

# Circuit Workbench

Joshua Gutwill

9/29/1999

THIS IS NOT A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analyses
  - brief reports
  
- **look at an earlier version** of the exhibit/program, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit/program

# Circuit Workbench (formerly Batteries and Bulbs) Exhibit Studies

Joshua Gutwill

September 29, 1999

## Observational Studies

### Baseline Observational Study

#### Goal

Determine whether visitors are engaged by the original exhibit and whether they have difficulties using it.

#### Method

Watch visitors as they use the exhibit. Record the time each Visitor's spends at the exhibit; record the circuits the build, any problems they have with the wire & spring connectors, and whether the use any of the switches in their circuits.

#### Results

In a 46 minute period, 10 visitors or Visitor groups used at least one station at the exhibit for at least 5 seconds. The distribution of time spent at the exhibit is shown in the table below:

Number of Visitor groups	Time spent
1	46 minutes
1	10 minutes
1	2 minutes
1	1 minute
4	5-10 seconds

Two visitors built more than one circuit. Others left after building 0 or 1 circuits.

Two visitors seemed to have difficulty using the wire and spring connectors.

## Conclusions

The exhibit has potential — two visitors were quite engaged. However, the majority of visitors approached the exhibit and simply walked away. It seemed it was not either engaging or accessible enough for them.

## **Circuit Breaker Orientation Study**

### Goal

Determine which orientation of the circuit breaker is easier for visitors to notice and use, horizontal or vertical.

Check for a visitor's success at resetting the circuit breaker after s/he has shorted the battery.

Check for a visitor's success at resetting the circuit breaker when a previous visitor has shorted the battery.

### Method

Observe visitors using Stations 1, 2, 3 and 6. Stations 1-3 have the circuit breakers mounted horizontally; station 6 has the circuit breaker mounted vertically.

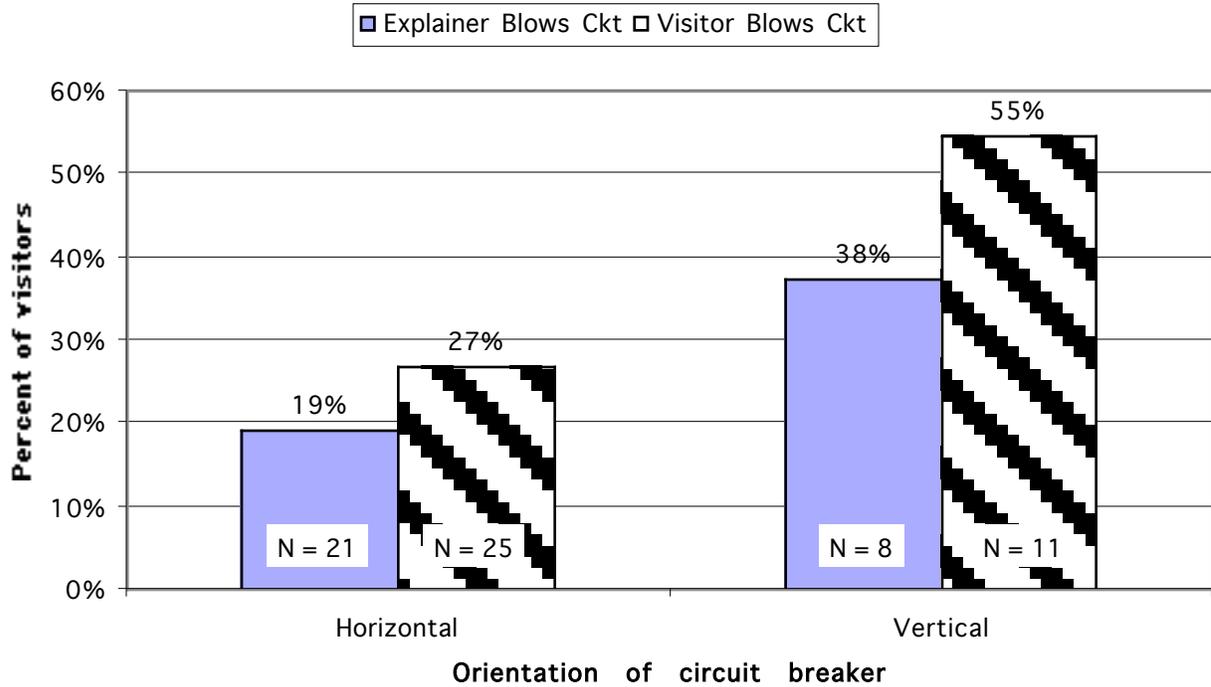
Method 1: If a visitor shorts the battery at any of these stations, mark whether or not the visitor "recovers." A successful recovery is defined as resetting the circuit breaker and attempting to make a circuit.

