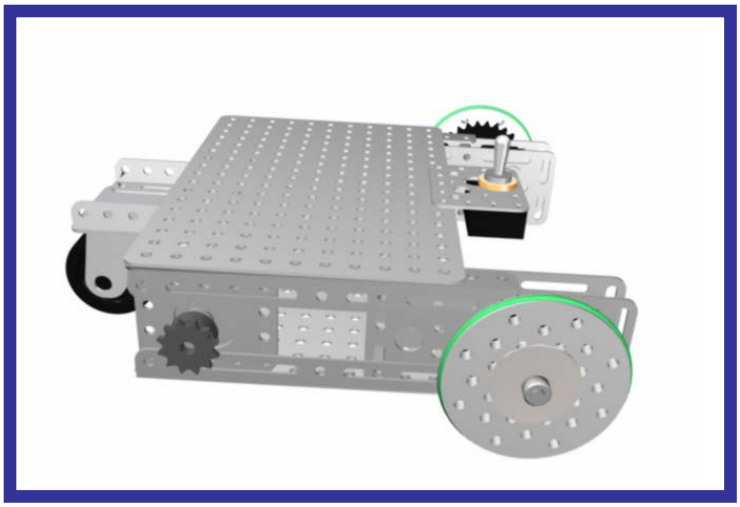
Gears Educational Systems, LLC

GEARS-EDS . . . technology education in a box

Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com

Build a Drive Train and Chassis

Build and Use the Drive Train and Chassis to Explore These Engineering Principles:



DESIGN/BUILD/TEST/ PLAY

Use The GEARS-IDS™ Invention and Design System to create **Radio Controlled Game Playing Machines** *(designed and built by students)*. Students and teachers can create exciting engineering challenges similar to those played at major engineering colleges and on TV!

Students and teachers who participate in these 4 activities learn the necessary math, science and principals of engineering they need to create competitive machines.

- **Learn to configure a Control System**
- **Learn to build a Drive Train and Chassis**
- **Learn to build a Pneumatics Test Stand**
- **Learn to design and build Electro-Mechanical game playing machines.**

Basic Physics, Mathematical reasoning and the iterative process of experimenting, building, modifying and playing with ideas are the skills needed to successfully complete the challenge.

Mechanical Principles

- Bearings and Structures
- DC Motor Operation
- Power Transfer
- Chain Drives, Pulleys and Belts Gear Drives

Science and Engineering Principles

- Force and Torque
- Work and Power
- Traction and Friction
- Voltage and Amperage
- CAD
- Testing and Analysis

Design Principles

- Subassemblies and Components
- Linkages and Power Transfer
- Rigidity and Structures
- Threaded Fasteners

Mathematics

- Create and Use Basic Mathematical Models to Evaluate and predict Component Performance
- Assess Performance
- Algebraic and Geometric Manipulations

