



# MOVING FASTER THAN THE IMAGINATION: THE EVOLUTION OF SOUND RECORDING

## OVERVIEW

### ESSENTIAL QUESTION

How did multitrack recording technologies enable musicians to create a form of music that could only be realized in the studio?

### OVERVIEW

Until Thomas Edison successfully recorded and played back sound in 1878, the only way to hear music was to have someone play it, or play it oneself. Edison's invention, the phonograph, gave rise to a new music industry, but it also signaled the beginning of a massive conceptual shift in how people think about music: for the first time in history, people heard music without someone performing it in their presence.



Throughout the ensuing half-century, technological advances significantly improved the fidelity of the recording process. However, the concept of why musicians record remained largely unchanged. The recording studio acted as an aural portrait studio; bands arrived, performed their polished material--usually what they already performed at concerts--and departed with a kind of sonic photograph of the event.

In time, however, a few restlessly creative musicians recognized that the act of recording offered creative possibilities that went beyond those of capturing a single performance. Notably, guitarist and inventor Les Paul dreamed of "sound-on-sound," a way to record himself on top of an existing recording of himself. By layering recordings, he believed he could create the sound of a group performance without anyone else in the room. When Paul's ideas were realized in the form of "multitrack" magnetic tape recorders, the concept of recorded "music" experienced yet another seismic shift.

This lesson explores several of the recording mediums used throughout the early 20th century. Along the way, students learn how sound waves travel, how the human brain converts those waves to recognizable sound and how inventors learned to capture them on wax, magnetic tape, and finally as digital information. From there, this lesson then investigates the creative impulses and scientific developments that turned multitrack recording from a dream to a reality. Students also get hands-on experience using the Soundbreaking Mixing Board TechTool, which allows them to be sound engineers, playing with "the mix" of a multitrack studio.

## OBJECTIVES

Upon completion of this lesson, students will:

### 1. KNOW (KNOWLEDGE):

- A history of recording technology, including the machines, the recording formats (cylinders, vinyl records, digital files) and their inventors
- How sound waves travel through air
- How the human ear and brain turn sound waves into “sound
- The science of phonographic recording
- The science of magnetic tape
- What “analog” recording is and what it means to convert sound to “digital” information
- What “multitracking” is as a recording practice and how it redefined the possibilities of audio recording

### 2. BE ABLE TO (SKILLS):

- Evaluate the effects of technology on history and culture
- Consider the ways in which technology can be integrated into the human creative process
- Trace musical expression to the specific historical and social context from which it emerged

## ACTIVITIES

### MOTIVATIONAL ACTIVITY:

#### Ask students:

- Do any of you or your friends have GarageBand® or other music recording software on your computer, tablet or phone?
  - What kind of music do people make with it?
  - What does a program such as GarageBand® allow you to do that a simpler recording device such as a voice memo or cassette tape does not? (Students may list a number of things, but they should mention the ability to layer “tracks” and record new sounds over previously recorded sounds without erasing them.)
  - Is there anyone that can share an experience of layering audio tracks and explain to the class what you did?
  - Other than layering tracks, what are some of the other operations a program like GarageBand® offers? (Students may answer that GarageBand® is a “Digital Audio Workstation [DAW]” that allows unlimited layering of sounds. It also features built in drum accompaniment, a library of synthesizers and full palette of effects processing options. If no one mentions it, inform students that current DAWs offer a consumer version of nearly everything a professional recording studio would have charged \$150/hr to access until the 1990s.)

## PROCEDURE:

1. Inform your students that the first successful playback of recorded sound was from Thomas Edison's Phonograph in 1878. Ask your students:

- Before there were sound recordings, where do you think you would hear music? (Possible answers: only when someone played it. This might include concerts, on the street, in the home, and at any event at which someone might wish to employ musicians.)
- What are some of the places you hear music now? (Students might mention a number of places, such as at live concerts, on TV, from their phones, at the grocery store, as part of every advertising campaign, or even through the headphones of the person next to you on the bus.)
- When you hear music now, is it usually someone performing or from a recording? (Most students will likely say they hear recorded music.)

