

Tool Kit III

Industrial Design – Imagining New Musical Instruments

Objective

Using their knowledge of the characteristics of sound waves, as well as organology, students will design a musical instrument of their own invention. Students will explain how the instrument will be played, how it will sound, what materials it will be constructed from, and who might play it. They will also identify a potential market for their musical instrument.

Materials

- Pens or pencils
- Post-it notes or similar
- Whiteboard or butcher paper
- Paper for sketching design ideas
- Art supplies for 3-D modeling, such as paper, tape, scissors, paper clips, pipe cleaners, cotton balls, Play-Doh, or Legos
- Computer and access to the Internet for conducting research

Arizona Science Standards Addressed

Strand 3: Science in Personal
and Social Perspectives

Concept 2: Science and Technology
in Society

Strand 5: Physical Science

Concept 1: Properties of Objects
and Materials

Concept 2: Position and Motion of
Objects

Strand 1: Inquiry Process

Concept 1: Observations, Questions,
and Hypotheses

Concept 2: Scientific Testing
(Investigating and Modeling)

Concept 3: Analysis and Conclusions

Background Information for Educators

Industrial design is the process by which many consumer goods, including musical instruments, are developed. A key feature of industrial design is that the design process is conducted separately from the manufacturing process, thus facilitating imagination and creativity without an initial concern for engineering or manufacturing. Industrial design is, by its very nature, interdisciplinary in that the design of an object produces a need to explore other disciplines such as the mechanical or material sciences, engineering, or electronics. In this way, industrial design activities are fruitful starting points for embedded STEM learning.



Students brainstorm new designs for musical instruments.

The Process of Design

Activity 1: Brainstorm

Invite students to spend five minutes individually brainstorming as many new different musical instruments as they can, and to write or draw each new idea on a Post-it note. There is no restriction on what type of musical instrument it might be. As students imagine their new musical instruments, invite them to consider the following questions:

How is your new musical instrument held or played?

How does this instrument produce sound? What vibrates to produce the sound waves? How would an organologist categorize your musical instrument?

What is the inspiration for your musical instrument?

Activity 2: Ask Questions, Explain Ideas, and Organize into Groups

Invite the students to place all their Post-it notes from Activity 1 on a large whiteboard or piece of butcher paper and to spend a moment looking over everyone else's ideas, asking questions and giving explanations to fill in the details of their instrument designs for one another. (In particularly large classes, use additional whiteboards to facilitate discussions among smaller groups of students). Invite the students to begin grouping their musical instrument ideas according to any criteria that they would like, moving the Post-its accordingly. For example, instruments might be grouped by what they're made of or how they're played. They might be grouped using the Hornbostel-Sachs system introduced in Tool Kit II. Once all the instruments have been organized according to some criteria, invite the students to organize themselves into groups based on which musical instrument idea they are most interested in designing further with their classmates.

Activity 3: Model

Invite students to use the art supplies to create a rough 3-D model of their instrument and to refine their discussions of what each different element of the design will do. The 3-D model is not intended to look in any way like the final instrument itself. It exists to provide a physical form to discussions of the different elements and functions of the instrument. For example, a pencil shoved into a crumpled ball of paper wrapped in tape might give physical form to an imagined guitar-like instrument.



Students model and create prototypes of musical instruments.

Activity 4: Sketch and Present

Invite students to work as a group to sketch a design proposal for their instrument. For younger students, this activity can take on the spirit of a group art project followed by a presentation. For older students, the complexity and detail of the proposal can increase in whatever way might be most developmentally appropriate for the specific group of students.



Students share their design ideas with one another.

A typical design proposal might include the following:

1. A detailed drawing or schematic of the musical instrument
2. The function of all the different elements of the musical instrument
3. The materials the instrument will be built out of and their associated costs
4. The intended market for the musical instrument, including examples of any similar instruments
5. The specialized skills or manufacturing processes that might be required to build the design (e.g., metalworking, electrical engineering, woodworking, painting, 3-D printing, computer programming, etc.)

Extensions

MIM's advanced curriculum for "STEM: How Science Brings Music to Life" begins with activities that explore acoustic amplification (i.e., resonance), electronic amplification, and electronic oscillation.

Advanced modeling techniques can be used to create a prototype of the instrument itself using

inexpensive materials such as Play-Doh, PVC pipes, rubber bands, tape, carved Styrofoam, etc.

Autodesk is a company that produces a suite of design programs used by professional designers worldwide, many of which are available to students for **free**. Autodesk's **Tinkercad** program is designed to help young children design and print their own creations in 3-D.

Assessment

Formative

Students will demonstrate their understanding of the physical properties of the materials, the uses of various kinds of technology in society, and the process of scientific inquiry as they work with peers to develop, design, model, and sketch their musical instruments.

Summative

The formal design proposal provides an organic opportunity for summative assessment of basic student understanding of material properties and physical motion, as well as the use of technology in society.