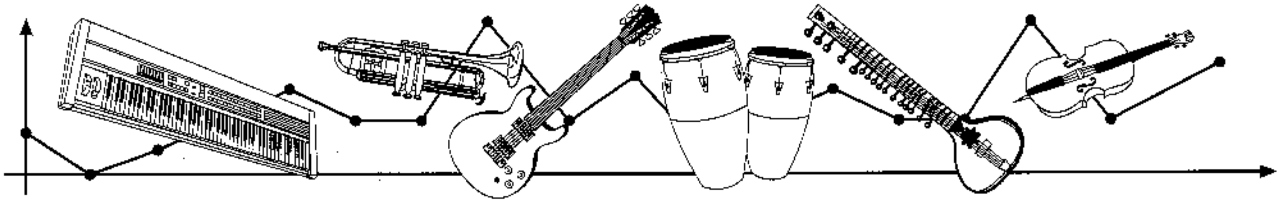

The World Is a Drummer

Every day the sun rises and sets. This cycle has been repeating since the earth began and will probably go on for some time. Most animals follow the sun closely in their sleep patterns. Other things in our lives—and in the world at large for that matter—run in cycles. Long cycles like the revolution of the earth around the sun determine the seasons. Short cycles like the beating of a bee's wings are barely noticed; they just sound like a buzz. Some cycles are very important to us, such as our heartbeat, a repeating cycle we can both hear and feel.

When you start thinking about it, you realize that thousands upon thousands of things going on around us are running in cycles. Some are made by humans and some are made by nature: the tick of a clock, the turning of a bicycle wheel, the revolutions of a motor, the drip of a leaky faucet, waves hitting the beach, tides, the migration of birds, the return of a comet, and so on.

What does this have to do with mathematics? Well, one thing humans like to do is count things. Have you ever counted the tiles on the ceiling just because you were bored, or counted the cracks in the sidewalk as you walked to school? Most of us enjoy counting money. We always seem to want to know "how much" or "how many." So it's no surprise that we find ourselves counting cycles also. But counting cycles can be kind of messy. Each cycle follows its own pattern with its own length of time before it repeats, and sometimes the amount of time it takes to repeat a pattern changes from cycle to cycle. As if that weren't messy enough, some cycles happen along with other cycles, for example, waves hitting the beach and the daily tides.

Musicians refer to the rate of a cycle repeating as its *tempo.* Tempo is measured by different things for different cycles, but it is always related to the number of repetitions within a certain amount of time. The tempo of the earth's rotation is one rotation per 24 hours. The tempo of a heartbeat is about one beat per second (or faster when you are exercising). Musicians refer to *rhythm* as the pattern of soft and loud (accented) beats within that tempo. The rhythm of the heart is a loud thump, a soft thump, then a pause.

An important part of what musicians do is count cycles and create rhythms to delight our senses. They are modeling the cycles and rhythms of nature. How counting and combining cycles can create rhythms that seem to provoke emotional responses in people is pretty mysterious.

Let's review what's really going on. Nature contains many cycles repeating at various tempos and creating rhythms; people like to count; people count cycles; musicians count cycles and create rhythms with sounds that remind us of the cycles of nature. This is getting complicated! It's no wonder that every step of the way we're doing mathematics to keep track of it all.

HELP AND INFORMATION

Polyrhythms means many rhythms (just as a *polygon* has many sides). You will learn that the essence of what makes polyrhythms interesting to listen to comes from a mathematical principle we apply to numbers and algebraic expressions.

Special terms and definitions

- *Beat:* An even pulse in time with no accents
- *Rhythm:* A pattern of accents in relation to the beat
- *Polyrhythm:* A rhythm created by a combination of rhythms
- *Phrase length:* The number of beats for a rhythm or polyrhythm to repeat

What to do

Following the direction of your teacher, you will clap to the metronome beat the rhythms assigned to your group. On the polyrhythm chart, each rhythm is represented on a different horizontal row. The vertical lines represent the beats. After each rhythm is clapped, use the polyrhythm chart to make a visual record of the claps. Place marks on the appropriate vertical line to indicate the beats on which you and your classmates clapped. Mark each rhythm with a different symbol. Use a circle, a triangle, a square, an X, or something else.

Polyrhythm Chart and Problems

Problem 4: Refer to the polyrhythm chart and observe how the individual rhythms that make up the polyrhythms of Table 1 relate to each other. Now observe the polyrhythms of Table 2. What is the same for all the polyrhythms of Table 1 that is different for all the polyrhythms of Table 2?

Problem 5: Compare the tables as you did in problem 4, but do not use the chart. Instead, focus on the relationship between the numbers that make up the polyrhythms. What do they have in common? How are they different?

Problem 7: This problem is asking you to find a general rule for determining the phrase length of any polyrhythm. How do the numbers in the individual rhythms relate to the phrase length of the polyrhythm?

Polyrhythms in Music

Problem 4: This problem is fundamentally different from the others. Feel free to use a chart and map it out. Read the problem carefully. The general rule for this type of polyrhythm is much more complicated than that for the other polyrhythms.