Method 2: After each visitor leaves a station, the observer intentionally shorts the battery and leaves the circuit breaker "open." When the next visitor approaches, the observer marks whether or not the visitor recovers.

### Results

The percent of visitors recovering from a shorted battery were greater for the circuit breaker oriented vertically than for the ones oriented horizontally. This pattern was found in both methods for shorting the battery. See the graph below for the frequency distributions for each orientation and each observational method. Note that none of the apparent differences are statistically significant with such small sample sizes. However, the results suggest a statistical trend

## Visitor Recovery from Short Circuit



### Conclusions

We recommend that new ways for dealing with shorted batteries be developed. At best, only 55% of the visitors could recover from a shorted battery. If no substitute for the circuit breakers can be found, we recommend orienting all breakers vertically. In both experimental conditions, vertical circuit breakers seemed to offer visitors a better chance of recovery than horizontal breakers.

## Cued Interview Studies

For the Bulbs and Batteries Exhibit rebuild, the developer (Erik Thogersen) and the evaluator (Joshua Gutwill) worked together to come up with interview questions which might influence rebuild choices, especially whether to use graphic flaps with contextual missions on them.

Studies were designed to answer these questions:

### Contextual Mission:

- Does it increase appeal / interest / relevance?
- Do visitors understand the mission?
- Presentation (should the mission be separated from the solution by a flap?)

### Wires:

- Problems using / stripping the wires
- Comparing the banana plugs and the spring+wire connectors

### Circuit Breakers:

- Use problems
- Resetting after short-circuit
- Resetting after other V short-circuit

Josh also checked up on these issues:

### Title

- Appeal / comprehensibility

### Circuits:

- Number made
- Ignore or follow museum suggestions

### Variable resistor:

- Use problems

### AC Generator:

- Use problems

## **Pre-changes study (B&B.iv.1.01)**

### Goal

Check for problems, engagement, main ideas of exhibit

Method

Interview visitors about their experience with the exhibit. Use standard exhibit interview.

N=2 visitors

Results

Post-use interest: 5, 4

Seemed engaged: both visitors built more than one circuit, and built their own circuits instead of or in addition to circuits suggested by the museum.

Problems: Had difficulty stripping wires.

Conclusions

Change method for connecting circuit elements. Possibilities include new type of wires (banana plug) or magnetic connections such as those used at the San Jose Tech Museum.

**Missions vs. No-missions Indirect Comparison — Different Groups of Visitors (B&B.iv.3.01)**Goal

Determine if the exhibit is more engaging and interesting when the circuits include a contextual mission, such as creating a flashlight or a dimmer light. Determine which version of the exhibit is more challenging (difficult) for visitors. Determine whether visitors understand the mission statement, and whether it helps them make sense of the exhibit. Determine the best title from the following list:

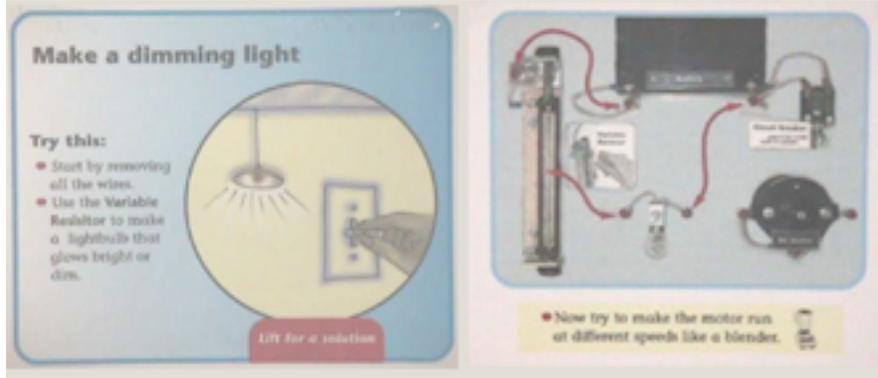
Bulbs & Batteries  
Circuit Workbench  
Build Everyday Circuits

