

























## Key to symbols used in this book

S	source tape
M	master tape
W	work tape
L	loop
	tape recorder in playback mode
	tape recorder in record mode
	line connection
	carry out the operation just described
	cut the tape
	splice the tape, using diagonal slot
	splice the tape, using vertical slot
	loudspeaker (or headphones if highpass filtering)
	microphone
	lowpass filter
	highpass filter
	bandpass filter
	reverberation
	tremolo
	vibrato
	filter modulation
	tape recorder superimposing
	tape echo
	variable speed playback
	variable speed playback, recording on other track
	accelerating speed
	decelerating speed
	accelerating and decelerating alternately
	irregular fluctuations of speed
	stereo playback

# Making Electronic Music

*A course for schools*

TERENCE DWYER

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*Photographs by Kenneth Padley*

Book 1

Music Department

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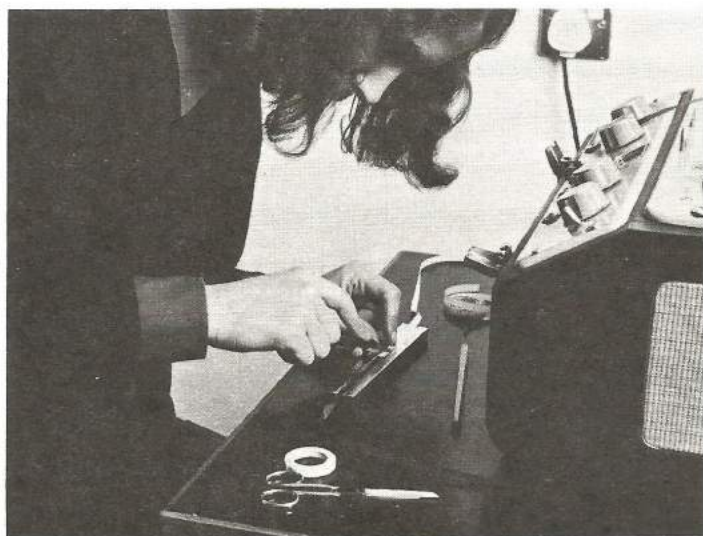
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## Welcome!

You are about to join the growing band of people who are entitled to call themselves electronic musicians. Electronic music has many forms: the particular kind you will be starting with deals with magnetic recording tape and the many ways it can be processed so that the sounds on it seem magically new. After learning this approach you may be interested enough to want to go on discovering other ways of making electronic music.

With this book comes a set of records full of electronic sounds made on a synthesiser. (Your teacher has probably made a tape copy for you.) This will provide the sound material, and you will learn how to make pieces of electronic music out of it. Remember that electronic music, like much modern music, does not have to sound like older music. It need not have melodies and regular beats – in fact it usually does not – but for many people this makes it more exciting. But like all music it must attract the listener and make sense, so try to notice, as you go through the course, how the arrangement of certain things can make the pieces interesting: loud and soft, fast and slow, active and calm, and so on.

Always use your ears carefully and remember you are trying to make *music*. Good luck!



*The final operation in a complex piece*

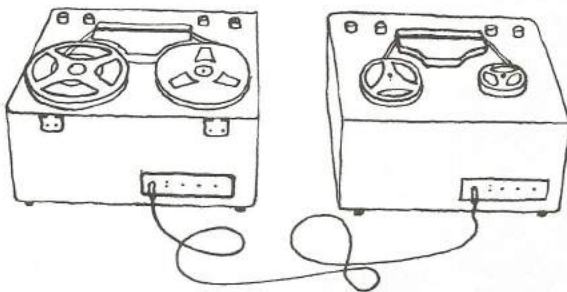
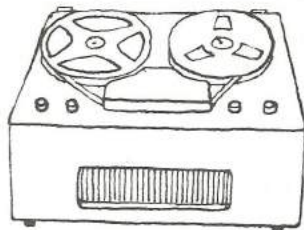


## Basic Information

### EQUIPMENT REQUIRED

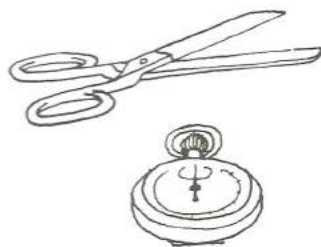
You will normally need to have the following equipment ready for each session of work:

- 1 *Main tape recorder*, ready plugged in and switched on.
- 2 *Your tape* correctly threaded on it, ready for recording. This will be called the *master tape*. If you are keeping several pieces of music on one spool of tape, make certain you are ready to start at the correct spot, where you left off last time. It may also be mentioned here that you will sometimes record on to a *work tape*. This is one that is afterwards copied on to your master tape, so you need not preserve the sounds on it once your piece is finished.
- 3 *Second tape recorder* (or *record player*), ready plugged in and switched on. Your teacher will have copied the sounds from the records on to a *source tape*, if possible. If not, you will be using the records themselves. Throughout the book this second machine will be referred to as the *source machine*.
- 4 *Source tape* correctly threaded on the source machine (or *disc* on the record player).
- 5 *Line connection* between the two machines. This is a special cable with the correct plugs. Get your teacher to show you exactly what to do if you are not sure. If there is no way to do this, you must use a microphone even when told to use a line. Plug the microphone into the Microphone socket of the main tape recorder and place it about 18 inches from the loudspeaker of the source machine.



6 *Editing kit* consisting of splicing block, jointing tape, scissors, cutting tool or razor blade, coloured leader tape (red, green and white), yellow china-graph pencil.

7 *Stop watch* or wristwatch with second hand.



## HOW TO WORK THROUGH THE BOOK

It is essential that you read all instructions carefully, and that you do not omit any chapter. (It may be possible to omit some exercises in each chapter – ask your teacher.)

Sooner or later a symbol or group of symbols will appear. This means 'Do it now'. (See inside cover for the meaning of the symbols.) So what you do is to read the instructions till you come to a symbol, then do the operation required, then read on again, and so on.

For example, you will often see the group of symbols:

S  —  M

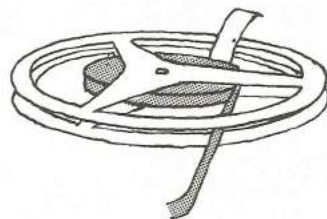
Reading from left to right, this means 'Play the source tape on one machine and record through a line on to your master tape on the other machine.' This is known as copying, and the process will now be described.

## HOW TO COPY

N.B. You will need to do this a great deal during the course. If you forget what to do at any time, or keep getting bad results, look up the procedure given here and check every step carefully.

1 Set up the source tape on the source machine and the master tape (or work tape) on the main machine. Both machines must be at normal studio speed unless you are transposing (see p. 11). See that the line is plugged in (or the microphone set up, where this is required, i.e. main machine microphone about 18 inches from source machine loudspeaker).

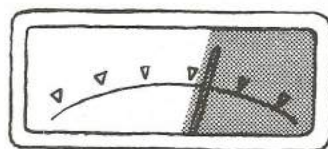
2 Set the revolution counters (place markers) to zero on both machines. If either machine lacks a revolution counter, slip a tiny piece of paper in the right hand spool just where the tape is winding on. This will mark the place if you have to wind back.



3 Switch the source machine to Playback. Make *certain* this is not on Record or you will wipe out the source tape and spoil things for yourself and others. If you are using a line, turn the playback loudspeaker off if possible. If you are using a microphone, set the playback volume control to full. (However, if this produces a harsh distorted noise when the tape is played, turn it down until the sound is good.)

4 Switch your main machine to Record. On some machines it is impossible to do this unless you start the tape moving at the same time. In this case, first press the Pause control to hold the tape still. If this is also impossible, go straight to instruction 6.

5 Set the Record volume control of your main machine about halfway, and start the source machine. Look at the main machine. You should now see the needle of the level indicator move. (Or it may be a 'magic eye'.) Adjust the Record volume control so that the needle keeps flicking into the beginning of the red zone (or the magic eye keeps *just* closing). The recording level is now set correctly. Rewind the tape of the source machine to where it was when you started.



6 Now you are ready to record. Simultaneously press (a) the Start button (Playback) of the source machine, and (b) the Start and Record buttons of main machine. Check the level indicator to see if the needle stays just up to the red zone. If there are two of you, obviously you can work one machine each. If there are more than two, somebody could be responsible just for the volume controls.



## HOW TO MONITOR

This means to listen whilst you are recording. This is a good way of preventing mistakes. If you are in a separate workroom you may be able to use the loudspeaker of your main machine without disturbing others; but in any case *don't* do this if you are using a microphone, or it will pick up the sound twice over and spoil the recording. The rule when using a microphone is to keep the playback volume control of the main machine at zero. If you have headphones and a proper socket, this is the best way to monitor. But remember it is the machine which is doing the *recording* which you want to hear, because the idea is to see if things are turning out the way you want. We already know the source tape is all right, so there is no point in monitoring that.



## CORRECTING MISTAKES

If you cannot monitor whilst recording, do not worry. Simply wait till you have finished, rewind the tape on the main machine and switch to Playback. You can then hear the recording. If it is not satisfactory in any way, wind back both tapes and start all over again. This will automatically erase the unwanted recording. This is why we set the revolution counters (or put the pieces of paper in). Make sure you have both tapes at the right spot, if you have to try again.

## IDENTIFYING RECORDINGS

On the discs (and source tape) you will hear a voice giving the number of the recording you are copying. This is to help you identify the right sounds. Do *not* copy this voice on to your tape; there is a silent gap after each announcement, so start your recording during this silent gap.

To identify your own recordings there should be a piece of leader tape before each piece, on which you can write the title or number of the project, and your name if necessary. At the beginning of the tape there should be about three feet of green leader tape, and at the very end of the tape on the spool there should be three feet of red leader tape; but in between the various pieces on the



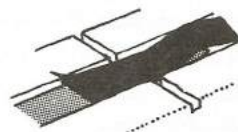
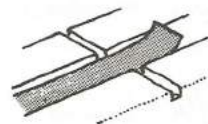
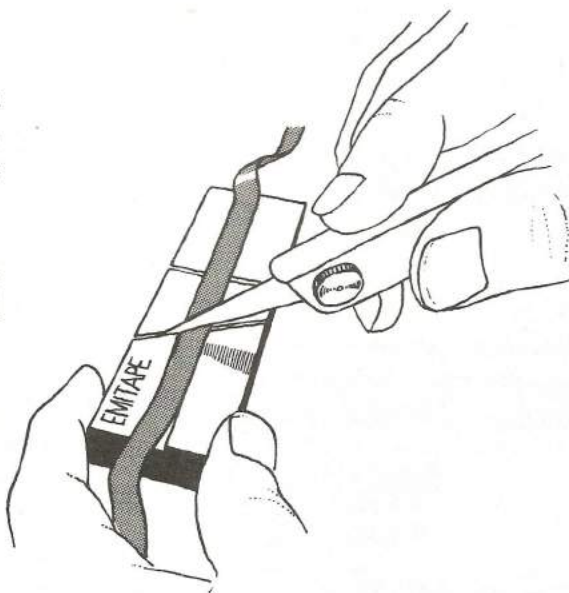
spool we need one foot of white leader tape. Learn how to splice tapes together as soon as possible because you need to do it often. Perhaps one member of your group could specialise in splicing.

So each time you finish a piece you splice in a foot of white leader tape (rough side outwards) and then write the number or title of your piece on the *previous* leader tape at the beginning of your piece. Use ordinary pencil. If any piece is designed to be played at a speed other than normal studio speed (this will be explained later in the book) then write the playback speed on the leader also, or your piece may get played too fast or too slow.

## SPLICING

This is how to splice:

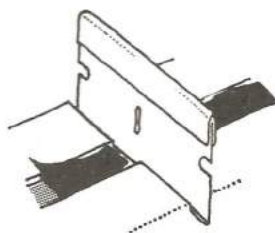
- 1 Cut the tapes you wish to join with scissors to the right length. This is about one inch longer than where the joint will be.
- 2 Have your splicing block ready, and find the diagonal slot.
- 3 Fit one tape in the splicing block with about one inch projecting across the diagonal slot. (Recording tape must be *smooth* side uppermost, leader tape should be *rough* side uppermost.) If you have marked a tape with chinagraph pencil, this mark must be exactly over the slot (this will be explained later in the book).
- 4 Bring the other tape into the block from the opposite side and overlap the first tape, also leaving an inch spare across the slot.



5 Clip the arms down, if your block has them. If the block is armless, press the tape smoothly into the groove.

6 Check that the tapes are exactly level.

7 With your cutting tool or razor blade, cut firmly through both tapes, using a slicing action towards you. Make sure the blade goes right to the bottom of the slot.



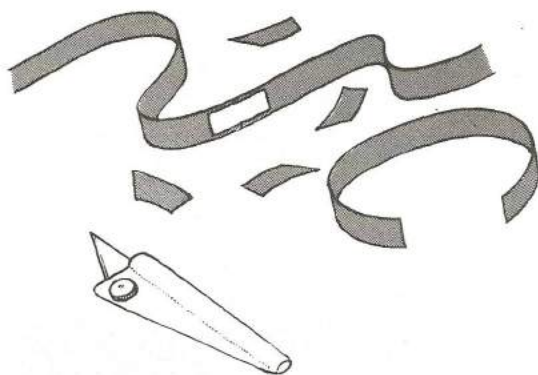
8 Remove the unwanted one-inch end from the top tape and throw it away.

9 Cut off about half to three-quarters of an inch of special jointing tape and carefully press it on to your joint, exactly over the cut. Rub it to get rid of tiny air bubbles.



10 Lift up arms and take out the tape. (On the armless type of block, peel out the tape at an angle towards you or the edge will get crinkled.) Look for the unwanted inch from the lower tape. It should be in the splicing block; get it out and throw it away. If you can't see it, it is probably sticking to the underneath of your joint. Carefully pull or cut it off.

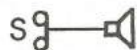
11 Examine the joint from the reverse side. If you can see any jointing tape sticking out at the edges, carefully trim it off with scissors.





## 1 Shaping The Dynamics

Listen to the source tape, Material 1 (60 seconds). Although a lot is happening, the piece is monotonous because it is all on one level of volume.



Rewind the source tape and set up everything as described in the Basic Information. If there are four people in your group, they should be ready to work thus:

One person to start and stop source tape.

One person to start and stop main machine.

One person to work stopwatch and give time signals.

One person to work volume control on main machine.

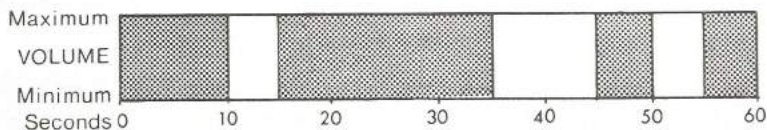
But two people could manage, one to do the first two jobs and one to do the other two.



*Ready to go*

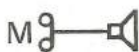
Start the copying process and work the volume control, keeping to the scheme given:

### EXERCISE A



If all went well, you moved the volume control quickly to zero at seconds 10, 35 and 50, thus producing silence, and quickly up again at seconds 15, 45 and 55. You should have seen the level indicator move between minimum and maximum.

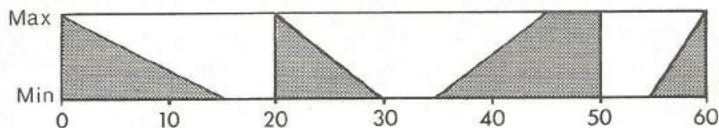
Play back the result, checking the times if you like, but don't worry if these weren't dead accurate.



Are you satisfied? If not, try again.

### EXERCISE B

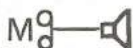
Now we are ready for a different way. In this diagram, a sloping line means that you should turn the volume control smoothly, so we get gradual changes. Use the same sound-source (Material 1).



(Notice what is supposed to happen at the 45th second.)

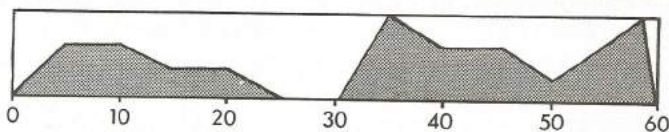


Again, check the result until you are satisfied.



### †EXERCISE C

Here is a much more adventurous way:

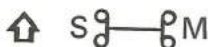


Can you manage that – especially the fairly quick dip at the end? (It is not too quick, because it should take about two seconds.)



### EXERCISE D

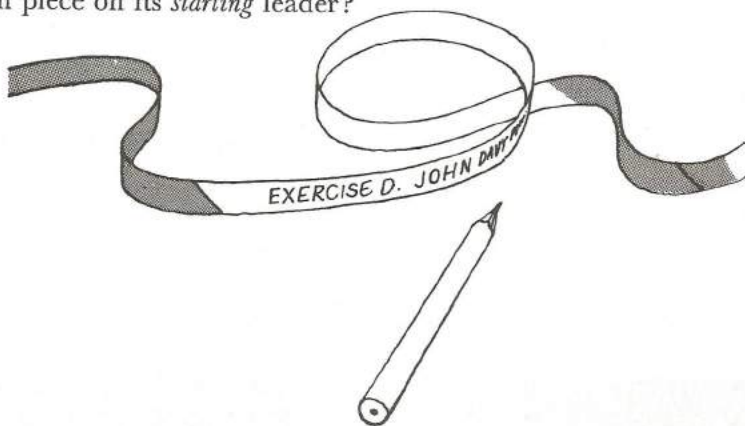
Draw your own picture of the volume level and record it, using the same material. Use quick and slow changes, and at least one silence. We call this shaping the dynamics. The dynamic level means the loudness level. Perhaps the level indicator on your tape recorder has little marks on it at various intervals. If so, your dynamic picture could have horizontal lines to represent each level. Then you will know more accurately how to set the volume control. But realise that because the sounds on the master tape are not absolutely steady there are bound to be difficulties in setting the level exactly as you want it.



Can you think of a title for this last piece?

#### *Reminder*

Did you remember to put a white leader at the end of each piece? And to label each piece on its *starting* leader?





## 2 Speed Changes

I expect you have already tried playing back a tape at the wrong speed. If you haven't, now is the time. It's great fun, and it also happens to be an important technique used in creating electronic music. Let us see how many ways we can do it.

These are the speeds used in modern tape recorders:

$\frac{15}{16}$	inches per second	(or	2.38	cm per second)			
$1\frac{7}{8}$	"	"	4.75	"	"	"	"
$3\frac{3}{4}$	"	"	9.5	"	"	"	"
$7\frac{1}{2}$	"	"	19	"	"	"	"
15	"	"	38	"	"	"	"

On your machines you will find only two or three of these as a rule. If you are good at arithmetic you will see that each speed is exactly double the one before it. So if we record at one speed and then play back at the next highest speed, everything is exactly twice as fast. Or if it is played back at the next lowest speed it is exactly twice as slow.

Now every studio has a normal speed. (Yes – your classroom, or wherever you are working, is now an electronic music studio.) Your normal studio speed is probably  $3\frac{3}{4}$  i.p.s., but check with your teacher. The source tape should have been recorded at normal speed. From now on I shall usually refer to normal speed as 'speed N' and the next speed up as 'speed 2N' and the next speed down as 'speed  $\frac{1}{2}N$ '.

You might be lucky enough to have two tape recorders, both with three speeds, in which case you will find it easy to get all the speed changes you want. It is rather hard if either or both machines has only one speed, but it is only impossible with two machines, both having only one speed – the same for both.

### METHOD

You must think carefully which of these methods you will use to *raise* the speed. You can use either of the ways shown below:

	Playback machine (source tape)	Recording speed of main machine (master tape)	Playback speed of main machine (master tape)
(1)	2N	N	N
or (2)	N	$\frac{1}{2}N$	N

If you want to *lower* the speed, you can use either of these ways:

	Playback machine (source tape)	Recording speed of main machine (master tape)	Playback speed of main machine (master tape)
(1)	$\frac{1}{2}N$	$N$	$N$
or (2)	$N$	$2N$	$N$

N.B. In both cases, method (1) is recommended where it is possible. Notice that in *all* cases, final results are always replayed at normal speed.

If a record player is being used instead of a source tape, the turntable speed can be set to 78 rpm as an equivalent of  $2N$  and to 33 rpm as an equivalent of  $\frac{1}{2}N$ , even though these are not really double and half respectively: but it is the best you can do.

With a cassette machine and a 2-speed tape recorder, *lowered* speed can only be achieved by playing back the master tape at  $\frac{1}{2}N$ . If you wish, this recording can now be copied on to a spare cassette and copied back on to tape at speed  $N$ .

*N.B. In the rest of this book, whenever the phrase 'copy at  $\frac{1}{2}N$ ' appears, this means that the final copy playback (at  $N$ ) must sound at half the speed of the source-material, NOT that the recording machine has to run at  $\frac{1}{2}N$ . Similarly, 'copy at  $2N$ ' requires the  $N$  playback to give a sound twice the speed of the original.*

#### EXERCISE A

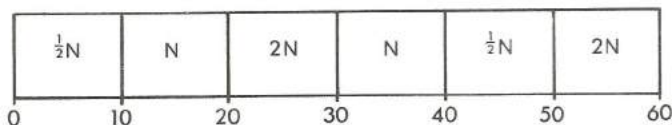
Copy Material 2 (48 seconds) at  $2N$ . Stop the master tape exactly at the end, and wind back the source tape. Copy Material 2 again at  $\frac{1}{2}N$  so that this follows on immediately, without any break if possible. But don't worry too much if there is a break, or a click.



What do you notice about these results? Discuss with the other members of your group all the changes that have taken place, then check with the list at the end of this chapter to see if you missed anything. Bear all these changes in mind carefully; they are important to the electronic composer because they can be used to help shape a composition.

### †EXERCISE B

Make a piece from Material 2 using three different speeds according to this scheme:



*The above numbers represent seconds in real time (i.e. playback time).*

Method: At the end of each section, stop both machines, using Pause controls if you have them; change speed as required and continue recording. Stop again at the end of the second section, change speed, and continue in a similar manner until all six sections are finished. When the source material gives out, rewind it.

Notice carefully that the timings apply to the master tape running at speed  $N$ . If you have to run the master at  $\frac{1}{2}N$ , allow 20 seconds per section; if you run it at  $2N$  allow only 5 seconds. If you do all this correctly, your finished piece will last 60 seconds, or slightly more allowing for stops and starts.



Play back your piece (at normal speed, remember) and see how you like it. There may be gaps and clicks where the sections join. Don't worry about this; in the next chapter you will be told how to get rid of these.




### EXERCISE C

Use Material 3 (60 seconds) to make a new piece called 'The Breakdown of the Machines'. Listen first to the material and then decide how you will alter the speed several times to give a good effect.



Make out a time-plan first, but try to aim at a piece lasting *two* minutes, even though the material lasts only one minute.



Remember that there is nothing to stop you from using the material more than once, and you can select just a part of it if you wish. One more thing before you start: don't forget to shape the dynamics. We don't want everything at the same level, so plan it first. Here's a new hint for you – try working in somewhere a very rapid turning up and down of the volume control (not all the way). This is called *tremolo* and should be indicated as  on your dynamic picture. (Draw your dynamic picture above the time-plan.) Try to imagine what the effect will sound like before you actually hear it.



Did it sound as you thought it would? Check the timings and the dynamic curve to see if you made things happen the way you expected. Do you think the title 'The Breakdown of the Machines' fits your piece?

*Reminder:* Have you spliced in the leaders and labelled all the pieces?

#### ANSWER TO QUESTION IN EXERCISE A

The following changes happen when we double the tape speed:

- (a) The events on the tape happen twice as fast.
- (b) The whole passage takes half the time to play.
- (c) Every sound is half its previous length.
- (d) The pitch is higher (exactly one octave).
- (e) Timbre (quality of sound) is changed. Most sounds are thinner and brighter, or more squeaky.

The following changes happen when we halve the tape speed:

- (a) The events on the tape happen twice as slowly.
- (b) The whole passage takes twice as long.
- (c) Every sound is twice its previous length.
- (d) The pitch is lower (exactly one octave).
- (e) Timbre is thicker and duller.

### 3 Editing

You have noticed that in the Chapter 2 pieces you had sections following each other with bad joins, or clicks (caused by the switching of stop and start buttons). If you didn't, your machine must have a very good Pause control. Another problem may be a short silence between sections which is not intended. Yet another fault is a swooping noise sometimes heard at the beginning of a recording. (You can try to puzzle out what causes this, if you like.) All these snags can be cured, and our next step is to take the pieces made in Chapter 2 and clean them up so that the result sounds smooth and professional. This is called *editing*.

