Objective – to create physical model using indirect observation and inferences.

Materials (per 3-4 students)
- Plastic container (approximately 12”x6”x4”)
- Sand
- Grid paper (2 different resolutions)
- Thin rod (such as a bamboo skewer)
- Legos

Directions
1. Prior to the activity prepare the plastic containers by building shapes out of legos, placing the shapes in the plastic containers and covering them with sand (see suggested design above).

2. Without mentioning anything about modeling, pass out the containers and tell the students their goal is to create an accurate depiction of the object in the container.

3. Pass out 2 copies of the low resolution grid paper, one with holes at the intersection points and one without holes to draw the model on.

4. Instruct students to place the grid paper with holes over the top of the container and use the rod as a probe to determine the shape of the object. As an extension students could use the rod and a ruler to accurately measure the height of the object in order to create a 3D model. The height could be represented on the 2D drawing by color or shading.

5. Students should draw the model on the 2nd copy of the grid paper. With the low resolution they will have to make a lot of inferences/guesses as to the exact shape, but that’s the idea.

6. Repeat steps 3, 4, and 5 with the higher resolution graph paper. Students should get a much more accurate picture of the shape of the object.

7. Allow students to remove the object from the container and compare it to their drawings.

Discussion/Post Lab questions
1. How accurate were your representations of the model?
   Students should notice that neither of the models are completely accurate and miss the finer scale structures of the legos and the exact shape and size.

2. Which representation was more accurate? Why?
   Hopefully the representation from the higher resolution grid will be better. Students should say
something about the fact that there were more observations which allows for more accuracy.

3. What could you do to make a perfectly accurate representation of the model?
   Make grid paper and a container with an infinite number of locations to test with the rod.

4. What effects does resolution have on creating a model?
   Increased resolution makes the model more accurate but also requires more measurements each of which has to be plotted, therefore greatly increasing the time needed to construct the model.

5. What are examples of actual models that you know of or have used?
   Depending on the level of student, answers will vary but may include: Earth’s interior, Sun’s interior, Atomic structure models, Human body models, Population growth models, Economic models, Climate and Weather models, Genetic models, etc.

6. Which of these are created through indirect observations and inferences like the ones you used to make this model?
   Anything that we can’t see

Possible Extensions / Changes

1. If a more hands on version is needed, have two sets of legos, one in the box covered, and then a box of possible legos next to where they were putting in the bamboo skewers. They are to recreate what they think is in the box and then compare.

2. Have students decide how few or how many skewers they need in order to correctly predict the shape of the legos below the surface. Costs or points could be added or taken away for more used, or better accuracy. (For example, this could be a 100 point assignment, where they are given 10 skewers for free, but it costs one point for each extra skewer they use. Up to a certain grid size. Then bonus points or extra points are given for more accuracy)

3. Student groups build on what previous groups have used. This could be dovetailed into number two where points or costs are included if they use a previous group’s drawings or building. (For example: Students can start from scratch with no cost or point loss, but then are given no clue on what the shape )

4. Use this as a station, where each group builds on what the previous group did. They are allowed 5 skewers each time and can add (only through a grid design) more each time, thus refining what the previous group did. If building a lego model outside of the box to mimic the one in the box, they can either add, subtract, or change one to two pieces as they pass through that station. Thus, the project becomes more successful as more students work together on it.