Method

N=6

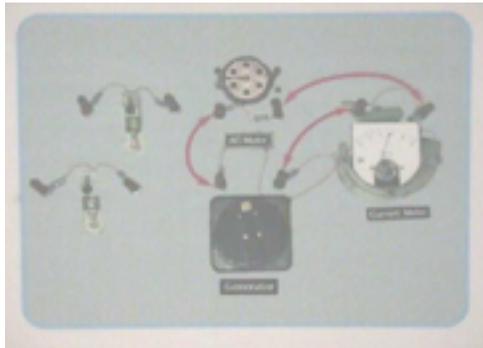
Each visitor plays at only one station, which either includes a mission and solution to build a dimmer light or merely includes a directive to build a circuit shown in a diagram.

Half of the visitors get the Mission version:



The other half of the visitors get the No-mission version:

“Build this circuit”



Visitors are randomly assigned to the Mission or No-Mission stations on the exhibit.

## Results

Average “Interest level” after building a circuit was 4.3, between Somewhat Interesting and Interesting.

Half of the Vs either ignored the mission or found it unhelpful. The other half found it understandable and helpful.

Regarding the difficulty level of building the circuits, there was a wide range in experience, from not challenging to very challenging. The challenge level did not seem to correspond to whether or not there was a mission.

## Conclusions

This study did not show many differences, but it has a very small N. Furthermore, it is difficult to infer differences when comparing visitors from one treatment to another. Developer and Evaluator decided to change experimental strategy and ask each visitor to directly compare two stations.

### **Missions vs. No-missions Direct Comparison — Single Group of Visitors (B&B.iv.4.01)**

#### Goal

Determine if the exhibit is more engaging and interesting when the circuits include a contextual mission, such as creating a flashlight or a dimmer light. Determine which version of the exhibit is more challenging (difficult) for visitors. Determine which type of wires (banana or flat-into-springs) are easier for visitors to use.

#### Method

N=6 visitors

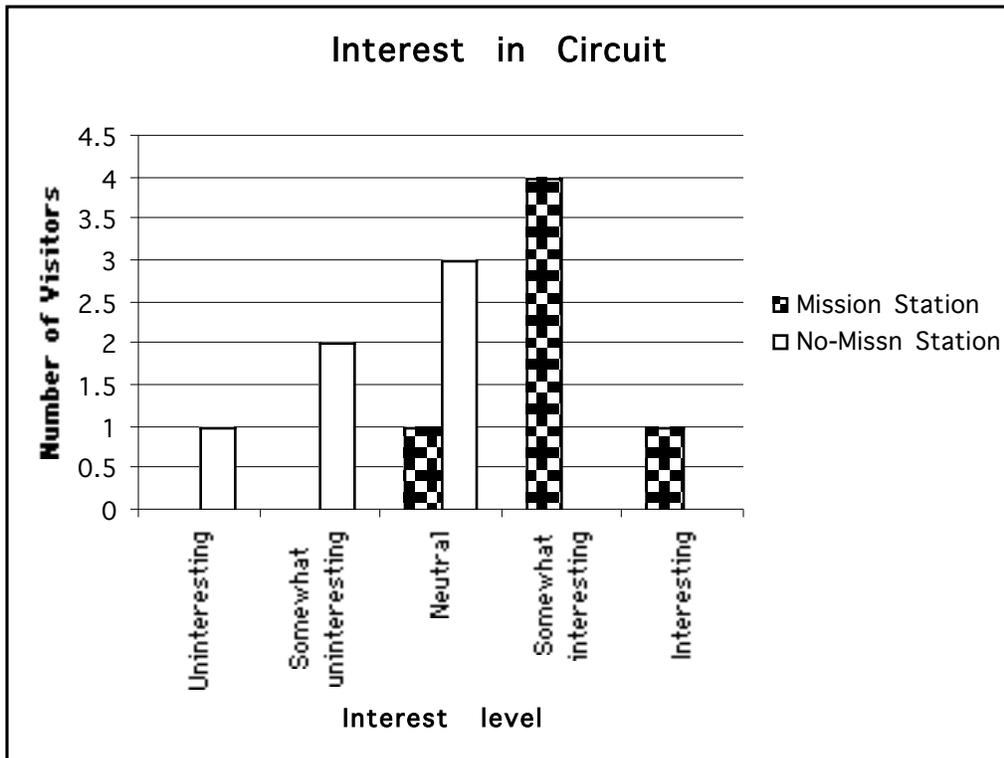
Ask visitors to compare two exhibit stations directly: one with a mission and one without. Each visitor interacts with both stations.

