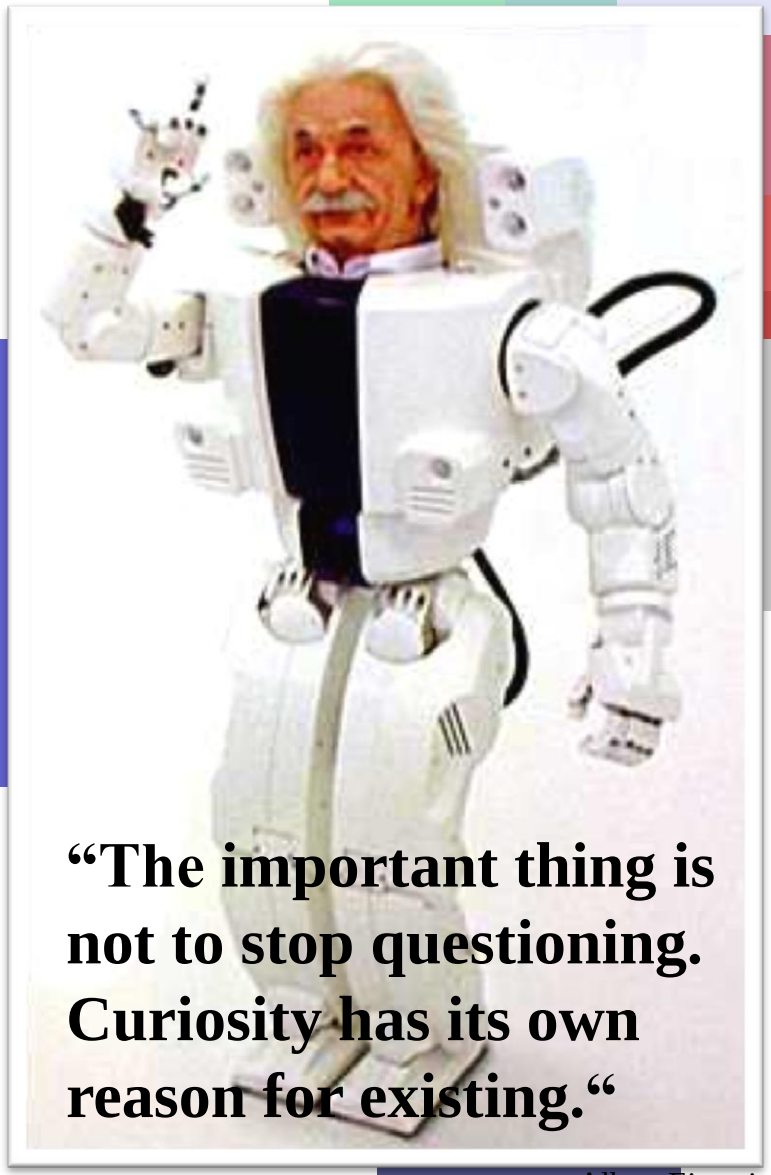
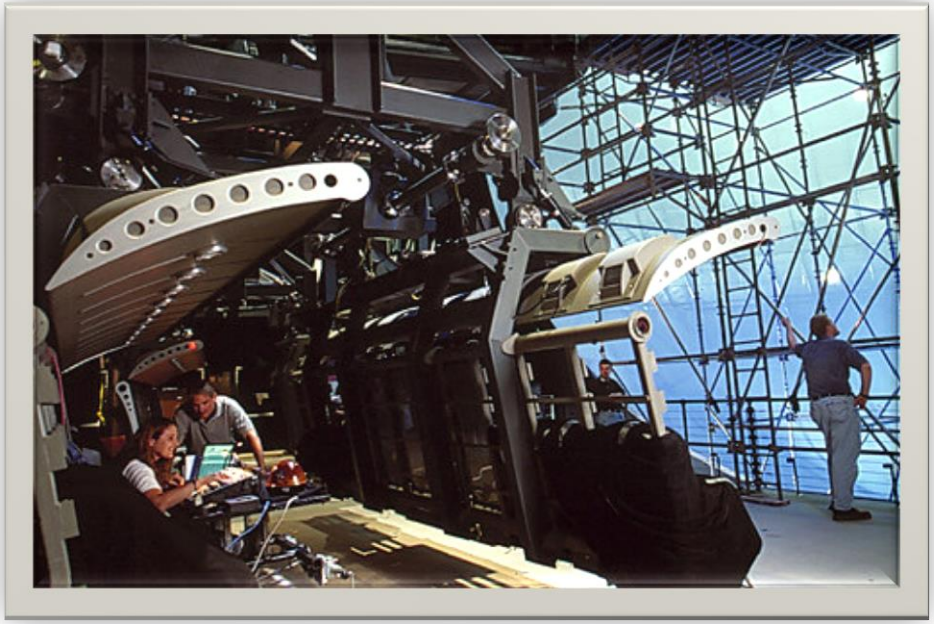
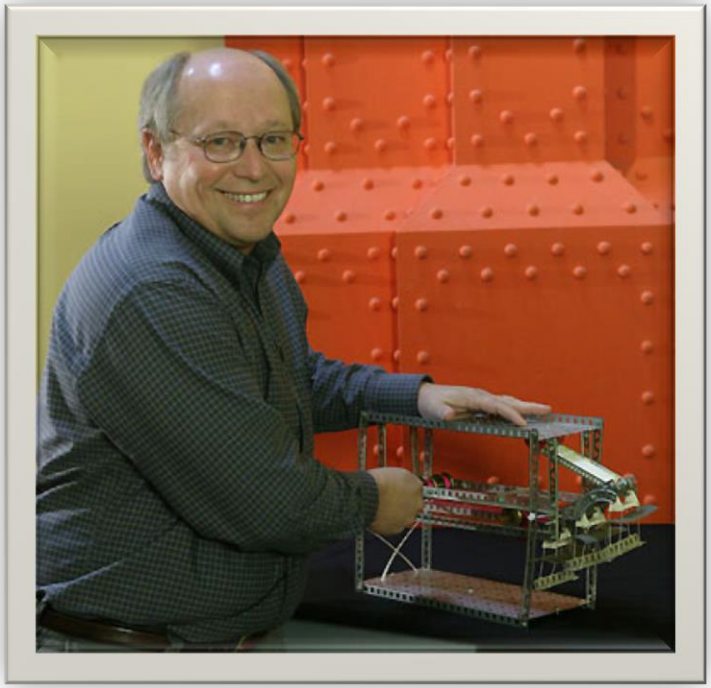
Robotics at the Library



Albert Einstein



Soarin' Over California



Mark Sumner
Disney Imagineer

D
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I can’t draw..

Sorry!

Seriously?

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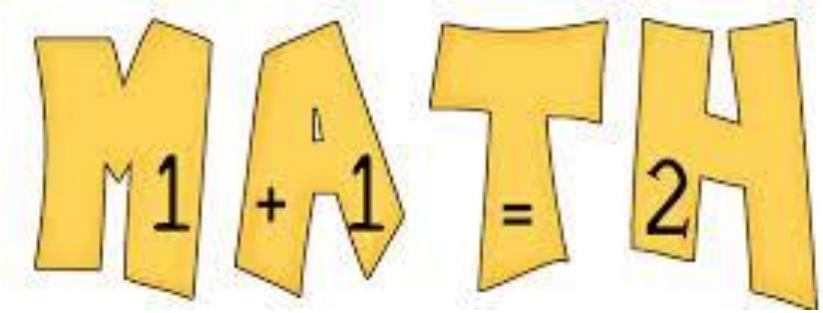
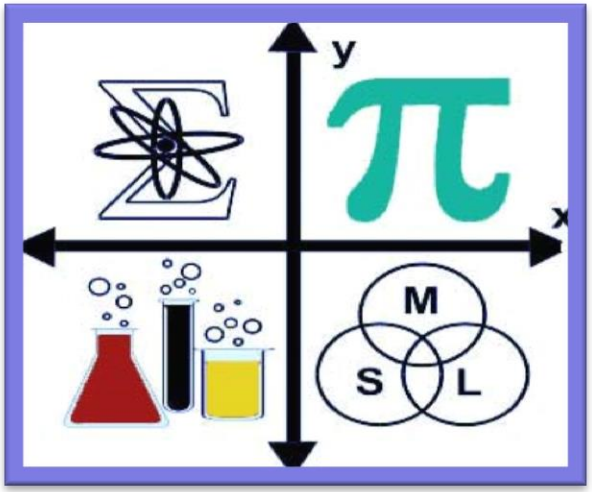
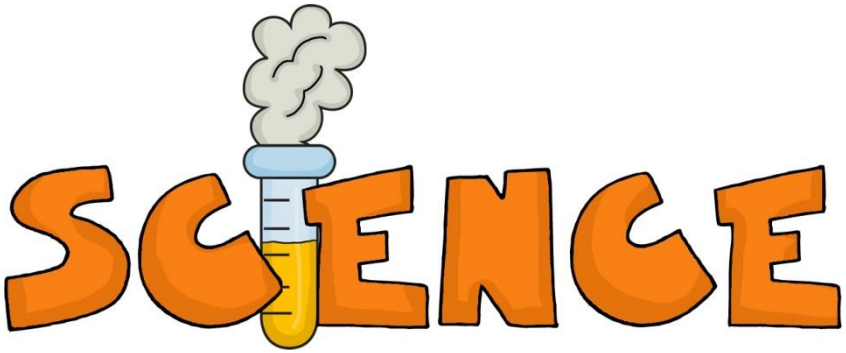
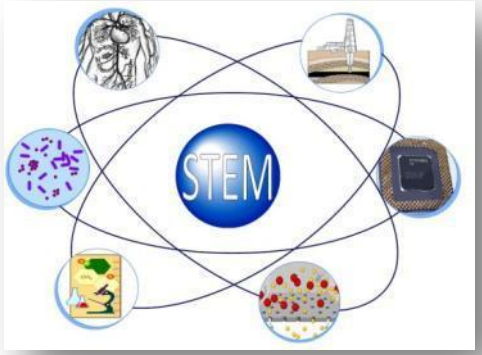
I am terrible.







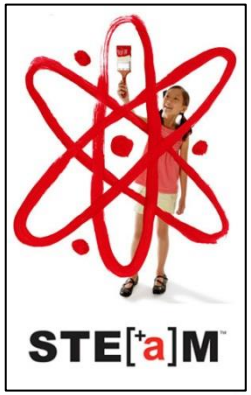
PCS eD! ventures

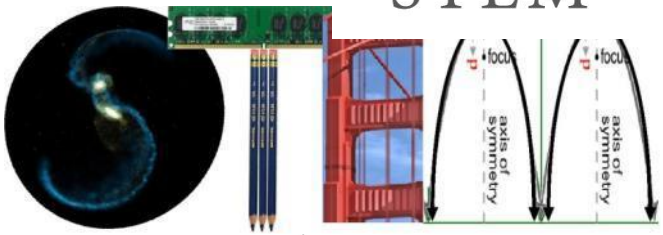


STEM

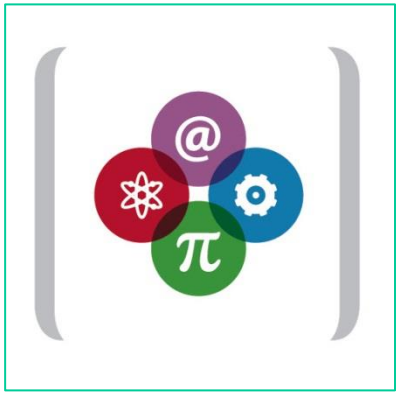
STeAM
SCIENCE.TECHNOLOGY.ENGINEERING.ART.MATH

