Instructor's Manual for *Electronic Circuits, Switches and Sensors* (Versikit 1)

Introduction

Congratulations on your selection of a kit that provides a great and fun way to learn about electronics! The kit, which includes an illustrated *User Instruction Manual*, was designed to be largely self-contained. However, it is ideally suited for use in a classroom setting. Included in this *Instructor's Manual* are tips and techniques that have been successfully used to teach the class to groups of kids and adults.

Basic Guidelines

- When teaching children, it is recommended that you have adult volunteers available to help keep kids focused on the instructions while going through the experiments. Kids naturally get excited the moment they hear the first buzzer sound!

- A good rule of thumb is to have at least a ratio of 1 volunteer to 4 young children (e.g. 4^{th} to 5^{th} grade). With age comes greater self-sufficiency and therefore less need of help. Thus, for high school students a sufficient ratio is more likely to be 1 volunteer to 8 or even 10 students. So in the latter case the instructor plus one volunteer for up to 20 high school students is doable. NOTE: Girl Scout events tend to have troop leaders and parents present. They are usually glad to assist and they make great helpers, thus further reducing the number of volunteers needed.

- Although not absolutely necessary, it is nice to have volunteers read over the instructions before the class is taught, and even better if they can go through the experiments first (an adult can typically work through this in about an hour).

- The class can be comfortably taught in about 60 to 75 minutes.

- This kit and course are ideal for 5^{th} graders and up. Children as young as 3^{rd} grade can be taught, but generally will require assistance from a parent / older helper.

- Useful items to have on hand: Needle-nosed pliers, flashlight (optional)

Suggested Course Presentation

Introduction

Start off by telling the class that the course serves as an introduction to *Electrical Engineering*. Explain that one important aspect of electrical engineering is working with *electronic circuits*. You can also tell them they have a chance to build many fun and interesting circuits with a kit, and even take the kit home with them (if applicable).

Next, take a moment and have the class brainstorm about how electronics affects our lives. What electronic products do the students encounter on a day-to-day basis? Here are some examples that often come up:

Telephones, radios, cars, television, computers, lights, alarm systems, medical equipment.

You can point out that the examples they provide clearly demonstrate the importance of electronics, and the relevance that the field has to our lives.

Getting Started With the Kit

After the brainstorming session, explain that you are going to pass out the manuals, and that you will *read the first four pages in class together*. This takes about 20 minutes, and will empower them with the knowledge they need to a good understand of what is going on as they build the circuits. There are also a few safety concerns and practical tips they need to know. Ask for student volunteers to read paragraphs as you go along. On the rare occasion all of the students are shy (it can happen!), its okay to call on adult volunteers or read some yourself.

NOTE: See the *Electronics Component Guide* page of the kit manual for picture identification of the parts. This is also important to point out to the students to help them quickly identify the parts during the experiments.

Page References

Page 1

The loads in this kit are:

- Buzzer,
- Light Bulb ("lamp")
- Green LEDs (light-emitting diodes; one RED and one GREEN)

Page 2 ~ 3:Answers to "Quick Review" questions

1) What is the power source in the water circuit? **Sally**. The electric circuit? **The battery.**
2) What is the load in the water circuit? **Water wheel and drill combo**. The electric circuit? **The buzzer**.
3) What are the conductors in the water circuit? **The water troughs**. The electric circuit? **The wires**.
4) How do we "charge up" our power source in the water circuit? **Feed Sally**. **Let Sally rest**. The electric circuit? **Use a battery charger**.
5) What happens if a water trough breaks? **The water current stops flowing, and our load stops working**. What do you think will happen if a conductor (wire) breaks in our electronic circuit? **The electric current stops flowing, and our load stops working.** In electronics, such a breakage is referred to as an ***open***.

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(Please refer to the "*Detailed Explanation of Parts*" below for references to the battery and clip)

Detailed Explanation of Parts

At this point, you can pass out the kits to the students, and provide more information about the parts.

NOTE 1: If the class is very large, you may want to initially provide a kit only to each adult volunteer. That way, as you talk about the parts, the adult volunteers can keep control of the parts, and prevent students from playing with the parts instead of paying attention. It is good for the students to get some hands-on familiarity while receiving explanation, but getting the parts in hand also tends to add a new dimension of excitement that can make it more difficult to maintain control of the class. Take into account the students' ages when you decide whether to hand out all the kits or just a limited number at this point.

NOTE 2: As far as working with the kits, it works well to provide one to each student; kids will naturally help each other out as they learn how to do build each circuit. On the other hand, it also works well to form small teams (2 to 3 members each); real world engineers work in teams, and the class itself can itself serve well as a team-building / ice-breaker type of activity. Also, having teams work together tends to decrease the time required to complete the class (i.e. students finish a bit sooner).