Randomly decide whether V starts with Mission or No-Mission station.

Mission station and No-Mission station are same as above.

#### Results

Visitors found the Mission circuit more interesting to build, as shown in graph below.



Visitors found the circuits somewhat challenging to build. Difficulties included:

- Not understanding the difference between a motor and a generator
- Confusion over black banana wires and red plugs
- Not understanding electricity or circuitry
- Confusion about the motor and the battery

All six visitors preferred the banana plugs to the flat wire and spring connectors.

### Conclusions

Use mission statements.

Use banana plugs instead of flat wire and spring connectors.

As black banana plug wires break, replace with red ones.

### **Flip-up mission vs. No Flip — Mission and circuit diagram on one page (B&B flipups.iv.02)**

#### Goal

Check to see whether flipping the mission up to see the circuit diagram is better or worse than seeing it all on one graphic.

## Method

Each visitor sees both versions of the graphic — one version as a flip up and the other version all on one graphic. A single station (dimmer light) was used.

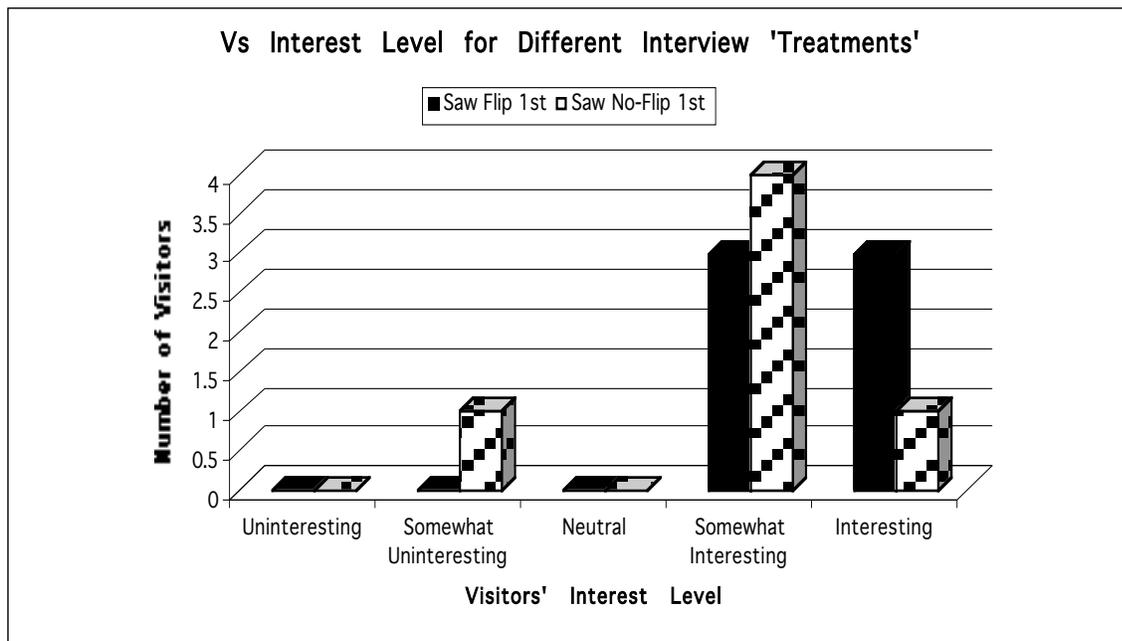
Randomly choose which version the visitor sees first.