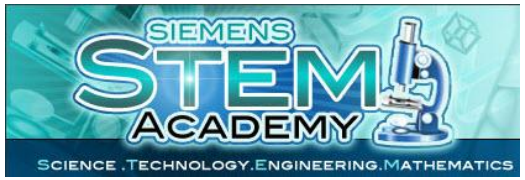
STEM





S Science
T Technology
E Engineering
M Mathematics





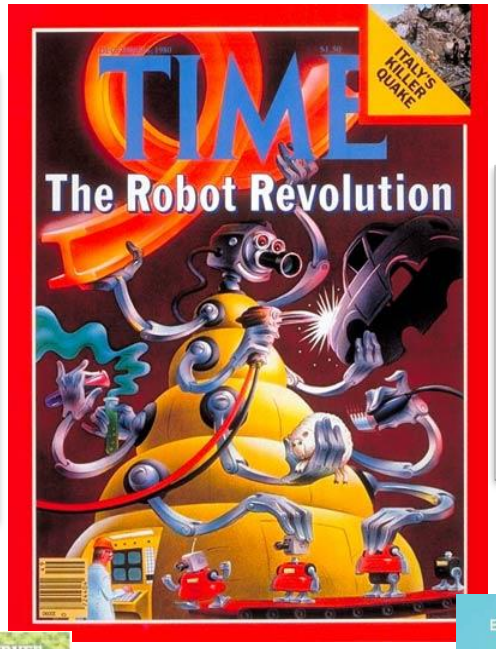
STE[+a]M™

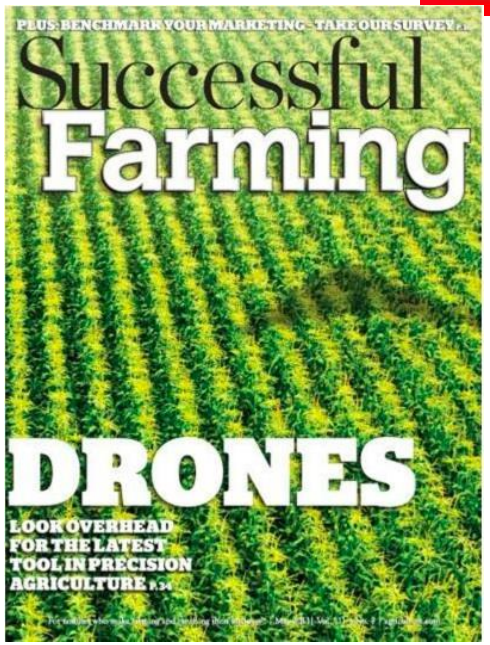
{creativity}
is the process of having original ideas which have value
– Ken Robinson

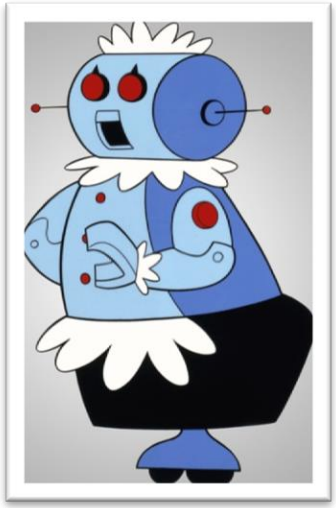
The Net Generation

STEM/STEAM Generation

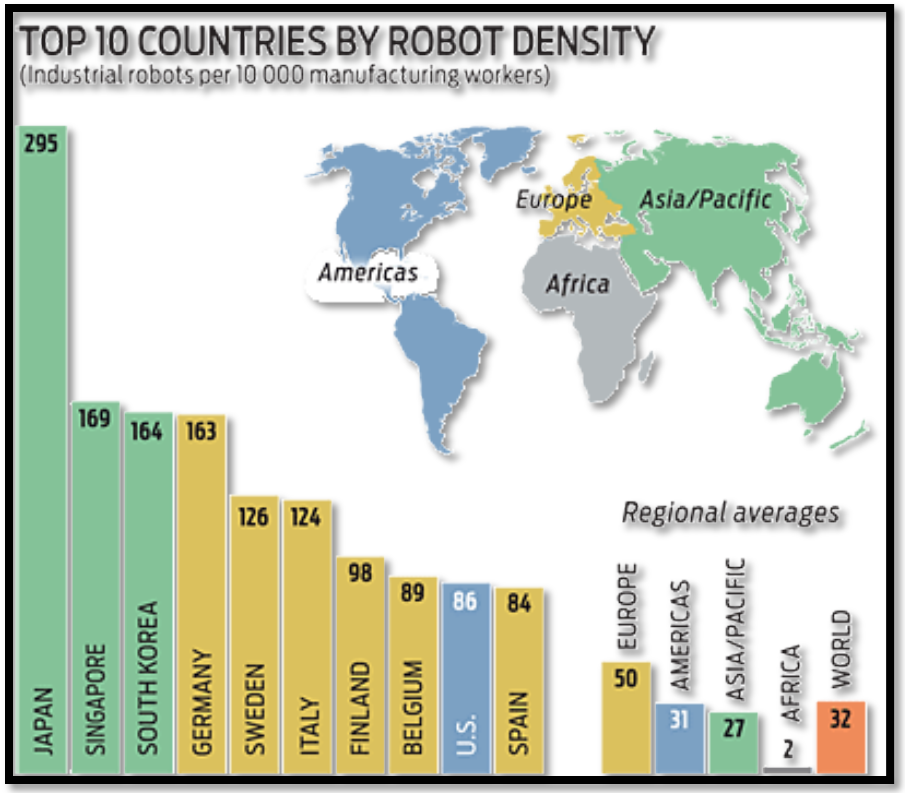
Creative Generation



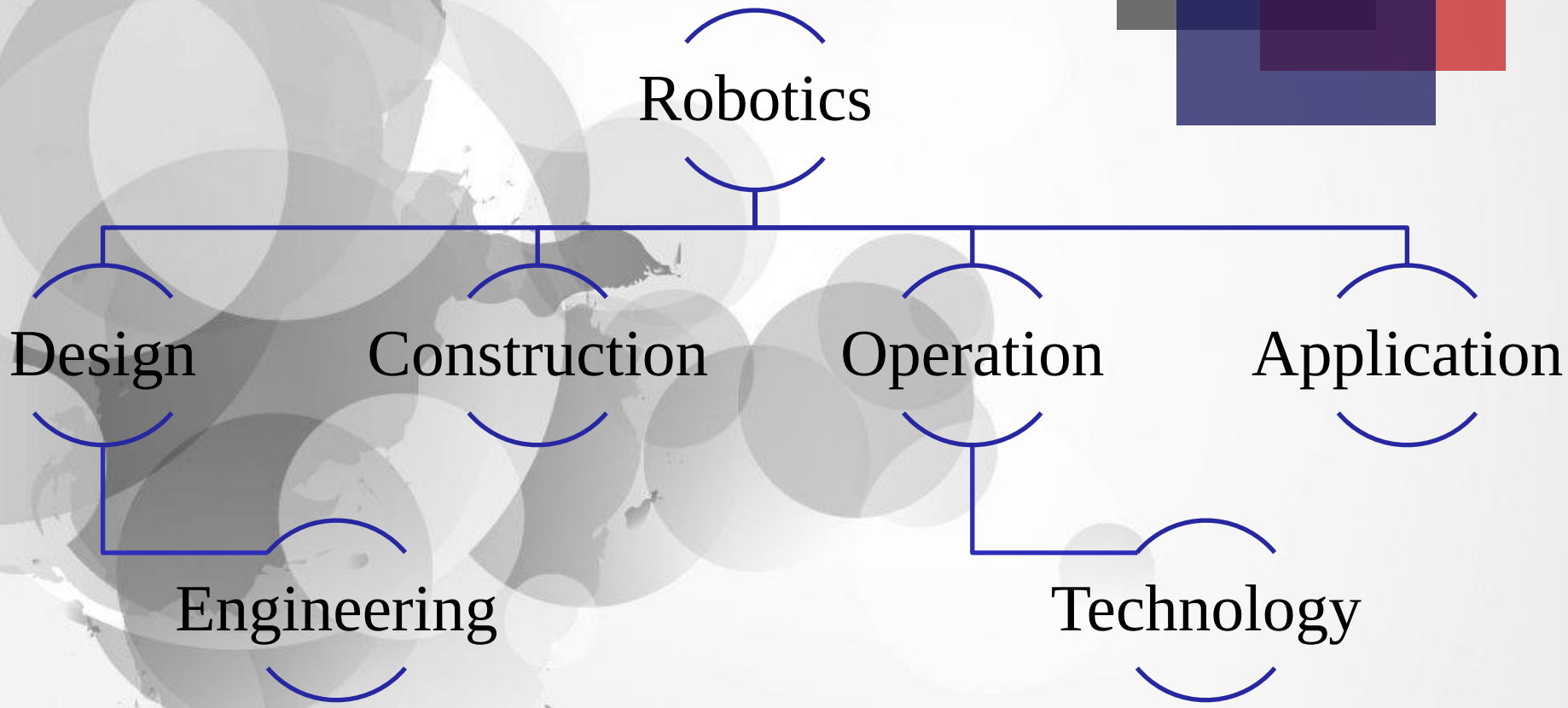


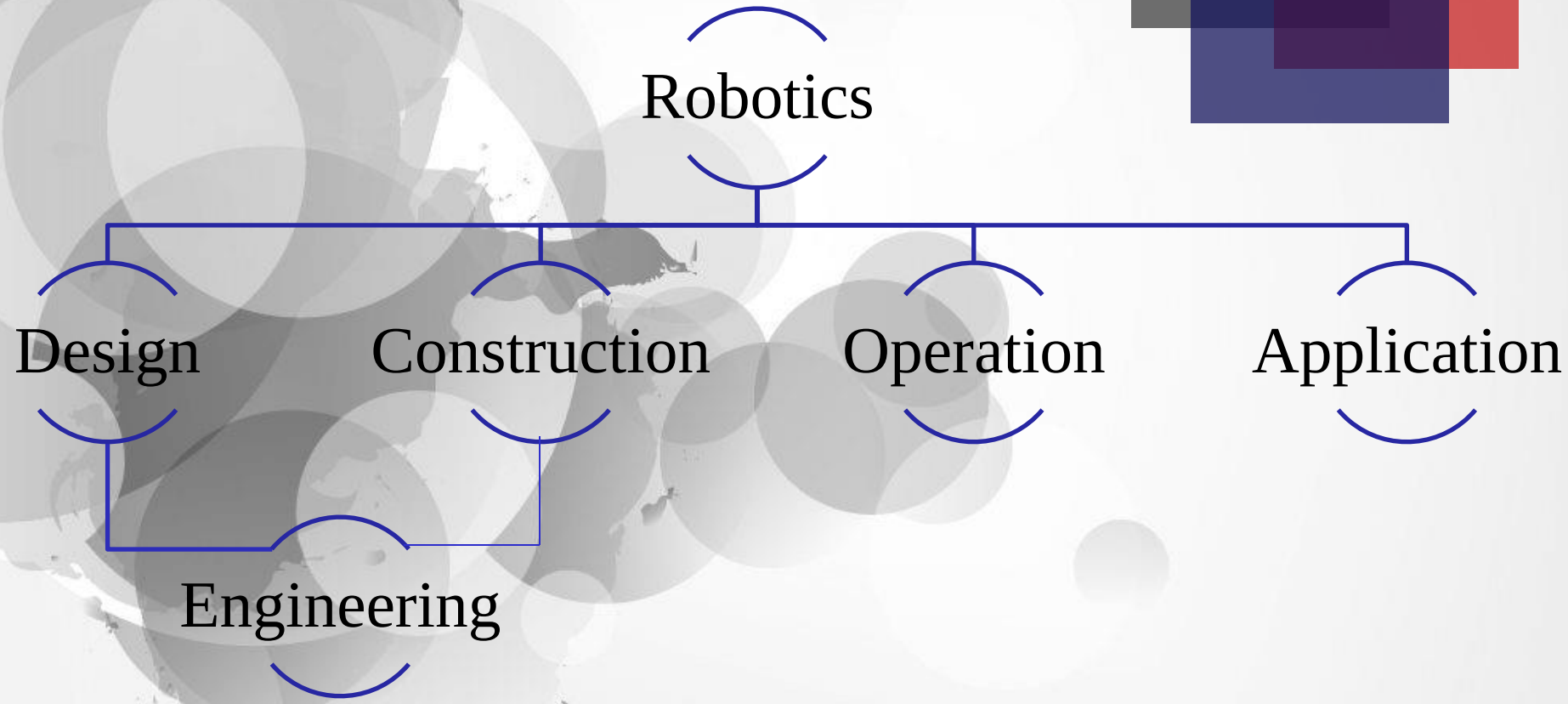


PCS eD! ventures



More than one million robotic mechanisms are working throughout the world, mainly in Asia (50%), Europe (31%) and North America (14%).