#### METHOD

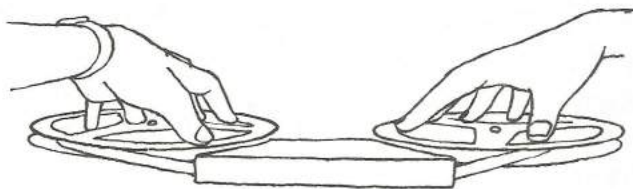
What we are going to do is simply cut out (with scissors) the unwanted bits of tape and join the rest up to close the gaps, using the splicing technique you have already learned. I hope you haven't been leaving out those leader tapes! It should have been giving you practice in making good joints. A rough joint doesn't matter too much with leader tapes, but in the middle of a piece it is much more important to make a good job of it. Check up on your splicing technique by referring back to page 6.

However, there is also a new problem, and that is finding the right place on the tape.

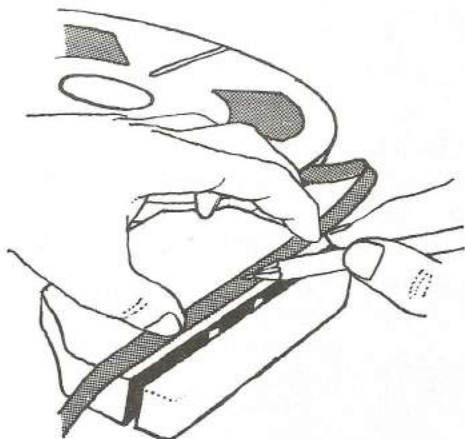
#### EXERCISE A

You only need one tape recorder for this. Put on your master tape of Piece 2A and play it until you hear the place where you changed the speed. Stop the tape. Run it back a little way, then play it again. If necessary, do this several times, until you can stop the tape just where the first section ends (there is probably a bit of silence after it). In order to find this place really accurately, we need to move the tape by hand. Try the pause control. Press it, then hold the tape spools one in each hand and move the tape backwards and forwards several times. Do you hear anything? If not, the tape is not contacting the playback head. The heads are small, slightly rounded metal cubes, and the playback head is the one on the right. You may have to remove the head cover

to see them. Perhaps one of you can push the tape gently on to this head whilst another rocks the spools. If you still can't hear anything, there may be a special Edit button on the machine. If none of this works, you will just have to find the place by starting and stopping the machine in the ordinary way.



Now – having found the end of the first section as accurately as you can, you are going to mark it with a yellow chinagraph pencil (this, being wax, is the only kind that will show up on the tape). Keeping a careful eye on the spot which was on the playback head, pull the tape out to a convenient place on the tape deck and put a small vertical mark on the outermost (usually shiny) side of the tape. Do *not* do this with the tape still in contact with the playback head: wax from the pencil could easily get on to the head and cause trouble. And if ever you scratch the highly polished surface of the head you could ruin it for ever.



Replace the tape in its playing position and start it up. You are now looking for the beginning of the next section (it won't be far away: perhaps even a fraction of an inch). Find the place by the same method and mark that with chinagraph pencil.



If you have done all this correctly, the portion between the two marks is the unwanted part. Cut the tape with scissors, about one inch on the *waste* side of



each mark. (If the unwanted bit is two inches or less, obviously one cut will do.)



Fit the two ends into the splicing block so that both the wax pencil marks are over the diagonal slot, and join them exactly as you did with the leader tape. Remember to have the shiny side uppermost and stick the jointing tape to that, because it is the rough side which has the sound on it. It is important to use the diagonal slot of the splicing block: if you use the square slot you may get an unwanted click when you play the result.



Now test the result by playing through the whole piece. If it is unsatisfactory, you can always peel off the jointing tape and try again, or even cut each side of the bad joint and make a new one. In most cases it will do no harm to cut a little bit off your sounds. No one will miss a fraction of an inch, and it is better to cut off too much than too little.



#### EXERCISE B

Edit your Piece 2C ('The Breakdown of the Machines'). There are of course several joins here. If you have kept your plan you can find the spots approximately by using a watch, but I expect you'll do just as well by listening carefully. After all, if *you* can't hear where the bad joins are, the chances are that nobody else will!



If you like, you can also edit the rubbish out of Piece 2B.



#### †EXERCISE C

Copy Material 4 (8 × 10 seconds) on to your tape.



It consists of eight short sections separated by one-second silences. Listen to this sequence several times. The sections are not really in the best order.



Do you think you can alter the order of the sections so that it makes better sense? Before trying this, mark your tape with chinagraph pencil. Find the beginning of the first section and mark the place as usual, but put a figure 1 after it (to the *left!*) thus:



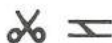
At the end of this section a double mark is a good idea (like a double bar in music). This time put the figure 1 to the right:



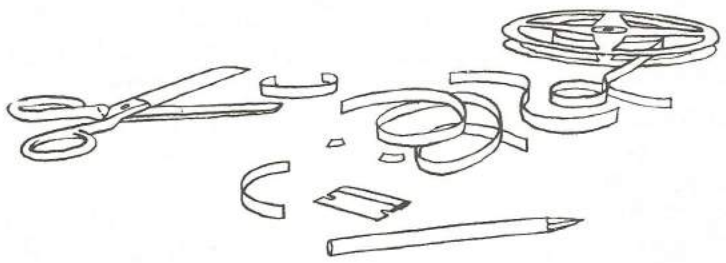
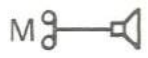
Mark up all the remaining sections in the same way until you have reached section number 8. Now you can refer to each section by number. Discuss the best order to put them in. For example, you might want the lowest sounds first, then each section getting gradually higher. Or you might start high, get lower, then go up again. Another way is to ignore pitch and listen for *texture*: how thick is the sound, i.e. how many things are happening at once; how busy is it? You could arrange the material so that the texture gets constantly thicker, thus working to a climax. Or then again, you might decide that what matters is how fast the sounds come, and begin with the slowest section. Or you could arrange the sections according to some other aspect of the sounds: the main thing is that the order should represent a meaningful sequence, not a random order.



When you have settled the order you want, write down the numbers in that order before you forget. Now cut up the tape into the eight pieces and join whichever piece is first in your plan on to the white leader, winding it on to the right-hand spool. Join on the other pieces in the correct order and finish with a white leader as usual. Join the white leader to the rest of the recording tape in the left-hand spool, if any.



Play over the result. Are you pleased with it? Suggest a title.





## 4 Tape Loops

We are now going to make a piece with a kind of 'theme' by a combined editing and speed change operation, plus some dynamic shaping. During the work on this piece we will be making a tape loop.

### † EXERCISE A

Copy Material 5 (20 seconds) on to an extra spool of tape (work tape). It consists of three sounds with a one-second silence between them.

s g — p w

Now mark your work tape with chinagraph pencil where each sound begins, or better still, about an inch after this.



We are now going to cut the recording into pieces by measuring the tape with a ruler. This is a more accurate method than using a watch.

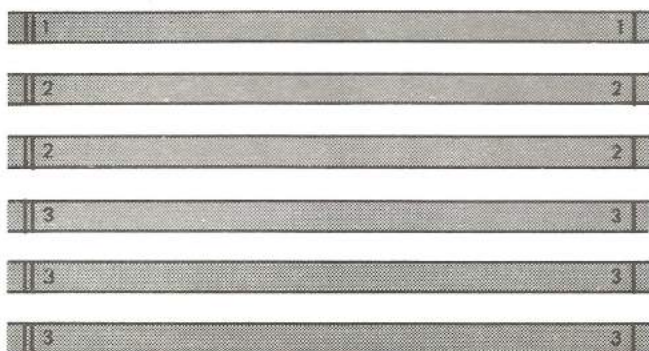
Cut the tape on the waste side of your first mark, measure off 2 seconds and mark with the double line. How do you measure 2 seconds? Well, if your studio's normal speed is  $3\frac{3}{4}$  i.p.s. you need  $7\frac{1}{2}$  inches, don't you? You can easily work out any period of time in this way. Just multiply the normal speed by the number of seconds required. Cut off the piece behind the end mark and carefully mark your piece with a 1. (Always draw the 1 with serifs, not just a vertical stroke; that way you can tell if you get the tape backwards by accident.)



Now cut up sound 2 into *two* two-second lengths, each marked 2. Then sound 3 into *three* two-second lengths, all marked 3.



This is what it should all look like:



Now splice the pieces together in the following order: 1 3 2 3 2 3. Remember to join each piece to the *left*-hand end of the previous piece.

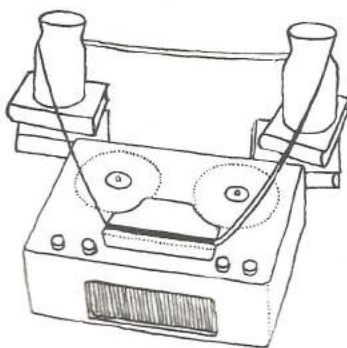


Next, join the beginning of this chain to its own end, so as to make an endless loop. Make sure you haven't twisted the tape anywhere.



Can you see what will happen? When we play the loop, the sequence 1 3 2 3 2 3 will keep repeating itself without stopping, for as long as we like.

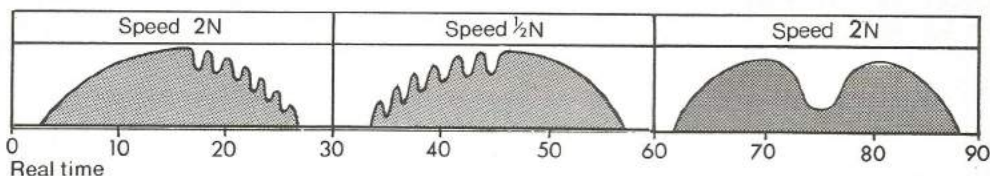
Thread the loop carefully on the source machine, avoiding the spools (in fact they may be better taken off). If you have no second open-reel recorder, play it on the main machine, but you can only listen to the result, not record it. If your studio normal speed is  $3\frac{3}{4}$  i.p.s., the loop will be 45 inches in total length, but when placed in position it will have about 30 or so inches of slack to take up. Pull this slack to one side. Keep the tape *almost* tight by letting it go round a smooth object such as a pencil or an empty coffee jar filled with water, or perhaps two of these.



Set up the main machine for copying as usual. Set the speeds ready for a double speed transposition. (To transpose means to change the pitch: here, we are going to transpose upwards.) Have Record volume at zero.



At this stage you had better look at the dynamic plan below:



Think carefully whether your main tape recorder is going to run at speed N or not. If not, you must double or halve the time accordingly. Which is it? Set both machines going and record the first section, gradually moving the volume control as indicated. Remember to include a couple of seconds silence at the beginning and end of this section.



The second section is done in the same way, but at half speed (octave lower than normal; *two* octaves lower than first section). Decide again whether you are using real time or not. Again a couple of seconds silence begin and end this section.



And so to the third section, once more at double speed, but with a different dynamic shape.



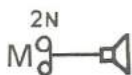
You will, of course, have stopped your main tape recorder (preferably on Pause) each time you changed speed. This has almost surely left clicks. Edit



out the clicks but keep the silences. (Your skill at splicing will show here: if when you play back the finished piece there is no break in the silences you have made perfect joints.)



Did you hear the 'theme' as it kept repeating itself? You might enjoy playing back your piece at double its proper speed, if your equipment makes that possible.



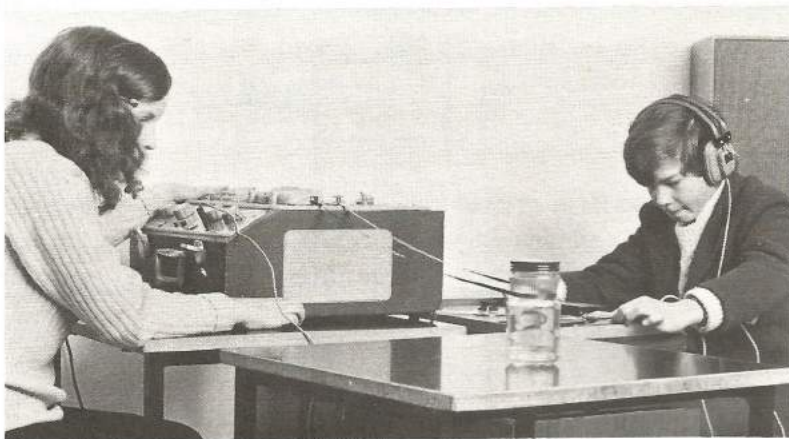
Finish off with the usual white leader, and either throw your loop away or keep it as a souvenir.

### EXERCISE B

Plan a piece of your own. Choose any material you like from the source tape, and use all these techniques somewhere:

- Speed change
- Editing into correct order
- Loop(s)
- Dynamic shaping

Find a title for it, and remember to write this on the starting leader when you have finished.

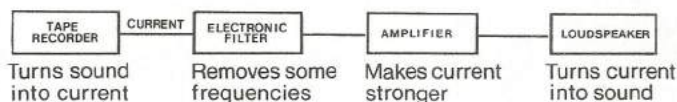


*Recording from a tape loop*

## 5 Filtering

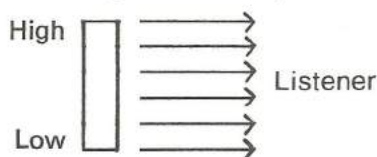
### WHAT IS A FILTER ?

A filter is a device which lets some things pass through, but keeps others back: for example, a tea strainer or colander in the kitchen, a sieve in the garden. The coloured gelatines which are used in stage lighting are known as filters, because they keep some of the light back and let some through, thus colouring it. An *audio filter* is one which can filter sounds, and we can thus talk about 'coloured' sounds. Unfortunately there is no such thing as a filter which lets through, say, the sound of a violin and keeps back the sound of a trumpet; but audio filters let through certain *frequencies* and keep back others. Frequency is roughly the same as pitch, though we must remember that even a single note on one instrument contains many frequencies, most of which are not noticed separately: these are called *harmonics*. If some of these frequencies are filtered out the instrument will sound different and may be quite unrecognisable. An *electronic filter* does its job whilst the sound is not yet a sound, i.e. it is an electrical current travelling along a wire. Look at the diagram:

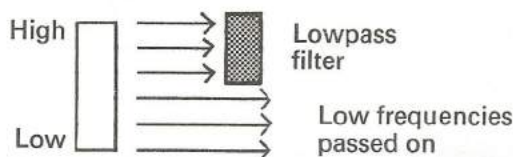


### TYPES OF ELECTRONIC FILTER

Think of all the possible sound-frequencies there are, from very low to very high (difficult, but try!). Let us represent this by a white band:



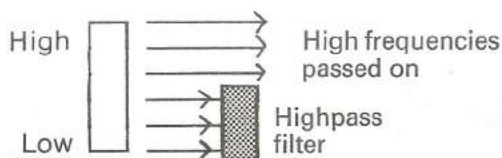
Unless we have some form of deafness, we can detect all the frequencies. Now one kind of filter is called a *lowpass filter*. As you may guess, it passes low frequencies and cuts out higher ones. Like this:



Listen on the disc or source tape to Example A (23 seconds). We hear an electronic note first in its normal form, then sent through a lowpass filter, then we hear the normal note gradually changing into the filtered one.



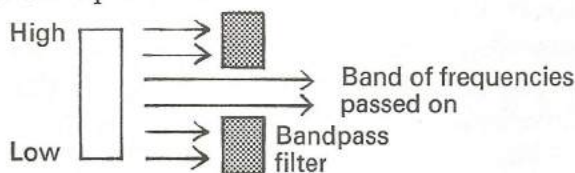
Another kind is the *highpass filter*. The diagram shows what happens:



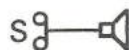
Listen to Example B (23 seconds). First the electronic note, then the same highpass filtered, then one changing into the other.



One more kind of electronic filter is called a *bandpass filter*. This lets through a more or less narrow band of frequencies:



The band which is allowed through can be pitched at different frequencies. Example C (23 seconds) lets you hear the same electronic sound bandpass filtered at six different frequencies, then the complete sound.



Here are the symbols which will be used in this book:



Lowpass filter



Highpass filter



Bandpass filter

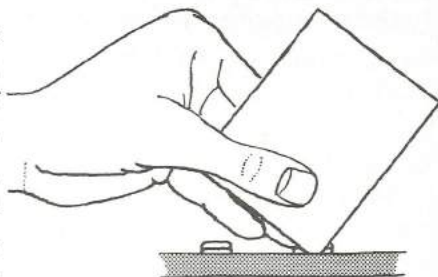


## CLASSROOM FILTERS

If you can actually get hold of an electronic filter (perhaps borrowing it from the science department) filtering sounds will be easy, but it is more likely that you will have to do without. There now follow various ways of making substitutes for electronic filters.

### *Lowpass paper filter*

If you are using a tape recorder as source machine (rather than cassette or record) and if you can get at the playback head of your source machine, then you have an excellent lowpass filtering device available. Remove the head cover if necessary and examine the playback head (the one on the right) with the source tape in position. The idea is to hold a piece of paper between the tape and the head, thereby separating them a tiny fraction of an inch. This cuts out high frequencies. The paper should be really thin (typing copy paper or hard toilet paper) and should be inserted diagonally so that you can experiment with the amount of paper you are putting between tape and head. Try this on Material 3, for example. The high-pitched clanking should disappear but the lower sounds should still be clearly audible. You may have to turn up the volume controls a bit to get the signal up to its usual level. If your paper is thin enough, the diagonal angle will be unnecessary. Keep such paper handy so that you can use it whenever instructed to do lowpass filtering. Because the other methods of lowpass filtering about to be described need the microphone, I will be using the following diagram to indicate lowpass filtering generally:

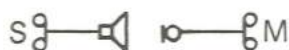


When you see this diagram, use the paper method but use line connection if possible, ignoring the microphone. However the method works quite well if you do use the microphone for any reason.

### *Acoustic filters*

Now we come to other filtering methods which can be done in the classroom. For all these processes you will need your microphone plugged into the main tape recorder, which should be switched to Mic. input. Play Material 6 (30

seconds) of the source tape on the source machine through its loudspeaker and have the microphone 18 inches from the loudspeaker. Record this on your own tape.



Already there has been some filtering, because no loudspeaker is perfect and yours has probably cut out some very high and very low frequencies. For that matter the microphone also will cut out something, and will in addition probably emphasise certain frequencies which it 'likes'. So the source material has been 'coloured'. This is why you are normally advised to use a line connection for copying. This loses nothing.

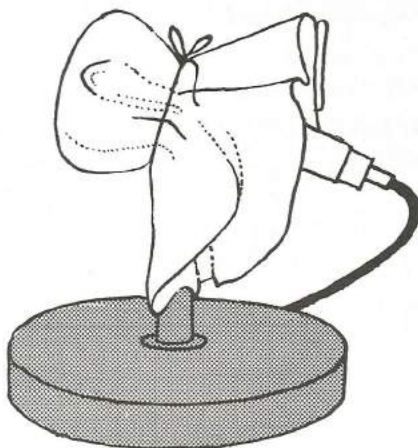
Next we try the *tone controls* of your source machine (or amplifier, if you have been sending its signals through one). These are the Treble and Bass controls. Try turning each as far as it will go. These act as filters to a limited extent: the treble control is a lowpass filter and the bass control is a highpass filter. On some equipment there may be only one tone control; this will be a treble control.



But probably none of this is drastic enough. Let us go a little further.

#### *Acoustic lowpass filter*

Use this only if you cannot make the paper filter work. Get several layers of thick cloth or felt, or a coat, and wrap it round the microphone. This muffles it and acts like a filter. Actually it cuts down *all* the sound to some extent, but mostly it cuts down the high frequencies. Check that the recording meter (level indicator) hasn't fallen too low. Try a recording of Material 6 again (using this method) and compare it with your first one.



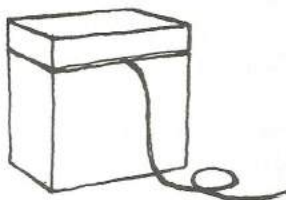
If your acoustic lowpass filter doesn't work very well, try a different method. Put the microphone in a drawer, and shut it, if possible. It will help if the drawer is full of books, or better still, cloth.



If that doesn't work, try both methods at once.



If anyone is really keen, he could make or adapt a special box made of wood and lined with thick cloth (don't use foam sponge – it lets sound through easily). The box should close completely round the microphone, with just enough space for the wire.

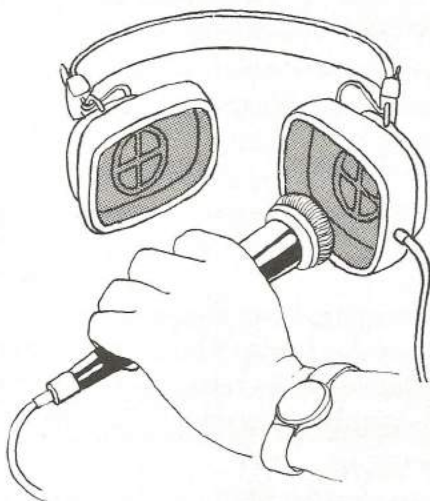


One more method worth trying, if your tape recorder has the right socket, is to plug in the microphone to the Phono or Gram Pickup socket, if it will fit. This will usually cut out treble frequencies. When you have decided on the best method, always use it whenever you see the symbol for lowpass filter:



#### *Acoustic highpass filter*

Only a large loudspeaker can reproduce low frequencies properly. A really small loudspeaker cannot do so, and is a kind of highpass filter. Use the smallest loudspeaker you have to play the source tape and the bass frequencies will disappear. If you have headphones these are certainly the smallest loudspeakers around.





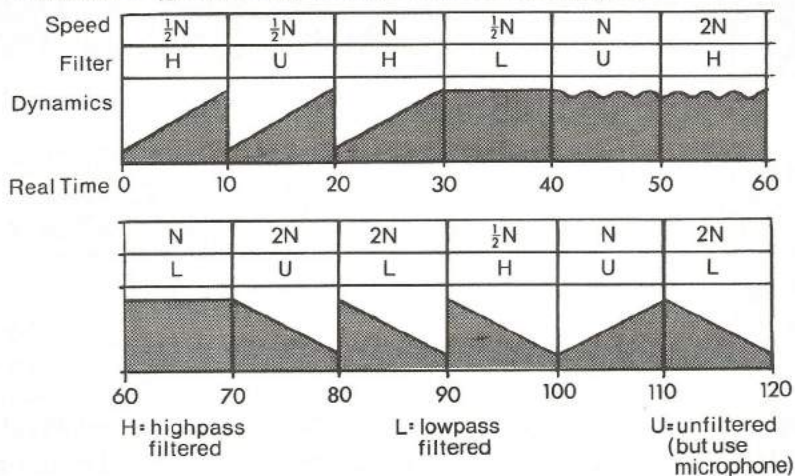
Link the headphones to the playback machine (you may have to use your main tape recorder for this purpose) and place the microphone between the earphones, or pointing directly at one earpiece (not *too* close). Record Material 6 once more and compare results with the two previous recordings.



There should be a marked difference. By the way, when recording highpass-filtered sounds, the recording meter will not show as high a level as usual. This is because it is bass frequencies which make most impression on it, and we have cut them out. Don't worry about this, provided the result *sounds* loud enough. You need not keep the recordings made so far in this chapter. Now we come to an actual piece.

### EXERCISE A

Use Material 6 (30 seconds) to make the following piece:



Stop the tape between the sections, and edit out the gaps afterwards, as usual.

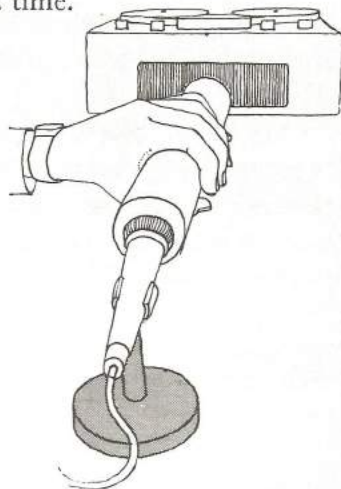


#### *Acoustic bandpass filters*

One way of getting a bandpass effect is to muffle the microphone and place it between the headphones, thus combining the two previous methods. Or use any two ways of filtering which seem to work together to cut off the treble and bass ends of the sound, leaving only the middle – but be careful you don't filter away just about everything! A very interesting acoustic bandpass filter

system is the use of pipes or tubes. Ask your teacher if he has any – if not, perhaps you can find one or two yourself. It is best to have tubes and pipes of different lengths, though you can only use one at a time.

Place one end of the tube over the microphone, point the other end at the loudspeaker, and record Material 6 again. Everything must be held perfectly still, or the microphone will pick up knocking and rustling sounds. Watch your record meter! It will show a strong signal because the pipe greatly strengthens one frequency only. (If you smack one end of the pipe – when it's off the microphone – you will hear this frequency.) Other frequencies are not really cut out, but they will be weakened. Every time the music you are recording hits the pipe frequency it will come through strongly.