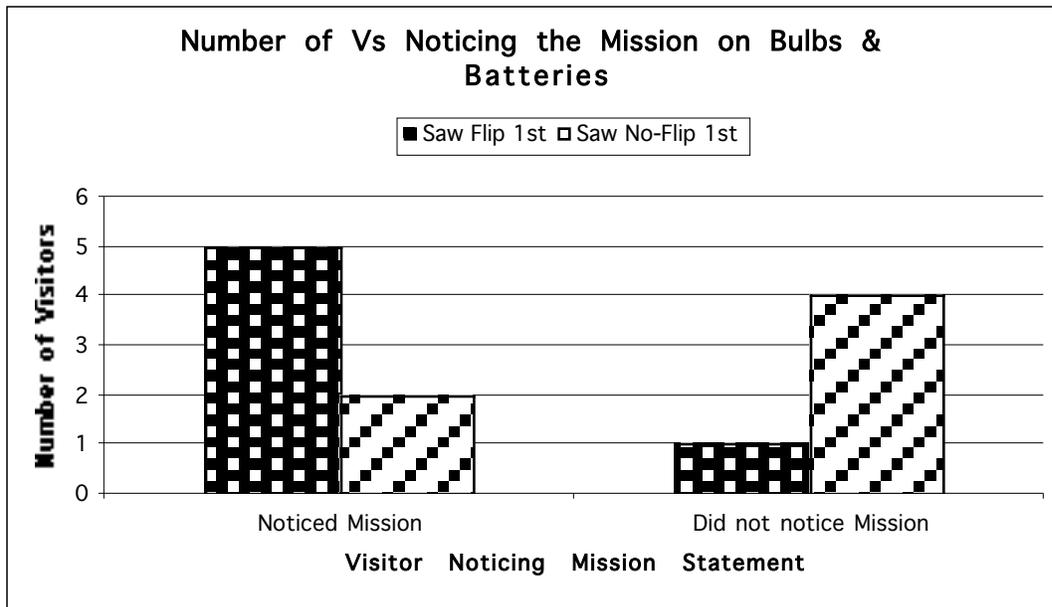
No pic available for no-flip version. Flip version same as above.

N = 12 visitors; 6 who saw the flip up 1<sup>st</sup> (before the all-on-one graphic) and 6 who saw all in one 1<sup>st</sup>.

## Results

Flip 1<sup>st</sup> visitors seemed to find the exhibit a little more interesting and less challenging. In addition, more than twice as many of the “Flip First” visitors as the “Flip Second” visitors noticed the mission statement. Graphs of these results are shown below.





### Conclusions

Although the numbers of visitors in this study were too small for statistical analyses, the evaluator and developer decided to retain the flip-up with the mission on the front and the solution underneath.

Date: Day: Time: Location:  
 Age: Gender: M / F ESL: N Y Yes, but fluent  
 Others in Group: Batt&Bulb.iv.1.02

Excuse me, my name is \_\_\_\_ and I work here. I'm trying to find out what Vs think of this exhibit. Would you be willing to talk with me? It'll just take a few minutes.

### Cued Study Questions

#### Wires:

- \*Did you have any problems using the wires?
- \*Did you ever stick two wires together? Yes: On the top or on the side?

#### Missions:

- Did you find the missions appealing or interesting?
- Did the mission statements make sense to you?
- \*Did you make any of the circuits in the missions? How challenging were they?
- \*Did you make any circuits that weren't suggested by the museum?

#### Variable resistor:

- \*Did you use this [variable resistor]?
- \*Did you have any trouble using this [variable resistor]?

#### Circuit Breaker:

- \*Did this ever glow red and then shut off?
- \*Did you have any trouble resetting it?
- What do you think this is?
- Do you ever see anything like this outside the exploratorium?

#### AC Generator:

- \*Did you use this?
- \*Did you have any trouble using it?

#### Titles:

Bulbs and Batteries vs. Circuit Workbench vs. Build Everyday Circuits

Uncued Observational study**Inquiry:**

Do Vs create the circuits in the mission?

Do Vs check under the flap?

Do Vs construct circuits other than the mission?

Do Vs create the circuit from the second mission?

Do Vs try anything that they weren't told to do? E.g., connecting wires in funny ways, using components from multiple stations, touching switch with keys or coins

**Engagement:**

Do Vs try more than one station?

Which stations do Vs choose most?

