Grades
K-12

Career Pathways
Graphic Designer
Mechanical Engineer
Biologist
Puppeteer

Academics
Math: Graphing, Symmetry
Science: Environment, Structure, Function, Systems

Professional Career Skills
Collaboration
Creativity
Perseverance

Materials
Formcard or Instamorph
Heated Water in Heat Resistant Cups
Recyclables (Straws, Spoons, etc.)
Craft supplies: Cardstock/Paper, Color Pencils, Scissors, Tape, Hot Glue Gun

Optional -
Autodesk Sketchbook
Autodesk Fusion 360
Tinkercad

Dancing Nēnē Activity

Team Goal
Level 1
Construct a Nēnē puppet with moveable wings using the templates.

Level 2
Design and construct your own puppet animal with moveable wings. Use principles of symmetry and coordinate graphing along with tips for mechanical construction.

Level 3
Research various mechanics for puppetry. Construct your own puppet by innovating different mechanics for moveable parts. Use principles of symmetry and graphing or software to produce a design. Consider the interplay of form and function!
<table>
<thead>
<tr>
<th>Iterative Design</th>
<th>Product</th>
<th>Fabrication &amp; Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>As you create your design, continue to think of new ideas and make improvements so it works and looks great! You do this through cycling through the engineering design process.</td>
<td>When you decide to create or build a prototype or model, you are producing a product. Your Nêné or puppet is a product that can be shared with other people.</td>
<td>If you have a lot of requests for your Nêné or puppet, then you might need help with manufacturing a lot of them! Many people would help and be involved.</td>
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<tr>
<td>Precision</td>
<td>Criteria</td>
<td>Constraint</td>
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<tr>
<td>Engineers pay attention to the details in how components are put together. They need to be precise in measurements and make sure they sequence construction in a specific order. When you build the mechanical skeleton, you’ll need to be precise!</td>
<td>You will know your Nêné or puppet is successful by how well it works for your audience. One criteria for success includes that your puppet has moving parts.</td>
<td>All designers and engineers are limited by resources or time. You may have a limited number of supplies or time to build. You’ll need to work with what you have to make the best product possible. It is very creative work!</td>
</tr>
<tr>
<td>Scheme, Blueprint or Diagram</td>
<td>Prototype or Model</td>
<td>Troubleshoot</td>
</tr>
<tr>
<td>If a friend wanted to make your design, they would need your plan. A scheme, blueprint or diagram shows a plan that other designers and engineers can use. The plan might have labels, like measurements, so the size is accurate.</td>
<td>Before putting too many resources, like time or money into a final product, you should sketch a plan and build a small model of your product first. You might make a few drafts before deciding a final version.</td>
<td>When you assemble your Nêné or puppet model, it may not work as well as you expected. Designers and engineers always test, modify and refine their designs so they work!</td>
</tr>
<tr>
<td>Component</td>
<td>Modular</td>
<td>Assembly</td>
</tr>
<tr>
<td>Your model has many parts that are needed to make it function and work. You might need to modify different components so they fit better or work together. The components all work together to make your puppet move!</td>
<td>Many engineers and designers create products with components that can be fixed or replaced without having to throw away everything. Are parts of your design modular? Modular products are good for the environment and a future budget!</td>
<td>You need to be precise when you put all the components together. It is helpful to assemble a model in a certain order otherwise putting it together may be difficult or even impossible!</td>
</tr>
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Engineering Design Process Directions:

1. Define the Problem
   Choose a goal to tackle with your team!

2. Gather Pertinent Information
   Depending on your goal, learn about native species, puppetry mechanics, software or moldable bioplastics. Check out the Design & Engineering Prototype Tips and Graphic Design Tips pages.

3. Generate Multiple Solutions
   Think about how you might design the puppetry mechanics inside of your puppet to work with the outside. Sketch your ideas. If you are using software, you might want to save different options.

4. Choose a Solution
   Decide on a final design for both the inside and outside of your puppet. Your team may need to combine ideas.

5. Design a Culturally Responsive Solution
   As you create your solution, ask other people for feedback. Is your animal recognizable? In addition to your puppet, should you include relevant information about your animal?

6. Test and Optimize
   Put the pieces together and test your puppet’s mechanics. Does it work as predicted? Can the “mechanical skeleton” be improved? Share your models and use the feedback to improve your design.

7. Share & Reflect
   When and how did you use feedback to improve your solution? How did you and your team collaborate and practice perseverance? Talk to your team: What went well? What could have gone better?
Design & Engineering Prototype Tips

In design, both form and function are important. The form, or structure, accents how accurate or beautiful a design looks or feels. The function is all about how well the design works. Great innovations have a combination of both that work together! For example, if you design a phone, you want to create a product that works well, but also looks stylish and can fit in your hand. If something looks great but doesn’t work, no one will want to use your design. If something works well but looks terrible, your product won’t be popular either. The challenge to design is creating beautiful products that work!

Designers create prototypes or working models of their ideas. Then, they share these ideas with others, get feedback, and improve them. Prototypes help save resources, like time and money! This is because prototypes are usually made with inexpensive materials.

This design and mechanical engineering activity explores simple mechanics. You will use poles, loops and strings to create movement. Your challenge is to create a working prototype of a native animal puppet. The criteria for the puppet includes: (1) represent a native bird, bat, or insect, and (2) has parts that move without directly touching them.

Exterior Model Design (External Structure or Form)

The Graphic Design Tips and Nēnē are Endemic to Hawai‘i pages have low tech and high tech tips for tackling the exterior design!

Internal Mechanics Design (Internal Function)

Construct a “mechanical skeleton” that will create movement! Use components like poles, loops and strings. Be creative! Invent an internal structure that will support the movement of your design!

Low Tech: Use a moldable plastic, like FORMcard or Instamorph.

High Tech: Create your design using CAD (computer aided design) software, like Autodesk Fusion 360 or Tinkercad. Then 3D print your work.

FORMcard is a reusable, moldable, meltable bioplastic!
“Bio” means life. This plastic is made from a kind of starch!
1. Heat a cup of water in a heat safe container. Be careful not to burn yourself!
2. Drop the bioplastic into the water for a few seconds.
3. Pull pliable plastic out with a metal spoon or wood chopstick.
4. Mold it. Re-melt it. Mold it again. Be careful as it may be hot! It adheres (sticks to) any kind of plastic so you can build your prototype using a combination of recyclables, like straws, plastic silverware, and plastic bottles!
Graphic Design Tips

Low Tech: Use this template to design your own native bird, bat, or insect. Design a 2-dimensional image that will become a 3-dimensional model. To be sure your design is symmetric, use the x-axis (horizontal) and y-axis (vertical) to plot points.

High Tech: Graphic design software can be used to digitally create your work. Download a free version of Autodesk Sketchbook and use it to sketch by creating a free Autodesk Education account: https://www.autodesk.com/education
Nēnē are Endemic to Hawai‘i