work visually. IF the problem cannot be seen, cut the leads off and do it again.
> 2. A 50 or 60 HZ hum. Probably the Ground and Hot leads have been switched either at the disk end or at the plug end. The solution is to find the end which has been soldered wrong, unsolder that end and repair it.
> 3. One will hear a clean and healthy 'clink' when you tap the disk on the table surface.

At this point, if students have brought, or the class has access to a recording device, some might begin to experiment recording things with the disks. Again, expect it to be noisy. Direct the class into a discussion. Caution students about loud headphone use with these disks, and the potential harm from loud sounds.

As the class ends, other experiments might include taking an LED (a light emitting diode) and see if the diode lights up when it's leads are attached (use tape) to the piezo disk, and the disk is struck on a hard surface. When the disk is tapped, you may also measure the voltage using a voltmeter. It is best to use a low voltage AC (Alternating Current) setting for this. The needle or readout will move very quickly. Simply use the meter probes to touch either side of the piezo disk.

For persons not wishing to work with solder, because of its lead content, the diagram below provides instructions for making a solderless contact mic from a piezo disk. This will require some work in advance to prepare the ceramic surface on top of the disk.



Unit Three

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This phase offers a process for students to use the disks in the field and to make recordings with them. Recordings can be accomplished using a full variety of media equipment including boomboxes, cassette recorders, video recorders, etc.

I. Small spring clips should be given out for students who may wish to use them to attach the disks to various objects/plants, etc. Begin this session by attaching a clip so that it touches both the back brass part of the disk and the front ceramic part of the disk. This will cause the audio to stop completely and will illustrate what happens when the disk shorts out. They will understand empirically that they must use care to NOT short the disk out when they record. With plastic or wooden clothespins, this is not an issue.

2. Have students make a list of several things they wish to record. Expect things like plumbing, cars, themselves, etc.

3. Have them come back after about 15 minutes so there is ample time to playback and discuss the results. This might include a discussion of adjusting audio levels and getting the sounds to 'improve' in quality.

4. Have them discuss what has surprised them and then make a list of things they want to record better or explore the next time.

5. Assign them some things to record in addition to the many suggestions they will receive from their peers.

Unit Four

1. Listen to the new recordings in class (which they made the past week). Discuss the nature of vibrations and why hard surfaces are easier to record than are soft things when using a contact microphone. (For older students--why does a hologram of stale bread look different than one of fresh bread??)

2. This may lead to a discussion of what an 'air' microphone is and how a contact mic and air microphone both relate to the human ear.

3. Begin to mix, edit and orchestrate their pieces. This can be done using electronics to mix to tape. Alternately, I suggest taking many of the playback units to a large room (like the gymnasium, or auditorium) and playing the tapes back in that large space. Encourage them to walk around and listen. Encourage them to make a score for playback.

4. If there is a computer available, get some of these recordings into the computer which can lead to further discussions of sampling, editing, etc.

5. Websites employing techniques and theories concerning audio can be gathered for future research by these students. Later units, and those for older children would include some very basic circuit design.

The Units I have suggested here are designed to engage the curiosity of a wide range of students and treat them with respect. My suggestions are open for change, collaboration, and discussion. My firm position is that we must find ways to emphasize and embark on practical considerations in addition to the already abundant theories and critical studies in the realm of Soundscape.

By linking an introduction to Soundscape and Recording using piezo disks with some basic elements of scientific data gathering and observation, a viable, perhaps even 'subversive' strategy, is being suggested to introduce some WFAE concerns into educational systems around the globe. Where I live, the arts have been cut back drastically. Young children and teenagers are often only exposed to commercial radio, and television for their sonic education. It should be clear to us that we would rather have younger generations appreciate all that Acoustic Ecology implies by design and curricular innovation rather than by the accident of discovery. I encourage others to enter into this discourse, and to extend the efforts of their research, expertise and knowledge to younger generations.

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