1. Now that you've used the exhibit, could you tell me how interesting it was?  
Please rate it on this scale:

**Uninteresting**      **Somewhat uninteresting**      **Neutral**      **Somewhat interesting**      **Interesting**

2. Can you say what it is about this exhibit that makes it (un)interesting? (or vice versa)

3. How many circuits did you build?



8. Do you have any special interest, knowledge or training in the areas of electricity and magnetism?
9. Is this your first visit to the Exploratorium?      Y      N

## Methods

UNCUED interview

Age  $\geq$  13 years

Watch people use exhibit. See if I can tell how many circuits they build and whether they're following directions or building their own.

Let them refer back to the label during the interview



5. Did you make any circuits that weren't suggested by the museum? Y N

6. How challenging were they?

7. Which title do you like most?

Bulbs and Batteries

Circuit Workbench

**Build Everyday Circuits**

8. Do you have any special interest, knowledge or training in the areas of electricity and magnetism?

9. Is this your first visit to the Exploratorium? Y N

Observations

Missions (museum-suggested circuits vs. not)

Wires (problems using; stick two together)

Variable resistor (use it; problems)

Circuit Breaker (what is it; see elsewhere; blow it; problems resetting)

AC Generator (use it; problems)

Anything unexpected / not suggested (multiple stations)

Uncued Observational study**Inquiry:**

Do Vs create the circuits in the mission?

Do Vs check under the flap?

Do Vs construct circuits other than the mission?

Do Vs create the circuit from the second mission?

Do Vs try anything that they weren't told to do? E.g., connecting wires in funny ways, using components from multiple stations, touching switch with keys or coins

**Engagement:**

Do Vs try more than one station?

Which stations do Vs choose most?

1. Now that you've used the exhibit, could you tell me how interesting it was?  
Please rate it on this scale:

**Uninteresting**      **Somewhat uninteresting**      **Neutral**      **Somewhat interesting**      **Interesting**

2. Can you say what it is about this exhibit that makes it (un)interesting? (or vice versa)

3. How many circuits did you build?



8. Do you have any special interest, knowledge or training in the areas of electricity and magnetism?
9. Is this your first visit to the Exploratorium?      Y      N

#### Methods

UNCUED interview

Age  $\geq$  13 years

Watch people use exhibit. See if I can tell how many circuits they build and whether they're following directions or building their own.

Let them refer back to the label during the interview

Date: Day: Time: Location:  
 Age: Gender: M / F ESL: N Y Yes, but fluent  
 Others in Group: Batt&Bulb.iv.4.01

**Standard intro...** **Missions 1st** **Missions 2nd**

1a. How interesting to you was the mission to build a circuit?

**Uninteresting** **Somewhat uninteresting** **Neutral** **Somewhat interesting** **Interesting**

1b. Can you say what it was that made it (un)interesting for you?

2a. How interesting to you was it to build a circuit?

**Uninteresting** **Somewhat uninteresting** **Neutral** **Somewhat interesting** **Interesting**

2b. Can you say what it was that made it (un)interesting for you?

3a. Did the mission statement [flashlight, dimmer switch, bathroom light & fan] help you realize what kind of circuit you were building? Y N

3b. Was having the mission statement **better**, **worse** or **same** as not having it? Why?

4. How challenging were the circuits to build?

**Not Challenging**      **Somewhat Challenging**      **Challenging**      **Very Challenging**

4b. Can you say what it was that made them ()challenging for you?

5a. Which kinds of wires and wire connections did you find easier to use?

Banana      Flat

5b. Can you say what it was that made the [banana/flat] wires easier for you?

6. Did you make any circuits that weren't suggested by the museum? Y      N

7. Do you have any special interest, knowledge or training in the areas of electricity and magnetism?

8. Is this your first visit to the Exploratorium?      Y      N

General Observations:	Start time:	Switch time:	Stop time:

Observations

Start time 1:	Start time 2:	Start time 3:
Stop time 1:	Stop time 2:	Stop time 3:
Start time 4:	Start time 5:	Start time 6:
Stop time 4:	Stop time 5:	Stop time 6:

General description of behavior:

Missions (reads? museum-suggested circuits vs. not)

Wires (problems using? stick two together)

Variable resistor (use it; problems)

Circuit Breaker (what is it; see elsewhere; blow it; problems resetting)

AC Generator (use it; problems)

Anything unexpected / not suggested (multiple stations)

Methods

Cued interview

Age  $\geq$  10 years

Ask Vs to use either Station 2 (dimmer switch) and Station 5 (AC generator).

Randomly choose first station.