For parts check and explanation, have students locate the Electronic Component Guide page in the manual It works well to hold up parts as you describe them..

Battery (Included with VS-1B)
Be careful not to short the battery terminals together. For example, placing a quarter across the terminals (don't do this!!!) would rapidly drain the battery. Note that such a (bad) circuit has two ingredients—a power source and a conductor (the quarter)—but no load. Actually, the battery itself becomes its own load and would likely overheat as its energy drains away.

IMPORTANT: The battery comes in its own plastic bag. That protects the battery from shorting itself out while in the storage tube. It is a good idea to store the battery in its own bag to keep it from shorting.

Battery Snap Tips
Children sometimes have difficulty with the battery snap when it is new. To connect the battery to the snap easily, place the snap on a table with terminals facing up, and press the battery down onto the snap.

NOTE: The black and red wire leads have been cut to different lengths to add further protection against shorting the battery. Advise students *not* to touch leads together!

Jumper Clips
These are easy-to-use connecters: just squeeze the insulated clips to open the jaws, and clip on the wire or lead you are trying to connect to. CAUTION: Do not pinch fingers with alligator clips! (This seems like common sense, but it doesn't hurt to warn them about this.)

Push Button
This part is a very common part and also simple device that allows you to turn something on. Just press the button, and it completes—or "makes" —a circuit (turning something on). This particular push button is a "momentary" type, which means it makes the circuit *only while you are pressing the button*. When you let go, it "breaks" the circuit. Other push button switches are referred to as "push on, push off."

Tip: You may want to have a pair of needle-nose pliers on hand to spread the push button leads out a little.

Reed Switch & Magnet
This is really a cool part! It is a small glass tube, and has two metal "reeds" inside. When a magnet is brought close to the switch, the reeds come together and make contact. This is the very same type of switch that is used in home alarm systems (ask you students how many have alarm systems at home) where a magnet is mounted on the window, and the reed switch is mounted on the window frame.

Tip: Have each student place the reed switch up against his/her ear, and try moving the magnet close to the reed switch. If you listen carefully, you can hear the tiny reeds click when the magnet is near!

Transistor
This amazing part is so important to modern day electronics. It is used as both a switch and an amplifier. Many modern computers have the equivalent of thousands of these packed onto microchips. If you look closely at the "face" of the transistor, you will see the letters "E", "B", "C". That stands for *emitter, base,* and *collector,* respectively.

Resistors
The basic purpose of resistors is to restrict (or "resist") current flow. This kit contains two "fixed" resistors. Fixed resistors limit current by a certain amount, based upon their value (the colored bands indicate their value). They are analogous to a bottleneck in a water pipe to reduce water flow; resistors reduce the flow of electrons.

Potentiometer (type of resistor)
The *potentiometer*, or "variable resistor," allows you to control the amount of current simply by turning the control. You might point out that students typically use these every day. For example, stereos often have a knob for controlling the volume. Behind the knob is a potentiometer. This device is analogous to a water faucet, where you simply turn the faucet to achieve the desired (water) flow.

Photocell (type of resistor)
The *photocell* (sometimes referred to as an "electric eye") is also a really cool part. This is the very same kind of part that is used to automatically turn nights on at night, and off during the day. Ask your students how many have "dusk-to-dawn" lights at home. The photocell changes its resistance according to how much light is striking it.

Buzzer
The buzzer is a load that is often used as an alerting device (i.e. alarm). Note that the colors of the wire leads indicate polarity. That is, it must be connected so that the red lead is closer to the red lead of the batter clip, and black lead closer to the black batter clip lead.

Lamp
This is a very small incandescent light bulb. Note that it has two white wires. The bulb does not "care" which way it is connected (i.e. it is "non-polarized").

LEDs
There are two light-emitting diodes (or "LEDs") in the kit. These are very interesting parts, and also very common. Chances are every student's TV or computer monitor has a little red or green LED that comes on when the power is on.

LEDs pass current only in one direction. So in that sense, they are like a one-way valve. Ask your students if they can think of any one-way valves (the human heart is a good example; it pumps blood in one direction, and can be considered to be a part of a "blood circuit").

LEDs are polarized. You can identify the negative lead (the minus side) by a flat spot on one side of the LED where the lead enters the plastic "hat" (this is illustrated in detail in subsequent manual diagrams).

Tip: When working with the transistor and LEDs, *spread the leads out* (see photos in *User Manual*). This will make it easier to connect each clip to the lead you want it to connect to, but without touching (shorting to) the other leads.

Questions and Answers (Optional)
This would be a good point to take questions about electronics.

Building the Circuits
Once you have discussed all of the parts, you are ready to set the students loose! Instruct them to start by building ***Circuit 1*** (page 5), and keep building subsequent circuits until they have finished them all!