Of course you can combine a pipe filter with a highpass or lowpass filter, but this will not work well if the pipe frequency has already been cut out by the other method.

#### † EXERCISE B

Use Material 7 (30 seconds). It is called *white noise* and consists of all possible frequencies at once, from low to high (just as all the colours of the rainbow make white light). You are going to colour the noise by filtering it. Method:

1 Copy the white noise and cut a convenient length to make a loop.



2 Play the loop on your source machine and record on your main machine by as many of these methods as you can manage; 5 seconds each:

- (a) Normal
  - (b) Lowpass filtered
  - (c) Highpass filtered
  - (d) (b) & (c) combined
  - (e) Pipe 1
  - (f) Pipe 2
  - (g) Pipe 3
- } if possible
- (h) Pipe combined with one other method.

Take great care that all these recordings are made at approximately the same volume. Remember that the more you filter, the weaker the sound is, so make up for it. Also remember that highpass filtering does not show up well on the recording meter, even when there is enough sound on the tape.



3 Now repeat all the above at half speed, then repeat them again at double speed. You should now have at least 15 different sounds.



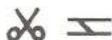
4 Go through your tape marking the beginning and end of each section (roughly will do).



5 Cut the tape into pieces – one for each sound. Keep the tapes pointing in the right direction or they may get put in the machine backwards and then you will hear nothing.



6 Cut shorter pieces off these five-second strips at random. Don't bother to measure them, but make some pieces longer than others, and keep moving from strip to strip in a constantly changing order. Better not cut too many pieces or the splicing will seem endless: even so there will be 30 or 40 pieces to join up. One of you can get started on the splicing whilst someone else cuts up the lengths and hands them over. If there are two splicing blocks available it will save time if you share the work and join the chains together afterwards. Only if you have a *lot* of time and patience will you actually use up all your tape. Take care that your growing chain does not fall on the floor and get dirty or creased in any way.

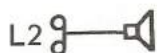


7 When you have had enough, stop and join your tape into a loop. Throw the remaining pieces away.

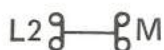




8 Play the loop on the source machine, carefully supporting it and making sure it runs without sticking anywhere. Try different playback speeds until you find the best one.



9 Record the loop on your main machine, master tape, using a line, and improvise the dynamics by continually turning the volume control quickly and slowly, watching the level indicator as usual. It is a great help if you can monitor this by headphones. This piece could go on for as long as you like. Each member of your group could make a version if there is time.



Call the piece 'Random Coloured Noise Structure', or give it a better title if you can think of one.



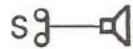
*Preparing to use a tube filter*

## 6 Envelope Shaping

Listen to Example D (15 seconds) on the source tape or record. It consists of several sounds which could be depicted thus:



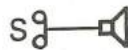
This is because the sounds begin with a rapid crescendo and then end with a rapid diminuendo. The shapes resemble our previous dynamic contours, except that now each shape occupies a short time, and is thought of as one sound rather than as a section of sounds. We call such a shape an *envelope*, and all the sounds in Example D have envelopes with just two parts: the growing part is called the *attack* and the fading part is called the *decay*.



Now listen to Example E (15 seconds). This time the envelopes could be represented thus:



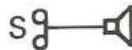
Now we have an attack, a *hold*, and a decay.



Next, Example F (12 seconds) gives this shape:



Here the attack and decay times are so short that we can say they don't exist: there is either silence or hold.



Next, Example G (14 seconds) gives sounds whose envelopes look like this:



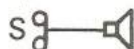
These have instant attack, no hold, sloping decay; and they perhaps remind you of instruments being plucked or struck.



Example H (8 seconds) would look like this:



Obviously these have sloping attack, no hold, and instant decay.



### †EXERCISE A

Try recording Material 1 or Material 3 again, using the record volume control to shape the envelopes given. Raising the volume gives the attack and closing it gives the decay, but remember to keep the control at zero in between the sounds, and keep it on full when you want hold. Try all the following shapes. Do each shape many times, and try for notes of various lengths, the longest being about three seconds, and the shortest as short as you can make them.






Some of them are quite hard, aren't they? The hardest part is the instant attacks and decays, because however hard you try, it takes *some* time to open or shut the control. There is one way to improve the slope of these attacks and decays, and that is to record at  $\frac{1}{2}N$  and play back at  $N$ . This will make your 'instant' moves twice as quick, though clearly it will also make all your other envelope times twice as short. What other effects will it have? Try playing your working of Exercise A at speed  $2N$  if you can.


## HOW TO ACHIEVE INSTANT ATTACKS AND DECAYS


Electronic composers using synthesisers are fortunate; they have a device which can produce automatically any attack, hold or decay time from virtually zero up to, say, 1 or 2 seconds, or in some cases much longer, just by setting dials. This device is called, not surprisingly, an *envelope shaper*.

Well, we are trying to make do without expensive equipment, so we have to use our volume knob and a quick hand, plus a couple of tricks. We have already seen one trick – doubling the tape speed – but obviously this will only work if we are prepared to have the sounds an octave higher, and the music twice as quick. Wait, though – if you play *both* machines at  $\frac{1}{2}N$ , and shape the envelopes by hand, taking care that all notes are twice as long as you really want them, then when you play back the recorded result at speed  $N$ , all the 'instant' attacks and decays will be twice as good as your hand was able to make them. This might be worth remembering in future.

But there is another way to get an absolutely instantaneous attack or decay, quite easily! This is what you do:

1 Suppose we are trying for this shape  (It is one of the most useful shapes: we call it the *percussive envelope*.)

2 Record the shape by flicking up the control as fast as possible, then turning it back steadily. The result would look like this:  because your hand could not open the control instantly.

3 Using the editing procedure described in Chapter 3, carefully mark the tape where you think the loudest part of the sound is: 

It will of course be just after the start of the sound. Rewind the tape a little (backwards) until you find a silent bit just *before* the sound begins. You now have two marks, not more than about an inch apart, thus:



4 Cut the tape with scissors between the two marks. Place the ends in the splicing block so that both marks are exactly over the *vertical* slot.

5 Cut and join as usual. This now gives an instant attack because the sloping portion of the original attack has been cut away: ▲▲

leaving the shape we want. The same method used near the end of a sound will give you an instant decay, if you should want it.

If we had used the diagonal slot of the splicing block we would still have got a very good attack, but it would not have been absolutely instantaneous. Note, however, that right-angled cuts probably give a noisy click if used in quiet passages. They should be used only at the beginning of a strong sound, as here.

### EXERCISE B

This piece has four sections, each using a different method. Try to get the envelope shapes as accurate as possible, but don't worry if the exact timings aren't quite right. Just get them as near as you can. Use Materials 8-11, and be careful to get the right material for each section.

*Section A* Copy Material 8 (20 seconds) with the main machine at 2N. Four sound-envelopes, with silence before and after each one.

2N time	1	2½	1	2½	1	2½	1	4
Real time	2	5	2	5	2	5	2	8

S M

*Section B* Record Material 9 (50 seconds) with main machine at ½N. (No tape-cutting in this section.) 11 sound envelopes:



All sounds as short as possible, one sound every 2 seconds (1 second, real time). Record the above sequence twice in succession. Total time: about 40 seconds at ½N, 20 seconds at N.

S M

*Section C* Copy Material 10 (20 seconds) at N. Five envelopes:



Each sound 1 second long, about 1 second silence in between. This section is to have instant attacks and decays by tape cutting, as described above. Work as follows:

- 1 Record sounds, shaping by hand as near as possible.

S  M

- 2 Mark up all the places where vertical cuts need making, using yellow china-graph pencil. It will help if you draw a horizontal line on the piece of tape which you are going to cut away, thus:



Then there will be no mistakes. Don't forget that the second and fourth sounds will need their beginnings *and* endings cut off.

- 3 Rewind this section, cut across the first horizontal line, and join.

- 4 Continue similarly with the other four sounds.



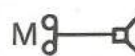



- 5 Check that you have made *seven* joins (one for each vertical line in the picture).



*Section D* Use Material 11 (30 seconds) to make up your own sequence of envelopes and silences. You may use tape cuts if you feel like it. Why not try the diagonal cut to see how it sounds? Total length of section, 30 seconds real time.

S  M

Now cut out the gaps between the four sections, and join everything together, ending with leader tape. Listen carefully to the whole piece. If there are any noisy joins or bad spots of any kind, edit them out so that you have a smooth clean result.

  M   [   ]



## TITLES

Does any title occur to you for this piece? It is always a good idea to give your pieces titles whenever possible. You *could* call it Exercise 6B but titles are remembered more easily. If the sounds remind you of anything, of course you could work that into the title. But if not, use suitable technical words. Here you have made four sections using different methods and envelope patterns. So we can play with these words, for example:

Four, fourfold, quartet.

Structure, pattern, plan.

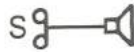
Envelopes, sounds, shapes.

Attacks, holds, decays.

Thus we might call the piece 'Envelope quartet' or 'Sound shapes' or 'Fourfold attack and decay structure' depending how impressive you want to sound. Sometimes humour is possible, e.g., 'Bits and pieces' or 'Attacks from four directions' or 'Knob-turning symphony'. But perhaps 'Dentist's delight' is going a bit too far. By the time you've explained to everybody that there's a lot of decay in the piece, it may not sound so funny after all. However, it's well worth finding the right title if you can. In future, give all your pieces titles (*after* you've heard each piece. That's much easier than deciding the title first, then trying to make the piece sound right!).

## 7 Reverberation

Listen to Example J (35 seconds). You will first hear three sounds, then these three sounds will be repeated with *reverberation*. This means the lingering copy of sounds which we hear in certain places like changing rooms, empty corridors and large cathedrals.



If you try a single loud hand-clap in any room you can often hear the room reverberation quite clearly. The more furniture and soft materials – and people – in the room, the more these absorb the sound so that there is little reverberation. Reverberation is not quite the same thing as echo because echo is a distinctly separate copy occurring after a time interval, but rather it is like hundreds of echoes all overlapping and gradually dying away. It is caused by sound reflecting from walls, floors and ceilings and bouncing round many times before finally decaying. Listen now to Example K (35 seconds). You'll hear a short section of electronic music, then the same music with reverberation added.



Music of all kinds usually benefits from some reverberation, and this is normally provided by the room in which it is performed. But electronic music starts life as electric currents, and as you have just seen from the examples, sounds a little 'dry' without the added reverberation. Electronic composers add reverberation to their sounds either because it makes the music sound more natural, or just because they like it, or sometimes to give the effect of distance. They have an automatic device to add artificial reverberation in any desired amount. As usual, we will need an acoustic substitute, though it would be more true to say that acoustic reverberation is the real thing, and artificial reverberation is the substitute!

There are two methods we can use, or rather one method in two forms.

### *Method 1*

Is the room you are working in a reverberant one? Try the hand-clap. If the sound takes 2 seconds or more to die away, then it is. If not, is there a reverberant place to which you could move your machines (it must have mains plugs handy) and work for a short while without interruption? If you can

work in reverberant surroundings, the method is to record by microphone, but place the microphone well away from the loudspeaker, and with its back to it. Thus it will pick up reverberation from the walls, etc.

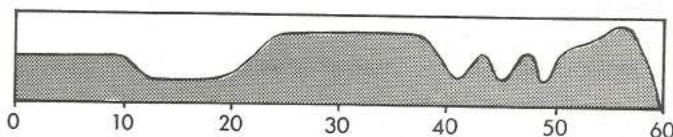
*Method 2*

To increase further the reverberation time of a room, we set up the equipment as just described, but play both the machines at  $2N$  (if this possible). All the sounds will be wrong, of course, but when we play back the copy at  $N$ , they will come right. However, something else happens. The room reverberation which our microphone picked up will now be twice as long. Simple, isn't it? Whichever method you use, the symbol for reverberation is:



†EXERCISE A

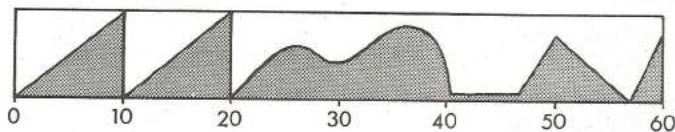
1 Copy Material 12 (64 seconds) with as much added reverberation as you can, using this dynamic plan:



This is called version R.



2 Copy it again with no reverberation (dry) using this dynamic plan:



This is version D.





3 Cut both recordings into three parts each, cutting at carefully selected points. We now have R<sub>1</sub> R<sub>2</sub> R<sub>3</sub> and D<sub>1</sub> D<sub>2</sub> D<sub>3</sub>.



4 Edit them into this order:

D<sub>1</sub> R<sub>3</sub> D<sub>2</sub> R<sub>2</sub> D<sub>3</sub> R<sub>1</sub>



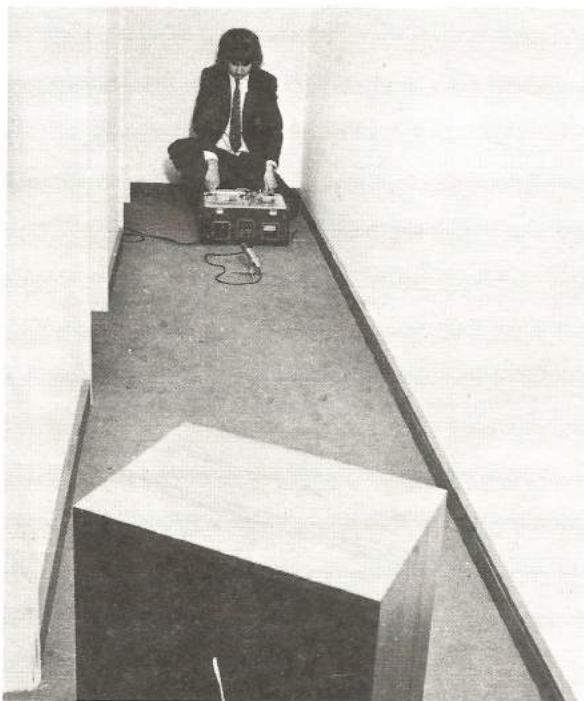
5 Find a title.

#### EXERCISE B

Use Material 12 again (several times if you wish) to make a piece of your own composition. Be sure to use all the following techniques:

- Speed change
- Filtering
- Envelope shaping
- Reverberation
- Dynamic shaping

Try to make the piece grow gradually to a climax, then gradually sink to rest. Don't forget the value of silences.




*An empty corridor is good for reverberation*

## 8 Some Further Techniques

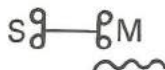
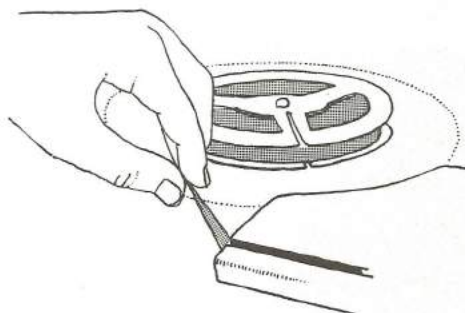
There is rather a lot of reading for you to do in this chapter. However, several new possibilities are opened up, so it is worth being patient in order to acquire new skills.

### VIBRATO

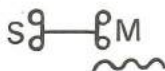
The performance of singers and many instrumentalists is made more expressive by *vibrato*, that is, a slight raising and lowering of the pitch about 7 times a second. We have already seen how *tremolo* can be achieved with your volume control . This is very similar to vibrato but changes the volume rather than the pitch.

We can make more or less rapid pitch changes by two methods:

1 Get your thumb and finger each side of the source tape, at a point between the feed spool and the head assembly. By pinching lightly on and off rapidly you will affect the pitch and produce a rough kind of vibrato. This shows up more on steady than on complicated textures. Try it on Material 13 (42 seconds) which consists of steady notes. Use different speeds and strengths of pinch-repeating in order to find out what is the most effective. Notice the new symbol for vibrato.



2 You can press or dab the feed itself, using regular repetitions again. Pressing is best done near the centre; dabbing is best near the edge of the spool. Try this method also on Material 13.



## FILTER MODULATION

When using tube filters, again we can use rapid hand movements to *modulate* the sound, i.e., change it in some way. (In this case we can change the tone colour. This will be symbolised thus  $\{ \}$  )

Again two methods are available:

1 Have the microphone near the end of the pipe rather than in it. Wave the microphone end of the pipe up and down so that it keeps flashing past the microphone.

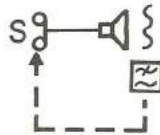
2 Have your hand over the loudspeaker end of the pipe, and keep flapping your hand to cover and uncover the pipe. This can be done slowly with good effect. Mind the microphone, though – the slightest knock will sound bad on the tape, and may even damage the microphone itself. It's best to keep the microphone just out of the pipe.



Try both these methods on Material 13.



When using the lowpass paper filter method, we can modulate the sound by moving the paper away from the playback head and back in again. This can be done gradually, or quickly many times. Try this also on Material 13, but there is no need to record the result.





## TRANSPOSING TWO OCTAVES

Transposition means changing the pitch completely, and you already know that doubling the tape speed means transposing up an octave, and halving the tape speed transposes down an octave (amongst other changes). Even more effective is a change of two octaves. This of course involves quadrupling ( $\times 4$ ) or quartering ( $\times \frac{1}{4}$ ) the tape speed. If you cannot work out how to do it, ask your teacher. The method depends on what equipment you have, but remember that you are aiming at always playing back the final result at speed  $N$ . When you have decided the method, copy something (say Material 13) at  $4N$  and then at  $\frac{1}{4}N$ . Play them back and listen.



Apart from the obvious enormous changes in pitch, tone colour and tempo, notice also:

- 1 All envelope times are quartered when transposing  $\times 4$ . Thus your attempts at instant attacks will be greatly improved without the need for tape cutting.
- 2 Room reverberation is four times longer when transposing  $\times \frac{1}{4}$ . Here is an easy way of adding quadruple reverberation to an ordinary recording:
  - (a) Play source at  $N$ , record on a work tape running at  $\frac{1}{2}N$ .
  - (b) Play back work tape at  $2N$ , record on to second work tape (reverberant conditions) also running at  $2N$ .
  - (c) Play back second work tape at  $\frac{1}{2}N$ , copy by line on to master tape at  $N$ .

This method keeps the material at its original pitch. If you want to transpose the material at the same time, you could perhaps leave a step out. Think it all out carefully.

## GENERATION LOSS

Every time we copy from one machine to another two things happen. First, we can't help *distorting* the original sounds. This means we no longer have a faithful copy. This *may* be an advantage for electronic music but the trouble is we can't control it. Secondly, *noise* is added. This is because even a tape with nothing recorded on it makes a hissing sound. Every time we copy we double this noise. There may also be a third trouble if any of your machines does not run at a perfectly even speed. If the speed wobbles the pitch of all sounds will have vibrato, though you may not notice this except with steady sounds. (Slow wobble is called *wow*; fast wobble is called *flutter*.) Every time a copy is made further wobble will be added.

All these troubles are known as *generation loss*. The sounds on the discs are second-generation sounds, because the originals were on tape. Your source tape is therefore third generation and the best your master tape can ever hope for is fourth generation. Now some of the processing methods shown in this book will add two or three generations more, so when you are using such things as vibrato, filtering, speed change and reverberation, try to combine them in one operation if you can, and not use up extra copying processes for each step. However, it is important to remember that there is far more generation loss in copying via loudspeaker and microphone than when using a line; so you can afford several generations of line copying but fewer acoustic copies.

One last tip. Save your dynamic shaping for the *last* copy whenever possible. In other words record all previous copies at *full* volume, then do the shaping at the end. This keeps down the unwanted noise considerably.

And now for some music! These pieces will be specially good, containing just about all the techniques you have learnt. They will take some while, but you are used to that, and you can always spread your work over several sessions.

#### † EXERCISE A

This is a *rondo* in the form  $A^1 B A^2 C A^3 D A^4$ . Each section is to last approximately 40 seconds, so the total length will be getting on for 5 minutes. Make sure you have plenty of tape (a new spool if you are using the 3-inch size) and an extra spool of tape for a work tape.

*Section A<sup>1</sup>* On Material 14 there are three sounds lasting 25 seconds each. Copy the first sound on to your work tape, breaking it up into four envelopes as follows:



Mark the tape carefully at the beginning and end of each envelope; but because we shall tape-cut for hard attacks and decays, for all but the third envelope the start mark will be a little way in (as described on page 35), and for the third and fourth envelopes the end mark will be made just before the sound ends. Number the envelopes 1, 2, 3, 4.



Now repeat exactly the same process with the second sound of Material 14. This time number the sounds 5, 6, 7, 8.



Again use the same four envelope shapes for the third sound of Material 14. Number them 9, 10, 11, 12.



Cut up your envelopes separately and lay them out on the table in order.

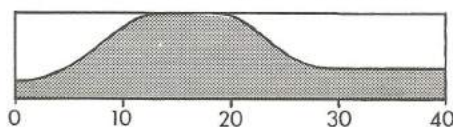


Make sure you have some silent (unused) recording tape handy. Leader tape will do but blank recording tape is better. Now splice as follows:

1, 6, 11,  $\frac{1}{2}$  sec. silence; 4, 5, 3, 10,  $\frac{1}{2}$  sec. silence; 8, 12, 7, 1 sec. silence; 2,  $\frac{1}{2}$  sec. silence; 9, and join into a loop.



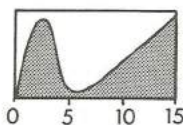
Play the loop on the source machine. It is several feet long, so you will need a coffee jar for it to go round (if you have a long table) or a music stand might do the trick. Failing these, someone could hold a pencil up straight and let it go round that. Remember that the loop must run slightly slack. Using reverberation, copy on to the master tape. Dynamic shape:



This makes section A<sup>1</sup>. Keep the loop on one side as it will be wanted again.

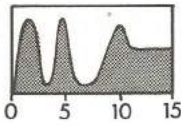
*Section B* Use Material 15 (62 seconds) and make three sub-sections:

B<sup>1</sup> Lowpass filtered with modulation

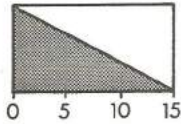




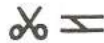
B<sup>2</sup> Tube-filtered with modulation



B<sup>3</sup> Highpass filtered



Edit and splice these three on to follow A without a break (in order A<sup>1</sup> B<sup>1</sup> B<sup>2</sup> B<sup>3</sup>).



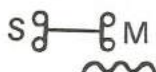
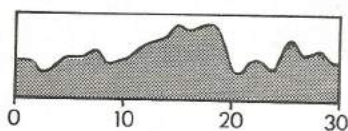
*Modulating a tube filter*

Section A<sup>2</sup> Either (a) copy the loop at half speed, with reverb, or (b) if you feel like having heavy reverb, copy A<sup>1</sup> at half speed. Either way, the section must last for 40 seconds, real time. Splice on to follow B.



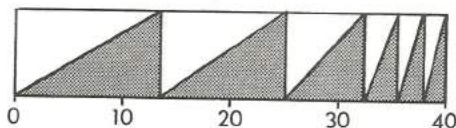
*Section C* Copy Material 15 at double speed, using vibrato both by pinching the tape and by pressing the spool.

Approximate dynamics:



Add this section to your master tape.

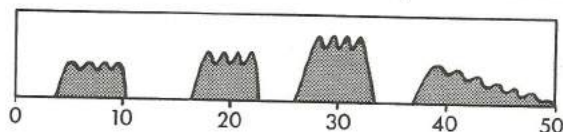
*Section A<sup>3</sup>* Copy the loop at double speed.



Splice on after section C.



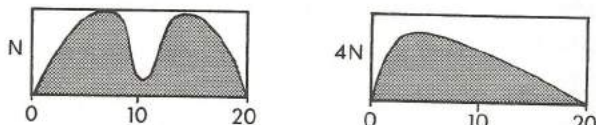
*Section D* Copy Material 15 *two* octaves lower. 50 seconds real time.



Add to the master tape.



*Section A<sup>4</sup>* Use the loop again at normal speed for 20 seconds. Stop the machines, then set up for a 4N recording, 20 seconds real time.



Splice both pieces on to master tape and end with a white leader (or red, if there is to be no more on this spool).



*Final Check* Play through the piece and check for the following:

- (a) No unwanted noises, clicks, or silences.
- (b) Duration of each section approximately correct.
- (c) Dynamic shaping approximately correct.

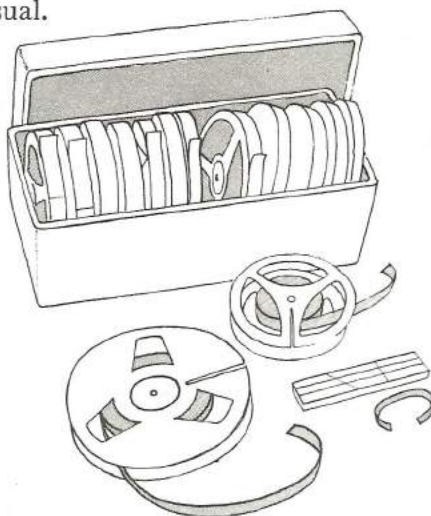


Invent a title incorporating the word 'rondo' or 'round'.