Robotics
Design
Construction
Operation
Application
Engineering
Technology


Robotics
Design
Construction
Operation
Application
Engineering

The Design Cycle

Excite:
Identify the Problem
or
Question(s)

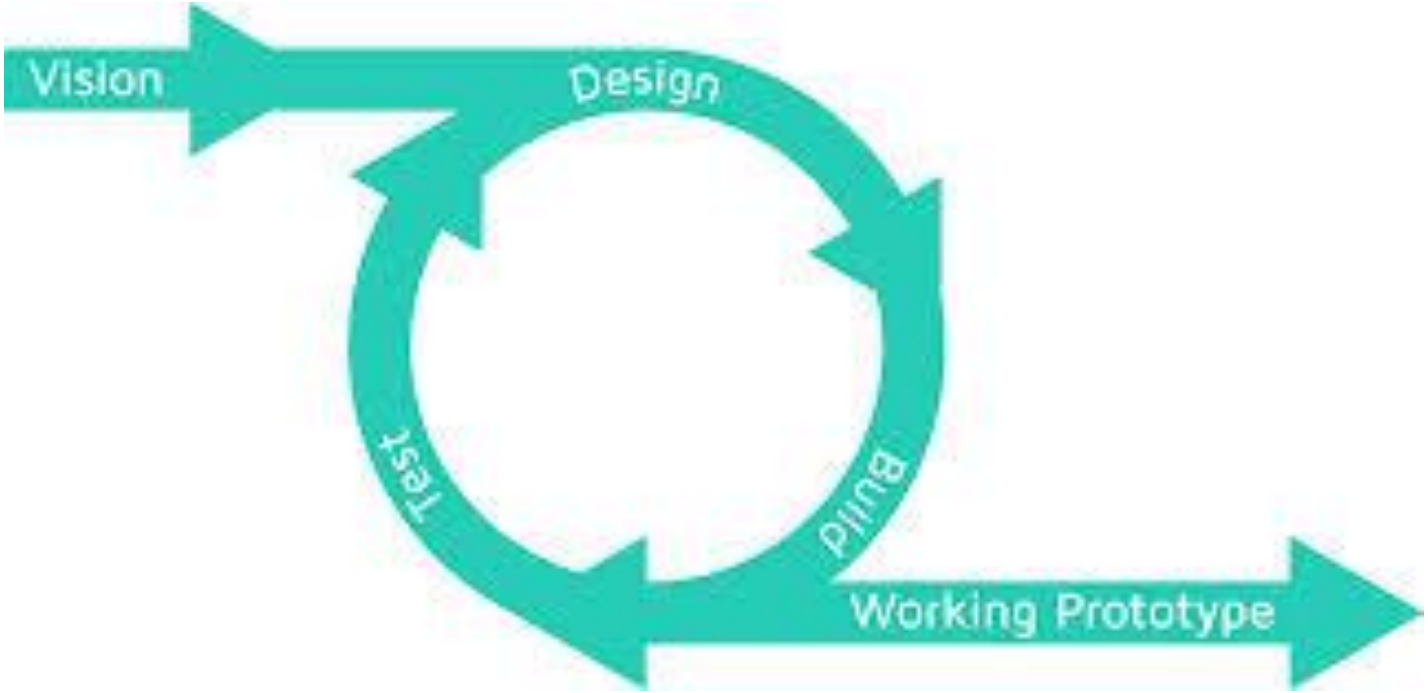
Explore:
Develop Solutions
or
Make Predictions

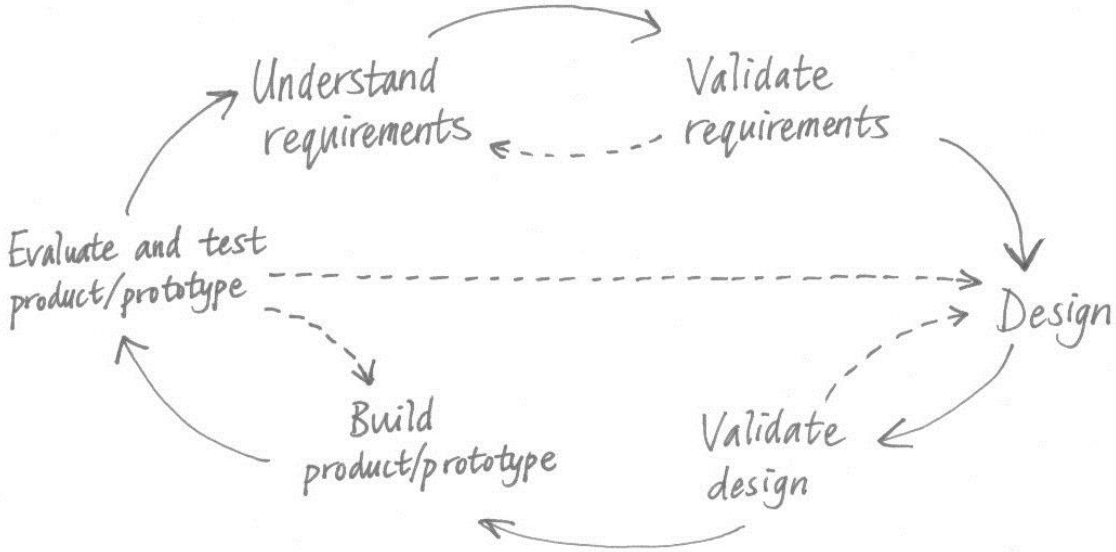
Engage:
Choose Best Solution,
hierarchy of the questions

Experiment:
Build/Construct
Write/Model
or
Design/complete an experiment

Evaluate:
Test/Assess
or
Justify the Approach

Elaborate:
Communicate solution
or
Explain the predictions compared to the results


Vision
Design
Build
Test
Working Prototype


Understand requirements
Validate requirements
Design
Validate design
Build product/prototype
Evaluate and test product/prototype

CERAMIC AND MATERIALS

AUDIO

COMPUTER

BIOMEDICAL

CHEMICAL

OSPACE

ENVIRONMENTAL

MA

OCEAN

MECHANIC

LECTRICA

UFACTURING

BIO

EEPING

EMICAL

MIN

LEUM

AGR

STRIAL

GEOLOG

FAILURE
FAILURE
Ooops!

ROBOTICS EDUCATOR PACK
ROBOT
AGES 14+

Materials Included

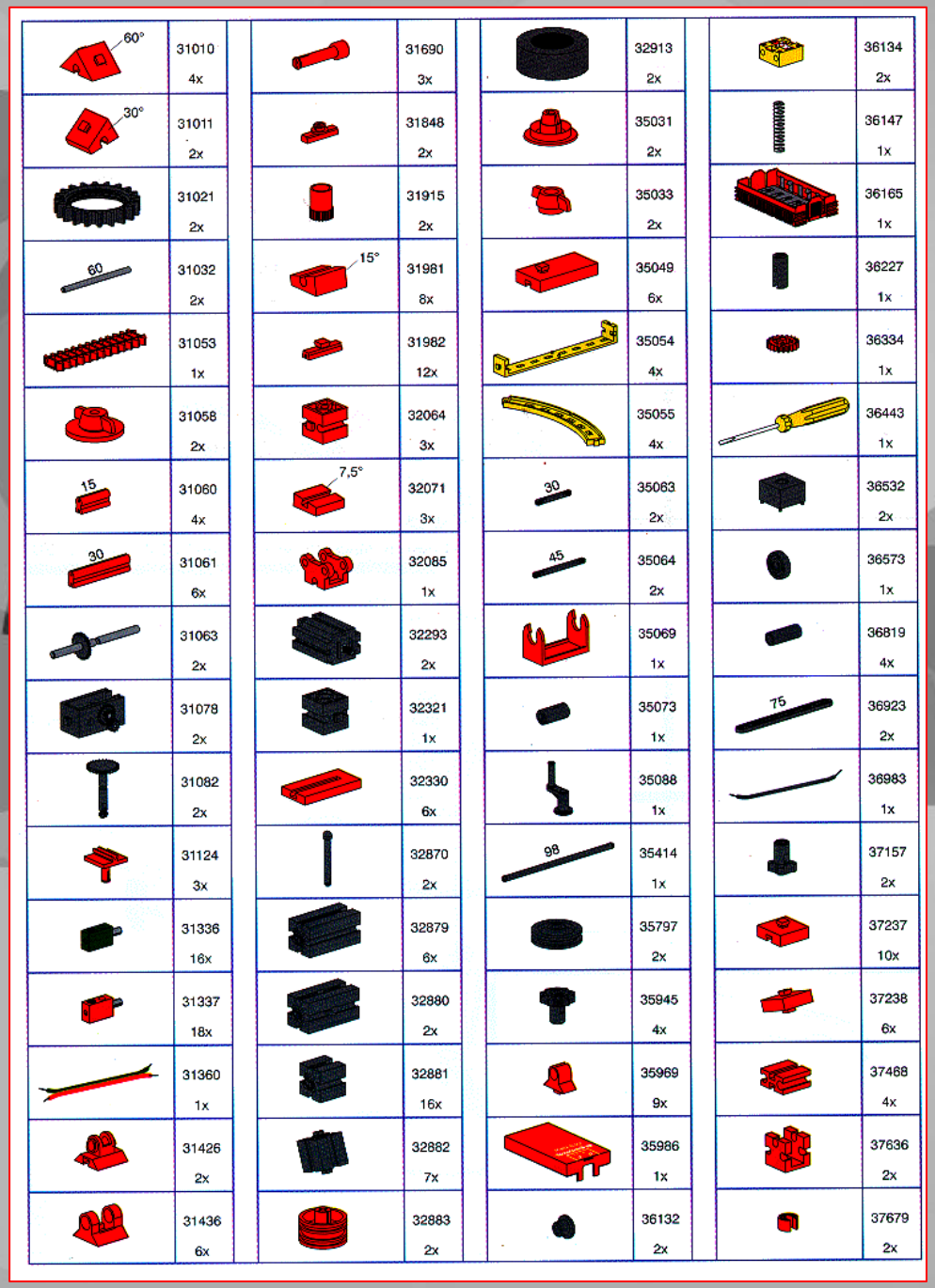
Curriculum

Manipulatives

Brain Pack

Organization trays

Nomenclature



60°	31010 4x		31690 3x		32913 2x		36134 2x
30°	31011 2x		31848 2x		35031 2x		36147 1x
	31021 2x		31915 2x		35033 2x		36165 1x
60	31032 2x	15°	31981 8x		35049 6x		36227 1x
	31053 1x		31982 12x		35054 4x		36334 1x
	31058 2x		32064 3x		35055 4x		36443 1x
15	31060 4x	7,5°	32071 3x	30	35063 2x		36532 2x
30	31061 6x		32085 1x	45	35064 2x		36573 1x
	31063 2x		32293 2x		35069 1x		36819 4x
	31078 2x		32321 1x		35073 1x	75	36923 2x
	31082 2x		32330 6x		35088 1x		36983 1x
	31124 3x		32870 2x	98	35414 1x		37157 2x
	31336 16x		32879 6x		35797 2x		37237 10x
	31337 18x		32880 2x		35945 4x		37238 6x
	31360 1x		32881 16x		35969 9x		37468 4x
	31426 2x		32882 7x		35986 1x		37636 2x
	31436 6x		32883 2x		36132 2x		37679 2x

Key Components

Building Blocks
The building blocks are referred to as the Build Block 30, 15, 7.5, and 5.
This means they are 30mm to 5 mm in length.