2. Distribute Handout 1: Glossary of Terms. Use this handout throughout the lesson as new terms arise. Begin by reading the entry for "Phonograph" out loud as a class.

3. Show Clip 1, Soundbreaking - Recording Before Magnetic Tape. Tell your students that they'll see jazz composer and band leader Duke Ellington lead a phonograph recording session that was likely done sometime in the 1940s at a studio that records from a single microphone directly onto a record. Direct your students to take notes on how the recording session looks and ask:

- How is Duke Ellington's band arranged in this clip? What do you hear him saying to the band? (Students might observe that they are arranged around the recording device. Like a sports coach, Ellington is encouraging his musicians to get a good take this time through the material.)
- What are the limitations to the method

of recording you see in this clip? (Encourage students to recognize that the single microphone requires the musicians to arrange themselves in a bizarre fashion and also that the recording discs were not re-usable, so a false start or imperfect take would result in a complete re-recording and waste of a disc.)

- How do you think musicians prepared for these recording sessions? (Students should recognize that artists would necessarily prepare in advance. Under such conditions, a musician would want to arrive to the recording session with all of the elements of music preconceived and practiced. In this sense, the recording is akin to sitting for a photograph, it simply captures the music played in the room.)

4. Show Clip 2, Soundbreaking - Les Paul & Sound-on-Sound. Tell your students that Les Paul was a pioneering inventor responsible for major developments in the electric guitar and later multitrack recording. Have students read the definitions of "multitracking" and "sound-on-sound" from Handout 1 out loud. Then ask the students and keep track of answers on the board:

- What are the differences between the Duke Ellington recording session in the first clip and Les Paul and Mary Ford in the second? (Possible answers: Ellington uses many musicians to create a "full" sound, Paul and Ford are able to create a "full" recording by layering themselves. Paul and Ford are able to stop and start while Ellington's band must play from start to finish; Ellington's band must play all at once, Paul and Ford are able to layer themselves on top of previously completed recordings; Ellington's recording is being cut into a record as he plays and cannot be changed after, Paul and Ford can use the tape repeatedly.)
- Considering the way you have seen recording presented in these two Soundbreaking clips, why do you think Jeff Beck's mother suggested that Paul and Ford's music was "fooling" people? (Encourage your students to consider listener's expectations of recorded music at this time. If students return to the

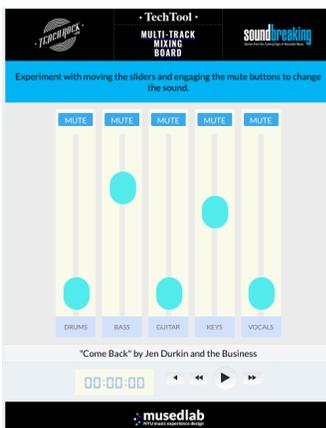
## PROCEDURE: (CONTINUED)

idea of the “photograph” of a recording, the alterations Paul and Ford are able to make after that initial “photograph” recording is made bend expectations of time and finality. Paul and Ford use this new technology as an instrument to create recorded music that they could not perform live as a duo.)

5. Break students into small groups and distribute Handout 2: Magnetic Tape and Multitracking. Have the groups read the handout and then discuss the following questions within their group:

- Who invented the phonograph? How did it capture sound? (Students should recall that Edison invented the phonograph by etching the vibrations onto a surface.)
- What is “magnetic tape”?
- Looking at the diagram of magnetic tape on the handout, how does the medium of tape make multitracking possible? (Students should recall that magnetic tape could be divided into small sections, each of which holds a “track” of the

6. Now direct the groups to open the Soundbreaking Mixing Board TechTool and do the following:



- Experiment with engaging the “mute” buttons on different tracks, what happens?
- Slide the faders up and down, what possibilities do you notice? How does the sound of the music change?
- Can you change the way the overall recording

sounds and feels just by using the tools presented here? How?