### EXERCISE B

Use Material 16 to make a Theme and Variations, i.e. A<sup>1</sup> A<sup>2</sup> A<sup>3</sup> A<sup>4</sup> . . . for as many times as you like. The sections should all use Material 16 but in different ways. They need not all be the same length. Try to make an effective finish – it is only too easy to stop just because you are running out of ideas. The remedy for a weak ending is to hide it in the middle. For example, if you manage A<sup>1</sup> A<sup>2</sup> A<sup>3</sup> A<sup>4</sup> A<sup>5</sup> A<sup>6</sup> and you think A<sup>6</sup> is a bit feeble to end on, but A<sup>3</sup> would be better, just change them round. Indeed you can change the order in any way you like. To unpick a joint you have already made, turn the tape over and carefully pull up one of the corners from the inside; the jointing tape can then be peeled off.

Find a good title as usual.





## Index and Glossary

- acoustic to do with sound rather than electricity  
amplifier electronic device for making signals stronger  
attack 33 beginning of a sound: part growing in volume  
bandpass filter 25, 30 filter which lets through only a selected band of frequencies  
chinagraph 6, 16 soft wax pencil able to mark smooth surfaces  
click 17 very brief, usually high-pitched sound; normally unwanted  
coloured 27 having a tone-colour altered by filtering or other means  
copy 3 make a tape like an existing one: sometimes called dubbing  
decay 33 fading end of a sound  
dynamics 8, 10 loudness level  
edit 15-19 select, reject and arrange into final order  
envelope 33 dynamic shape of sound or group of sounds  
filter 24 device for cutting out or weakening certain frequencies  
generation loss 44-5  
head 15 electro-magnetic device which contacts tape  
highpass filter 25, 28 filter which cuts low frequencies  
hold 33 part of a sound with steady volume  
i.p.s. inches per second  
leader tape 2 tape used for identifying recordings; does not carry sounds  
level indicator 4 shows how much signal is being recorded on tape: normally has a moving needle  
line 2 special cable for transmitting sounds in the form of electrical currents: used between two machines  
loop 21 length of tape in circular form: for repetition  
loudspeaker device for converting electric current into sound (perhaps concealed inside tape recorder)  
lowpass filter 26-28 filter which cuts high frequencies  
master tape 2 tape used for finished piece of music  
magic eye 4 level indicator which indicates full recording when no space between two lights

microphone 2	device for converting sound into electric current
modulate 43	change in some way
monitor 5	listen to signal during recording process
N 11	normal studio speed (usually $3\frac{3}{4}$ i.p.s.)
noise	unwanted sound
pause control 4	used for holding tape still without cancelling record or playback button
percussive envelope 35	one with instant attack and sloping decay
real time	normal time: time used for playback of master tape
reverberation 39	multiple echoes caused by reflection of sound from walls, etc.
revolution counter 4	set of moving numbers on tape recorder used for place marking
r.p.m.	revolutions per minute
source tape 2	tape used for supplying sounds ready for processing
splice 6	join two pieces of tape together
splicing block 6	device used for holding tape whilst splicing
speed 11	rate of tape movement
synthesiser	collection of electronic music devices in one cabinet
tape	special magnetic recording tape $\frac{1}{4}$ -inch wide, consisting of plastic backing (shiny side) and ferrous oxide coating (dull side): latter carries magnetic signals
texture 18	consideration of simultaneous events or layers
titles 38	
transpose	change pitch
tremolo 14	rapid fluctuation of volume
vibrato 42	rapid fluctuation of pitch
white noise 31	all possible frequencies at once
work tape 2	tape used for intermediate stages of work; not kept afterwards

# Making Electronic Music

*A course for schools*

TERENCE DWYER

*Illustrated by Eric Tranter*

*Photographs by Kenneth Padley*

Book 2

Music Department

OXFORD UNIVERSITY PRESS

44 Conduit Street, London W1R 0DE



## Contents

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## I Superimposition

To superimpose means to add something on top of something else. A very important process in electronic music is to add one sound-layer to another so that we can hear them both simultaneously. This process can be repeated several times to build up complex, dense sections of simultaneous sounds. This has already been done on most of the material you have so far been supplied with (in Book 1), but now you will be asked to do this yourself. Then when you wish to create pieces in your own way, you will know how to do this part of the work.

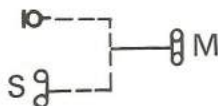
The method you will use to superimpose sounds depends on the equipment you have. You should now consult your teacher, who will show you how it is done. As soon as you think you understand the process, try the following:

### EXERCISE A

As a test piece, superimpose the following four sounds on one another so that they are heard simultaneously when you play back the tape:

- 1 A voice reciting the months of the year.
- 2 Anyone playing an instrument.
- 3 Material 17 from the source tape.
- 4 Part of one of your previous tape pieces.

This should occupy 10-15 seconds only.

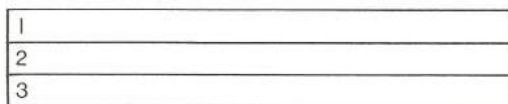


When you listen to the result, can you hear all four sound-layers equally well, or is one of them rather faint? If this is the case, or one layer is too loud, try to find out what went wrong so you can correct it in future. There is no need to keep this recording, though if the result was poor you could try again.

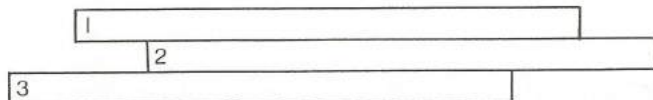
† EXERCISE B

In superimposing the sound-layers of this piece, you are to shape the dynamic curve of each layer as it is recorded, remembering that once two layers have been mixed you cannot later alter the dynamics of one without altering the other in the same way, so mistakes must be dealt with by trying again before going any further.

Begin by recording, at speed N, Material 17 as layer 1 with its dynamic shape (given below), then superimpose Material 18 as layer 2 with its correct dynamics, then Material 19 as layer 3 with its own shape. (All three materials last 60 seconds each.) Try to synchronise correctly, that is, make the three layers come together in time, thus:

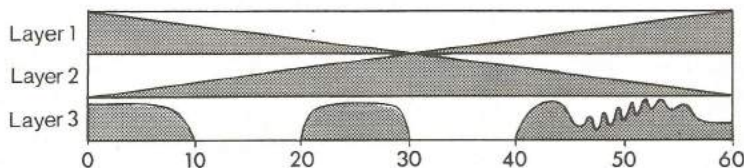


and not get displaced so that one begins before another, thus:



A good way is to find the beginning of each passage (using our editing method of rocking the spools) and then wind back both (or all three) machines to *one second* before this point. Measure this fairly accurately, according to tape speed. Now if you start the machines simultaneously the layers should come together after one second. Slight mistimings can be dealt with later, with the scissors!

Here is the overall plan:



When you hear the result played back, you will hear layer 1 gradually fade out and layer 2 take over: after 30 seconds they will change places again. Meanwhile layer 3 is behaving independently.

L 9 — 8 M



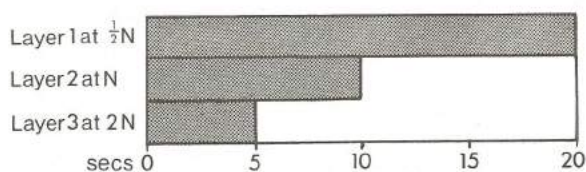
### EXERCISE C

Use the same materials as in Exercise B. Draw your own plan of superimposed dynamic shapes and then realise the piece.



### EXERCISE D

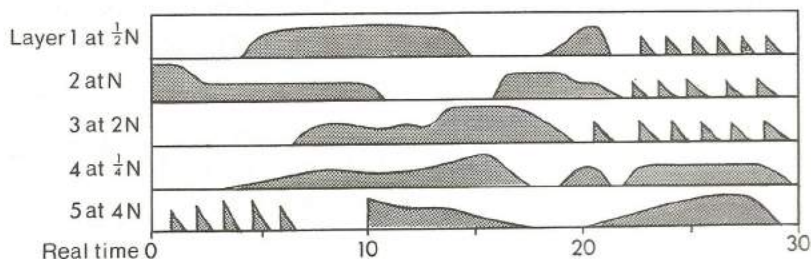
Use Material 20 and superimpose it on itself at three different speeds:  $\frac{1}{2}N$ ,  $N$ , and  $2N$ . There is a problem, since the material is only recorded for 10 seconds. Are we to end up thus? –



There is no need for this. Record Material 20 at speed  $N$  and make a loop of continuous sound for use on the source machine

$$sg - pW \times \approx = L$$

Now make the recording according to the table below, but remember that real time on the *recording* machine is calculated only whilst it is running at normal speed. If other speeds are used, the timings must be doubled or halved accordingly. If you feel confident, add layers 4 and 5; but you need not do so unless you wish.



N.B. The short envelopes given should last about  $\frac{1}{2}$  second each. Their exact number and timing are not important: aim at a random, rather jumbled effect.



### EXERCISE E

This is a fairly complex piece, and uses all the techniques so far learnt. Try to work out the piece patiently, because it will teach you a great deal about how tape pieces can be constructed.

*Section A* This is to have three superimposed layers. Record Material 21 (10 seconds) with recording machine at  $\frac{1}{2}N$ , forming 6 percussive envelopes of varying length, say:



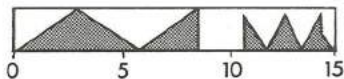
If you have the time and energy, you can cut each envelope with scissors to give a hard attack, and join up again (as shown in Book 1, pages 35, 36).



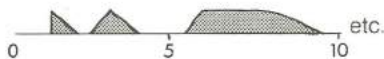
In any case make a loop of your sounds.



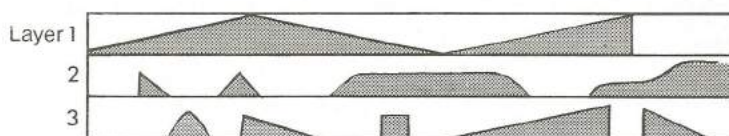
*1st layer* Play back the loop on source machine at  $2N$  (this gives a two-octave transposition upwards and a fourfold speed increase). Record for 15 seconds with the following dynamic shape:



2nd layer Use Material 22 (30 seconds) and superimpose it on this last recording, making various envelopes as you record, for example:



3rd layer Do the same with Material 23 (30 seconds), adding it on top of the other two layers. Try to fit the new envelopes in between those of the second layer, or overlapping them, something like this:



Next we add reverberation by copying under reverberant conditions. We also want to end up by playing the result at half speed, thereby doubling the reverberation time. The best way is to record at speed 2N. (If this is impossible another copy will have to be made to achieve the speed change after reverberation has been added.)

Final dynamic: all *mf*, slight crescendo in middle.



Total real time=30 seconds.





**Section B** Material 24 (70 seconds) is to be used twice, superimposing different parts on each other.

*1st layer* Copy through highpass filter, adding vibrato, on to the section of the master tape following section A, and stop both machines after 30 seconds.



*2nd layer* Wind back master tape, but take care not to go too far or you will superimpose on section A. Copy through bandpass (pipe) filter, using filter modulation and reverberation, transposing an octave higher and superimposing on 1st layer. Total real time: 30 seconds. Final dynamic: all very loud.



**Section C** Material 25 (65 seconds) is to be superimposed upon itself, just as in the last section.

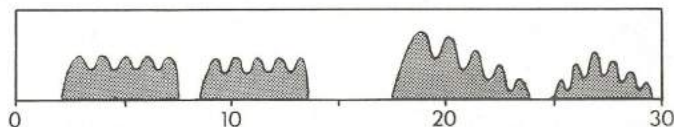
*1st layer* Copy at  $\frac{1}{2}N$  on to a work tape (30 seconds real time).



*2nd layer* Copy at  $2N$ , superimposed on 1st layer (30 seconds real time).



The work tape is now to be filtered and enveloped in one operation. (N.B. No reverberation.) Use bandpass *and* lowpass filtering, but *not* in series, i.e., both on the same microphone. If you have two microphones and mixing facilities, use them in parallel (one filter to each microphone); otherwise use one method at a time, stopping the tape after 15 seconds to change filters. (Edit the join out afterwards.) Use tremolo on all envelopes, following this plan:



Make the copy on to the master tape, following section B.



Keep the work tape you have just used carefully on one side. We now have to make two more sections. They will be made on to work tape but will nevertheless count as master tape when made.

*Section C*<sup>A</sup> Copy section A, *backwards* if possible.  
Alternative methods:

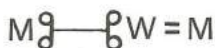
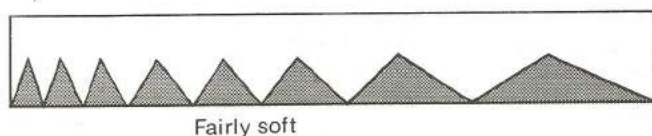
1 If your main machine is a 2-track recorder and your source machine is a 4-track recorder, put the master on the source machine upside down and select the inner tracks (2 and 3) for playback.

2 If either of your machines is a 2-track stereo recorder, play the master on this upside down, selecting track 2 for playback.

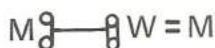
3 In all other cases, play the master on the source machine upside down and inside out (dull side of the tape outwards). This unfortunately reduces volume and filters off top frequencies. If it gives too unsatisfactory a result, forget about the reversal and play the tape normally.

N.B. In all cases of tape reversal, remember to begin playback at the *end* of the passage you are copying!

Approximate dynamics for this section:

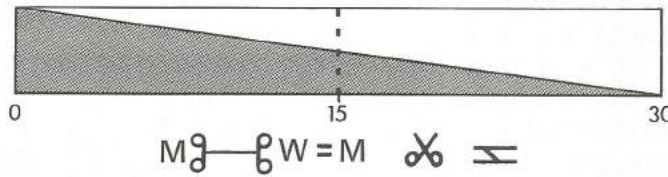


Superimpose section C on this (forwards) with its original dynamics. If you keep your recording level control to its usual maximum, section C should come out as it did before.



Wind this *C*<sup>A</sup> section on to a spare spool.

<sup>A</sup>  
**Section B** Copy section B at double speed, twice in succession (total real time 30 seconds) and edit out the join in the middle. Dynamics:



Superimpose section A on this, using the same dynamic.

$$M \text{ ♩} — \text{♩} W = M$$

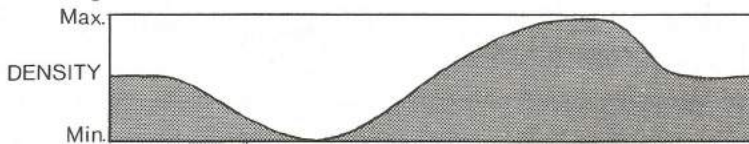
Wind this <sup>A</sup>B section on to a spare spool.

**Final operation** Splice together in the order <sup>A</sup>A <sup>A</sup>C B B C. Listen for faults and correct if possible. Find a title.

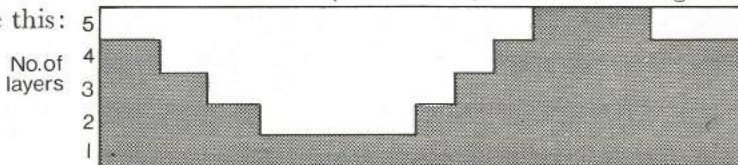
$$\text{✂} \text{ ≍ } M \text{ ♩} — \text{♩}$$

### EXERCISE F

Using Materials 21-25, plan a piece which uses any techniques you like; but consider the *density*, i.e., how many layers we have at a time. One layer is obviously the thinnest density (or perhaps you think silence is the thinnest), and 5 or 6 superimposed layers is about the thickest density we can manage without too much generation loss. Plan your densities to follow this plan throughout the piece:



You cannot easily make 'curves' when changing densities (though there *is* a way if you have time to think it out). However, it will be all right to work in steps, like this:





Apart from the above requirement, you are free to plan every aspect of the piece. But remember these points:

1 Avoid monotony of volume. (Reminder: all copying is normally done at maximum volume on to work tapes and loops, but overall dynamic shaping is done, if possible, on the last copy, i.e., on the master. However, the exception is when you want to superimpose layers having *different* dynamic contours: here the shaping is done as each layer is recorded. But notice that if you wish all the layers to follow the *same* dynamic contour, they should be superimposed at full volume to avoid generation loss, then the total result shaped later.

2 Don't use reverberation all the time, unless you are seeking a particular effect.

3 Use various filter methods.

4 Sometimes use envelopes, sometimes continuous sound.

Remember also that you can carry out the operations in any order. For example it can be:

Transpose Reverberate Envelope Filter

OR

Filter Envelope Transpose Reverberate

and so on.



## 2 Tape Echo

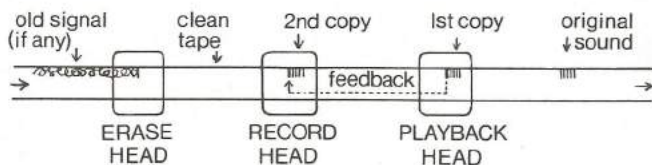
Listen to Example L (20 seconds). You will hear every sound echoed several times. How is this achieved?



Some tape recorders have two heads, some three. Lift off the head cover and look at yours. The first head on the left is always the erase head (this wipes out previous signals from the tape when the machine is in the record mode). If there are only two heads the other is a combined record/playback head. Obviously it can perform only one of these functions at a time. If your machine has only two heads, you cannot use tape echo and will be unable to make the piece of music suggested at the end of this chapter: however, you may like to read through it so that you will understand what is involved. More expensive machines have separate record and playback heads, the playback head being the last on the right. The three-headed arrangement has certain technical advantages which need not concern us at the moment, except that if your machine has three heads you can use tape echo. This is what will happen as the tape travels from left to right:

- 1 Any old recordings are wiped out by the erase head.
- 2 A new sound goes on to the tape at the record head.
- 3 The spot where this sound is recorded moves on till it gets to the playback head; a distance of, say, two inches.
- 4 The playback head 'reads' the sound and feeds it back to the record head, where it is once again recorded on the tape, a couple of inches behind the original.
- 5 This copy moves on to the playback head and the process is repeated a number of times.

Let us see this in a diagram:



Note the all-important *feedback* from playback head to record head. How is this achieved? Well, on many machines it is done by means of an internal wiring arrangement controlled by an Echo switch. Use it! If there isn't one, we use the loudspeaker of the recording machine. This, you remember, is normally turned off whilst recording with a microphone. (What do you mean, you don't usually? No wonder you have been getting some funny recordings!) By turning up this loudspeaker (output volume control) and selecting *off-the-tape* monitoring (there is always a switch for this on three-headed machines) we simply feed back the sound acoustically, via the microphone. If your machine allows the mixing of microphone and line inputs, this can be done even when copying by line.

The symbol for tape echo is:



One important point concerns the *level* at which the signal is fed back. This depends on the output volume control; or, if you have an Echo switch, the record control level. Balance it so that the repetitions grow ever fainter, though not too quickly.

Another important point concerns the *frequency* of repetition. Clearly the faster the tape speed, the faster the repetitions; but it is the final playback speed which counts, in other words it is possible to record at one speed, using echo, and play back at another speed, in which case the echo frequency will be affected just like everything else on the tape.

## USES FOR ECHO

There are three main uses, though you might think of others:

1 *Echo effect*; in other words, we use it because we like the effect of repeated sounds dying away. Now try using echo on Material 26 (40 seconds). Note the effect it has on different sounds: short, long, and especially on short phrases of different notes, and on *glissando* (sliding pitch).



2 *Multiplication*, in cases where we desire a thick texture consisting of many rapid and varied (probably short) sounds. The echo acts as a multiplying device and should not be perceptible *as* echo; rather it is like superimposing the cloud of sounds on itself three or four times. The rather jumbled result means that



we should not expect to hear individual sounds clearly, but will treat the passage as a block of composite sound. Thus a group of successive different pitches.:



will end up as a cloud of sounds:

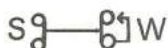


Try this effect on Material 27 (32 seconds).



3 *Substitute for reverberation.* Reverberation is really dozens of overlapping echoes which merge into each other to make a smoothly decaying envelope. If we can get our echoes fast enough (by using 15 i.p.s. or copying upwards 2 or 3 octaves) the result may be smooth enough to pass as reverberation. This is a particularly useful method because the level control can decide the reverberation time, i.e., how long before the 'reverberation' dies away. Try this:

(a) Play back Material 26 (40 seconds) at  $\frac{1}{2}N$  and record with main machine at  $2N$ , with long echo.



(b) Play this back at  $2N$  and record at  $\frac{1}{2}N$ .



(c) Play back at  $N$  to hear 'reverberation' effect.



#### † EXERCISE A

Use Materials 26 and 27 to make a piece. Some of the planning is given here, the rest is up to you. There are two approaches possible:

1 Discuss among yourselves exactly what the plan is before you start, and write it all down;

2 Begin work on a trial and error basis, deciding the next step after you have listened to the result of each operation.

These are the only conditions:

1 The piece must use all three types of echo (true echo, multiplication, and reverberation substitute).

2 Somewhere in the piece (in several places if you like) the sounds should *gradually* change from echo to normal, or from normal to echo. This is done by controlling the amount of feedback.

3 The piece is called 'Space Gold' and represents the following story: a space ship crashes on Earth and is found to consist of gold. Earthmen venture out into space seeking the source of this gold, and various planets are tried until the golden planet is found. On trying to land, the Earth spaceship also crashes. Do not try to interpret things too literally, though you should be able to manage the crashes well enough. Let *one* of the three echo types stand for 'gold' and the other two types for 'the seeking after gold'.



### 3 Variable Speed

We can already vary the speed of our tapes, but only by doubling and halving. What we are now seeking is *infinitely variable* speed change, i.e., the use of all possible speeds between those we already have. Here are some methods, in order of preference:

#### 1 VARIABLE SPEED RECORD PLAYER

A few record player decks have an infinitely variable speed control (a lever sliding round in an arc). If you are lucky enough to have one, work as follows:

(a) Set up your source machine and record player side by side (tape recorder on the left) and at the same level.

(b) Place source or work tape spool on source machine on left hand (feed) spool holder.

(c) Thread tape through heads as usual but *not* between capstan (rotating shaft) and idler wheel. Test by starting machine: the tape should not feed through as usual.

(d) Thread the right hand end of the tape to an empty spool as usual (a large one is best for this purpose), but put the spool on the centre of the record player turntable, having first twisted the spool 180 degrees away from you so that the tape enters the spool on the far side. This is because the turntable rotates in the opposite direction to the tape recorder.

(e) Now put the tape recorder on playback and start the record player. By moving the speed control of the latter you can gradually speed up and slow down.



*Using a turntable at variable speed*



## 2 FREE-RUNNING TURNTABLE

If your turntable does not have infinitely variable speed control ('fine control' does not count), you may be able to turn it by hand, so long as there is a way of disconnecting the drive unit. Many turntables have an 'off' position for the speed selector, and this will very likely leave the turntable spinning free. If this is so, set up the equipment exactly as described above, but spin the turntable by hand, varying the speed as you do so.

## 3 HAND SPOOL DRIVE

This method does not need a record player, but it gives rather erratic results. This is what you do:

- (a) Thread source tape up on source machine in the normal way, except that the tape must not pass through the capstan drive (see 1(c) above).
- (b) Place a finger somewhere convenient on the right hand spool and spin it round, varying the speed as you do so.

Whichever method you use, the symbol for variable speed playback is:












The idea is to achieve such results as:

- 1 Gradual acceleration. This will make the sounds gradually rise in pitch and tempo. Symbol: ↗
- 2 Gradual deceleration. The sounds will of course slow down and fall in pitch. Symbol: ↘
- 3 Both the above alternately. Symbol: ↗↘
- 4 Erratic and irregular variations. Symbol: ~

By doing these things to the source tape we can hear exactly what is happening. If for any reason you can only do them to the recording tape, they will still work, but you will not hear the variations till you play the result back, and then everything will be opposite: e.g. ↗ will produce ↘. Think out why this is so.

† EXERCISE A

Use Materials 26 (40 seconds), 27 (32 seconds), and 28 (30 seconds) to make a piece based on the following plan:

Section	A	B	C	D	E	F
Speed		2N				N
Other					cut up & re-edit	
No. of Layers	1	2	3	2	4	1
Time	20	15	10	10	15	20

Decide on which material will be used for each section (Section E can use one material twice over, perhaps once in reverse). Also decide what other processes might be used.

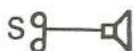


When you have made the piece, see if you can compose parts for live performers to go with it. Discuss this with your teacher, and try to arrange a performance.