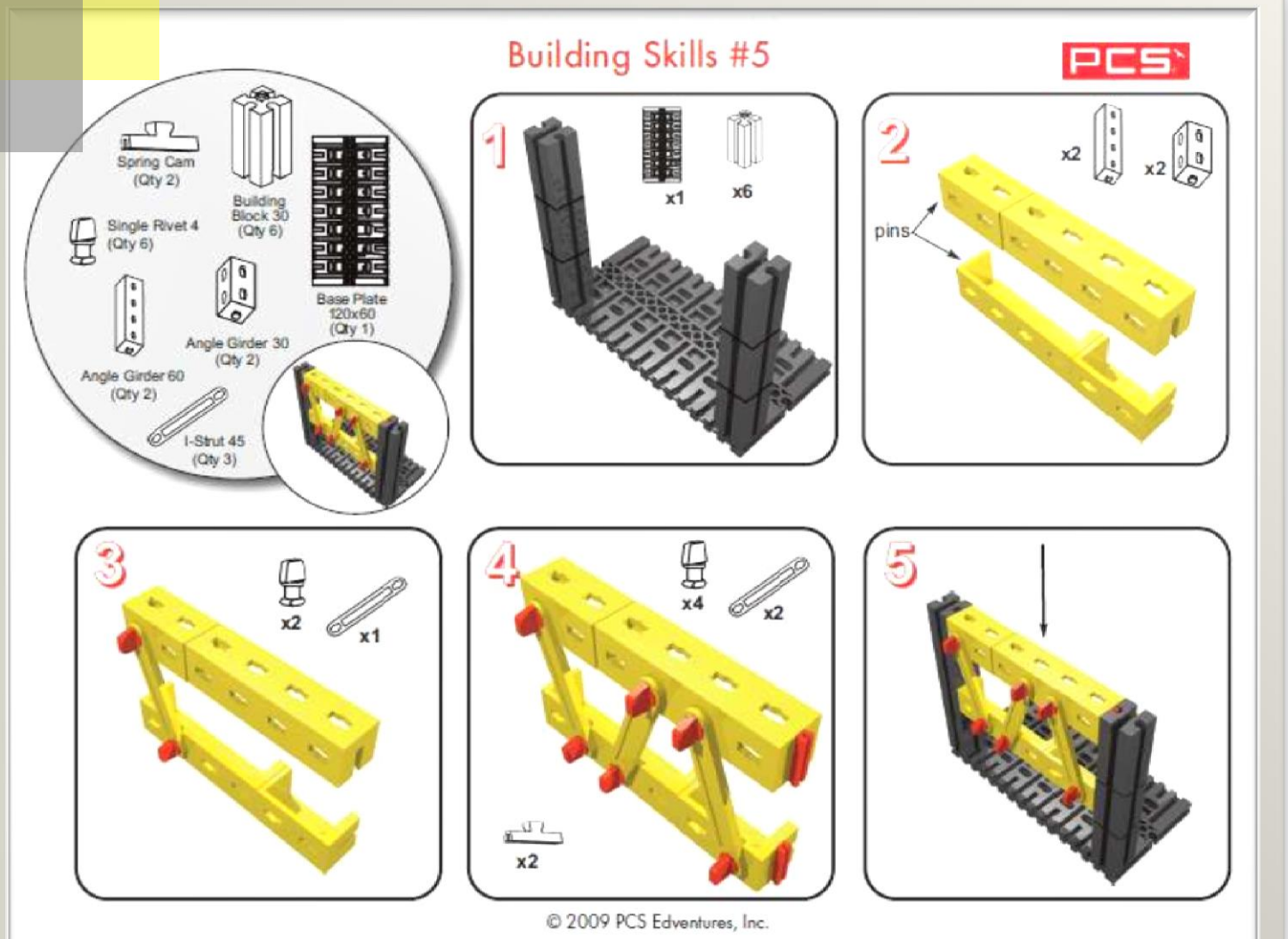
Axles
There are a variety of axles in the labs. The most used is the Clip Axle.
Clip Axle indicates there is a fork at each end.
Remember, size is universal so a 30 clip axle is the same length of a building block 30.

Building Plates and Angle Plates
These adaptable components are mainly used for spacing and connecting and offer versatility to builds. Fischertechnik has four angles to choose from: 7.5, 15, 30, and 60 degress..
Be careful not to confuse the 5mm building plate with the 7.5 mm angle plates.

Mounting Plates/Building Plates
1mm thick and flat on one side, these plates are used for attaching to builds.

Girders
Attach to builds via pin and groove or rivets.

Gears
The Academy of Robotics provides a variety of gears. The usage depends on need.


Building Skills #5
PCS
Spring Cam (Qty 2)
Building Block 30 (Qty 6)
Single Rivet 4 (Qty 6)
Base Plate 120x60 (Qty 1)
Angle Girder 30 (Qty 2)
Angle Girder 60 (Qty 2)
I-Strut 45 (Qty 3)
1
x1
x6
2
x2
x2
pins
3
x2
x1
4
x4
x2
x2
5
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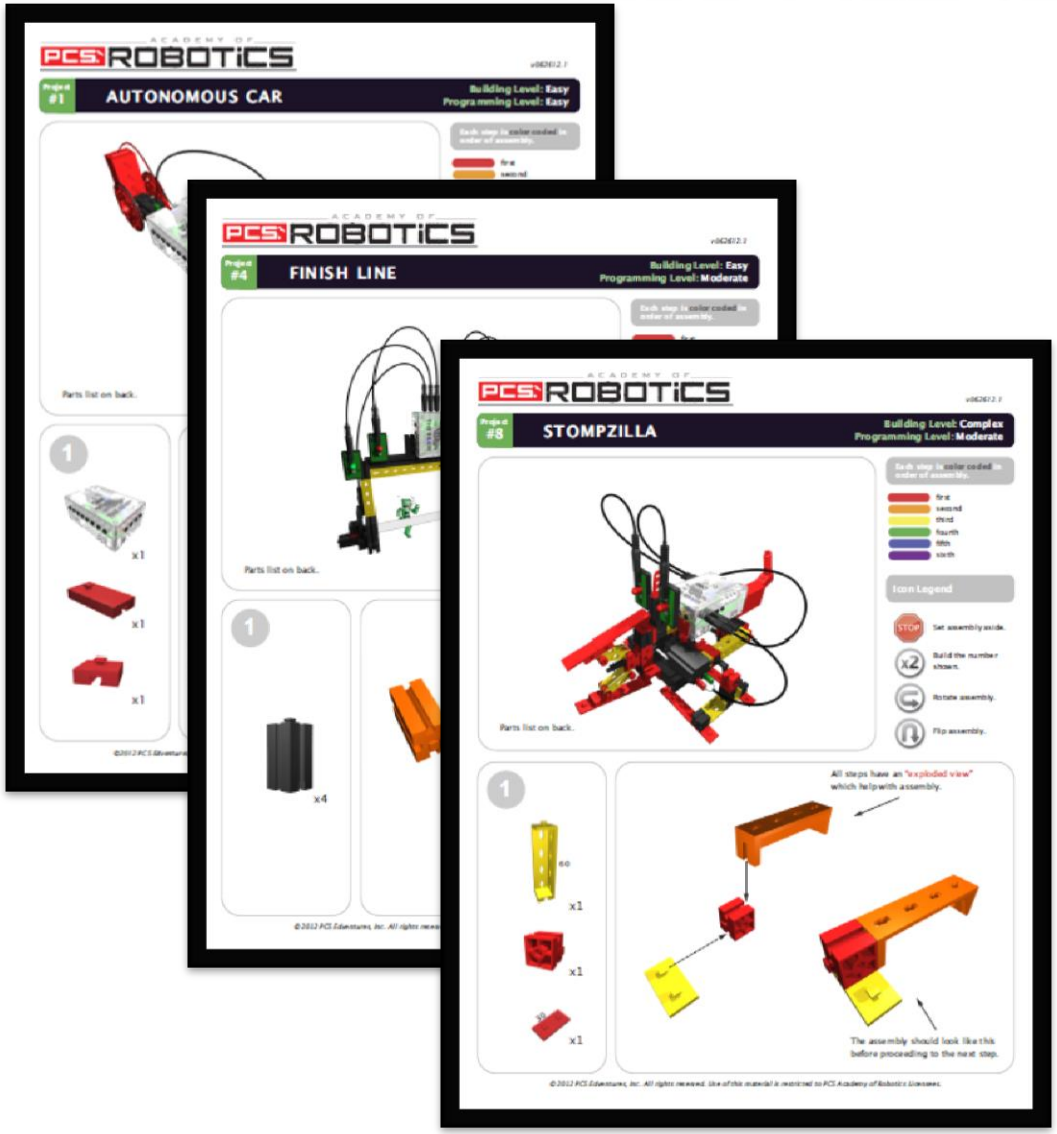
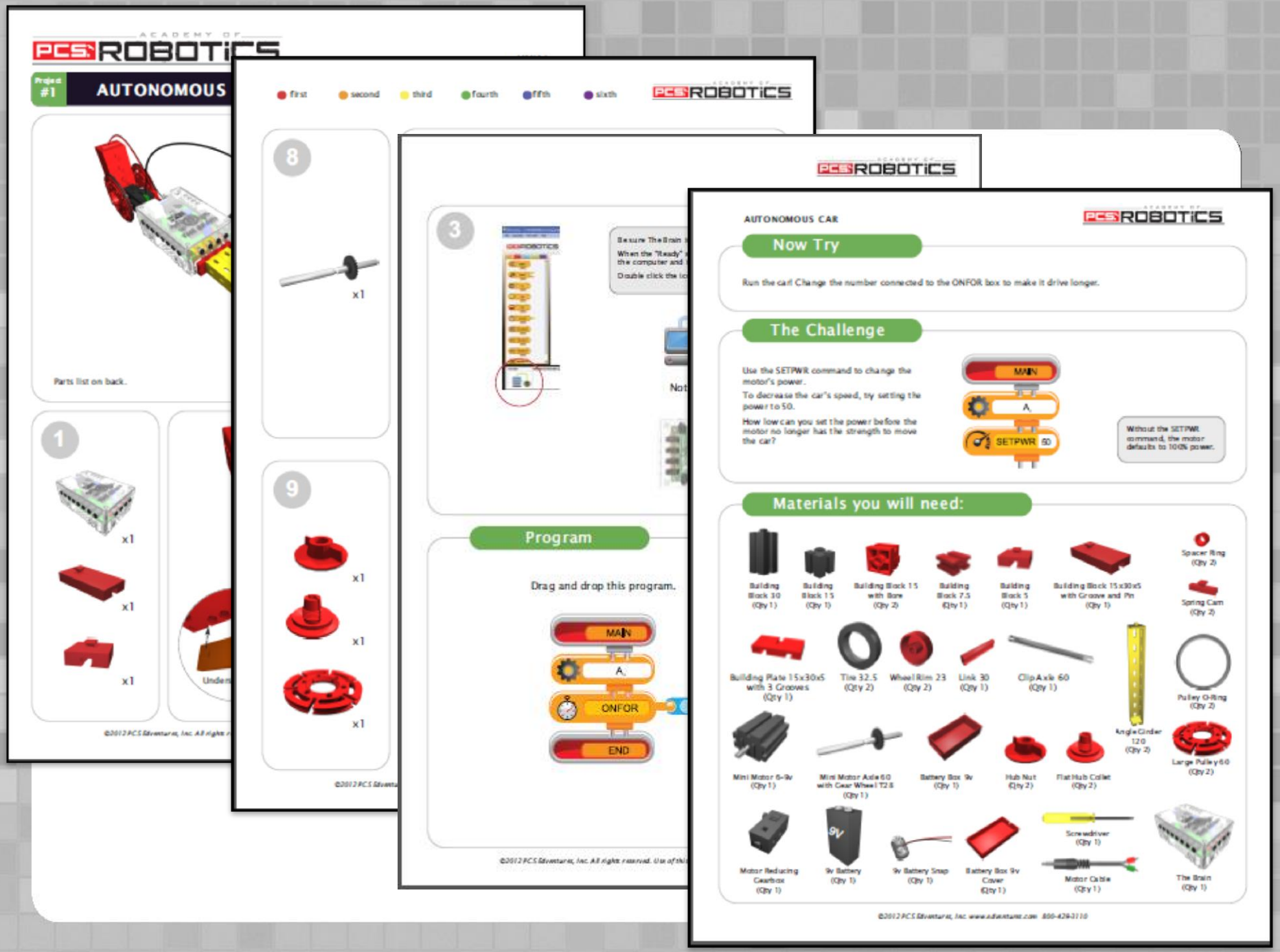
Curriculum



8 Building booklets that get progressive more difficult. Each has step by step directions and a, build appropriate, program written in visual logo.


