

Expanding Your Horizons, 1993  
Mechanical Dissection  
Professor Sheri Sheppard  
Stanford University

## **SAFETY !!**

- 1. KEEP WORK AREA CLEAN**
- 2. DRESS PROPERLY** -- Secure loose clothing, jewelry and hair
- 3. USE SAFETY GLASSES**
- 4. SECURE YOUR WORK** -- Be sure parts are secure in jig. Be sure someone is holding the jig secure.
- 5. DON'T OVERREACH** -- Keep proper footing and balance at all times.
- 6. AVOID UNINTENTIONAL STARTING** -- Don't carry drill with finger on switch. Lock the "off button" when not in use
- 7. STAY ALERT** -- Watch what you are doing and use COMMON SENSE
- 8. REMOVE ADJUSTING KEYS AND WRENCHES** before using the drill

## ***BEFORE DISSECTING***

-- BEFORE YOU START - be sure the DRILL BIT is REMOVED --

### **A. INSPECT YOUR DRILL**

#### **1. Examine your drill.**

- LOOK at it, touch it, pick it up.
- DESCRIBE your drill -- colors, weight, texture, how it feels in your hand

#### **2. Identify the parts you see on the outside of the drill.**

- What is the NAME of each part?
  
- What is the FUNCTION of each part? (write it next to the name)
- HOW MANY parts are there (that you can see)?

**3. Make the drill work** -- how can you control the speed and direction of the drill chuck?

**STOP** -- wait for GROUP DEMONSTRATION on "OPERATING the DRILL"

## **B. ASSEMBLE YOUR CAR**

*be sure to **remove all drill bits** when you are finished !!*

### **STEP #1**

PLACE the car pieces in the jig

### **STEP #2**

INSERT and tighten small drill bit

### **STEP #3**

DRILL the bottom holes

### **STEP #4**

REMOVE the small bit

### **STEP #5**

INSERT and tighten the large phillips head screwdriver bit

### **STEP #6**

DRIVE in the bottom screws

### **STEP #7**

REMOVE the screwdriver bit

### **STEP #8**

INSERT the large drill bit

### **STEP #9**

DRILL the 2 axel hole through the guide holes on the side of the jig

### **STEP #10**

REMOVE the car from the jig

### **STEP #11**

INSERT the tip of an axel into 1 wheel

### **STEP #12**

INSERT the axel through the axel hole in the car

### **STEP #13**

INSERT the other end of the axel into the other wheel

### **STEP #14**

REPEAT steps 11-13 for the other axel and wheels



## **C. HYPOTHESIZE - HOW DOES IT WORK?**

Now that you've used your drill, how do YOU think it works???

**1. What FUNCTIONS need to be performed?**

**2. What PARTS do you think are inside performing those functions?** -- write these next to the FUNCTIONS you listed above

**3. HOW MANY parts do you think are inside?**

(4. if time allows -- SKETCH what you think the inside of the drill looks like - be sure to label the parts you have drawn)

## ***DISSECTION***

### **D. DISSECT YOUR DRILL**

*be sure **all drill bits are removed** before you begin*

1. How is your drill fastened?
2. Remove the fasteners.
3. How many fasteners are there?
4. OPEN the drill -- LOOK at what is inside.
  - Is it how you thought it would be?
  - Are there more, or less parts than you thought?
  - What is MOST SURPRISING about what you see?
5. Name all the different FUNCTIONS you see being performed.
  
6. What are the PARTS that are performing these functions -- write these next to the functions you listed above (if you dont know their names, ask a coach)
  
5. HOW MANY different parts are in your drill?

## E. EXPLORE YOUR DRILL

Below are questions and tips to guide you as you explore your drill.

*The functions that your drill performs can be broken down into*

*SUBSYSTEMS. Each subsystem performs a different FUNCTION.*

*The function of the subsystem is performed by one or more PARTS.*

*Each part also has its own function.*

1. What do you think are the “subsystems” in your drill? (Remember, a *subsystem* is just a *group of parts* that perform a particular *function*)

2. What other devices or large systems can you think of that can be broken down into subsystems? (A bicycle? a car? your house? your school? )

# The SIX SUBSYSTEMS of your Power Drill

\*\*\*\*\* *please fill in the PARTS section for each subsystem* \*\*\*\*\*

## 1. Power Source

FUNCTION: to provide energy to the system

PARTS:

EXPLORE: • how many batteries are there?  
• how are the batteries hooked together?  
• why are the wires different colors?  
• trace (follow) the wires with your eyes and see where they go

## 2. Energy Transformation

FUNCTION: to change electrical energy into mechanical energy

PARTS:

EXPLORE: • how does the motor work?  
• what makes it spin?  
• what type of energy is going in, and what type is coming out?