## 4 Variable Filtering

You have seen how different filters can cut out different frequencies. Your tube filters emphasise certain frequencies, depending on their length. One of the most interesting devices on a synthesiser is the *voltage-controlled filter*. Whilst a sound or sequence of sounds is being passed through such a filter, the cut-off frequency can be moved around rapidly, thus changing the tone-colour drastically (the 'wa-wa' pedal used on some electric guitars is a similar device). This is called *sweeping* the filter. You can listen to a swept filter in Example M (12 seconds).



Is your tape recorder such that you can play back one track whilst simultaneously recording on the other? Try to find this out for yourself, but consult your teacher to make sure. If you can do this, then you can get variable filtering by combining it with variable speed playback. Try it out, using Material 28:

1 Copy source on to Track 2 of master tape.



2 Place microphone facing loudspeaker of its *own* machine, and set up a tube or other filter.

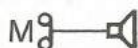
3 Thread tape as for variable speed, using one of the methods described in the previous chapter.

4 Set machine to record on Track 1, playback on Track 2, and operate variable speed (  $\curvearrowright$  for example).





5 Rewind tape, thread normally, and play back Track 1.



6 You should now hear the original programme without pitch or tempo alteration, but with swept filter effect. This should be quite drastic, but notice that it will work even without the filter, because of the way in which every loudspeaker and microphone colours the sound to a greater or lesser extent.

If for any reason you are unable to achieve this type of variable filtering, you can always fall back on varying the paper lowpass filter described in Book 1, by pushing the paper in and out.

### † EXERCISE A

This is a tough piece, and a real challenge because the material provided is very thin, and becomes busy and interesting only because of the work you will put into it. But you will get a great sense of achievement if you can succeed. If your equipment makes it impossible to do any particular process (e.g. variable filtering), leave it out and go straight to the next step, or find a substitute if you can.

Material 29 consists only of six notes, 10 seconds each, made by a square wave generator. Material 30 is 10 seconds of white noise.

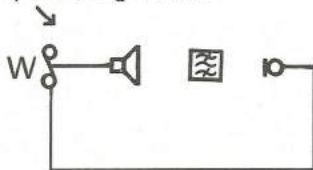
First you should make three work tapes which we shall call Assembly A, Assembly B, and Assembly C. Each will last 60 seconds approximately.

#### *Assembly A*


1 Superimpose Material 29 on itself at three different speeds:  $2N$ ,  $N$ , and  $\frac{1}{2}N$ . (The  $2N$  layer will have to be done twice running to make 60 seconds: edit out the join). All this is to end up on Track 2. (Track 1 if the next step is impossible.)

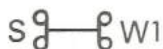


2 Filter this with variable bandpass as just shown above. The result should have gradually rising filter frequency, so you must do the transfer to Track 1 starting fast and gradually slowing down.



*Assembly B*

1 Copy Material 30, making various envelopes, particularly the percussive type . This will be made easier by playing both machines at  $\frac{1}{2}N$ .




2 Cut tape for hard attacks and join into a loop.



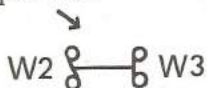
3 Copy for 60 seconds with echo and reverberation (on to Track 2, if next step possible).



4 Filter with variable bandpass, irregular. 



5 Copy with decelerating transposition.



*Assembly C*

1 Copy Material 29



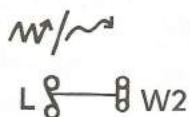
2 Mark the copy with the beginning of each note, and cut it up into six strips, one for each note.



3 Cut out various pieces from individual notes, some short, some longer. About ten pieces will do. Arrange into a random order. Join into a loop.



4 Using variable transpositions  $W^1$  and  $W^2$  superimpose on itself *four* times.



5 Copy, shaping envelopes. Again some hard-edged attacks will be useful, so out with the scissors!



6 Add reverberation.



Before going any further, it is interesting to see how the composer (in this case me, up to now) decided on the *order* of operations in each Assembly to give different effects. Let us compare them:

<i>Assembly A</i>	<i>Assembly B</i>	<i>Assembly C</i>
Superimpose	Envelope	Edit/Loop
Filter	Reverberate/Echo	Transpose/Superimpose
	Filter	Envelope
	Transpose	Reverberate

Your problem now is to finish the composition by regarding the three Assemblies as materials, and using any further processes you like. Look out for generation loss, though. Do your results sound pretty good so far; or full of noise, hum, distortion, vagueness? If the latter, keep further processes to a minimum, or even confine yourself to cutting and editing the assemblies into a satisfactory structure. But if your tapes are good and you still have energy and patience, plan a bit further. Remember you can combine the assemblies by superimposition, or alternate them by editing, and you can filter, reverberate, etc., again if you wish, in any order. Think of an overall plan, and shape the final dynamics carefully – don't have everything loud.





## 5 Musique Concrète

### MICROPHONE AS SOURCE

Up to now all the sounds you have used were electronic in origin, i.e., generated by electronic circuits and impossible to hear until they were fed into a loud-speaker. Now it is time to use real sounds as material – sounds which you cannot use until you have captured them with your microphone and tape recorder.

In the early days of electronic music a 'school' of composers experimented with such sounds in Paris (from 1948 onwards) and called their work 'musique concrète' because it was made from concrete (i.e. real) sounds. A little later a rival 'school' in Cologne used only true electronic sounds ('elektronische Musik') but nowadays both kinds are mingled freely and known as 'electronic music', or possibly 'tape music'.

### IMITATING ELECTRONIC SOUNDS

What sort of sounds can we use for our purpose? One way to begin is to try to imitate the wave generators found in synthesisers (the sort of sounds provided with this book). You could then pretend you were actually generating electronic sound, and fool your friends into thinking you have a synthesiser! Here is a brief list of the most important electronic sound sources, together with suggestions for imitating them. Samples of the actual electronic sounds can be heard in Example N (45 seconds) in the order given.

<i>Electronic waveform</i>	<i>Substitutes</i>
Sine wave (pure, no harmonics)	Recorder Tuning fork Whistling Rubbed wine glass
Sawtooth (ramp) wave (all harmonics)	Kazoo Comb and paper
Square wave (odd-numbered harmonics)	Clarinet
White noise (random superimposition of all frequencies)	Vocal hissing by several people, as below
Filtered noise (narrow bands of random frequencies)	One person making various hissings such as Ss, Sh, Ch, F, V, Z, Zh, Kh, Hh

It is also worth noting that true electronic white noise (or something very like it) can often be obtained by tuning a radio or television set between stations. White noise is not very useful to us, by the way, until it is filtered and enveloped. Sine tones are often put out on the air at certain times as station recognition or tuning signals. If you are very keen to use true electronic sounds, see if your science department can lend you a sine/square wave generator (sometimes called an oscillator) for you to experiment with. Another source of electronic sound (somewhat random) is the use of microphone feedback, sometimes called 'howl-round'. Set your machine recording through microphone, but have your loudspeaker turned well up. The howling and squeaking sound which 'should' happen can be controlled to some extent by placing the microphone at different distances from the loudspeaker, and by pointing it in different directions. (I put 'should' in inverted commas in the previous sentence because normally it should *not* happen!)

## CONTROLLING THE SOURCE

One of the drawbacks of standard wave generators is the difficulty of controlling their frequency and thus getting a rapid succession of different pitches. In the last chapter you had to cut up and join different bits of tape to make pitch-successions (we won't call them melodies!). You should be well used to splicing tape by now, but nobody pretends it's a quick job or even a particularly pleasant one. If the sound-source can be made to give out patterns of pitch and rhythm in the first place, then tape-splicing can be reduced to a minimum, and we would all like that.

Synthesisers can control the oscillators very easily. This is what makes them attractive, but it also makes them expensive! But if we use some of the substitutes given above (e.g., recorder) it is easy to perform melodic and rhythmic patterns in the first place. Clearly, all musical instruments are well suited to controlling pitch and rhythm (so is the human voice), so why not simply record a musical performance and call the result electronic music? It does not take much thought to see that this is not electronic music: it is music, electronically recorded. The real essence of electronic music is 'the realisation of the impossible'. Listen now to Example O. It was made from the sound of one flute. The flute performed melodies in the original source-recording, but these are not too easy to detect now. This demonstrates that it is the tape processing which creates the electronic music.



Another point is that any 'melodies' played are probably best if they sound new and adventurous rather than old-fashioned in character. There is, of course, nothing wrong with traditional-type melodies, but they sound better when played live, and are rather out of place in a piece of electronic music.

So use musical instruments (of any kind) by all means. Let them play unconventional melodies and rhythms, let them improvise, play at random even. Record the result and use the processes described in this course. Don't overlook that you can start filtering, reverberation, etc., right away in the very first source-recording, if that suits you. Notice also that the instruments are already producing enveloped sounds. It may be that you don't need to envelope any further. Try also using your voice as a source; singing, speaking, growling, hissing, etc.

In fact, literally any sound can be used in a tape composition. It is up to you to decide what appeals to you, but here are a few suggestions:

Musical instruments

Voices

Paper

Everyday objects

Machines

Workshop noises

Water

Traffic

Sounds of nature

Building site

Some sounds will have to be made very close to the microphone to get sufficient signal. It is apparent that for the open-air sounds you will have to use a portable recorder. Use an open-spool battery recorder if you have it, otherwise it will have to be a small cassette recorder, but the latter is probably only worthwhile if you can copy later from cassette machine to main machine by line, as the speaker of most cassette players is so poor. Still, anything is worth a try!

Another idea is to use gramophone records or radio programmes as source material. Again, try to use a line connection when you make the source tape. Be sure to jumble up the sounds with your processing, so that the originals are unrecognisable.



### † EXERCISE A

Record three different sound-sources:

- 1 A musical instrument.
- 2 An everyday sound.
- 3 Banging or rubbing one object on another to make an interesting sound.

Make a piece in five sections, thus:

Section A, using sounds 1 and 2	10 seconds
„ B, „ „ 2 and 3	15 „
„ C, „ „ 1 and 3	20 „
„ D, „ „ 1, 2, and 3	60 „
„ E, <i>one</i> sound	20 „

You will decide the processes yourself. Study once more the idea of varying the order of these. See page 20 for ideas. For that matter you could copy some of the methods exactly and compare results.



### EXERCISE B

There is a lot of talk today about whether machines and computers are taking over from men. Let us use two types of sound in a composition:

- 1 Imitation electronic sounds, as described earlier in this chapter. These will represent machines. (If you would rather, use some of the electronic material provided with this book.)
- 2 The human voice, to represent mankind.

The piece should represent a struggle between the two forces. You can decide which sound begins, what the struggle is like, and who wins; but let your plot be reasonably clear to the listener.



## 6 Methods of Composing

You will surely have noticed that the exercises given in this course have differed in character from one another. In some you had to follow strict instructions exactly; in others you were almost completely free; and in others you followed instructions in some respects and were left free in others. It is now time the burden of composing fell even more upon you, so it is the aim of this chapter to help you feel that you can organise a composition yourself.

It has been said that absolute freedom includes freedom to go wrong, and it is easy to see that in composing music we cannot afford to go wild and do the first thing that comes into our heads, followed by the second, and so on! If our music is to hang together and mean something to the listener it needs a certain amount of organisation. The main question is: what kind of organisation?

We know that in ordinary music the pitch and rhythm elements are carefully organised, but in electronic music they can often be secondary to other factors. It should be clear to you by now what these other factors are, because you have been handling them a great deal. They are all present, as a rule, in the material you have used, but you can control and alter them to a great extent. Here they are, together with the means of control:

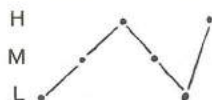
Pitch register	Speed change Filtering
Envelope shape	Speed change Tape reversal Hand volume control Tape cutting
Tempo	Speed change Editing Successions of envelopes
Timbre	Speed change Filtering Reverberation
Texture density	Superimposition Echo Reverberation
Volume	Dynamic shaping

Clearly it is possible to alter our source material in many ways. But how do we do this in such a way as to make sense?

One approach is to decide on a particular order of operations (for example, Reverberation, Filtering, Speed Change, Envelope) and try to imagine what our source-sound will end up like, thus guiding us in organising the order of our sections to make sense. But most of us lack the imagination and experience to say 'Here is a source which sounds thus. When I have reverberated, filtered, transposed, and enveloped it, it is going to sound thus', and promptly imagine the new sound! You may say, 'Why not actually carry out the operations and see what it sounds like?' Of course we can, and if the result is convincing enough (and long enough) we have a composition. It is more likely, though, that we would want to have several sections, perhaps many, showing different treatments. Well, we could make these sections, listen to them all, and then edit them into the best order. But it is inconvenient to have long pieces of tape all over the table, and much better if we knew the right order in the first place. A rather more efficient way is to structure the operations whilst they are still on paper. You will find evidence of this in the pieces in this book and in Book 1. For example, Exercise B in Chapter 2 of Book 1 asked for three speeds in the following order:  $\frac{1}{2}N$  N  $2N$  N  $\frac{1}{2}N$   $2N$ . This is not a random order. If we imagine the results for a moment, although we cannot easily forecast what they will sound like (even if we are familiar with the material) we can at least tell that the pitch registers will make a logical pattern thus:

Low Medium High Medium Low High

and this will be perceptible to the listener almost as a sort of slow 'melody':

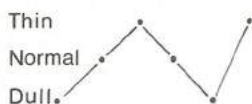


Of course, *any* order would have been a kind of melody, but the above shape is simple to follow, for it moves up and down one step at a time. Until the last section, that is: this would be Medium if the logic were continued. Why is it High, then? There are two answers: firstly we don't want things too predictable, so just as the listener is grasping the system we surprise him (this sort of thing is very common in conventional music); secondly it allows each register to appear twice, thereby making maximum use of the various possibilities in the given time. It is worth noting also that the other effects of speed change mean we shall hear different tempos:



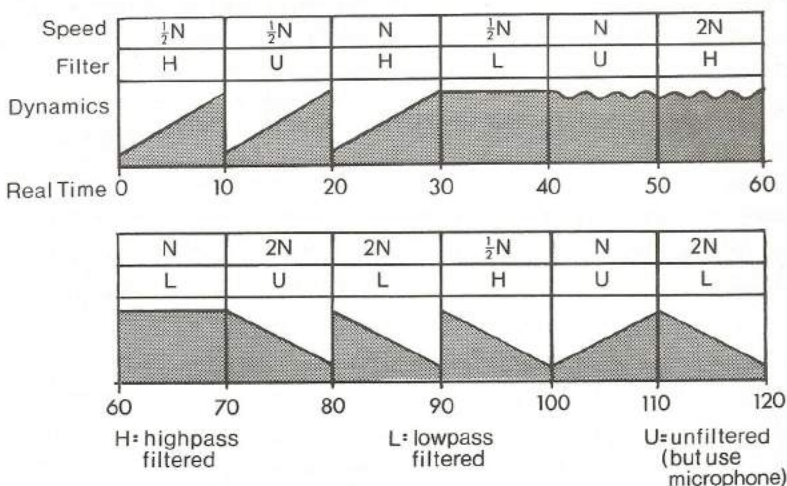


and different timbres:



Thus the listener has three chances of perceiving the pattern.

Now let us study another example. It is taken from Book 1, Chapter 5, Exercise A:



Look only at the first nine sections to begin with. There are three kinds of speed and three kinds of filtering. Can you see that these have been *permutated* together so that every possible combination of speed and filter appears once each? Next, look at the progression pattern of the speeds in the first nine sections:



Although not quite as simple as our previous example, it has the following features:

- 1 Each speed appears three times.
- 2 There is a gradual shift from slow to fast (and, of course, from low to high).
- 3 The pattern is symmetrical. It looks the same if the page is turned upside down.

Looking now at the first nine filter values, we see:



The following features are present:

- 1 Each filter method appears three times.
- 2 There is a gradual shift from highpass to lowpass filtering, though perhaps the zigzag character is the most obvious feature.
- 3 Again there is a symmetrical pattern.

Now what about the last three sections of the piece? They form a *coda*, and they briefly recapitulate what was done in the main part, thus:

<i>Main part</i>	<i>Coda</i>
Speeds gradually shifted up	Speeds go up
Filterings gradually shifted down	Filterings go down

Lastly let us look at the dynamic shaping. First we see the principle of *repetition*, i.e., the first three sections are the same. However, just as the listener is thinking he knows what will happen next, i.e., that the crescendo will be followed by a sudden drop, he is wrong the third time because the volume stays steady. So here is the principle of *surprise*, caused by arousing expectation and then defeating it. (Beethoven was very good at that.) Then the tremolo gives us the principle of *contrast* and we have reached the end of the fifth section. Now it is easy to see that this dynamic pattern is repeated backwards, i.e., that this structure is also symmetrical. Interestingly, it takes ten sections and thus overlaps into the coda. The last two sections again summarise in a nutshell the general drift of what went before.

I hope this rather laborious explanation shows how it is possible to structure a composition on paper without even knowing what the source-material is. But though we cannot foretell the exact nature of the end result, we know quite a lot about its *general* nature (tempo, register, timbre, volume). When planning your own pieces, consider using such methods. Make the alternative settings of each operation appear in some sort of logical order; but don't get too complicated – remember the listener should be able to perceive the structure.

All this can help to structure the variable elements of a piece, but it is worth remembering that music needs *unity* as well as variety. How can we achieve unity? We have seen one way to do this, which is by repetition, but beware of too much exact repetition, which is the curse of so much music. (This is where loops can be a nasty temptation!) Unity can be achieved in other ways. Before leaving the above example, notice two aspects of unity it possesses:

- 1 Everything is based on the same source-material.
- 2 All the sections are of equal duration.

These facts should offer you a hint – in some pieces you could structure the nature of the material, and keep your transformations relatively static; and again you could structure the durations of the sections, say getting longer, then shorter again.

By now it should be clear that a logical ordering of operations will be valuable, but we should be careful of two extremes: one is a piece where everything is tightly structured, the other a piece without much planning, if any (we would call this a loose structure). If you care to look back at piece 6B in Book 1, you will see a certain looseness in the overall form of the piece, i.e., there are four sections without any particular reason for their order. However, they have an important feature in common (strings of envelopes) and each section has a certain amount of organisation within itself. (I leave you to look for what this may be.)

To sum up, musical compositions need to balance *unity* and *variety*. Unity can be achieved by keeping something *constant* (e.g., material or tempo), or by *repetition*. The monotony of pure repetition can also be avoided by *symmetrical patterns*. Variety can be achieved by using *permutations* and by *contrast*. Unity and variety can be combined by repetition followed by *surprise*, or above all by *logical progression*.

There is much more that I would like to tell you about composing, but it has been well said that composition can only be learnt, not taught. Incidentally one can learn a lot from all kinds of music, provided that one can see what principles are being used, and apply these principles to one's own music without simply trying to copy the style of what one admires. In any case it is important that you should bring some originality of your own into your work. This may show in the organisations of the sounds, or in the technical field (you may invent some new way of treating sounds or tape) or in ways of creating source-material. You will almost surely need some kind of notation: you could use



the symbols you learnt from this book, or you could invent your own notation. If you are still working as a group, perhaps it will now emerge that only one of you is keen on composing, and the rest would be content to carry out his instructions; perhaps more than one, in which case each of you can 'do his own thing'; perhaps none of you, in which case heaven help you, because you won't be able to do the next exercises!

### † EXERCISES

Choose one or more of these ideas from which you will create a composition.

*Exercise A* A piece called 'The animals enter the Ark'.

*Exercise B* A piece called 'Zig-zag'.

*Exercise C* A piece made from the sound of a cough.

*Exercise D* A piece in 'bridge' form: A B C B A.

*Exercise E* A piece in which the organisation of durations is the main starting point.

*Exercise F* A piece in which all (or most) operational changes are gradual.

*Exercise G* Compose a piece for your classmates to play (live). Leave some silent gaps. Make a tape which completes the piece, so that there are three recurring situations: tape alone, players alone, both together.

## 7 Space Music

Often when there is a film or television programme about space travel, we hear particularly weird music, and this is often electronic. This is because the drama director thinks of electronic music as 'futurist' or even 'alien', so he associates it with space (because space too is supposed to share these qualities) and he is determined that we shall share his views. Hence the popular equation, electronic music=space music. There is no need for this attitude. First of all, electronic music has been around for a good while now, so it is certainly not new; secondly its strange character disappears when you get used to it and it seems no more appropriate than any other music for films about space travel or anything else suggesting the future. Of course it *can* be used for these things (e.g., 'Space Gold' in Chapter 2), but we should not feel bound to this sort of thing all the time.

The real reason for the title of this chapter concerns the actual placing of the sound of music in performance. So far, your pieces have been played back through a loudspeaker, and it has hardly mattered where it was situated. Once it is put in position the sounds continue to come from one place, just like any instrument. Even if your tapes have been reproduced through a stereo amplifier into two loudspeakers, the same sound came from each speaker (because your music was mono, not stereo) and the sounds appeared to come from one place. But it is possible, by using two loudspeakers, to make sounds apparently move across the room, and to gain other space effects.

Space effects and movements in music are not new: in the seventeenth century pieces were popular for two or more groups of performers placed each side of the listener, and perhaps in front and behind also. Echo effects were also used, and of course in opera the singers often moved about as they sang, to say nothing of processional music and marching bands.

Given the right equipment, it is not difficult for you to make your sounds move about in a way impossible to live performers. If you have worked successfully through the course up to now, it is likely that you have been using a stereo tape recorder, because such a machine makes light of superimposition by means of its Sound-on-sound facility. If you have been managing without a stereo machine, then you have proved your perseverant and ingenious nature, so I expect you will do well in this chapter, though actual space movement is not really possible without a stereo machine. However, let us get as far as we can!

## EXERCISE A

We are going to use two exact copies of the same musical material and play them through two loudspeakers spaced well apart. Now if the two speakers are equally loud, and we sit equidistant from them, *and the two recordings are in perfect synchronisation*, the sound will appear to come from a central point between the speakers. (Mono use of stereo facilities.) However, we are *not* going to have the recordings running exactly together, but one a fraction of a second before the other. That way, all the sounds will appear to rush across the room from one speaker to the other, an effect known as *floodsound*. Method:

### 1 With a stereo machine

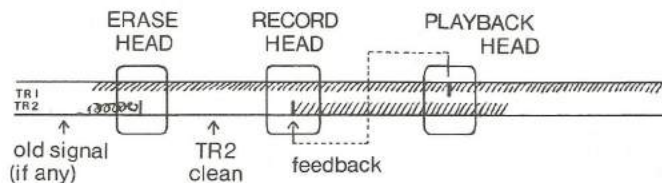
Use any material (such as an old piece, preferably one with plenty of action) and copy it on to Track 1 of a new master tape.



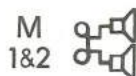
Now use the Sound-on-sound (Multiplay) to transfer this recording to Track 2 of the master tape.



The way in which this transfer is achieved is as follows: the Track 1 part of the playback head feeds back the signal to the Track 2 part of the record head. This is like tape echo except that the repeat is on the other track and is therefore not picked up again. Compare this diagram with the one on page 10:



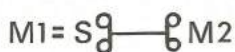
You will see that, because of the distance between the record and playback heads, the Track 2 copy is an inch or two behind Track 1. Depending on the tape speed used, this represents a time-lag of about  $\frac{1}{8}$  second to 2 seconds. At  $3\frac{3}{4}$  i.p.s. it will be around  $\frac{1}{2}$  second. Now play back both tracks in stereo, preferably through two widely-spaced extension speakers, to hear floodsound.



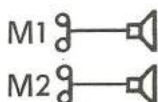


2 *With two mono machines*

Use any material (such as an old piece, preferably one with plenty of action) and copy it on to a second master tape.

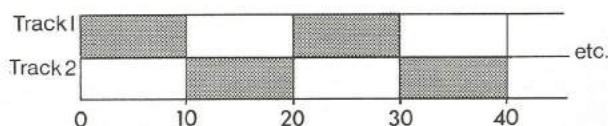


Play one master on each machine, widely spaced, and adjust till playback levels are equal. Find the starting place on each machine and set up ready. We want one machine *slightly* (half a second) behind the other, but we will probably achieve this by trying to start them together! The playback gives the flood-sound effect.



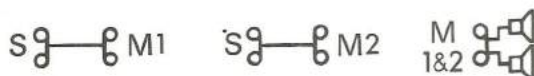
**EXERCISE B**

It would obviously be possible to record two different programmes in parallel and play them back simultaneously. This is so simple to do that we will not bother with it for the moment, but will attempt something slightly more ambitious. Use Material 1 (60 seconds) and arrange for the sound to come from left and right speakers alternately, thus:

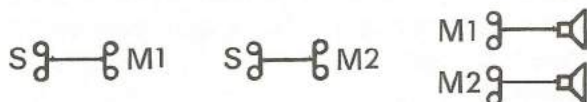


The patches of sound can be further shaped, if desired.