ACADEMY OF
PCS ROBOTICS
Project #1
AUTONOMOUS
Parts list on back.
1
x1
x1
x1
first
second
third
fourth
fifth
sixth
8
x1
9
x1
x1
x1
3
Program
Drag and drop this program.
MAIN
A.
ONFOR
END
AUTONOMOUS CAR
Now Try
Run the car! Change the number connected to the ONFOR box to make it drive longer.
The Challenge
Use the SETPWR command to change the motor's power.
To decrease the car's speed, try setting the power to 50.
How low can you set the power before the motor no longer has the strength to move the car?
MAIN
A.
SETPWR 50
Without the SETPWR command, the motor defaults to 100% power.
Materials you will need:
Building Block 30 (Qty 1)
Building Block 15 (Qty 1)
Building Block 15 with Bore (Qty 2)
Building Block 7.5 (Qty 1)
Building Block 5 (Qty 1)
Building Block 15x30x5 with Groove and Pin (Qty 1)
Spacer Ring (Qty 2)
Spring Cam (Qty 2)
Building Plate 15x30x5 with 3 Grooves (Qty 1)
Tire 32.5 (Qty 2)
Wheel Rim 23 (Qty 2)
Link 30 (Qty 1)
Clip Axle 60 (Qty 1)
Angle Girder 120 (Qty 2)
Pulley O-Ring (Qty 2)
Large Pulley 60 (Qty 2)
Mini Motor 6-9v (Qty 1)
Mini Motor Axle 60 with Gear Wheel 12 8 (Qty 1)
Battery Box 9v (Qty 1)
Hub Nut (Qty 2)
Flat Hub Collet (Qty 2)
Motor Reducing Gearbox (Qty 1)
9v Battery (Qty 1)
9v Battery Snap (Qty 1)
Battery Box 9v Cover (Qty 1)
Screwdriver (Qty 1)
Motor Cable (Qty 1)
The Brain (Qty 1)

Resource Sheets

ACADEMY OF PCS ROBOTICS

REP FT RESOURCE SHEET

Project 1 — AUTONOMOUS CAR

Before Construction

- Collect parts according to the materials list on the ba booklet.
  - Check that motor cables are assembled. (See the U assembly instructions.)

During Construction

- Step 6—Be sure the gears on the Mini Motor mesh wi Motor Reducing Gearbox so they cannot turn indepen ☼Hint - If any of the gears can move, the Motor Reduc fully engaged with the Mini Motor.
- Step 9 & 10—When securing the Large Pulley 60s (wh Collets, be sure they can no longer spin freely on the against the Mini Motor.
- Step 12—The Battery Snap must be secured onto the

The Brain and Programming

- If the Brain does not indicate there is power when sw
  - when using a 9v Battery:
    - » check that the Battery Snap is rmly pressed o
    - » the 9v Battery may be dead, replace it with a n
  - when using the provided Power Adapter:
    - » check that the Power Adapter is set to either 9
- If the wheels do not spin consistently when using a 9 ensure your program is working.

Program Description

When the provided program is executed, the Autonomou

The Run/Stop button can be pushed to run the program

After Construction & Programming

- If the motor is running but the back wheels do not sp
  - the connection between the Mini Motor and the Ce
  - that the Hub Nuts and Flat Hub Collets are tighten
- If the back wheels are turning the wrong direction, c
  - the placement of the green and red Motor Cable P
  - the motor direction command in your program.

Think About This

- What are some pros and cons to rear-wheel and fron
- While the motor is running, turn the car upside down fewer times than the smaller gear?
- Would adding a motor to the front axle help with per
- In the program, what would you need to change to:
  - accommodate two motors?
  - increase or decrease the motor run time?

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ACADEMY OF PCS ROBOTICS

Project 2 — CAROUSEL

Before Construction

- Collect parts according to the materials list on the back of the p booklet.
  - Check that motor cables are assembled. (See the User Guide assembly instructions.)

During Construction

- Step 4—Use the Clip 5 to secure the Clip Axle 45 in the Building with Bore. When securing the Gear Wheel 20 to the axle using t Nuts and Flat Hub Collets, be sure it can no longer spin freely o
- Step 6—Be sure the gears on the Mini Motor mesh with the gea cannot turn independently.
  ☼Hint - If any of the gears can move, the Motor Reducing Gearbo
- Step 8—Be sure the gears on the Gear Wheel T10 Narrow and th
- Step 9—When securing the Large Pulley 60 to the axle using the can no longer spin freely on the axle.
- Step 11—Be sure the gears of the two Bevel Gear with Sleeve m
- Step 14—The Battery Snap must be secured onto the 9v Battery

The Brain and Programming

- If the Brain does not indicate there is power when switched to t
  - when using a 9v Battery:
    - » check that the Battery Snap is rmly pressed onto the bat
    - » the 9v Battery may be dead, replace it with a new one.
  - when using the provided Power Adapter:
    - » check that the Power Adapter is set to either 9v or 12v.
- Refer to Programming Skills #5 Card for additional guidance

Program Description

When the provided program is executed, the Carousel will begin b Switch Sensor is activated.

Once the Push Switch Sensor is activated, the Carousel will reverse clockwise).

Each activation of the Push Switch Sensor will reverse the direction

It will continue spinning until the Run/Stop Button is pressed on T

After Construction & Programming

- If the motor is running but the Carousel does not spin, check:
  - the connection between the Mini Motor and the Gearbox (Ste
  - that the Hub Nuts and Flat Hub Collets are tightened around
  - that the Gear Wheel T20 meshes with the Gear Wheel T10 Na
  - that the two bevel gears mesh (Step 11).

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ACADEMY OF PCS ROBOTICS

REP FT RESOURCE SHEET

Project 3 — INCHWORM

Building Level: Easy
Programming Level: Easy

Before Construction

- Collect parts according to the materials list on the back of the project booklet.
  - Check that motor cables are assembled. (See the User Guide for assembly instructions.)

During Construction

- Steps 1 & 2—When securing the Wheel Rims to the axle using the Hub Nuts, be sure it can no longer spin freely on the axle. Also be sure the rubber tire is fully seated on the rim/wheel.
- Step 3—Be sure the gears on the Mini Motors mesh with the gears in the Motor Reducing Gearboxes so they cannot turn independently.
  ☼Hint - If any of the gears can move, the Motor Reducing Gearbox is not fully engaged with the Mini Motor.
- Step 12—The Battery Snap must be secured onto the 9v Battery.

The Brain and Programming

- If the Brain does not indicate there is power when switched to the "on" position,
  - when using a 9v Battery:
    - » check that the Battery Snap is firmly pressed onto the battery.
    - » the 9v Battery may be dead, replace it with a new one.
  - when using the provided Power Adapter:
    - » check that the Power Adapter dial is set to either 9v or 12v.

Program Description

When the provided program is executed, the wheels on the front of the Inchworm will move forward (extending its length) at 70% power.

Then, the wheels on the back of the Inchworm will move forward (compressing its length).

This pattern will repeat until the Run/Stop Button is pressed on The Brain.

After Construction & Programming

- If the motor is running but either set of wheels do not spin, check:
  - the connection between the Mini Motor and the Gearbox (Step 1).
  - that the Hub Nuts and Wheel Rim 30s are tightened around the axle (Step 2).
- If either set of wheels are turning the wrong direction, check:
  - the placement of the green and red Motor Cable Plugs
  - the motor direction command in your program.
- If the front wheels are running longer than needed to fully extend the Inchworm, or the back wheels are not catching up to bring the Inchworm upright, adjust the time that the corresponding motors in the program are on for (ONFOR). Timed operations depend on battery strength and may require adjustment.

Think About This

- What would be a benefit to using an inchworm design in a mechanical device?
- What would you modify in the program to make the Inchworm move backwards? What mechanical changes would need to be made?
- If you were to decrease the SETPWR of the motors, would you need to increase or decrease the motor ONFOR time to make it travel the same distance in the same amount of time?

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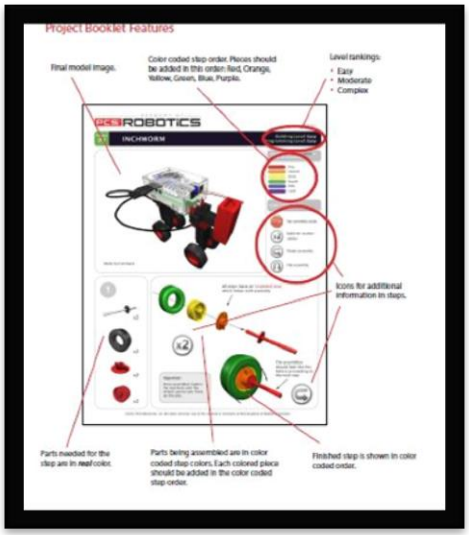
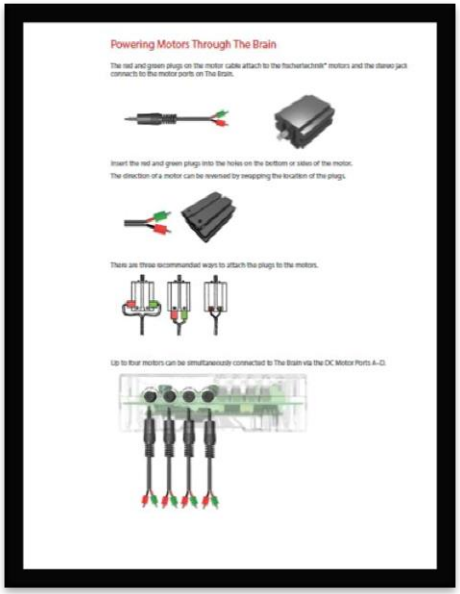




ROBOTICS EDUCATION PACK

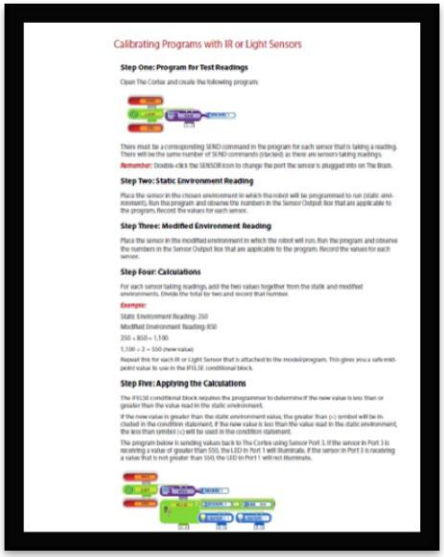
User Guide

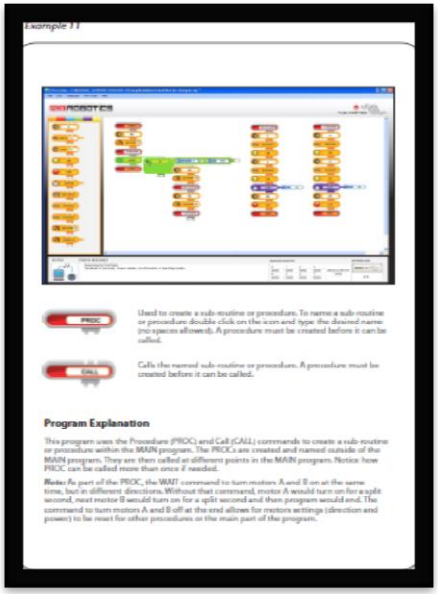
General Kit Information

Setup

Instruction

PCS edventures!





PRACTICE

Assembly

PCS ROBOTIC

PARTS THAT REQU

You will need the parts listed be
located in the Small Parts Orga

3. Grasp the Differential Gear C
Place the two Differential Pla
the pegs inside the Cage (Th
inward). Hold them in place

Look inside the cage. Rotate the
should be meshed and working
ceed to the next step until the ge

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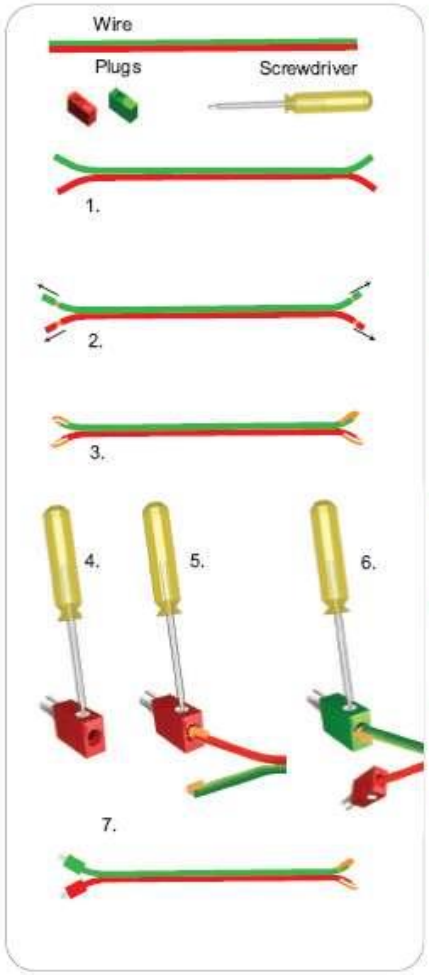
PARTS THAT REQUIRE ASSEMB



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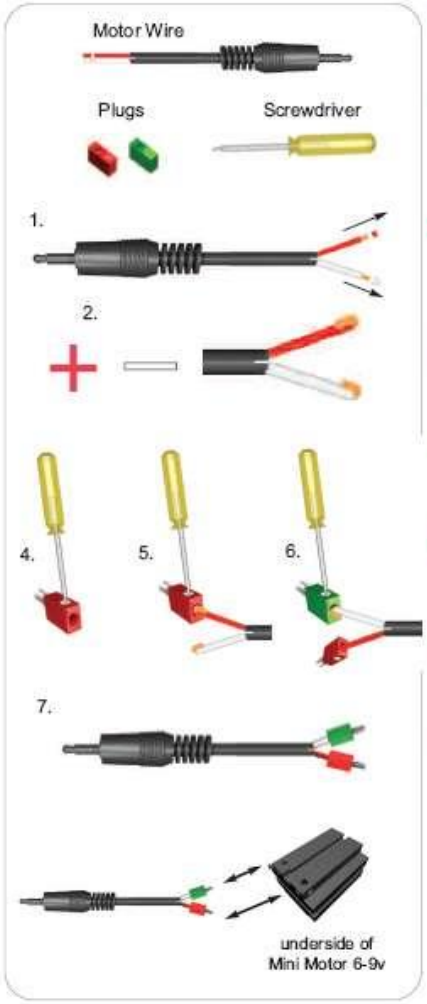
PARTS THAT REQUIRE ASSEMBLY



MOTOR WIRES

You will need a motor wire (Bin 46), 1 red plug, 1 green plug, and a screwdriver (Bin 3).

