

1.2a | By Chance or by Design?

Materials

- Fathom document
WestvacoDemo.ftm
(optional)

In the *Statistics in Action* student text, this activity introduces the process of simulation by using index cards. Students choose three Westvaco workers at random from a collection of ten workers and find the average age of the three chosen workers. The students' goal is to find out how reasonably likely it is that the average age would be 58 years or greater.

It would be a mistake to replace doing the activity by hand with using a Fathom simulation. Doing the simulation by hand at this early stage gives students a better feel for how chance-like behavior works. Furthermore, constructing an appropriate Fathom simulation requires considerable familiarity with the software. It is useful, however, to do a Fathom demonstration of the simulation *after* you have gathered and analyzed the results of the index card simulation. If you have the means to display the computer screen to students, you can reinforce the ideas brought up in the activity and introduce students to the power, beauty, and capabilities of Fathom for future activities that they can do themselves. This will also heighten student interest in using Fathom.

If you are brand-new to Fathom yourself, you may want to practice this demonstration in advance. Without prior preparation, this would be an ambitious first attempt at using Fathom in front of a class! Detailed, step-by-step instructions follow.

You can make the demonstration very brief by setting things up ahead of time in a Fathom document. For your convenience, a prepared demonstration, **WestvacoDemo.ftm**, is available on the CD that accompanies this book, though using a prepared demonstration is likely to create an unnecessary air of mystery to the whole process. If you can spare the time, it is recommended that you show and explain the steps of building the simulation.

Procedure

Here are the steps for demonstrating the simulation in front of your class. Where appropriate, parallels are drawn to the index card simulation.

Enter Data

Westvaco Workers

	Age
1	25
2	33
3	35
4	38
5	48
6	55
7	55
8	55
9	56
10	64



Westvaco Workers

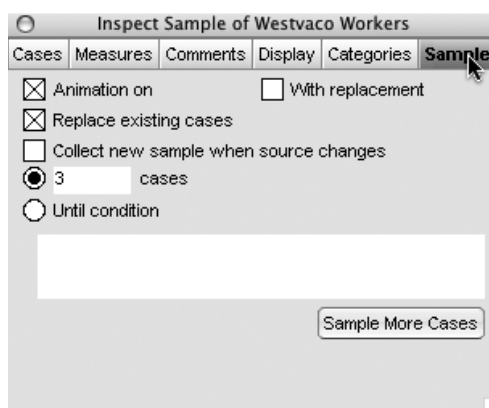
1. In a new Fathom document, make a new case table. To do this, drag a new case table from the object shelf. (You can also choose **Object | New | Case Table**.)

2. Click on the column label <new> and name the attribute **Age**.
3. Enter the ten workers' ages.
4. Double-click the collection name **Collection 1** and rename the collection **Westvaco Workers**.

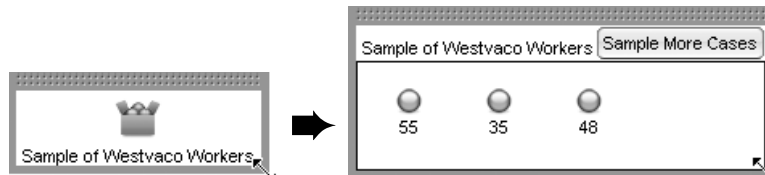
Each case in the case table corresponds to one of the index cards in the hands-on simulation. You now need to take a sample of three workers from the original ten workers.

Sample the Data

5. Click once on the attribute name **Age** to select the column. Choose **Use As Caption** from the **Table** menu. This conveniently displays the age of each worker in the sample collection. (See the art with step 9 for an example.)
6. Click once on the collection box and choose **Sample Cases** from the **Collection** menu. By default Fathom takes a sample of ten cases with replacement and places them in a new collection named **Sample of Westvaco Workers**. You'll change this to three cases without replacement.
7. Double-click the sample collection (not the *name* of the collection) to bring up its inspector. On the Sample panel, change the number of cases to **3** and uncheck the box next to "With replacement." (This keeps you from getting the same worker more than once within a single sample.)



8. Click the **Sample More Cases** button.
9. Resize the sample collection by dragging its lower-right corner. Make it big enough to see the three sampled cases and their age labels.



10. Click **Sample More Cases** several more times. Observe that you get a new sample of three workers' ages each time. (*Note:* You can use the **Sample More Cases** button on either the inspector or the sample collection.)

Clicking **Sample More Cases** in Fathom is equivalent to selecting three index cards in the hands-on simulation.

Next, you need to compute the average age for each sample.

Compute a Summary Statistic for the Sample

11. In the **Sample of Westvaco Workers** inspector, go to the Measures panel.
12. Click the row label **<new>** and name the measure **AverageAge**.
13. Double-click the formula cell to bring up the formula editor. Type the formula **mean(Age)** as shown here. Click **OK**. The mean of your sample will appear in the value cell.