1 With a stereo machine, or mono machine having parallel track replay, the method is to lay down Track 1, rewind and record Track 2 (3) along the same length of tape.



2 With two mono machines, the method is to record the Track 1 pattern on one tape, then the Track 2 pattern on another tape. Play back simultaneously.



### EXERCISE C

This can only be done on a stereo machine. You may need a special line for this – one which will send the source signal to both channels of the stereo machine simultaneously. Have *both* channels in record mode (stereo). First, experiment by moving the sound across from one channel to the other. The technique is:

- 1 Open Channel 1 record control to maximum.
- 2 Open Channel 2 record control to about  $\frac{3}{4}$  maximum.
- 3 Exchange positions of the two controls, so that Channel 1 is about  $\frac{3}{4}$  maximum and Channel 2 is maximum.
- 4 Fade out Channel 1.

This should be done smoothly and continuously. Keep the machines running: now do it the other way round, fading Channel 1 in again, and Channel 2 out. Do both several times. Play back the result. If you are successful, the sound moves across the room and back, without getting louder or softer.



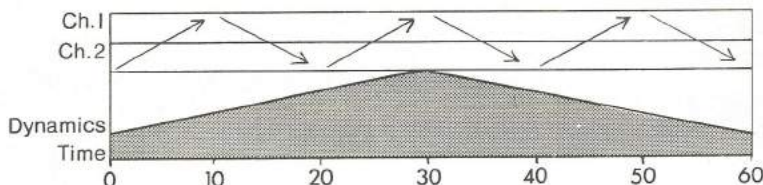
Next, try the same thing at half volume, i.e., treating half volume as if it were full. Again the result will move back and forth, but will remain quieter.



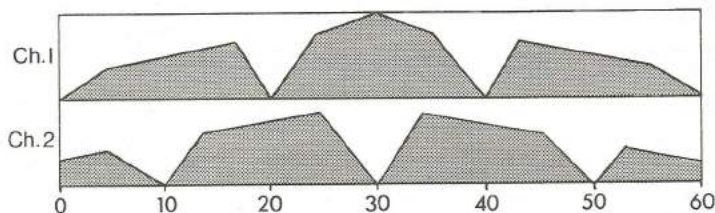
Now try this more difficult exercise:

#### EXERCISE D

Make Material 1 move backwards and forwards, and shape the dynamics as indicated:



The two record controls will probably have dynamic curves something like this:



After doing the above piece you should feel able to control the location and dynamics simultaneously.

#### SUMMARY OF POSSIBILITIES

If we have a stereo main machine, we have the following possible ways of placing the sounds *statically* in space (using the abbreviations L=left speaker, R=right speaker, C=centre):

- 1 In L only.
- 2 In R only.
- 3 In C only (same signal in L and R equally).
- 4 In L and R (two different programmes).
- 5 In any intermediate position (same signal in L and R, unequal volume).



Next we come to *apparent movement*:

6 In L and R alternately (like Exercise B) – but this must be the same or very similar material. The sound appears to jump back and forth.

7 Floodsound L to R. Again the sounds appear to move although they are actually static.

8 Floodsound R to L (material copied from Track 2 to Track 1).

And lastly we have *actual movement*:

9 Moving from L to R.

10 „ „ R to L.

11 „ „ L to C.

12 „ „ C to L.

13 „ „ R to C.

14 „ „ C to R.

15 Intermediate movements.

Where there are two mono machines, only 1, 2, 4, 6, 7 and 8 are possible.

## USING SPACE IN A COMPOSITION

There are different ways of deciding how to use the above possibilities in a piece. One way would be to make some kind of logical sequence, as indicated in the previous chapter, or set up a repetition and then bring in a surprise, and so on. Incidentally the space changes need not take place at the same times as other changes such as transpositions and filterings. Another way would be to make the space allocations depend on a previous process, so that if you wished you could have all lowpass filtered sections coming from the left, all reverberations coming from the centre, and so on. Yet again, if you were depicting a story in music, you could get your ideas from the story. Thus if you were doing 'The animals enter the Ark' you could make each pair of animals slowly cross from right to left, for instance. Lastly, you could use your instinct and preferences in deciding how to place and move your sounds.

N.B. It is important to realise that spatial allocation has to be the *last* process in any series of tape copying. This used to be true of dynamic shaping, and you can indeed do both at once if you are skilled enough (as in Exercise D). But if you can afford to make one extra copy without too much generation loss, it will be much easier to shape the dynamics last but one, then distribute the spacing. It follows from this that it is often possible to take a finished piece and make a two-channel version of it.

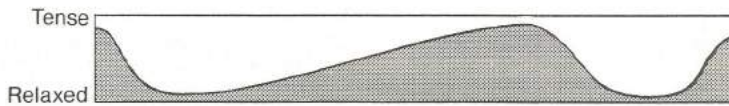
### EXERCISE E

Make a two-channel version of one of your old pieces. Study the music first and decide where space changes will take place. Make out a time plan and follow it. (Since dynamic shaping is already done, copying should be on a 'maximum volume' basis. This does not mean that the record level meter should show maximum all the time; merely that the record volume controls should be at the position usually adopted for maximum.)



### † EXERCISE F

Plan an ambitious piece which will use every technique you have learned on this course. Let every aspect of the technical processes show a logical and meaningful progression. Keep such progressions simple and obvious, and let them assist in shaping the following scheme of *dramatic tension*:



If you can also include parts for live performers, so much the better.



## Congratulations!

If you really have worked through this course, you are to be congratulated on having put in a lot of hard work, and, I hope, on having enjoyed yourself in the process. You must surely have learned a good deal about some very important principles of musical composition (surprisingly enough without really dealing with melody or rhythm) and sharpened your ears considerably as you listen to all sounds.

You will now be taking one of three paths: either you have had enough of electronic music and will turn your attention to other things; or you will use your hard-earned knowledge to continue making similar tape pieces; or you are curious to know even more about electronic music and its other methods. If the last, the world of synthesisers and computers may not yet be at your doorstep, but there are some things you could do to take steps in their direction. Why not make your own variable filter, or better still, a ring modulator? What's a ring modulator?  
Ah! That's another story . . .



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superimpose 1  
recording consisting of several superimposed layers  
rotating shaft which drives the tape during recording and playback  
set of sound-reproducing components from tape track to loudspeaker inclusive  
degree of thickness, i.e., number of simultaneous sounds  
immediate repetition of a sound  
re-routing from output back to input  
sounds heard first from one loudspeaker then immediately afterwards from another  
feedback from loudspeaker to microphone  
free-running rubber wheel which pinches tape next to capstan  
using only one signal at a time  
same as sound-on-sound  
use of tape echo to secure a thick texture  
electronic wave generator  
arrange a number of items in various ways  
same as idler wheel  
general area of pitch (high, medium, etc.)  
use of echo to imitate reverberation  
music or other sound-programme conveyed along a path by acoustic or electronic means  
device for superimposition found in tape recorders  
using two loudspeakers issuing different signals  
add signal on top of existing one

# Making Electronic Music

*A course for schools*

TERENCE DWYER

Teacher's Book

Music Department

OXFORD UNIVERSITY PRESS

44 Conduit Street, London W1R 0DE

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T.D.

## Foreword

Electronic music is easy! It can be done with the minimum equipment of a record player and a tape recorder. This has been achieved in this course by putting on to records all the electronic sound material needed, and showing the pupil how to mould it into musical compositions. It is only fair to say, however, that the addition of a cassette player, or better still a second tape recorder, will lighten tasks considerably in Book 1, whilst a stereo tape recorder is almost a necessity in Book 2. However, alternative procedures have been provided throughout, so that users of minimum equipment can still gain benefit from the work.

The course, which is expected to take from two to four years, can be begun by pupils as young as twelve years old, whilst the final chapters are suitable up to the sixth form. It is carefully graded, and offers a creative approach rather than a scientific one. The emphasis is on music rather than on electronics, and pupils should be encouraged to feel that they are producing real pieces of music even in the early stages. At all times they are guided with explicit instructions, but they are also given creative opportunities, and should be seasoned composers by the end of the course.

## 1 How to use the Course

### WHY TEACH ELECTRONIC MUSIC?

Today's music teacher is having a hard time. Not only has the old singing-class lesson lost its isolated supremacy with the almost universal introduction of instrumental work in class, but we have recently been told of our duty to prepare our pupils' ears for contemporary music by playing new-style pieces with new notation, and we have been shown the desirability of developing creativity through improvisation and other activities. What with trying to teach notation, aural training, musical appreciation, and perhaps G.C.E. 'music', it seems impossible to fit everything in on two periods a week (if that). And now – electronic music. What justification can there be for including yet another aspect of the subject?

There could be several answers to this question, all plausible. Let us try a few:

- 1 Because it is topical, and today's children ought to know what is going on.
- 2 Because music is a wide subject, and electronic music constitutes an enrichment which should be passed on.
- 3 Because the pupils don't seem interested in normal music lessons, and this new approach might work.
- 4 Because we are interested in small group projects, and this would take care of one group.
- 5 Because it would make an occasional change from the normal routine.
- 6 Because it is an enjoyable activity in itself.

These are mostly sound enough reasons for introducing the subject, even answer 3. (Perhaps especially answer 3, in view of the fairly recent Schools Council poll among school leavers, which revealed music as easily the least popular of school subjects.) Only answer 5 will not really do, because the nature of this course presupposes a reasonable continuity (though a lesson every second or third week might be made to work). But one more reason ought to be adduced, and it is this:

- 7 Because working with electronic music teaches one about the true inner nature of sounds, and sharpens one's ears enormously, thus nurturing deeper powers of receptivity for other kinds of music.



I personally find this last the most cogent reason (though I certainly don't reject the other reasons). Before starting electronic music myself a few years ago, I thought my ear as acute as the next man's, but I have now realised that I had hardly started listening at all. This seems to be the experience of all musicians who turn to electronic music.

## TO WHOM SHOULD WE TEACH ELECTRONIC MUSIC?

If the above is true, we might well feel that here is a benefit which should be offered to all our pupils, but there are snags, unfortunately. The chief one is that only a few people can use the equipment at a time. The ideal number of people is probably two, which can be stretched to three or even four. Clearly this is normally a subject for a special group who can be left to carry on their work while the rest of the class do something else. Who are these special people and how are they to be chosen? Do the rest of the class never get a chance? Where can the group work? How can the teacher measure their success?

There are so many ways of answering these questions that answering them is almost a creative art in itself. Individual teachers are bound to decide for themselves how to use a course like the present one. Everything depends on the size of classes, other facilities, whether there is a separate workroom, what equipment there is, and so on. However, here are a few alternative suggestions:

- 1 Work through the course by giving a class lesson on it every third week (or part of a lesson, more frequently). Either the teacher or selected pupils (possibly changing from lesson to lesson) would carry out the necessary operations whilst the rest watched and listened. Maximum use would probably be made of the tape/live performances which could involve everybody.
- 2 Select a small group (from two to four), or two groups alternating, whose exclusive province this subject would be. The class would hear the results of their efforts and again would take part in tape/live pieces.
- 3 Decide on the use of the crash course. (This consists of those exercises marked with a †). Let all pupils who wish to do so work through it, or the first part of it, in, say, half a term for each group.
- 4 If pupils can bring their own tape recorders to school, the number of groups working simultaneously could be increased, though there are at least four snags: (a) good tape recorders are usually too heavy for much transporting; (b) parental permission would be needed; (c) there would have to be enough power points available in the classroom (though a 'distribution panel' will help); (d) each group would require quiet conditions at times.

Where it is decided to allocate a small group, or groups, to this work, the question of selection-criteria arises; and there may well be some initial difficulty in picking the right people to undertake the course. Here are some pointers which may help:

1 Although the work is not difficult, it demands a perseverant and painstaking approach. 'Plodders' may do well, whereas the more flashy type of pupil is almost sure to give up after a few weeks.

2 'Electronic music' is popular *as a phrase*. Asking 'Who would like to do electronic music?' may well elicit scores of volunteers whose notion of the subject is coloured by the use of the Moog and other synthesisers in pop music. The present course has little to do with such a concept, and it is in their own interests that such volunteers should be, if not actually ruled out, at any rate firmly disenchanted.

3 Real success in the creative part of the course depends on the learning of important musical and acoustical concepts which I have made it my task to unfold steadily. Conventional musical skill is *not* a prerequisite: pupils who are put off music (or more exactly, school music) by the paraphernalia of learning music notation and the crushing weight of the classics may yet possess creative musical feeling, and they will have their opportunity within these pages.

4 Because electronic music is still an evolving art, there is ample room for the 'divergent thinker'. Heaven forbid that this course should ever come to be regarded as a classic exposition of how electronic music should be created. It is *one* way, albeit comprehensive of various techniques. Any pupil with an inventive, even 'freak' turn of mind, may well be a good choice.

So please take a little care in selecting your guinea-pigs. Why not a group consisting of (a) a moody genius who hasn't liked music yet, (b) a Grade 6 musician who is bored by too-easy class music lessons, and (c) a reliable plodder who will follow instructions and keep the other two at it? The interactions in such a group would at least be interesting!

## ACCOMMODATION

It is clear that only a school or music department with luxurious facilities can afford to use this course on a large scale. The teacher who has modest facilities will probably use a pilot group who could specialise in electronic music, until he sees whether the results would justify efforts to widen the scope of the subject. Nor should such a teacher feel permanently barred from better facilities. It is no use music teachers complaining bitterly to each other that they have no separate practice rooms or workrooms, no decent tape recorder or hi-fi;



such complaints must be made, repeatedly if necessary, to head teachers and music advisers, and thus through them to those who control purse strings. Unless we demand the things we need, how will anyone know we need them? It may be galling to see money spent on trampolines and television sets, language laboratories and lathes, but the answer lies in adopting the attitude which obtained them: 'Times and needs have changed, and I simply cannot teach my subject properly without the correct apparatus.' (Though expectations may have to be modified when money is as short as it has been recently.)

As to the organisation of a class into groups doing separate projects, this is nowadays normal in many subjects and at many levels of education, and music teachers ought already to be familiar with it (it could go a long way towards solving the problem implied at the very beginning of this chapter). It is not so impossible in music teaching as it may appear; seven or eight groups can in fact make music in the same room and show an amazing ability to shut out all unwanted sounds from their own ears. It is less easy for those using a tape recorder to ask a microphone to ignore unwanted sounds, so the tape group may have to call for 'Quiet, please' from time to time. Get this situation going and then invite your head teacher's inspection to emphasise your need for an additional small room. If this is, in the last resort, physically impossible to find, why not seriously consider asking for the partitioning off of a small corner of the music room, provided that suitable sound-proofing and ventilation can be incorporated? Even a bulky set of portable screens would be better than nothing.

## NATURE OF THE EXERCISES

Each chapter contains one or two exercises, often more. These are of three kinds: (1) more or less foolproof sets of instructions to follow; (2) starting points for free creative work; and (3) combinations of 1 and 2, where work is partly dictated, partly free. The course will offer maximum benefit to those who work through everything, but teachers might feel justified in restricting particular pupils to one of the above types of exercise, according to their abilities.

It will not escape notice that the early part of the course is couched in terms, both verbal and practical, which should suit children of about 12 years old, but the latter part of the course is more suited to 15-year-old pupils or sixth-formers. Certainly the work ought to spread itself over a period of from two to four years. Indeed often a single exercise will take more than one session. Generally speaking the more advanced work cannot be done without experience of the earlier processes; but because of the time lapse between elementary and

advanced work, pupils will naturally tend to forget sometimes what they have already learned. (A common malady in any subject!) It is to be hoped that teachers will be able to cope with this situation. Whilst not necessarily experts themselves, they should be able to spot quickly where pupils have forgotten basic procedures or overlooked previously taught possibilities, and to remind them briefly of what is required.

Some of the technical procedures involved have been described in the pupils' books, some in the teacher's book. This is partly because it is important that a pupil should work out some matters for himself whilst in others, because of the different equipment found in various schools, it is better that the teacher settle the best procedure and save the pupil's time: it is also partly in order to ensure a continuing thread of involvement by the teacher, who might otherwise be tempted to leave the specialist group to their own devices for too long.

### USE OF SYMBOLS IN PUPILS' BOOKS

Every time the pupils have to do something practical, a connected group of symbols appears across the page in their book. The reasons for this procedure are:

- 1 to act as a trigger ('Do it now');
- 2 as a double check on the nature of the procedure itself;
- 3 to familiarise pupils with a code of symbols, many of which are internationally standard;
- 4 to give pupils a shorthand language which they can use in their own compositions.

### JUDGING THE RESULTS

You will naturally take an interest in the progress of the pupils who are undergoing the course. Especially if you have left them to their own devices, seek to commend their efforts where possible. What are you looking for? At the simplest level, to see if they have carried out the technical instructions correctly (that alone deserves some praise). Listen for clicks or other extra noises, particularly at the joins between sections, and gently encourage a self-critical attitude in the pupils over this matter. These noises can usually be removed, even at a late stage, by editing. However, for obvious reasons, leave this matter alone until Chapter 3 is reached. At a higher level, you will wish to see if they have seized opportunities for creativeness. These are introduced right from the first chapter in a simple manner and go on increasing right through the



course. Obviously you will not expect the results to sound like conventional music, so the work must be judged by reference to the opportunities given. For example, in Exercise 2C the operators are free to shape their own dynamic scheme. Is it varied enough? Do they employ all the methods so far described to them (sudden change, gradual change, tremolo, silence)? Do they employ intermediate levels besides maximum and minimum? If they don't, question them about it. They may have perfectly good reasons, or they may simply have forgotten. On the other hand, don't be over-impressed if they seem to have worked in everything merely for the sake of all-inclusiveness. Again, discuss with them whether devices have been used effectively.

Don't expect any exercise or chapter to be completed quickly. For each minute of final result, a working time of ten to twenty minutes is very good going; even an hour may sometimes be a fair average. Much depends on the experience of the operators and the difficulty of the exercise, to say nothing of the state of harmony existing between the members of the team! It is so easy to go wrong and have to start again that ample time must be allowed. For example, I took over  $1\frac{1}{2}$  hours to do Exercise 8A (admittedly a fairly complex piece) working flat out. Inexperienced operators could take up to four times as long, so clearly there is work for more than one session in it. Overall progress cannot be quick; however, even with slow production of results, pupils are usually learning something, and subsequent progress may well be at an accelerating rate.

But it cannot be emphasised too much that, as in any kind of teaching, it is hardly fair or wise to judge work the like of which one has not tried oneself. Only from experience can real creative ability be commended, or technical excellence recognised. Thus it is important that the teacher should himself work through the book, performing at any rate the minimum crash course. One hopes he will find this an enjoyable venture in any case; if he keeps his more successful tapes he may enjoy even more the prestige-enhancing experience of nonchalantly producing a model solution to an exercise which is causing his pupils to flounder! At a pinch he could work along with the first batch of pupils to try the course, making the necessary discoveries almost vicariously; but many teachers would wish to hallow the hoary tradition of keeping one chapter ahead of the pupils. Assuming this necessary experience, then, it is better for the teacher to regard himself as consultant rather than instructor, leaving him free to cope with his other problems. However, if for any reason pupils of limited intelligence are put on to this course, the teacher might have an additional function, that of sparing them the reading of instructions in certain basic procedures and demonstrating them himself to save time.

## 2 Equipment

### EQUIPMENT REQUIRED

It is appreciated that the amount and nature of suitable equipment will vary widely from school to school. The minimum and maximum requirements will now be given, but even so, nothing unreasonable or very expensive is required, because the whole intention of this course is to avoid the purchase of a synthesiser or similar equipment by providing source-sounds on the accompanying records.

#### *Absolute minimum*

Record player

Tape recorder with  
2 speeds (open reel,  
not cassette)

Microphone suitable  
for tape recorder used  
(cardioid preferred)

Splicing block  
Scissors

Watch with second hand

#### *Desirable extras*

Hi-fi amplifier and large loudspeakers  
Special socket for feeding to tape recorder from  
amplifier  
Suitable cable to connect socket to tape recorder

(Facilities on tape recorder):  
Auxiliary (line) input socket  
3 speeds  
3 heads  
Stereo  
Multiplay and Echo  
Mixing facilities

Headphones (with loudspeaker adaptor if no socket  
on recorder)

Second tape recorder (*highly desirable*). Need only be  
mono: extra facilities unnecessary. Can be single  
speed but 3 speeds highly desirable  
Cable (line connection) to feed signals from second  
machine to first  
(Cassette recorder if no second open-reel machine  
available. Input and output line connections to  
main tape recorder essential)  
Tubes for filtering (see text)

Stopwatch

*Expendable software required*

Recording tape

Spare reels, various sizes, especially 3 inch

Storage boxes for finished tapes

Razor blades or cutting tool blades

Joining tape

Leader tape: green, red, and white

Chinagraph pencils, yellow

## ADAPTING THE COURSE TO THE EQUIPMENT

It will be clear from the above, and from the nature of the course itself, that ways of carrying out any given operation will differ according to the equipment available. It would be desirable for me to give absolutely precise instructions to the pupil in each project, but this could only be so if everyone used exactly the same equipment. Therefore simplifications have had to be adopted in the textual instructions to some extent, and where necessary these must be amplified and perhaps demonstrated by the teacher, at any rate until the pupils concerned have learnt the necessary processes. This should be unnecessary, though, where all or most of the above-recommended equipment is available.

Our next task, then, will be to examine in detail each piece of equipment, and each main operation used in the course, to see how one may be adapted to the other. I will do this as briefly as possible. For really full technical details, teachers should refer to the Bibliography.

*Records and record player*

All the sound-material found on the records is to be copied on to tape. Most of the time this sound-material has to be altered in some way, and these alterations *can* be made each time the relevant portion is copied from disc to tape, but this will soon lead to serious wear and tear on the record (including clicks and scratches made in lifting and lowering the stylus). Therefore a much better procedure is to copy all the discs on to a *source tape* whilst they are still brand-new. The discs can then be stored away safely against the day when someone accidentally erases the source tape. However, such a procedure, whilst highly recommended (indeed assumed), already presupposes a second tape



recorder, or (less desirably) a cassette player. Here, then, are the three alternatives in order of preference:

1 Copy all the discs on to a *source tape*, to be used as sole source material. For the exercises, play this tape on the second tape recorder (*source machine*) and copy on the main tape recorder, at the same time effecting the changes described in the text of the pupils' book. Most instructions in the book assume this situation. If 2 or 3 is used, teach the pupils to use the relevant machine and to adapt the instructions accordingly.

2 Copy the discs on to a *source cassette*, if only a cassette recorder is available as second machine. Use it in a similar manner to 1.

3 At worst, use a disc each time as required, making the changes *en route* to the (only) tape recorder. It must be realised that, by this method, the records will have a limited life; also that not every exercise in the book can be worked. However, one can certainly get far enough to know whether one means business and whether the acquisition of a second machine will be a necessity.

Full instructions for the process of copying will be found in Pupils' Book 1, page 3, and on the record sleeves, and more information is given in the next chapter of the present book, but note particularly when copying a disc on to the source tape the copy should be at the highest level the tape will take without distortion. Teachers who would like to make things a little easier for the pupils and save some lesson time could splice in a one-foot white leader between every Material and Example on their source tape, once copied from the discs. This will in any case give preliminary practice in editing and splicing procedure, and an insight into the problems involved. The number of the following Material or Example would then be written on each piece of leader tape for easy reference.

#### *Tape recorders and cassette recorders*

The current *Hi-fi Year Book* lists over 100 different models of high quality open-reel tape recorders, many of which can be obtained in slightly different versions. This is to say nothing of cheaper models (one of which your school may well possess) or of cassette players. Since no two of these have exactly similar specifications and controls, it is impossible for me to tell you just how to work your machine to best advantage (the maker's instructions should do that). What we are first concerned with is the compatibility of two machines, i.e. the ability to record a tape on one machine and play it back on the other without change or loss. Since we can save much time and trouble by doing this where possible we must know the chief features of our machines. The important ones are as follows:

*Tape and track widths* Open-reel recorders use  $\frac{1}{4}$ -inch wide tape; cassette recorders use  $\frac{1}{8}$ -inch wide tape. Tape recorders are 2-track or 4-track (more correctly  $\frac{1}{2}$ -track or  $\frac{1}{4}$ -track), mono or stereo, in any combination. Cassette recorders are either 2-track mono or 4-track stereo.