7. Ask the class:

- What is on each “track” of the recording here? What can you do with the buttons and sliders?
- In what ways does the mixing board reflect the possibilities of multitrack tape? (Students might observe that each channel on the mixing board represents a “track” of the tape.)
- How do you think recording musicians could take advantage of these possibilities? Thinking back to Duke Ellington’s recording session, what might he have done differently with a 16-track record

8. Show Clip 3, Soundbreaking - Pink Floyd and The Dark Side of the Moon and have students focus on the ways in which the members of Pink Floyd discuss embracing the possibilities of multitrack tape. Ask the students:

- How do the members of Pink Floyd suggest that multitracking allowed them create an album that expressed their feelings about “life, human emotion, and how the world impinges upon us”? What did it let them accomplish that they could not have by playing “live”? (Possible answers: It allowed them to work deliberately, recording, listening and reflecting, and then adding, subtracting, or making changes. They could return to a recording later with a new idea, or record a single instrument and then build a song around it, piece by piece; because they were no longer bound to playing as a band, they could write music based on sounds they imagined rather the roles formerly defined by each musician’s instrument.)
- What does Roger Waters suggest he likes about multitrack recording in this clip? (Students might recall Waters’ enjoyed the ability to listen back and make creative decisions about editing, recording more etc.)
- What art form does Roger Waters liken multitrack recording to? In what ways do you think this analogy applies? (Students should recall that

**PROCEDURE: (CONTINUED)**

Waters makes an analogy to painting, a great contrast to the idea of early recording as a sonic “photograph;” rather than a flash bulb and a final product, Waters sees a canvas and endless options.)

- In what ways does Roger Waters see multitracking as having potential pitfalls? (Students may answer that multitracking enables musicians to do to much and put off creative decisions until “later.”)

9. Show students Image 1, an Ampex 350 advertisement from 1965. Tell your students that the Ampex 350 could record on four tracks, weighed 204lbs and cost \$2,720, which is \$20,847 when adjusted for inflation. Ask the class:



**AMPEX**  
SOLID STATE  
**AG-350** Introducing...  
The New World Standard in Professional Audio Recording

- Who do you think owned Ampex 350 machines? Where do you think you might have found an Ampex 350 in 1966? Why?

10. Now show your students Image 2, an advertisement for the Tascam Teac 80-8. Tell your students that the Teac 80-8 was could record on eight tracks, weighed 75lbs and cost \$3,500, which is \$11,640 when adjusted for inflation. Read the advertisement out loud as a class and then ask:

**THE MACHINE THAT HOLDS THE WORLD TRACK RECORD.**

The Teac Series 80-8 has become the most popular track multitrack recorder in the world. Its reliability has been proven in thousands of studios and live performances. It handles every conceivable recording situation with ease. The 80-8 provides a new standard in multitrack recording. It's the only multitrack recorder that can provide the same quality as a conventional recorder. The 80-8 is proving that in professional recording, results are all that count. Because to us, the price is secondary. We guarantee it or your money back.

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**TASCAM SERIES**  
TEAC Professional Products

- Who is the Teac 80-8 being marketed to?
- Which of these two machines looks easier to move? How might the size and weight of a machine effect who uses it and where?
- How do you think being able to bring a machine into the home or office might affect the way a musician makes music?

11. Tell your students that you will now show them Clip 4, Soundbreaking - The Eurythmics and the Home Studio in which Annie Lennox and Dave Stewart discuss the studio they built that used a Teac Tascam 80-8. Ask the class:

- What are the similarities between the recording processes described by Roger Waters and Dave Stewart and Annie Lennox? (Students might answer that they're still using multitracking as a way to compose layer by layer.)
- How are the studios you see in each clip different? Where is the Eurythmics studio located? How do you think the Teac 80-8 figured into the size of their set up? Would they have been able to use the Ampex 350? (Encourage students to recognize how much smaller the Eurythmics studio is and how the size and reduced costs of the space allowed them to experiment. Though they could have used an Ampex 350, its size would have made getting it up to the attic quite difficult.)
- How many people does Lennox suggest were involved in the Eurhythmics sessions? In what ways do you think having so few outside people involved in recording influenced the Eurythmics' creative decisions? (Students might recall that they suggested they worked slowly and without concern for the opinions of anyone but themselves.)