1. Slide the small perforated plastic sleeves off the end of the cable, exposing the ends of the copper wire.

2. Twist the end of each copper wire and fold the wire back over the plastic sleeves. The red wire is positive, the white wire is negative.

3. Collect the mini screwdriver, one red plug, and one green plug to complete the next step.

4. Loosen the tiny screw on the top of each red and green plug.

5. Insert the copper wire from the red wire into the hole on the red plug. Tighten the screw.

6. Repeat steps five and six with the green plug and the white wire.

7. This is an example of the completed Motor Cable with fischertechnik® plugs.

This diagram shows where the plugs of the Motor Cable attach to the Mini Motor 6-9v.

The stereo plug end of the Motor Cable fits into the Motor Ports (A–D) on The Brain. There are detailed instructions regarding Motor Ports in The Brain User's Guide (pgs 9–14).

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Kit Rules and Procedures Ideas

Kit RULES:

1. Wash hands before use…hand washing is REQUIRED!
2. No food or drink around the lab or your workstation.

Kit PROCEDURES:

1. Keep the kit organized.
   (Brainstorm a system to keep the kit(s) organized.)

2. Take only what you need. Do not be a “part hog.”
   (Think of ideas about how to contain parts while building and where to store incomplete models.)

3. Kit location. (Where is the best location in the learning environment for the lab and why?)

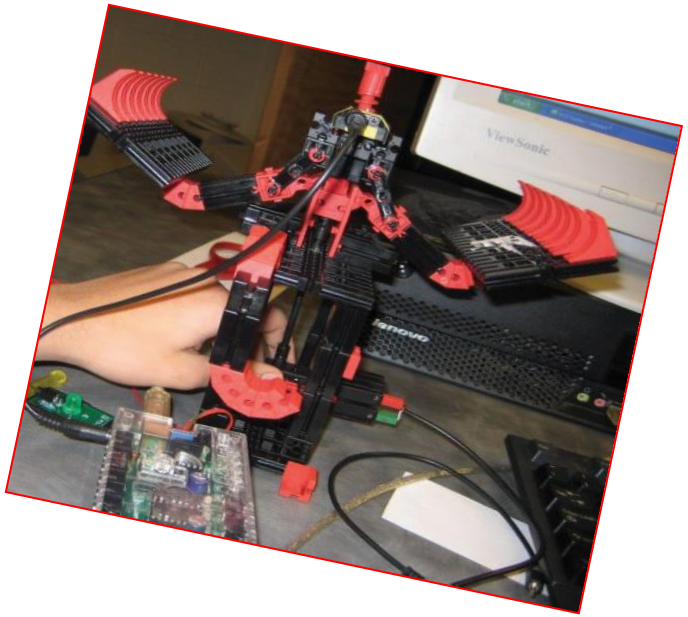
4. No chunk dumping. (Create a plan for determining how and when to break down models and put parts away.)

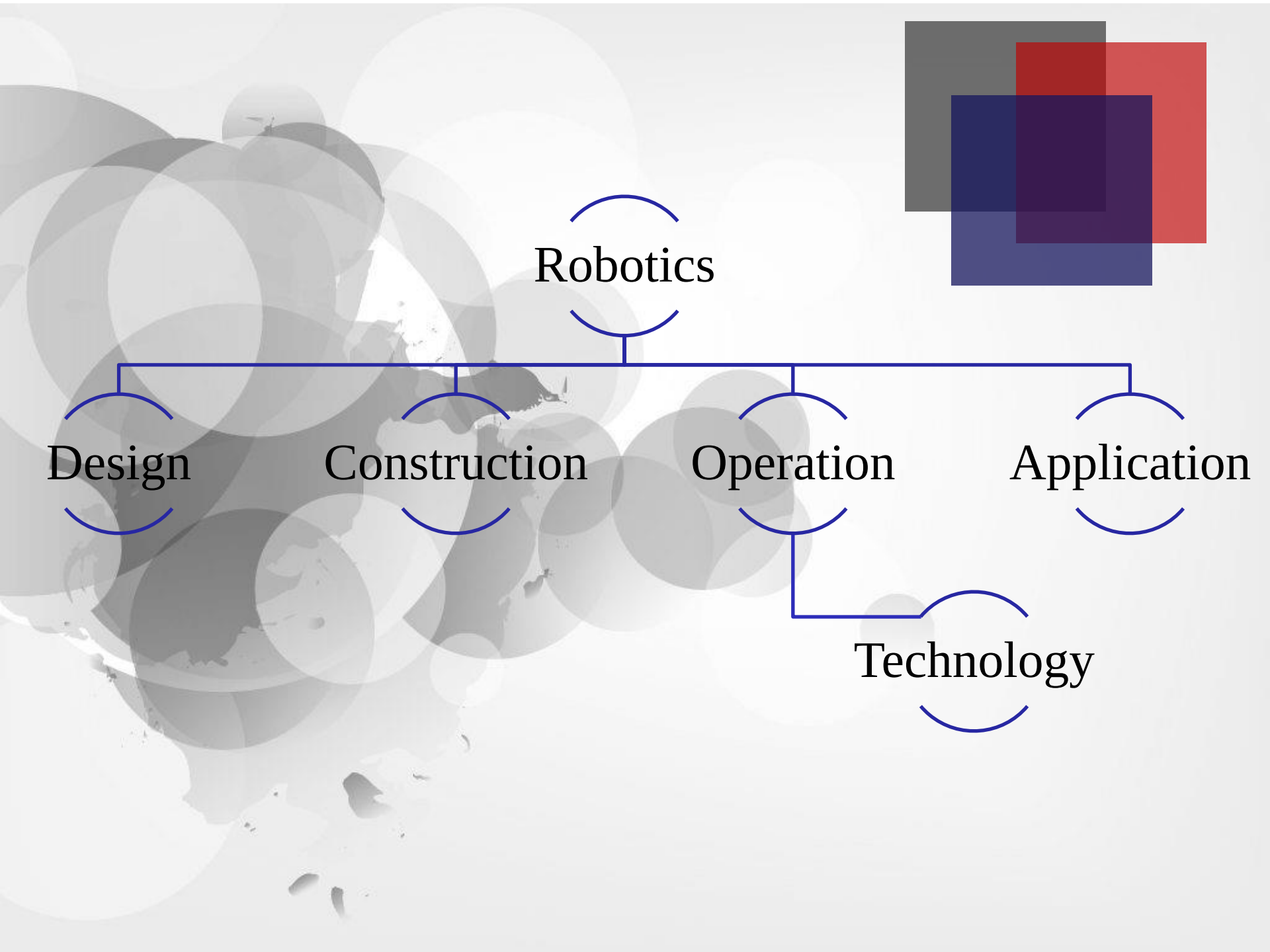
Consider the following…

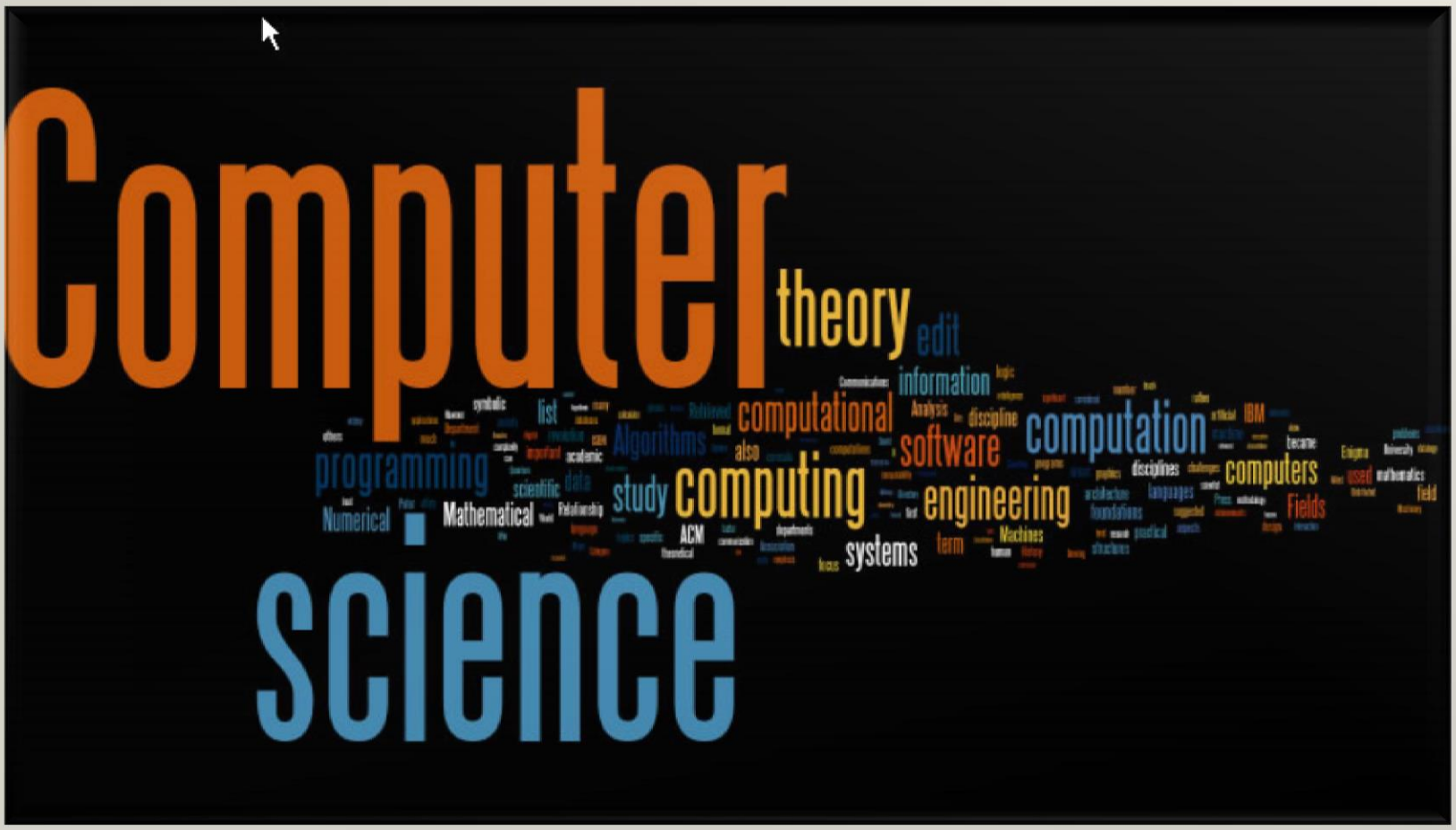
1. Take the time to build as many builds as possible so you can share your knowledge with the students.