*Tape speeds* We can regard  $3\frac{3}{4}$  i.p.s. (9.5 cm.p.s.) as standard. Our main machine should possess this, and preferably also  $7\frac{1}{2}$  i.p.s. and  $1\frac{7}{8}$  i.p.s. If the machine has only one speed we can do quite a lot of the work but transposition will be impossible and the exercises concerning it will have to be omitted or adapted. All cassettes run at  $1\frac{7}{8}$  i.p.s. only. On some tape recorders we may also possibly find 15 i.p.s. or  $15/16$  i.p.s. If the machine has any three speeds this is good. The *normal studio speed* (see pages 3 and 11 of Pupils' Book 1) adopted should be the middle of three speeds, or the higher of two. With one single-speed machine and one 2- or 3-speed machine, the speed in common must be taken as normal. In cases of doubt,  $3\frac{3}{4}$  i.p.s. is probably the best to adopt.

*Equalisation* For technical reasons, when music is recorded on tape the treble and bass frequencies are not treated equally. On replaying the tape the inequalities are compensated by electronic filters inside the machine. This is known as *equalisation*. Unfortunately it has to be different for each tape speed; in other words, the filtering system which gives good reproduction at  $3\frac{3}{4}$  i.p.s. will not work properly at  $7\frac{1}{2}$  i.p.s., and so on. Correct use of equalisation is dealt with in one of three ways: 1 on a cheap machine one equalisation serves for all speeds; 2 on most machines equalisation is switched automatically when you change the speed; 3 you may have to switch the equalisation yourself each time the speed is changed. To complicate matters there are different international standards laying down the exact nature of the equalisation (NAB, DIN, CCIR, IEC).

### *Compatibility*

It should by now be apparent that open-reel recorders and cassette recorders are quite incompatible. The only use, then, for a cassette recorder is to copy sounds on to it and copy them off again: a procedure which can be obviated if two tape recorders are available. For compatibility between two tape recorders we need:

- 1 at least one speed in common;
- 2 preferably both machines to be 2-track or both to be 4-track. What if you have one of each? The answer is that tapes recorded on one may be replayed on the other, provided that Track 2 of the 4-track is left blank, though there will be more tape hiss than usual;
- 3 similar equalisation. However, this is not crucially important: there *may* be



problems if the two machines use different standards – these will show as either brightening of treble frequencies (and tape hiss) or a dullness owing to loss of treble. If there are tone controls these might help, but they do not normally affect signals through line inputs. If all else fails, shrug the problem off. It will not spoil the work completely and may even improve matters in some cases by filtering sounds in the manner required by the exercise.

#### *Other features of tape recorders*

*Level meter or magic eye* There is normally a knob to control the recording level, i.e. the amount of signal one is putting on to the tape. (On a few machines this is done automatically, which is a great pity.) Do not fear to keep the recording level well up. In most cases it will pay to use high levels, even letting the needle flick well into the red zone (this is only bad if it stays hard up against the end). A little distortion usually passes unnoticed in electronic music although it might offend the ear more readily with something familiar like a violin. In any case slight over-recording is preferable to the extreme caution which produces a feeble signal, causing loud tape hiss when the playback volume is turned up, as it probably will have to be. This advice to use high levels is all the more important when much copying has to be done, so that the signal can smother tape hiss (noise) which will otherwise build up too high. (Most of the sounds on the discs are loud for this reason.) However, when soft sounds are called for as part of a dynamic scheme, obviously the needle will be kept out of the red zone and occasionally may even appear not to move at all.

*Pause control* A valuable facility which has two main uses: first, used during recording it can hold the tape still, and in the record mode, whilst a change is made in the incoming signal, or the speed of the recording machine is changed. When all is ready the pause control is released and with luck the change is clean and unnoticeable; with less luck there may be a slight click, but this is usually less than that caused by stopping and restarting the machine completely. Second, it may facilitate editing by holding the tape up to the replay head whilst the spools are moved by hand.

*Trick button* A button which lifts the tape away from the erase head and makes superimposition possible. Not many machines have it, but a wad of paper has the same effect; this is not an ideal way of mixing sounds, but it is the only one possible on simple machines.

*Input mixing* If the recorder has two input sockets, microphone and line (or auxiliary), signals can often be combined from both sources at once, ideally with separate volume controls for each. This is another way of adding signals together.



*Sound-on-sound (or Multiplay)* This is the best way of mixing signals, but is only found on stereo recorders. If yours has it, the maker's instructions will show you how to use it. It is most commonly found on machines with three separate heads (erase, record, and replay) instead of the commoner two (erase and combined record/replay). A three-headed machine will also probably possess:

*Echo* This is a means of feeding back signals during the recording process so that sounds are immediately repeated several times with diminishing volume.

*Monitoring* It is valuable to be able to monitor the tape, i.e. listen to it during the recording process. If a microphone is being used, one normally monitors with headphones to avoid the microphone picking up the sounds of the recording machine's loudspeaker. So a useful facility is a headphone socket. Even without it, the headphones may be connected to a loudspeaker socket if they are fitted with the correct plug and resistors to match the impedance where necessary. Three-head machines normally offer the choice between monitoring sounds before or after they appear on the tape (A/B monitoring). For electronic music it is recommended to monitor *before* the tape, placing the switch so as to listen to the source. (However the switch must be changed to the other position when playing back the recording.)

### *The ideal tape recorder*

The ideal machine will possess all the facilities mentioned above, except the trick button. It will be 2-track rather than 4-track, because this offers a higher standard of reproduction, besides ease in reversing the tape, which is sometimes useful. However, the vast majority of modern tape recorders are 4-track and this matter need not be regarded as too important. It will have 3 speeds at least, and will of course be stereo in order to offer all the facilities required. (However we will only use one track at a time for most work.) Even more ideally, we would have two such machines of identical make, though one elaborate stereo machine and one simple mono machine (used only for playback) will certainly see you through this course comfortably.

If the teacher would like more detailed guidance in understanding the mechanics and general operation of tape recorders, he is recommended to obtain from BASF (UK) Ltd, 197 Knightsbridge, London SW7, the booklet *Tape questions - tape answers* by Heinz Ritter, or alternatively *Tape recording manual 701E* from Agfa-Gevaert Ltd, Great West Road, Brentford, Middlesex. If contemplating buying a new machine, consult this year's *Hi-fi Year Book*, obtainable from hi-fi dealers, or perhaps available in your local reference library. It contains full details and prices of models by all important makers.

### *Care of equipment*

Little can be done with decrepit and obsolete equipment. Does your tape recorder utter mechanical noises, falter, crackle or hum? Get it overhauled by an expert. Is it ten years old? Then it may need replacing completely. All tape recorders should have their heads demagnetised at least every month and correctly cleaned every week. Without such care on the teacher's part the pupils cannot make many sow's-ear purses.

### *Electrical current and safety*

Obviously we all wish to avoid risk of electric shocks, which have been known to be lethal. We must distinguish between mains current and signal current. If mains plugs are wired correctly, then 240 volts flows into the machine via the live wire and back to the wall socket via the neutral wire. There is normally no danger unless a connection comes loose inside the machine. If the live wire contacted the metal body of the machine, anyone touching it could receive an electric shock. To guard against this possibility most electric appliances have a third wire connecting the metal body to earth. If your tape recorder has a triple cable make sure the earth wire is connected to the earth pin of the plug. Open it and see. If only a double cable is provided there is probably double insulation within the machine and it should be safe. Check that no insulation is frayed anywhere on the mains cable. One problem when connecting two tape recorders, or tape recorder and amplifier, can be hum caused by the two machines being earthed separately. In such cases the cure is to disconnect the earth wire of one machine from its plug and connect it to a suitable point on the chassis of the other machine, or to the earth pin of this second machine's plug. This is quite safe, but do not cure hum by disconnecting an earth wire and not reconnecting it to the other machine, or to the earthing point of an amplifier which is itself earthed.

Signal current is normally about one volt and is perfectly safe. So pupils of sensible age can handle plugs and sockets designed to carry audio signals without supervision. The same is true of leads from a power amplifier to a loudspeaker. Only a few volts are involved here, though if the two wires carrying signals to the loudspeaker are allowed to touch each other with sound turned on, the amplifier may be damaged or a fuse blown. So turn off amplifier or tape recorder whilst connecting or disconnecting wires at the loudspeaker.

### *Tape and spools*

Each pupil or group will want successful pieces preserved. Since none of them will be very long, we have to decide whether to keep everybody's work on one



long tape (dangerous because it is only too easy to record over the top of wanted material) or to split up work into small groups of pieces, each group on a small spool. The latter method is recommended. Buy a dozen or two 3-inch empty spools (the smallest made) and be sure to keep the cardboard boxes for storage. Alternatively, 3-inch 8mm. film spools can be used: they need no storage boxes if they are the type with a clip-on plastic cover. Camera shops and chemists will sometimes give them away. However, for convenient storage, if required, buy from Boots the Chemists a Dual Cine Reel Storage Box which will accommodate one dozen 3-inch reels. Buy tape in the largest size your machine will take and transfer it to the small spools. (A 5-inch reel of tape will fill four 3-inch spools; a 7-inch reel will fill eight.) This will work out cheaper than buying the equivalent number of small reels of tape. Each new tape should have a green leader spliced on to the beginning and a red leader at the end. Cut leaders about three feet in length and keep the shiny side towards the heads (opposite way to the recording tape) so that titles can be written on the matt surface. This cutting-up and splicing process makes an excellent introductory exercise for the beginner, whether teacher or pupil. In addition to this supply of tape on 3-inch reels, there should also be a small stock of empty reels for temporary winding on.

Finished pieces will be labelled both on the leader and on the storage box or container: titles should also indicate the playback speed, normally  $3\frac{1}{4}$  i.p.s., and whether 2 or 4 track, if both systems are in use. If more than one piece is stored on the same reel, spacers of white leader tape should be inserted between them, and the title of the following piece written on each spacer. (Instructions are given for this in the text.)

During the working operations of many pieces pupils are required to cut tapes and splice up again. This inevitably leads to wastage of odd pieces of tape which should normally be thrown away. They *can* be salvaged and joined up if tape is desperately short, but joins are always liable to give trouble used in this way. A better attitude is to avoid parsimony and resign oneself to the view that tape is expendable and must be supplied in sufficient quantity to make work possible. And whether the tape recorder is 2-track or 4-track, it is normally unthinkable to use more than the top track. The cutting and splicing involved in the work, to say nothing of inserted leaders, will rule out multiple use of the same tape.

The choice of tape is fairly wide, though one should stick to the tapes recommended by the maker of the machine where possible because machines are definitely 'tuned' to particular tapes: however this by no means excludes other brands. Use low-noise tape if you can, but don't be tempted to buy double- and triple-play tapes. These are too thin to stand up to editing and general



pulling about: they will only stretch, twist or snap. Use standard play, or long play if this seems to give greater freedom from 'drop-out' (brief gaps in signal caused by insufficiently close contact between tape and head).

### *Editing kit*

Most splicing blocks sold have hinged arms for gripping the tape whilst the cut is being made. These work after a fashion, but far more convenient and quick is the grooved block with no moving parts, used by all professionals (Emitape or Metrosound brands). All one has to do is to press the tape into the groove, which holds it firmly as if by magic; but remember when peeling the tape out afterwards to pull obliquely or the tape will crinkle along the edges. This type of block makes editing so much easier that it is worth going to any lengths to acquire one. Shops seem curiously reluctant to stock them; in case of difficulty write to Emitape Ltd, Blyth Road, Hayes, Middlesex, for an AP 123 Jointing Block, or better still an AP 124 Accessory Kit, which includes leader tapes and container tray.

Again, there are good and bad jointing tapes. Everyone knows now not to use ordinary Sellotape, but even some brands of special jointing tapes are unsatisfactory in various ways. Scotch brand can be thoroughly recommended. Jointing tape should be 7/32 inch wide: avoid the larger size.

For cutting most people use razor blades, but these soon blunt and make messy joints. I have found the ideal implement to be a Swann Morton cutting tool, sold by art materials dealers: it is pleasant and safe to handle. Buy spare blades with *straight* edges. A dozen will last for ages, because this tool cuts well even when blunt.

For marking tapes for editing purposes, a yellow chinagraph pencil is indispensable. One will last for a very long time.

An ordinary pair of scissors is necessary for preliminary cuts before joining. There is no need to buy non-magnetic scissors.

### *Filter pipes*

As described in the relevant part of Book 1, Chapter 5, for certain filtering purposes hollow tubes will be needed. They should be of various sizes, long and short, wide and narrow. The main requirement is that your microphone should preferably be able to enter one end of the pipe so that it 'listens' to sounds picked up at the other end, but apart from this the dimensions are not too important. The longer the tube, the lower the frequency which it will boost. (The tubes are more accurately described as single frequency resonators, rather than bandpass filters, but this does not matter much in the context.) The

narrower the tube, the more intensely it will resonate. Suitable pipes are: cardboard tubes used for holding maps, charts, etc., empty tubes used for supplying badminton shuttles, sections of drainpipe (plastic or metal). Pupils can obviously help here by supplying what they can find.

### 3 Working Techniques

As referred to on page 5, some working procedures are given in the pupils' books, some here. It is now time to give more details of three important basic procedures.

#### COPYING

Since this will be the most frequent operation in all the exercises, the procedure for doing it must be clearly understood by teacher and pupil. First let us realise that for highest fidelity in copying we must use a suitable cable (*line*) connecting the two machines; this is normally screened with metal braid just inside the insulation to prevent interference. Input and output sockets will be marked Line, Tape, Auxiliary, or Radio. These will deliver the signal at a suitable level. Do *not* take the output from a Loudspeaker socket; and do not feed the line signal into a socket intended for microphones. In either case the signal will be too strong for the sensitivity of the input: severe distortion of the signal is inevitable and damage to the equipment quite possible. However, an input marked Gram, Phono, or Cer(amic) may work satisfactorily. There is also the question of impedance matching. This is not normally a problem, but if an unduly weak or rough signal transfer should ensue in nominally favourable circumstances, seek technical advice or abandon the line method.

If the right sockets are provided but you have no cable with the right plugs, make every effort to get one, or have one made up to your requirements by a hi-fi shop or helpful colleague.

Failing the highly desirable line method, copying will have to be done with a microphone. Place it about one to two feet from the loudspeaker of the other machine and plug the microphone to its correct socket. This does not give such faithful reproduction, and moreover may pick up any sounds made in the room during the recording process: for this reason use a cardioid (unidirectional) microphone if you have a choice. This will also be important when reverberation is used (Book 1, Chapter 7). When using reverberation or filtering, the microphone method is essential and the pupils' books contain instructions to use it where necessary. Where they are instructed to use the line method but you have no cable you should first instruct pupils verbally to use the microphone in all copying processes.

The first piece of copying to be done is for the teacher to copy all the discs on to tape, as mentioned earlier. (N.B. The discs must be played at 45 r.p.m.) Once again I must emphasise the importance of taking good care that the



recording level is at the permitted maximum indicated by the recording level meter on your tape recorder. This will ensure a good signal/noise ratio throughout the ensuing work. All the sounds on the discs have been recorded at a high level for this reason.

## TRANSPOSING TWO OCTAVES

After reading the following, be ready to instruct the pupils in whatever method suits the equipment which you have available, but note that this technique is not required until Book 1, Chapter 8.

### 1 *With two 3-speed recorders*

To transpose up:    Play source at  $2N$   
                          Record at  $\frac{1}{2}N$   
                          Play back at  $N$

To transpose down: Play source at  $\frac{1}{2}N$   
                          Record at  $2N$   
                          Play back at  $N$

### 2 *With a 3-speed recorder and a 2-speed recorder*

One of the above methods will work. To transpose the other way, use the next method (3).

### 3 *With two 2-speed recorders or a 2-speed recorder and a 1-speed recorder*

Use your method for a one-octave transposition, but make the recording on an extra tape (*work tape*). Transfer the work tape to the source machine and repeat the process on to your main tape (*master tape*).

### 4 *With a tape recorder and a cassette machine*

Use your method for a one octave transposition. Copy this on to a spare cassette and repeat the process. It is hardly worth attempting this if a microphone is involved; the deterioration of quality will be too great with all the copying that has to go on. Even line connection may give poor results.

### 5 *With record player and 3-speed recorder*

To transpose up:    Play record at 78 r.p.m.  
                          Record at  $\frac{1}{2}N$   
                          Play back at  $N$

To transpose down: Play record at 33 r.p.m.  
                          Record at  $2N$   
                          Play back at  $N$

Of course neither of these gives exactly two octaves.

6 *With record player and 2-speed recorder*

One of the above will work; the other will not.

## SUPERIMPOSITION

After reading the following, be ready to instruct *and demonstrate* when the pupils reach Book 2, Chapter 1. This book introduces and maintains the question of superimposing one sound on another, a most exciting and important technique in electronic music. The following methods are in order of preference, but depend on the equipment available.

1 *Multitracking*. In professional recording studios may be found 4-channel, 8-channel, or 16-channel tape recorders (some have even more). Note that this is channels, not just tracks. Thus many layers of sound can be laid down separately, one on each channel and parallel with the others. On playback all the outputs are blended through a mixer unit into one composite sound-assembly, with negligible loss of quality. This is not an impossible dream if you have a stereo machine and need only two layers to be superimposed! Furthermore, some mono machines have the facility known as Duoplay or Parallel Track Replay. Again this is limited to two layers.

2 *Sound-on-sound, or Multiplay*. Found only on stereo machines. Briefly, a sound layer is recorded on Track 1, then transferred to Track 2 whilst adding a second layer. The two (mixed) layers can then be transferred back to Track 1 (thus crasing the first layer) whilst adding a third layer. This process can be repeated several times, building up say, five or six layers (normally enough). Exact details of working the necessary controls will appear in the maker's handbook of instructions.

3 *Input mixing*. There are three forms of this, given in order of preference. All need three machines, one to record and the other two to play back the two signals which are to be combined. (One machine might be a cassette player or record player.)

- a) Line input from both machines, mixed in the recording machine, if it has two line inputs, or in a separate mixer.
- b) If your main machine has one line input and one microphone input, can they be mixed? This is a reasonably common facility.
- c) One microphone can be used to pick up the combined sounds of two machines playing back.

4 *Literal superimposition.* A tape is recorded with the first layer. After rewinding, the second layer is recorded on top of it, on the same track. Clearly to accomplish this the erase head must be put out of action. This can be done in one of the following ways:

- a) Erase head switched out of circuit (seldom possible).
- b) Trick button used, if provided. This pushes the tape away from the erase head.
- c) The tape is threaded behind the erase head, or in some way which avoids contact with its front surface.
- d) A temporary wad of paper is inserted between tape and erase head.

The erase head is the first one on the left. But the tape must make proper contact with the record head (the next one along). This whole method is unsatisfactory because the record head always causes partial erasure of the first layer, so allow for it.

Whatever form of superimposition is adopted, we are not restricted to the addition of two layers. By treating a two-layer assembly as a new source, we can mix it with another source, which can itself be single or double. The process can be repeated indefinitely, but watch for deterioration of quality in the first layer. This sets a limit to the number of transfers. Another point of importance is the desirability of monitoring all sounds during the superimposition process and controlling relative levels to give a satisfactory balance, where this is possible. In any case a way must be found of balancing old and new signals whilst recording. This should preferably be done with recording input controls, but if this proves impossible then the source output levels must be manipulated. Finally it should be realised that such is the importance of superimposition (sometimes known as mixing, layering, or synchronisation) in electronic music that familiarity with a reasonably easy and controllable way of accomplishing it is a necessary condition for any kind of advanced and really creative work. In practical terms this means that without a stereo tape recorder possessing Sound-on-sound (Multiplay) facility, the work in Book 2 will be achieved only by a rather thorny road. Unless there is great keenness all round, therefore, teachers should not normally carry the course beyond Book 1 without such a machine.



## 4 Performing the pieces

The whole class will often want to hear the results of their colleagues' labours and you will normally allow this. On some occasions a discussion may start and this can be encouraged: because a pupil is not actually engaged in making electronic music is no reason for his learning nothing about it. A member of the group could describe what was aimed at and what method was used, whilst listeners could question and comment.

A common medium in the world of electronic music is a piece for live performers and tape. In several cases I have made suggestions for a more or less improvised realisation of parts for live performers. These suggestions are skeletons which the teacher should expand and adapt to the resources in his classroom. Parts need not be written out; there is value in a 'head' arrangement, one which the players can remember long enough to perform. The live parts will usually be instrumental, but there is no reason why suitable texts, if they can be found, should not be sung, chanted or recited to tape accompaniment. Classes who are used to making abstract vocal sounds (as in some modern class music) could use those.

There is also scope for composition in class, either by the teacher or (better) by a pupil. The latter could be one of the tape group, or a guest to whom the workings of the tape can be explained and who can compose the live parts whilst tape is still being made. An obvious alternative is to let the composer wait until he has heard the finished tape. There are many other uses for tape pieces, from class improvisation against them, through reinterpretation of the tape music in purely instrumental terms (a difficult listening exercise), to use of the tape as an accompaniment for dance or drama. The field is wide, but the 'tape-worms' must not be made to feel cut off from the rest of the class: rather they are honoured representatives with a special skill.

A by no means unimportant point is that playback of tapes under performance conditions needs adequate amplification, particularly when live performers are involved. Use the biggest available loudspeakers and the best hi-fi amplifier you have available.

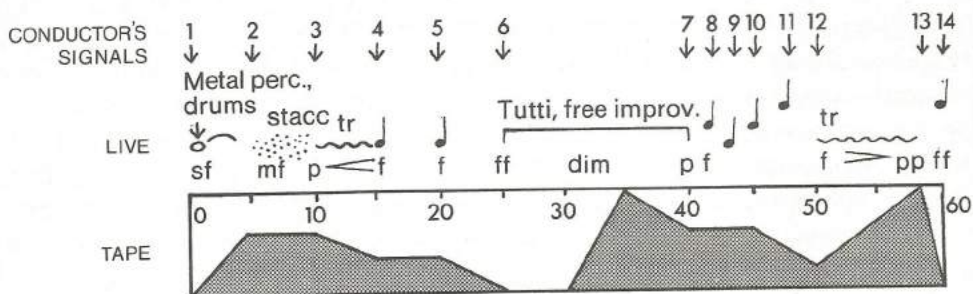
See also p. 29 for ideas involving live electronics.

## 5 Notes on individual chapters

### BOOK 1

#### CHAPTER 1, p. 10, Exercise 1C

*Suggested live parts:*



*Key:*



Random staccato sounds made at pupils' discretion.



Shakes and rolls can be limited to suitable instruments.



Staccato sound made on teacher's beat. Pitch can be prearranged to give chords, or left random.

#### CHAPTER 2, p. 14

*(Answer to Question)*

Another possible result of doubling tape speed is an unfortunate hum which was not evident when the original was played. This is because hum on a tape may pass unnoticed when it is too low in pitch for either the loudspeaker used to reproduce, or for the average ear to detect, but an octave higher may make all the difference. The cause of such hum should be traced if possible and removed. It may be: 1 general background room noise (murmuring voices, distant boiler machinery, defective fluorescent lighting, heater fans, etc.) 2 the sound of the motor of one of the tape recorders being used, picked up through

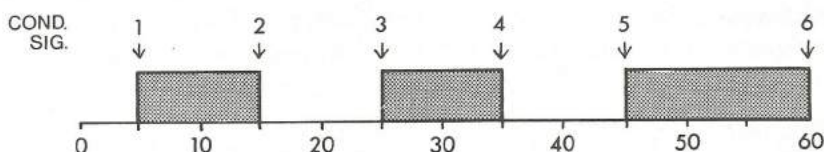
the table. (Cure: keep microphone on separate table); 3 electricity mains hum. If this is being picked up by a microphone or line lead incorrectly screened or earthed, the cure is simple. It may, however, be inherent in the tape recorder. Test by recording a length of tape at slowest speed possible, with no input and input volume at zero. Repeat test with input volume turned up to normal maximum. Play back tape at fastest speed possible. If a loud hum is heard, then the machine is inducing the hum itself. Unfortunately there is often no cure other than a major overhaul, or replacement by a higher quality machine. All this is one more reason for recording signals at high levels where possible.

Another possible result of halving tape speed is increased tape hiss. This may have been of too high a pitch for the loudspeaker or the ear, but brought down an octave it is more obtrusive. Use low noise tape and keep recording levels high. Apart from this there is nothing to be done, except possibly the use of treble control (if there is one) on playback.

These ills were not mentioned in the pupils' book because there seemed little point in drawing attention to something which might not be noticed. The teacher should search his conscience, however, and make things smoother for the pupils if possible.

### p. 13 Exercise B

*Suggestion for live parts:*



The teacher merely signals the start and end of each shaded area, which represents a period of improvised playing of any kind. Different groups could be allocated a different section of the piece, if desired; but the piece makes an easy introduction to a 'free-for-all' type of playing, useful if the class have done little or nothing of this kind before.