- Do you think there was a cost difference in the two studios? (Encourage students to contrast the prices of the multitrack recorders and then imagine that they represent the overall costs in general.)
- How might the differences in size, location and cost change each group's approach to recording?

## PROCEDURE: (CONTINUED)

Do you think it would be better to record in a “professional” setting, or at home?

12. Distribute Handout 3: Analog to Digital, a Basic Take On Waves and read it out loud as a class. Ask the class:

- In what ways does a microphone function like the human ear?
- How does digital sound conversion differ from analog?

13. Play Clip 5, Soundbreaking - Pro Tools and the Digital Audio Workstation. Direct your students to note the language with which Bon Iver refers to the possibilities of the computer audio software “Pro Tools” and then ask the class:

- What language does Bon Iver use to express what he sees as the possibilities enabled by the Digital Audio Workstation? (Students might recall that Bon Iver describes it as “infinite” and

“limitless.”)

- What is Pro Tools enabling Bon Iver to do as a composer that he wouldn’t have been able to do in the era of tape? In what ways does the “digital” nature of Bon Iver’s set up permit this? (Students might answer that Bon Iver has almost infinite storage space on his hard drive unlike tape which runs out. The “tracks” on analog tape were made by dividing its width and were limited by dimensions of the tape, and with tape Bon Iver would have to rewind or fast-forward, but Pro Tools allows a large, visually-oriented display in which Iver should be able to locate any moment within the music. To edit, Iver clicks an image and takes an action.)
- Thinking back to Roger Waters’ comments in the previous clip, how might software such as Pro Tools increase the possibility of the “pitfalls” he mentioned? (Students might recall that Roger Waters mentioned that there were too many choices, no clear idea how or when to say “it’s done,” the impulse to say, “we’ll fix that later,” etc.)

## SUMMARY ACTIVITY:

To summarize the idea of multitrack recording, discuss these hypothetical recording situations with your students:

- In Clip 1 we saw Duke Ellington in the 1940s with his 20+ piece orchestra around a single microphone that recorded directly to disc.. What are some of the possible tools Ellington would be able to use if he recorded his large ensemble today? (Students might answer that today, Ellington could record a big band with one person performing every instrument. Also, he could use different microphones for the individual sections and even individual instruments. He could set his band up in the formation they use live because the volume of the individual instruments could be changed later. Ellington could also choose to record one or a few instruments at a time and then layer the tracks.)
- What are some of the differences between Bon Iver’s layering of sounds with that of Les Paul and Mary Ford’s layering? (Students should recall that Paul and Ford used tape, therefore they had to rewind and record again on a separate track, whereas Bon Iver is taking advantage of the digital era’s tapeless hard disk recording.)

## EXTENSIONS:

### 1. Experiencing the layers: The Les Paul sound-on-sound method

- Nearly all phones and tablets have a “voice memo” option. This is a simple, one-track recording device. The following steps replicate the earliest phases in which sound-on-sound recording was attempted.
- Step One: Using a voice memo feature, have a student record the statement, “1-2-3-4, Today is [date], we are recording.”
- Step Two: Now have a second student open voice memo. Student two will now record him/herself reciting the same sentence along with the playback of the first recording.
- Step Three: Have a third student record a voice memo with the playback of student two’s recording. Continue this process as many times as you wish.
- Discuss with your students:
  - How is their method like Les Paul’s early experiments with sound-on-sound? In what ways is it different? (Students might observe that conceptually, it’s the same. Modern technology allows the recording to occur on hard disk rather than the shellac discs Paul used. Paul however didn’t have the option of stopping and starting the record mode; when he made a mistake, he had wasted a disc.)
  - Using this method, what can you change about the recording after it has been made? (Students should answer that they can’t change anything. All planning is done before the recording. It is not possible to hear the recording and then make a change later.)