2. Pad allotted kit time by 15 minutes when you begin working with the lab.

3. Communicate build, maintenance, and assessment expectations..




Robotics
Design
Construction
Operation
Application
Technology


Computer
science
theory
edit
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computational
computation
software
programming
computing
engineering
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Algorithms
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Numerical
Mathematical
systems
Fields
IBM
discipline
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languages
foundations
Machines
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ACM
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academic
Analysis
Communications
logic
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mathematics
field
Enigma
University
problems
Press
architecture
practical
Relationship
theoretical
departments
Texas
Department
Peter
Turing
Author
Editor
Reviewer
Reviews
Reviewed
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Computing
Software
Engineering
Information
Theory
Science
Mathematical
Numerical
Programming
Algorithms
Systems
Fields
Machines
Term
Discipline
Disciplines
Languages
Foundations
Analysis
Logic
Enigma
Mathematics
Field
Author
Reviewer
Reviews
Reviewed
Department
Turing
Peter
Texas
Relationship
Theoretical
Practical
Architecture
Press
University
Problems
Became
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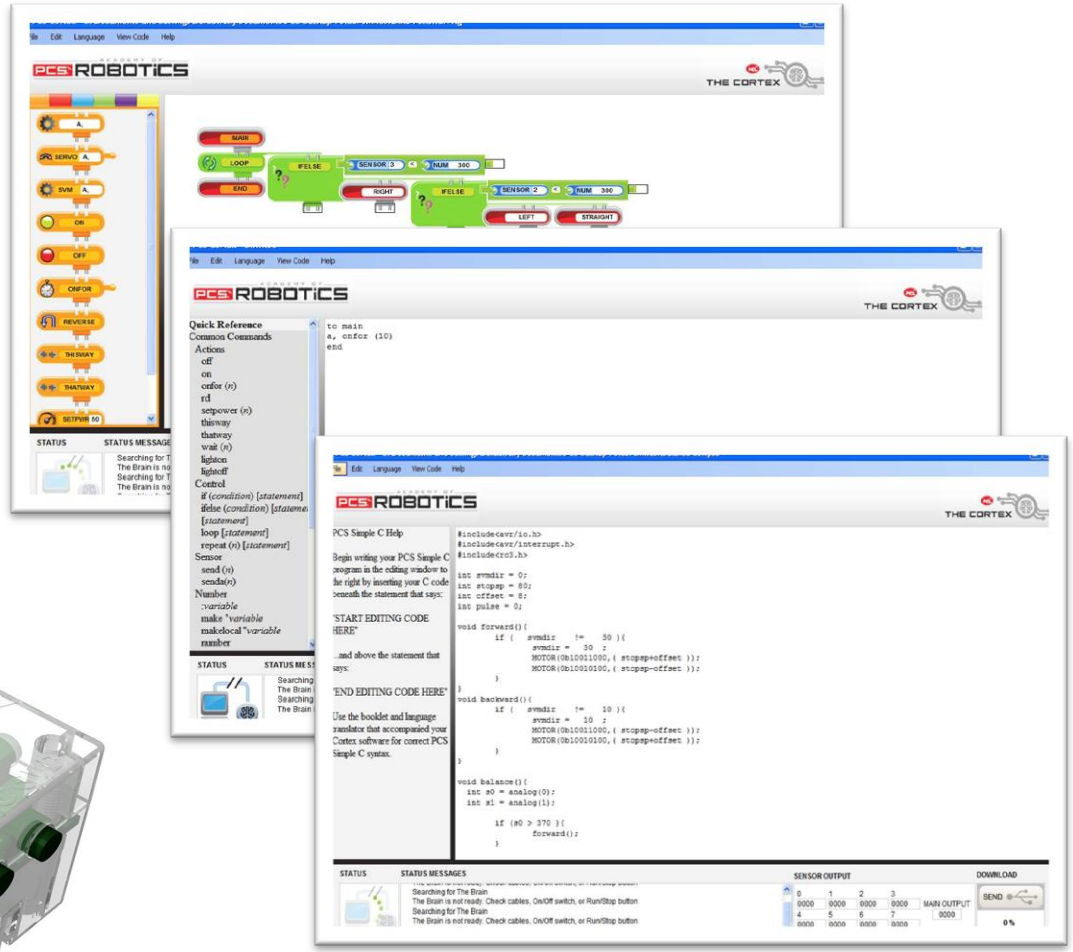
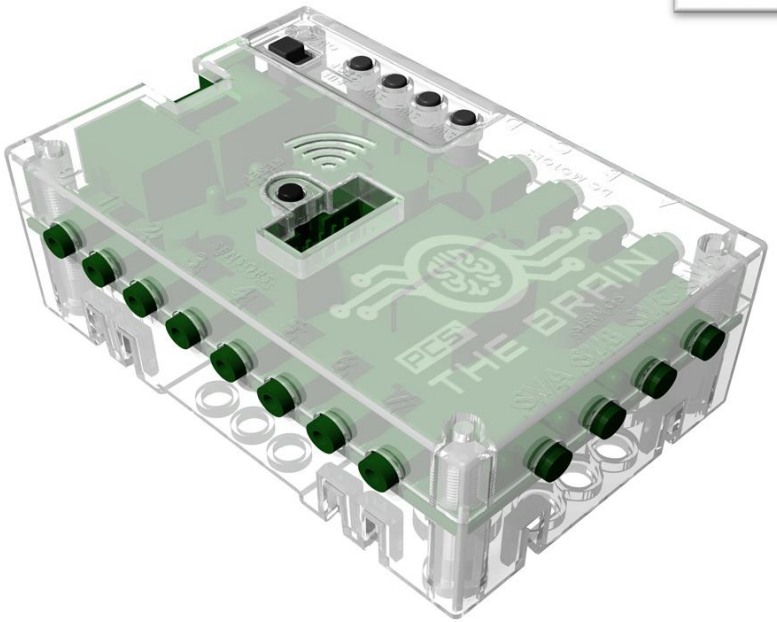
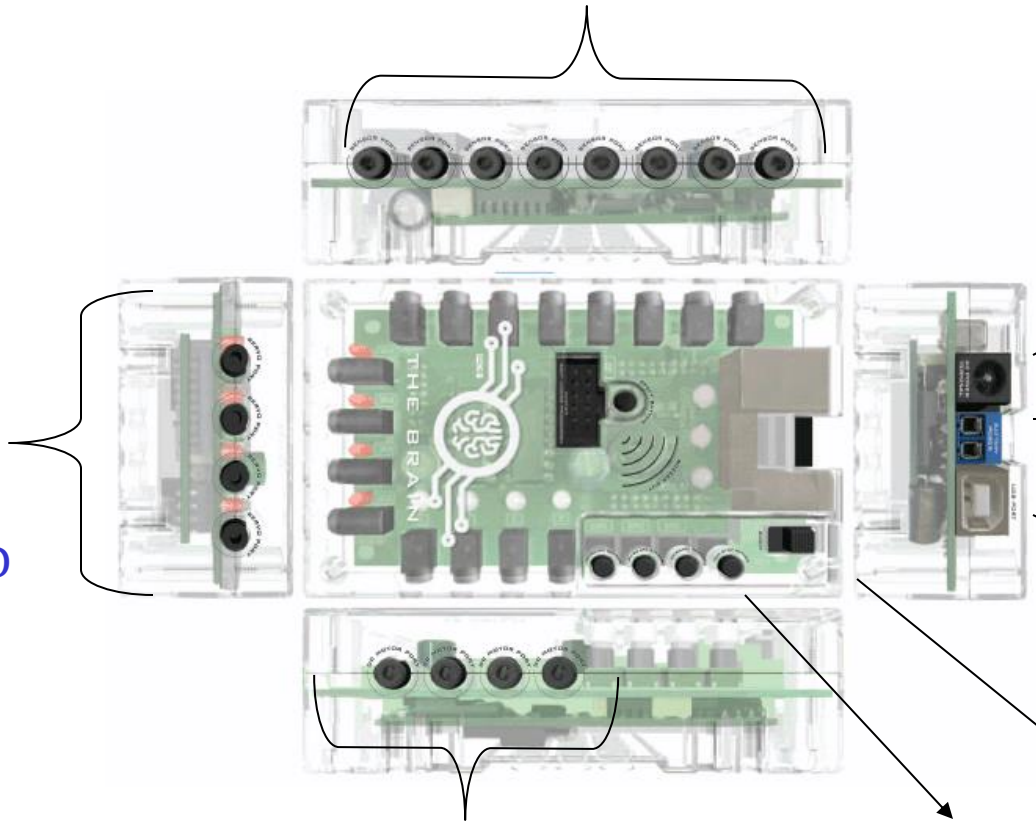
Foundations
Fields
IBM
Mathematics
Field
Enigma


PCS ROBOTICS
THE CORTEX
MAIN
LOOP
END
IFELSE
SENSOR 3
NUM 300
RIGHT
SENSOR 2
LEFT
STRAIGHT
Quick Reference
Common Commands
Actions
off
on
onfor (n)
rd
setpower (n)
thisway
thatway
wait (n)
lighton
lightoff
Control
if (condition) [statement]
ifelse (condition) [statement] [statement]
loop [statement]
repeat (n) [statement]
Sensor
send (n)
senda(n)
Number
:variable
make "variable
makelocal "variable
number
to main
a, onfor (10)
end
PCS Simple C Help
Begin writing your PCS Simple C program in the editing window to the right by inserting your C code beneath the statement that says:
"START EDITING CODE HERE"
...and above the statement that says:
"END EDITING CODE HERE"
Use the booklet and language translator that accompanied your Cortex software for correct PCS Simple C syntax.
#include<avr/io.h>
#include<avr/interrupt.h>
#include<rc3.h>
int svmdir = 0;
int stopsp = 80;
int offset = 8;
int pulse = 0;
void forward(){
if (svmdir != 30){
svmdir = 30 ;
MOTOR(0b10011000,(stopsp+offset));
MOTOR(0b10010100,(stopsp-offset));
}
}
void backward(){
if (svmdir != 10){
svmdir = 10 ;
MOTOR(0b10011000,(stopsp-offset));
MOTOR(0b10010100,(stopsp+offset));
}
}
void balance(){
int s0 = analog(0);
int s1 = analog(1);
if (s0 > 370){
forward();
}
STATUS
STATUS MESSAGES
SENSOR OUTPUT
DOWNLOAD
Searching for The Brain
The Brain is not ready. Check cables, On/Off switch, or Run/Stop button
MAIN OUTPUT
SEND
0 %

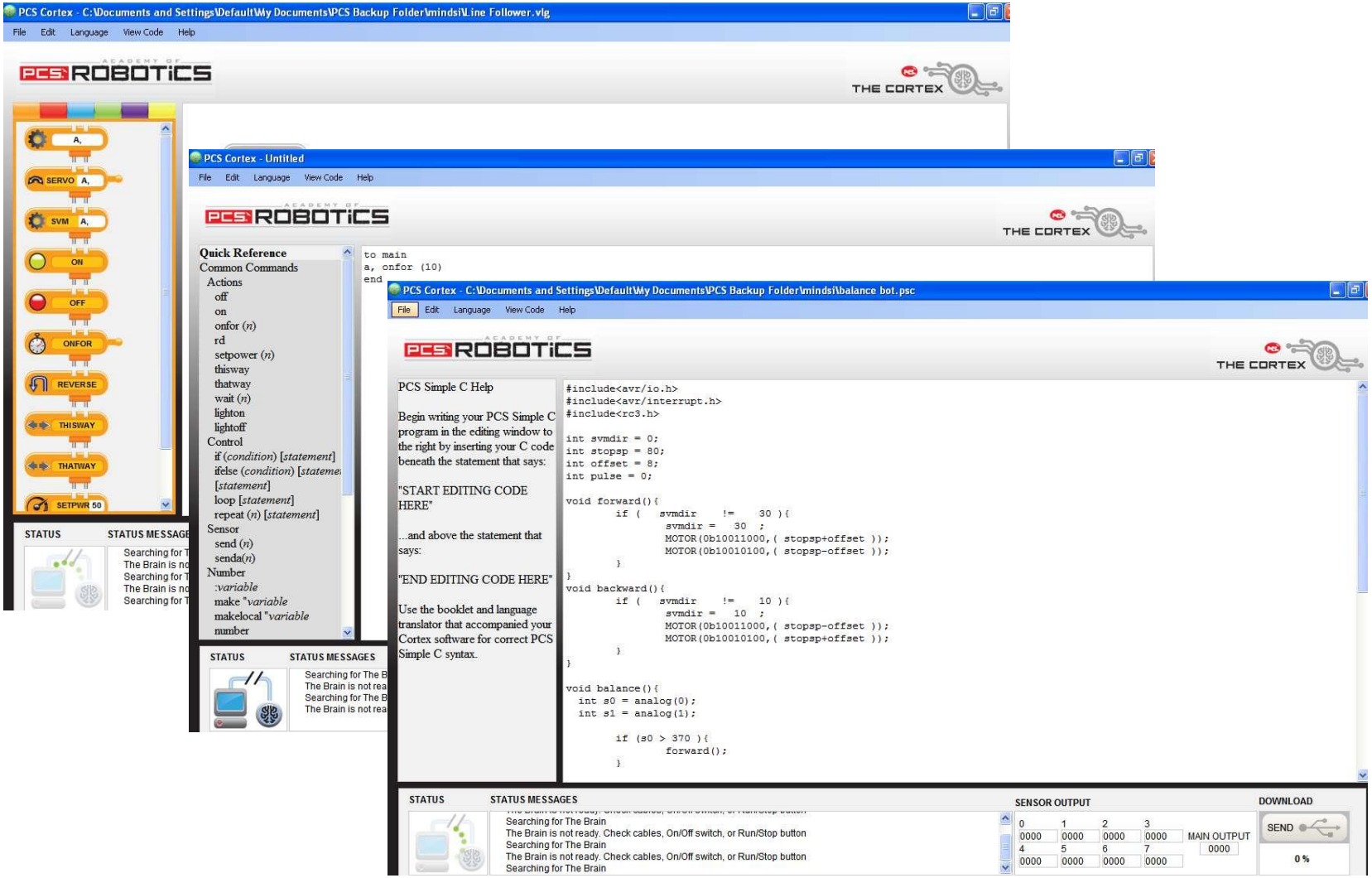

PCS
THE BRAIN

The Computer Parts

The Brain


Sensor Ports – 8 total – labeled 0 -7
Servo Motor Ports 4 total labeled A - D
A/C power terminal
Battery terminal
USB terminal
On/Off Switch
Run/Stop button
Motor Ports – 4 total – labeled A - D