Inspect Sample of Westvaco Workers		
Cases	Measures	Comments
Measure	Value	Formula
AverageAge	46	mean (Age)
<new>		

Formula for AverageAge

AverageAge = mean (Age)

Medium

7 8 9 + =

4 5 6 - <

1 2 3 x >

0 . ^ ÷ ()

1/x √x ↑ not and

|x| ← → or Cancel Apply OK

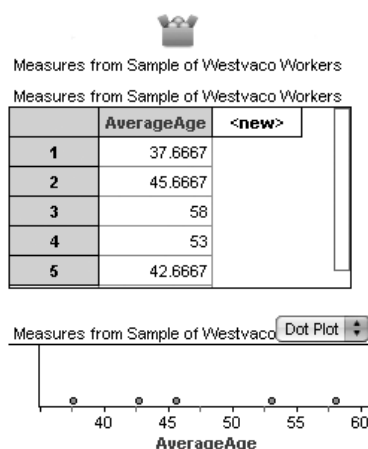
- Attributes
- Functions
- Global Values
- Icon Names
- Measures
- Special

14. Click **Sample More Cases** again. Observe that the measure **AverageAge** updates each time you take a new sample. Close the inspector.

Now you want Fathom to keep a record of the average ages for multiple samples.

Collect Summary Statistics and Display the Distribution

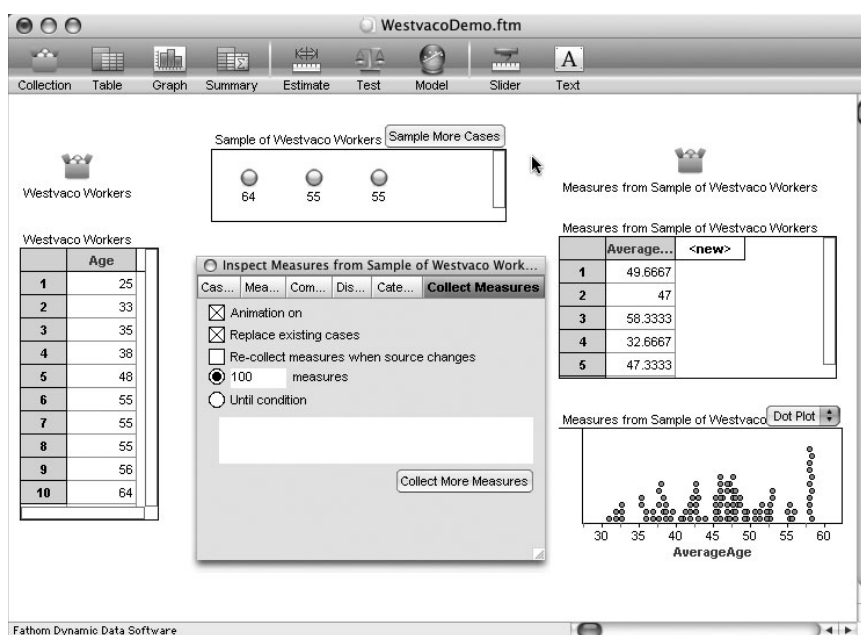
15. Select the sample collection and choose **Collect Measures** from the **Collection** menu. By default Fathom collects five measures and places them in a new collection named **Measures from Sample of Westvaco Workers**.
16. Make a case table of the measures collection. The easiest way to do this is to select the measures collection, then drag a new case table from the shelf.
17. Make a new graph by dragging one from the shelf. (You can also choose **Object | New | Graph**.) Press and hold the attribute name **AverageAge** in the measures case table. The cursor icon becomes a hand. Drag **AverageAge** to the horizontal axis and release. By default, Fathom makes a dot plot. Are any of the average ages 58 years or more?



You'll collect more measures in order to better estimate the probability.

Estimate the Probability

18. Double-click the measures collection to bring up its inspector. On the Collect Measures panel, change the number of measures to **100**.
19. Arrange your screen so students can see everything. Make sure there is a check in the "Animation on" checkbox. Then click **Collect More Measures**. With animation on, this simulation proceeds slowly, and students can absorb what is going on. They will see a flow of blue balls from left to right as samples are collected from the population of ten workers. Then measures from these samples are gathered (green balls), and the dot plot is updated.



20. When all 100 measures have been collected, count the dots that represent an average age of 58 years or more. Calculate the probability by dividing by 100 and interpret the results. The results from the Fathom simulation should be roughly comparable to those obtained from the index card simulation.

If you uncheck “Animation on” in the inspectors of both the sample and measures collections, the simulation will proceed more quickly. You can then collect 1000 measures. Enlarge the dot plot and compare it to Display 1.10 in the *Statistics in Action* student text.

A nice way to close the demonstration is to ask students to make the connection between the Fathom simulation and the steps described in “Key Steps in a Simulation” on page 16 of the student text.

Extensions

1. Perform the simulation many times with 100 sample means and observe how the probability fluctuates for a small number of sample means. One way to do this is to define a measure, **Probability**, for the measures collection using the formula **proportion(AverageAge \geq 58)**. Then collect measures from the measures collection.
2. Explore what happens when you change the sample size. How does the probability change between 20 sample means, 100 sample means, and 1000 sample means? Does the probability approach a particular value?