### CHAPTER 3, pp. 15-16

In cases of difficulty, there is another method of marking tapes for editing purposes. If pulling the tape up and placing it on a convenient place away from the playback head leads to loss of accuracy, the tape can instead be marked at a given spot, to the right of the playback head, which happens to



be level with some more convenient marker. This of course means that the chinagraph mark will be put on the wrong spot on the tape; but this is compensated for by carefully measuring the discrepant distance and scratching a mark on the splicing block a similar distance from the cutting groove. If the tape is now inserted in the block with the chinagraph mark level with the scratch, the tape can safely be cut. Note that, if this method is adopted, two such scratches will be needed, one for each cutting groove.

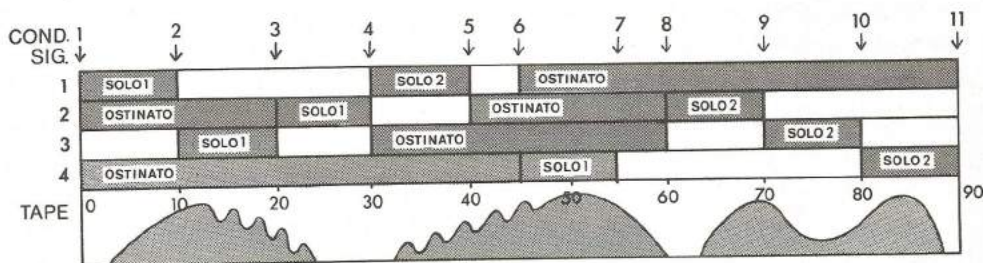
#### CHAPTER 4, p. 21

Here are some different ways of supporting a tape loop, depending on its length:

- 1 A very short loop needs no support, so long as it runs smoothly and correctly.
- 2 If the length of the loop can be contained on the tape deck, round-sectioned batteries are useful. Use one or two, whichever is more convenient.
- 3 Where the length of the tape takes it outside the tape deck, books or other objects may be needed to bring the jar up to the correct level. The water-filled coffee jar is usually best, especially if it has a ridge on which the tape may ride. Sometimes it is more convenient to use an empty tape reel for the tape to run round, using any heavy object to prevent it moving. Occasionally it may work to let the tape hang vertically over the side of the machine with an empty spool hanging in the slack.

The main requirement, whatever is devised, is that the loop run smoothly. Three common causes of jerkiness: 1 too tight; 2 too loose; 3 too much jointing tape used, causing sticking or jerking every time it turns a corner. As little as  $\frac{1}{4}$ -inch of jointing tape is sufficient, surprisingly enough.

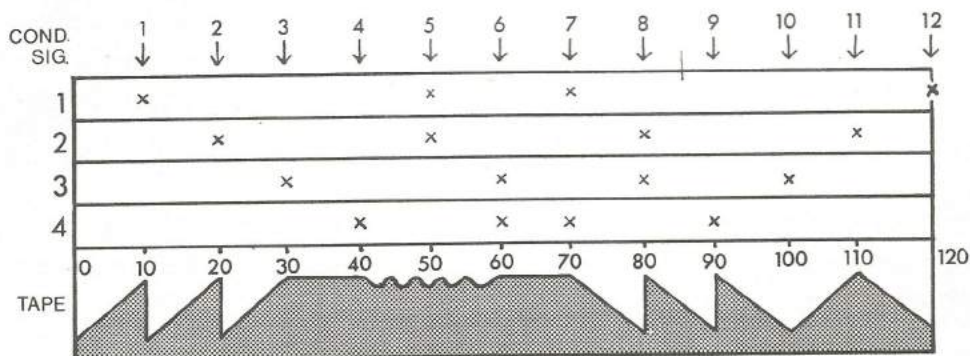
#### *Live parts for Exercise 4a*



For four contrasted groups. All playing should be fairly quiet: ostinati should not drown solos nor tape. The four ostinati may or may not be in time with each other: you must decide which.

CHAPTER 5, p. 29, Exercise A

*Live parts for four contrasted groups:*



Each group should be asked to make four different *unusual* sounds (abnormal use of instruments or voices). Practise these till all are agreed. The four different sounds (i.e. altogether 16 different sounds) will be made by each group as they are signalled in by the teacher. The idea is to make these sounds coincide with the sudden changes in the tape music. These changes *should* be every 10 seconds, but this will only happen if the tape workers have been very accurate!

CHAPTER 8, p. 44

*Transposing two octaves*

See p. 18 of this book. Again check for hum and hiss (see p. 22).

*p. 44, Generation loss*

The term is used because it is the standard one; but, in case there is any confusion about the explanation (which seems to show additions, not losses) I must add that the loss referred to is a loss of quality or clarity: normally the signal itself does not get lost.

*p. 45, Exercise A*

The suggestions for live parts here are minimal, and should be amplified by

the teacher. Timings are best taken from the actual tape rather than from the instructions.

*Section A*<sup>1</sup> Metal percussion, playing isolated notes on conductor's cues.

*Section B* Wood and drums, similarly.

*Section A*<sup>2</sup> Piano solo, soft chords.

*Section C* Tutti improvise, *p* cresc *ff*.

*Section A*<sup>3</sup> One cymbal or gong stroke to begin; individual drums on cues.

*Section D* Melodic fragments by violins, recorders, melodicas, etc. or by xylophones and glockenspiels. Overlapping, random effect.

*Section A*<sup>4</sup> Metal percussion and piano alternating, on cues.

## BOOK 2

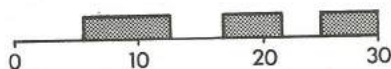
### CHAPTER I, p. 1

#### *Superimposition*

See this book, p. 19.

*Exercise 1E Suggestion for live parts:*

*Section A* Blocks of continuous sound, *p*.

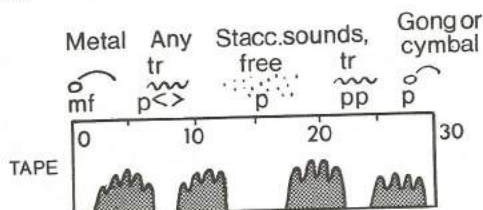


*Section A*  
*C* Solo(s) of sustained notes, *mf* (continuous).

*Section B* Staccato chords on teacher's cues. Different instrumental combination and different pitches for each chord.

*Section A*  
*B* Crescendo rolls. Tutti, or several overlapping.

*Section C* As follows:





*A final note on tape/live pieces*

No more suggestions are given from here on, because the pupils are being given increasing freedom to compose, and the final form of pieces is not known. This does not mean that live performers are excluded from now on; far from it. It means that teachers or pupils should do what composing or suggesting is necessary. See also p. 21 of this book.

CHAPTER 2, p. 12, Exercise A

When attempting, either here or in other pieces, to interpret a title or story (so-called 'programme' music) the teacher is warned against judging such a piece by the success or otherwise of this interpretation. Music is not really the art of illustration (certain other arts are better fitted for that) but always depends ultimately upon its abstract qualities. ('All art constantly aspires towards the condition of music' – Walter Pater.) The story given here is but a starting point, to stimulate imagination. Once the composition gets under way, if it develops a mind of its own this may be no bad thing as long as the result is musically convincing.

CHAPTER 3, p. 14

*Variable speed record deck*

The variable speed record deck referred to seems to be made nowadays only by Goldring Lenco. If a purchase is in the offing, this deck can be recommended from all points of view.

A very valuable addition to the apparatus is a 'Gramdeck'. In the early days, when tape recorders were beyond many people's budget, the manufacturer of this gadget (Andrew Merryfield) concocted a way of using a record player as a tape recorder, by placing the 'Gramdeck' on top of the turntable and using the latter to drive it. The 'Gramdeck' is a small, simplified tape recorder. It was not, of course, originally intended to vary the speed during operation, but if we have the Goldring-Lenco record player and a 'Gramdeck', we have very good control over speed of playback, without the need for the threading-up method described in the text. Alas, 'Gramdecks' have not been manufactured for years, but if you see one in a junk shop or market stall, snap it up; or even advertise for one. There should be a portable pre-amplifier with it, but this will be unnecessary if you have an amplifier with the right facilities.

*Exercise 4A*

If the result of this exercise is poor because of compositional difficulties, be patient. In their eagerness to try different orderings of operations, pupils may well go too far and lose quality, or lose sight of overall logic. Chapter 6 will help them when they get there. In the meantime a failure will help to establish the need for guidance in compositional principles.

CHAPTER 5, p. 22

For the phrase 'the realisation of the impossible' we are indebted to Elliott Schwartz.

CHAPTER 7, p. 34, Exercise c

If your stereo machine includes a *panpot* (panoramic potentiometer) or you can get hold of one, plus a knowledgeable friend who can show you how to fix it up, then the procedure described in the text will be unnecessary and moving the sound will be child's play. Without one, a fair amount of trial and error may be needed in balancing the two input controls. The special line referred to in the text is made as follows: the input plug should have its Channel 1 and 2 pins joined by a short wire and the cable from the mono source should be soldered to one or other of these pins, thus conveying its signals to both inputs simultaneously.

## 6 Further ideas

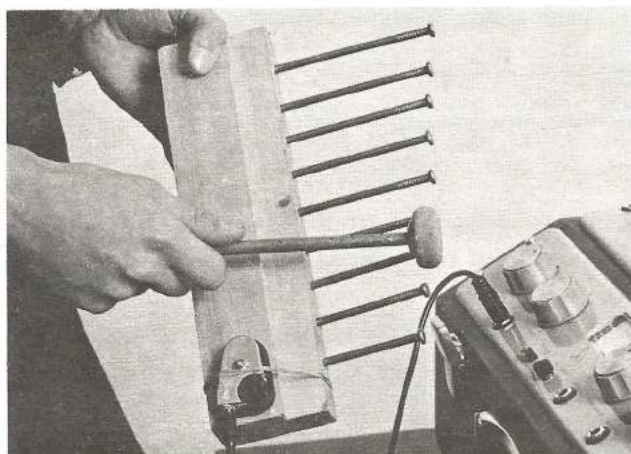
### LIVE ELECTRONICS

Electronic music is not confined to the production of tapes. Try to find time for an occasional experiment in one or more of the following:

- 1 Live production of electronic music (synthesiser, modules, generators, howl-round, etc.).
- 2 Electronic modification of live music (see below).
- 3 Pieces for tape and live performers (already covered to some extent in the book, but extendable to solos and small groups, reciters, etc.).
- 4 Live modification of tapes (not usually pointful because the modifications could have been done beforehand; but could fit an improvised situation where tape operators have to respond to actions by performers, for example).
- 5 Pieces for live electronics and prepared tapes.
- 6 Other combinations of the above.

Here are some fairly simple ways of modifying live music:

- 1 Amplification. By the straightforward use of microphone and amplifier (or tape recorder used as such) one instrument can dominate others. Quiet sounds can take on a new character. The microphone can be pointed in turn at different performers, thus continually changing the emphasis of the music. If a contact microphone (sold for guitars) can be obtained, many beautiful new effects can be gained. Such a microphone (note: it is *not* a guitar pick-up)



*A Naillophone fitted with a contact microphone.*



hears only what it touches and is deaf to airborne sounds. Thus the amplification can be turned very high without causing howl-round. Try it on a 'nailophone' (5- or 6-inch nails driven into a block of wood), or on the soundboard of a violin, or taped to a cymbal.

2 Filtering. By amplification using the tone controls (or an external filter module) the tone colour of the sounds can be changed, possibly during the sounds (swept filter effect).

3 Reverberation by 'echo chamber'. Pick up sound by microphone (any type), relay to reverberant room or corridor (door shut), play over loudspeaker, pick up by cardioid microphone with its back to the speaker, relay back to amplifier in original room.

4 Tape echo. With a three-headed tape recorder, record live performance and play back simultaneously over loudspeakers, using off-the-tape monitoring. Each sound will be repeated several times - balance the levels carefully. Try different tape speeds. At 15 i.p.s. the result resembles 3 above.

5 Tape delay. Exactly similar to tape echo, but needs two tape recorders, which need not be three-headed. Set the machines well apart and make a long tape loop to run through both machines, one recording and the other playing back. Depending on distance and tape speed, the echo can be many seconds late, by which time plenty of other sounds will have accumulated on the tape. But when sounds are played back, they will also be picked up by the microphone, and the process repeated until the tape is crowded with accumulated sounds. Adjust levels carefully, and also watch that one tape recorder does not run slightly faster than the other, thereby stretching the tape. It may be better to bypass one of the capstan drives, leaving the other to do all the work.

6 Ring modulation. If a ring modulator can be made or acquired, together with the necessary sine-wave input, wonderful transformations of sounds can be accomplished. These are better heard than described but can be very exciting.

7 Combination of tape delay with other methods. This can mean that modified versions of sounds are reproduced after a delay, to be picked up and further modified, and so on.

Any one of the above methods can make a fascinating transformation of a performance, and there is nothing to prevent you from changing from one method to another in the middle of a piece. The music selected for such treatment had better be contemporary in style, perhaps. Traditional music *can* be used, but it is already complete in itself, whereas some of the contemporary

music provided for schools (*pace* the composers) may on occasion sound equally well with additional electronic treatment. I mean such music as:

Self	<i>New Sounds in Class</i>	Universal
Dwyer	<i>Progressive Scores</i>	Oxford U.P.
Rands	<i>Sound Patterns 1-4</i>	Universal
Bedford	<i>Fun for all the family</i>	Oxford U.P.
Dennis	<i>Experimental Music in Schools</i>	Oxford U.P.

(The last-named includes pieces specially designed for electronic transformation.)

A class or group improvisation could also be the basis for an electronically modified performance. Many ideas for such pieces can be found in:

Paynter & Aston	<i>Sound and Silence</i>	Cambridge U.P.
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### LISTENING BY THE WHOLE CLASS

So far no mention has been made of making contact with electronic music by leading composers, an omission that needs putting right without delay. Examples of electronic music on record should reach the ears of all pupils from time to time. Not only will this stimulate the work of those making their own electronic music, but it is a necessary duty to those we are educating musically, and will evoke at times a surprisingly strong response from the more passive pupils. Whether this is for or against the music concerned, it should have beneficial effects, and cause all concerned to re-examine the nature of music and of their response to it.

Some suggestions will now be given. They are not very numerous, partly because of the timidity of record companies in issuing electronic music (a little surprisingly considering how suitable it is for gramophone reproduction), and partly because I have excluded records which I think unlikely to appeal to young listeners. Three extremely good records are:

- Electronic Music I* (TV 34004S)
- Electronic Music II* (TV 34046S)
- Electronic Music III* (TV 34177S)

They will be referred to as Records A, B and C in the next few paragraphs.

Let us begin with some pieces which are almost sure to attract those not used to the medium. First, there is the now famous *Switched-on Bach* by Walter Carlos (CBS 63501). Try also *Walter Carlos' Clockwork Orange* (CBS 73059) which uses music by Purcell, Beethoven and Rossini. *Silver Apples of the Moon* by



Morton Subotnick (Nonesuch H 71174) has attractive rhythmical patterns. Start by playing Side 2, perhaps; this has a section almost like beat music. A similar record by the same composer is *Wild Bull* (Nonesuch H 71208). Attractive in a different way are *Prelude XI* (Record C) and *Bowery Bum* (Record A) by Mimaroglu. Both pieces are based on the sound of a rubber band. Another winner is *Thema (Omaggio a Joyce)* by Berio (Record C) in which a speaking voice is broken up and reassembled in fascinating new patterns.

Now for pieces showing various dramatic qualities in different ways. Mimaroglu's *Le Tombeau d'Edgar Poe* (Record A) and Berio's *Visage* (Record B) use the human voice in a semi-abstract but compelling way; Varèse's *Poème Electronique* (unavailable at present), an early classic, has a curious pathos; whilst Cage's *Fontana Mix* (Record B) or *Variations IV* (Everest 3132) are cheerful surrealist collages. Parts of Stockhausen's *Hymnen* (DGG 2707039) will attract youngsters, but its two discs make it a very long piece and it is really up to the teacher to hunt out the best bits.

More solid fare, for enthusiasts, but by no means repellent, are: *Electronic Study No. 1* by Lewin-Richter (Record B), Stockhausen's *Gesang der Jünglinge* (SLPM 138 811), now a respectable classic (based on sine waves and a boy's voice), and the same composer's *Mikrophonie I* (CBS 72647) in which all sorts of methods are used to get sounds from a tam-tam which are then filtered and superimposed.

Pieces for live performers and electronic tape really belong in the concert hall, but then so does nearly everything else we buy on records, so we may as well enjoy recordings of such pieces. Stockhausen's *Kontakte* (Performing Version) on STGBY 638, Varèse's *Déserts* on SBRG 72106, and Gerhard's *Collages* on ASD 2427 are masterpieces by any standards, whilst less important but attractive are two pieces by Carlos (Record A) and Druckman's *Animus I* (Record C). All these have solo performers or an orchestra, with pre-recorded tape. In a slightly different category is Stockhausen's *Mixtur* (DGG 137012). It uses orchestra and ring modulators live, leading to complex and fascinating timbres, though musically it is perhaps heavy going for the uninitiated.

Whatever records you decide to order, put one or two extra in: it is seldom possible to get what one wants in this field and records keep disappearing from the catalogues without warning. However, your local record library may possibly have copies of deleted records.



Finally, for the teacher there are: Lorentzen's *An Introduction to Electronic Music* (JWC 1001, obtainable from J. W. Chester Ltd, Eagle Court, London EC1) which is an excellent summary of the subject; and Beaver and Krause's *None-such Guide to Electronic Music* (Nonesuch HC 73018) which is longer, more technical, and often cryptic.

Records are not the only source of electronic music. Pupils can be asked to listen to specific radio broadcasts or to look out for electronic music in television programmes such as space serials and even commercials.

## FURTHER LINES OF DEVELOPMENT FOR PUPILS

Pupils who wish to take electronic music in a different direction, either because they have completed the present course or because they find it unsuitable, have three main possibilities:

First, the exploitation of recorded sounds in *musique concrète*, using no more equipment than has been required in this book. For development in that direction a recommended textbook is:

Dwyer *Composing with Tape Recorders* Oxford U.P.

Basically a beginner's course, it is written primarily for adults, and approaches the subject from a rather different angle from the present book.

Second, the use of true electronic sound, whether by laboratory generators, electronic modules, or a complete synthesiser. Here the recommended book is:

Strange *Electronic Music* Kalmus

This gives full details of apparatus and techniques; though unfortunately no advice on composition methods.

Third, a fusion of the two above approaches, whereby concrete sounds are recorded and then processed electronically, by modules or a synthesiser. No textbook appears to exist specifically working out such procedures, but the present book can be immediately adapted to that situation by using electronic devices instead of the acoustic substitutes described here.

## FURTHER EQUIPMENT

Although the pupil who has worked through this book has not had his hands on them, he is familiar with the names and functions of several important electronic music devices. Here is a summary:

<i>Name</i>	<i>Function</i>
Filters: Lowpass Highpass Bandpass (many versions can be voltage controlled)	To select and emphasise certain frequencies and suppress or totally reject others. Used for reshaping tone-colour.
Envelope shaper	To fashion 'notes' or sounds from continuous material. Attack, hold and decay characteristics can be separately controlled. Function can be self-repeating or triggered by push-button, keyboard, external voltage, etc.
Reverberation unit	To add simulated reverberation to audio signals in controlled amounts. (Usually consists of two metal springs and special transducers.)
Oscillators	To generate particular wave forms. The commonest are: sine, square, ramp, triangular, pulse. Frequency is adjustable; best when voltage controlled, allowing, say, keyboard control.
Noise generator	To generate white noise (which is then normally filtered to produce coloured noise).
Ring modulator	To accept a pair of incoming frequencies and to deliver only their sum and difference (a kind of pitch converter).
Panpot	To guide a signal into left and right channels, also intermediate positions, so as to make stereophonic movement possible.
Mixer	To add two or more audio signals in controllable amounts into a single output signal.

Actually, the ring modulator was only mentioned (right at the end of the pupils' book) and not described; and the panpot and mixer were mentioned only in the teacher's book. But for the rest, one can imagine that to present a keen pupil with any of the above devices and to show him where the signal goes in and comes out would result in his making good use of it within a very few minutes. How can one obtain these units? Are they cheap? Let us explore some possibilities, beginning with the most ambitious.

### *Synthesiser*

What exactly is a synthesiser? It is simply a collection of miscellaneous electronic music devices, housed in a single cabinet and provided with convenient means of interconnection and control. There are various makes and models

available, some undesirable and most impossibly expensive. Easily the most suitable model for schools is the VCS<sub>3</sub>/Synthi A, available in slightly different versions for about £600 (1975 price). This contains all the devices mentioned above and others. Write for details to:

Electronic Music Studios (London) Ltd,  
277 Putney Bridge Road, London SW15 2PT

Many of these synthesisers are already being used in schools and colleges.

### *Home-made synthesiser*

To make one's own synthesiser is a very big project, and could only be undertaken as a long-term venture by a school with a very co-operative science department. Instructions on making one (or modules) have appeared in monthly magazines such as:

*Everyday Electronics*

*Practical Electronics*

*Wireless World*

and will doubtless continue to appear from time to time. Another possibility is to decide what modules one wants and put together one's own synthesiser. Advice and information on this matter can be obtained from the addresses given in the following section.

### *Modules (bought and home-made)*

Apart from occasional articles in magazines, another source for modules is one or more of the following firms, who sell them either cheaply as circuit boards requiring the addition of cases, control knobs, power supply, etc.; or a little more expensively as complete cased units, ready to use.

Chadacre Electronics Ltd,  
43 Chadacre Avenue, Clayhall, Ilford, Essex.

D.E.W. Ltd,  
254 Ringwood Road, Ferndown, Dorset.

Taylor Electronic Music Devices,  
P.O. Box 42, Greyfriars House, Chester CH1 2PW.

A unit like an envelope shaper or filter would cost about £13 or even less, but send for catalogues for exact prices.



Even without dealing with ready-made circuits, one can manage, with the aid of knowledgeable colleagues, to make some of the simpler devices fairly easily. For example, a ring modulator is one of the simplest circuits to build, and its construction is well known in electronics circles. Unfortunately it also requires a sine-wave generator for its second input, but that is not too difficult to make either.

## FURTHER DEVELOPMENT OF THE TEACHER

No one should be offended if the comparative ignorance of music teachers in the electronic field is pointed out. Things develop quickly and it is difficult to keep up; certainly we were taught little or nothing of the subject at colleges of education; and some of us might be the first to admit that we are none too sure of how to make the best use of our existing hi-fi equipment (that is, if we have any!) or even what hi-fi means precisely.

First of all, may I reassure you that there is no need to learn electronics, either theoretically or practically, if you don't wish to. Apart from a minimum of commonsense behaviour towards mains current and input sensitivities, you need only regard every piece of electronic equipment you encounter as a 'black box', i.e. a mysterious object with whose functions you are familiar but of whose inner workings you have no knowledge and no wish to acquire any. (The way some people treat a car, in fact – and they can still be good drivers.) If you do wish to learn at any rate a little more about hi-fi and audio electronics in a general way, you are recommended an excellent book:

Crabbe *Hi-fi in the Home* Blandford

and perhaps an occasional dip into monthly magazines such as:

*Hi-fi News*

*Hi-fi Sound*

*Popular Hi-fi*

*Everyday Electronics*

or even the more august

*Studio Sound*

*Wireless World*

All the above can be found in good newsagents.

A marvellously exhaustive and technical book on recording methods is:

Nisbett *The Technique of the Sound Studio* Focal

though it is a little expensive. It should be found in your public library.

Coming now to the place of electronic music in the contemporary scene, you could read the relevant sections of:

Salzman *20th-century Music* Prentice Hall  
Stuckenschmidt *20th-century Music* World University Library  
or even the necessarily limited

Wörner *Stockhausen* Faber

but for an inclusive, well-rounded book, there is none better than

Schwartz *Electronic Music – a Listener's Guide* Secker & Warburg  
which covers every aspect of the development of the art, and contains an  
exhaustive bibliography and discography for those who wish to delve further.  
Do read it.

The practical side of electronic music, i.e. how one uses the available devices  
(rather than how one constructs them) is comprehensively and clearly  
explained in

Strange *Electronic Music* Kalmus

This is a superb book and must be first choice where expenditure is limited.  
Apart from reading, the teacher may be able to attend a course at which he  
could learn more about the subject. The Music Teachers' Association runs  
annual summer schools which now include electronic music, and other summer  
schools may offer similar courses from time to time. Local evening classes may  
give an opportunity, or teachers may even consider applying for secondment  
to a suitable university course. One thing seems likely – that as fast as we catch  
up with current developments in contemporary music and music teaching,  
there arise new things to learn and pass on. While this happens, we know that  
music is a living and growing art. If it isn't, is it worth teaching?

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