The Cortex


PCS Cortex - C:\Documents and Settings\Default\My Documents\PCS Backup Folder\mindsi\Line Follower.vlg
File Edit Language View Code Help
PCS ROBOTICS
THE CORTEX
A,
SERVO A,
SVM A,
ON
OFF
ONFOR
REVERSE
THISWAY
THATWAY
SETPWR 50
STATUS
STATUS MESSAGE
PCS Cortex - Untitled
File Edit Language View Code Help
Quick Reference
Common Commands
Actions
off
on
onfor (n)
rd
setpower (n)
thisway
thatway
wait (n)
lighton
lightoff
Control
if (condition) [statement]
ifelse (condition) [statement] [statement]
loop [statement]
repeat (n) [statement]
Sensor
send (n)
senda(n)
Number
:variable
make "variable
makelocal "variable
number
to main
a, onfor (10)
end
STATUS
STATUS MESSAGES
PCS Cortex - C:\Documents and Settings\Default\My Documents\PCS Backup Folder\mindsi\balance bot.psc
File Edit Language View Code Help
PCS Simple C Help
Begin writing your PCS Simple C program in the editing window to the right by inserting your C code beneath the statement that says:
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MOTOR(0b10011000,(stopsp+offset));
MOTOR(0b10010100,(stopsp-offset));
}
}
void backward(){
if (svmdir != 10){
svmdir = 10 ;
MOTOR(0b10011000,(stopsp-offset));
MOTOR(0b10010100,(stopsp+offset));
}
}
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}
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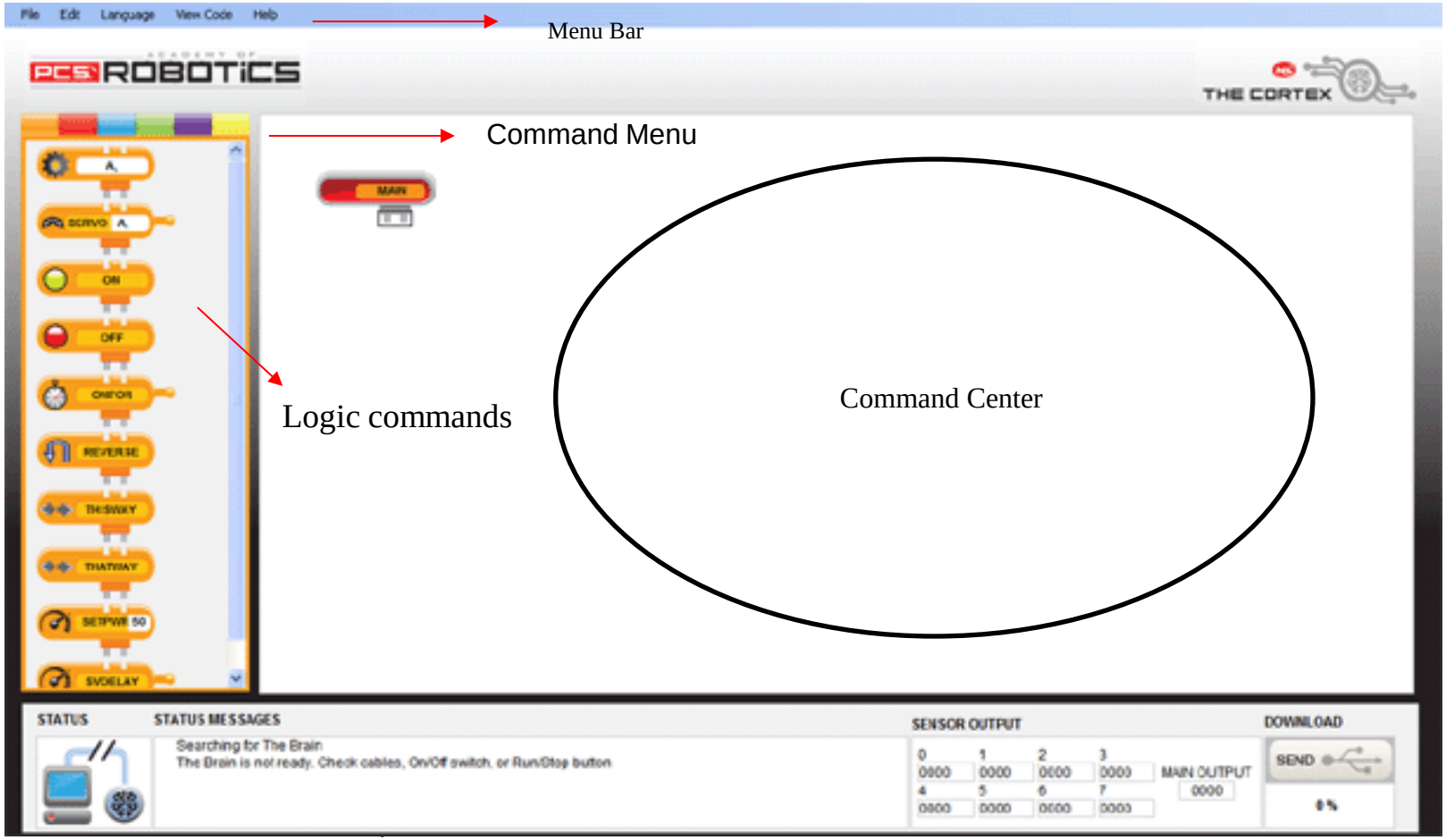
STATUS MESSAGES
Searching for The Brain
The Brain is not ready. Check cables, On/Off switch, or Run/Stop button
Searching for The Brain
The Brain is not ready. Check cables, On/Off switch, or Run/Stop button
Searching for The Brain
SENSOR OUTPUT
0 1 2 3
0000 0000 0000 0000
4 5 6 7
0000 0000 0000 0000
MAIN OUTPUT
0000
DOWNLOAD
SEND
0 %

Programming: Drag and Drop

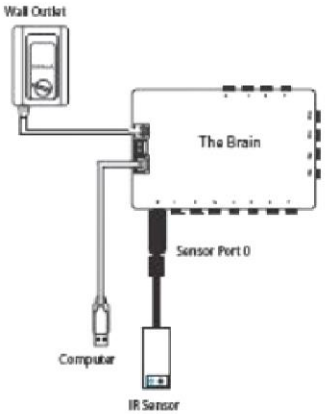


Skill #6: Using the Infrared (IR) Sensor and Taking Readings

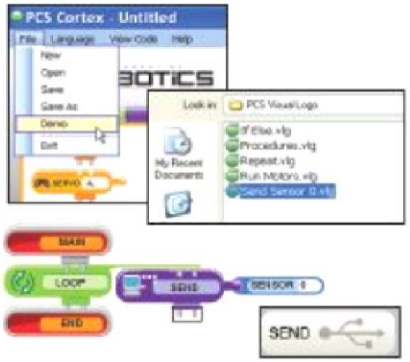
Materials you will need:

1 Draw a black square on a white piece of paper.

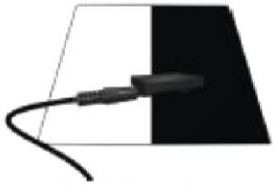
2



3 Open Demo Program Send Sensor 0.vlg. Run the program.



4 Place sensor over black paper.

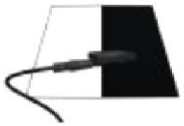


Watch the Sensor Output number change in box 0.

SENSOR OUTPUT

0	1	2	3	MAIN OUTPUT
0789	0000	0000	0000	0000
4	5	6	7	
0000	0000	0000	0000	

5 Move sensor over white paper.



The number changes.

The number or "reading" is useful information for more complex programming.

SENSOR OUTPUT

0	1	2
0082	0000	0000
4	5	6
0000	0000	0000

Move the sensor over different surfaces and watch the readings. Try lifting the sensor up and down too!

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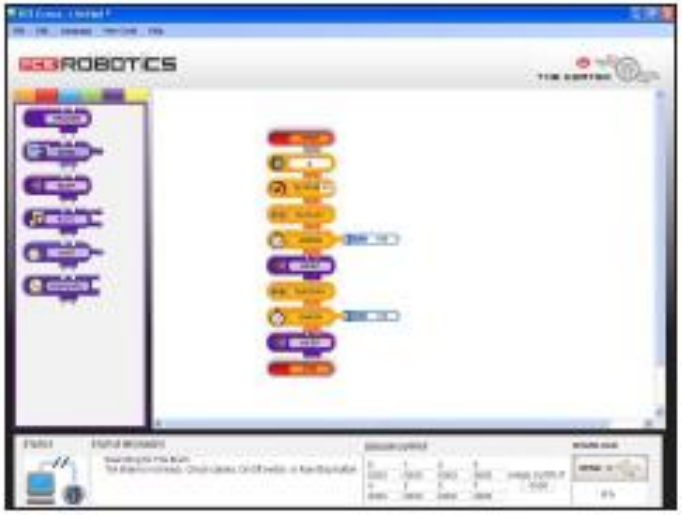
Example 2



Sets the selected motor(s) to the "thisway" direction. This is indicated by a green LED on The Brain above the corresponding motor port(s). If no direction is specified, the motor command defaults to "thisway."

Sets the selected motor(s) to the "thatway" direction. This is indicated by a red LED on The Brain above the corresponding motor port(s).

Program Explanation

This program states that the motor attached to Motor Port A is set at 75% power and it will travel THISWAY for 10 seconds, beep, and then travel THATWAY for 10 seconds and beep.

Note: Since the power level for Motor A was set to 75%, it will remain at that level until it is changed or the OFF command is applied.

In this program, the BEEP command provides an auditory signal that the motors had run for the specified duration of time, but is not necessary.

Example 11

Used to create a sub-routine or procedure. To name a sub-routine or procedure double click on the icon and type the desired name (no spaces allowed). A procedure must be created before it can be called.

Calls the named sub-routine or procedure. A procedure must be created before it can be called.

Program Explanation

This program uses the Procedure (PROC) and Call (CALL) commands to create a sub-routine or procedure within the MAIN program. The PROCs are created and named outside of the MAIN program. They are then called at different points in the MAIN program. Notice how PROC can be called more than once if needed.

Note: As part of the PROC, the WAIT command to turn motors A and B on at the same time, but in different directions. Without that command, motor A would turn on for a split second, next motor B would turn on for a split second and then program would end. The command to turn motors A and B off at the end allows for motors settings (direction and power) to be reset for other procedures or the main part of the program.

PRACTICE

Bonus Challenge: Tier II – Complete the above, but, in addition, have your robot return to the landing spot.

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“Technology can bring the real world into the classroom, which means that as teachers we can better prepare kids for the exciting adventures that they will face in their future.”

Dan Roberts– Seychelles