### 2. The Visual Multitrack

- Break your students into groups of four and give each group two blank sheets of paper.
- First give each group 5 minutes to collectively decide on a image and then draw it as a group.
- Now, on a separate sheet, within each group, have Student 1 draw a partial picture and then pass the image to Student 2 who draws a bit more. Continue this process until each student has added a “track” to the image. Then give the students 2 minutes to discuss the image, erase anything they’d like and then make changes.
- Finally, discuss as a class the good and bad of each approach. How did having to work as a group to make an image collectively in one attempt feel? How did it compare to the ability to work individually and make changes? Is one way better than another? Having done this exercise, do you now agree with Roger Waters’ analogy of multitracking as similar to painting? If not, how would you describe multitracking?

## STANDARDS

### COMMON CORE STATE STANDARDS

#### *College and Career Readiness Reading Anchor Standards for Grades 6-12 for English Language Arts*

Reading 1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text

Reading 7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words

Reading 10: Read and comprehend complex literary and informational texts independently and proficiently

Speaking and Listening 1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively

Speaking and Listening 2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally

Speaking and Listening 3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric

Speaking and Listening 4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience

Speaking and Listening 5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations

Speaking and Listening 6: Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate

Language 1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking

Language 3: Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening

Language 4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting

general and specialized reference materials, as appropriate

Language 5: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings

Language 6: Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression

## **SOCIAL STUDIES – NATIONAL COUNCIL FOR THE SOCIAL STUDIES (NCSS)**

Theme 2: Time, Continuity, and Change

Theme 3: People, Places, and Environments

Theme 5: Individuals, Groups, and Institutions

Theme 7: Production, Distribution, and Consumption

Theme 8: Science, Technology, and Society

## **NATIONAL STANDARDS FOR MUSIC EDUCATION**

### *Core Music Standard: Responding*

Interpret: Support interpretations of musical works that reflect creators'/performers' expressive intent. Describe a personal interpretation of works or contrasting works and explain how creators' and performers' application of the elements of music and expressive qualities, within genres, cultures, and historical periods, convey expressive intent

Enduring Understanding: Through their use of elements and structures of music, creators and performers provide clues to their expressive intent

Essential Question: How do we discern the musical creators' and performers' expressive intent?

### *Core Music Standard: Connecting*

Connecting 10: Synthesize and relate knowledge and personal experiences to make music. Demonstrate how interests, knowledge, and skills relate to personal choices and intent when creating, performing, and responding to music..

Enduring Understanding: Musicians connect their personal interests, experiences, ideas, and knowledge to creating, performing and responding.

Essential Question: How do musicians make meaningful connections to creating, performing, and responding? Demonstrate how interests, knowledge, and skills relate to personal choices and intent when creating, performing, and responding to music?

Connecting 11: Relate musical ideas and works to varied contexts and daily life to deepen understanding. Demonstrate understanding of relationships between music and the other arts, other disciplines, varied contexts, and daily life..

Enduring Understanding: Understanding connections to varied contexts and daily life enhances musicians' creating, performing, and responding.

Essential Question: How do the other arts, other disciplines, contexts and daily life inform creating, performing, and responding to music?

## RESOURCES

### VIDEO RESOURCES

- Soundbreaking – Eurythmics & The Home Studio
- Soundbreaking – Pink Floyd & The Dark Side of the Moon
- Soundbreaking – Recording Before Magnetic Tape
- Soundbreaking – Les Paul & Sound-On-Sound
- Soundbreaking – Pro Tools and the Digital Audio Workstation

### FEATURED PEOPLE

- Les Paul

### HANDOUTS

- Handout 1: Glossary of Terms
- Handout 2: Magnetic Tape and Multitracking
- Handout 3: Analog to Digital, a Basic Take on Waves