## SUBSYSTEMS

### 3. Drivetrain

FUNCTION: transfer the motion from the motor to the chuck

PARTS:

- EXPLORE:
- what do the gears do?
  - is the chuck going faster or slower than the motor output shaft?
  - how are the gears held in place? do they spin easily?
  - why is there grease inside?

### 4. User Control

FUNCTION: allow the user (person) to control the functions of the drill (turn it on and off, change the speed of the chuck, change the direction of the chuck)

PARTS:

- EXPLORE:
- what the each of the two switches do?
  - how the the buttons (on the outside of the drill) affect the switches (on the inside of the drill)?

## SUBSYSTEMS

### 5. Tool Interface

FUNCTION: allows the drill to hold onto a bit

PARTS:

EXPLORE:

- how does the chuck work?
- why is the chuck key needed?

### 6. Housing

FUNCTION: to hold all the parts in place  
and to protect the user from the parts  
and to protect the parts from the environment

PARTS:

EXPLORE:

- why do you think the inside of the plastic case looks so complicated?

**What is the TOTAL** number of \_\_\_\_\_ subsystems  
\_\_\_\_\_ different kinds of parts

## **F. EXPLAIN YOUR DRILL**

With your team , use the color markers and the butcher paper to draw your assigned subsystem of the inside of your drill - label the parts and tell what your subsystem does.

## **G. PUT YOUR DRILL BACK TOGETHER**

Be sure:

- all the fasteners are in tight
- there are no bits in the chuck
- the drill still works !!

Be sure it can be USED to build a car by the next person!!

## **GENERAL QUESTIONS, COMMENTS AND TIPS FOR THE COACHES**

1. Make the drill seem friendly, and simple.
  
2. Remind them that it is a product made *by humans* and *for humans*. It has a lot of stuff inside it , but was created by people like you and me -- and we can discover why they decided to design it the way they did, and we may even discover how it can be done better!!
  
3. Keep in mind these General Dissection Questions to prompt the students' thinking about FUNCTION as you are working with them through the lab: (these questions can apply to any specific part that you and the student may be exploring)
  - 1) **WHAT IS IT ??**  
(give it a name)
  
  - 2) **WHY IS IT ??**  
(why is it there -- what does it do -- what is its function in the system?)
  
  - 3) **WHERE IS IT ??**  
(what does it interact with?)
  
  - 4) **WHEN IS IT ??**  
(is it always used everytime the drill is used?)
  
  - 5) **HOW IS IT ??**  
(describe it - what qualities does it have? -- hard, soft, light, heavy, greasy, pretty)
  
  - 6) **WHAT IF IT WERE NOT THERE ??**  
(what would the drill do then -- would it still work?)
  
  - 7) **WHAT DOES IT REMIND YOU OF ??**  
(what else could do its job? - even silly things, for example the function of the motor could be replaced by a gerbil in a cage)

most importantly:

**!!! HAVE FUN Have Fun hAVE fUN HAVE FUN !!!**

**EXPANDING YOUR HORIZONS  
1993**

**presents**

***DISSECTION OF A POWER DRILL***

**a MECHANICAL DISSECTION exercise**

**brought to you by**

**PROFESSOR SHERI SHEPPARD  
and  
MELISSA REGAN**

**of**

**STANFORD UNIVERSITY  
MECHANICAL ENGINEERING**

**EXPANDING YOUR HORIZONS  
1993**

**presents**

***DISSECTION of a POWER DRILL***

**a MECHANICAL DISSECTION exercise  
brought to you by**

**PROFESSOR SHERI D. SHEPPARD  
and  
MELISSA REGAN**

**of  
STANFORD UNIVERSITY  
MECHANICAL ENGINEERING**