History of Science and Technology

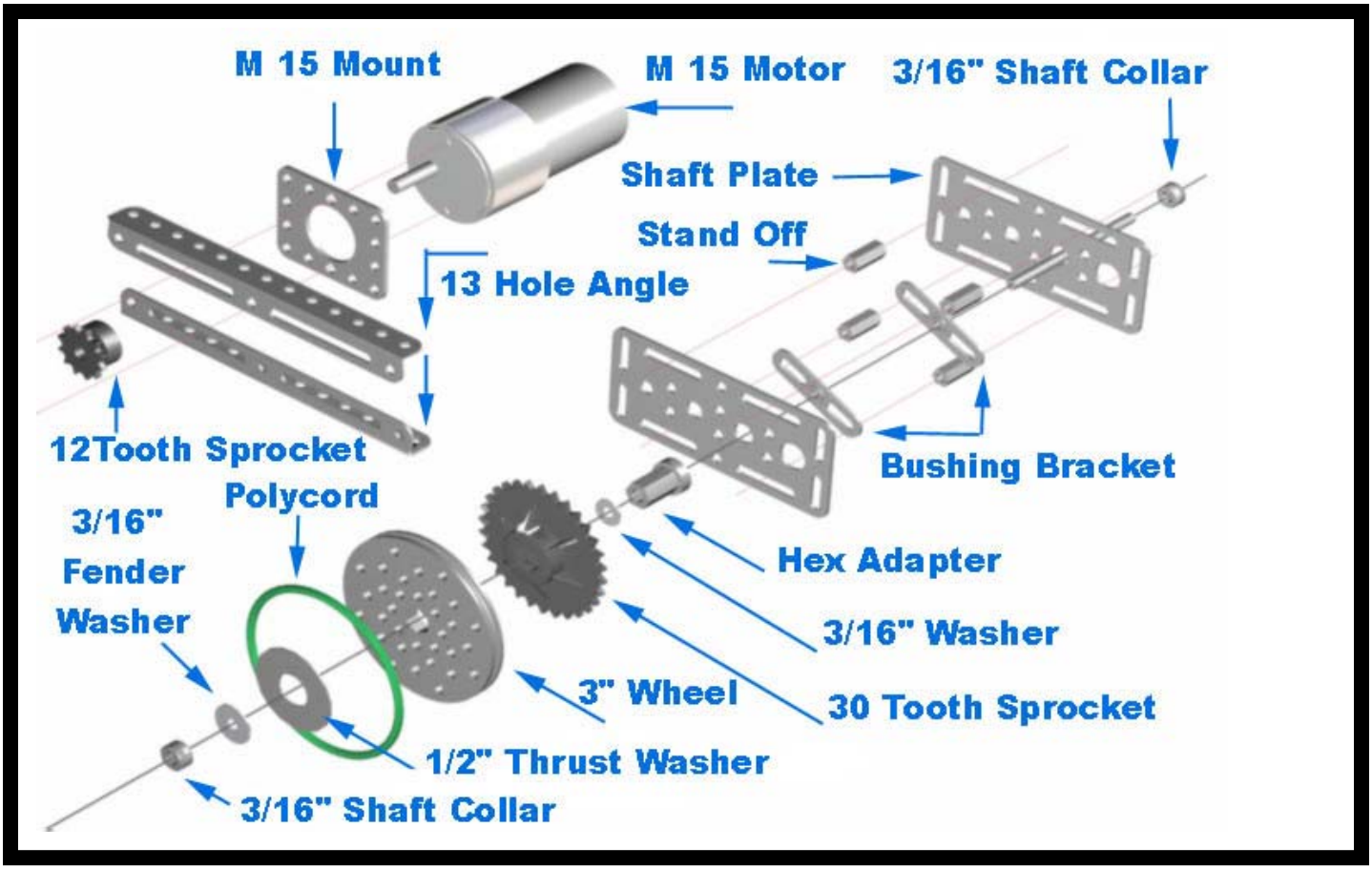
- Physicists, Chemists and Philosophers that contributed to the science of Energy Power and Transportation.

Personal and Interpersonal Skills

- Acquires and Evaluates Information
- Allocates and Organizes Time and Materials

NOTE: Integrate the Drive Train and Chassis with the RC control system and play simple games like robot sumo and tug of war to test drive train and chassis performance.

DESIGN – BUILD – TEST - PLAY



Performance Tip. Before beginning any project, it helps to have a sense of what the beginning, middle and end of the project looks like. For **Best Results Read the Entire Document Before Beginning**

The drive train and chassis can be built in 1-2 hours by a team of 2-3 people. Each team member can build 1 or more of the subassemblies from which the drive train and chassis are constructed. Each person in the group should participate in the activities listed below.

Performance Tip. Engineering is a team sport. Be an engineering MVP. Accept and commit to completing specific responsibilities.

1. **Obtain and organize the Tools and Materials** *(Listed below)*
2. **Build one or more of the subassemblies** *(Illustrated in this document)*
3. **Integrate the subassemblies into a working chassis.**

Always collect, organize and carefully store the Materials Tools and Equipment as directed by your instructor

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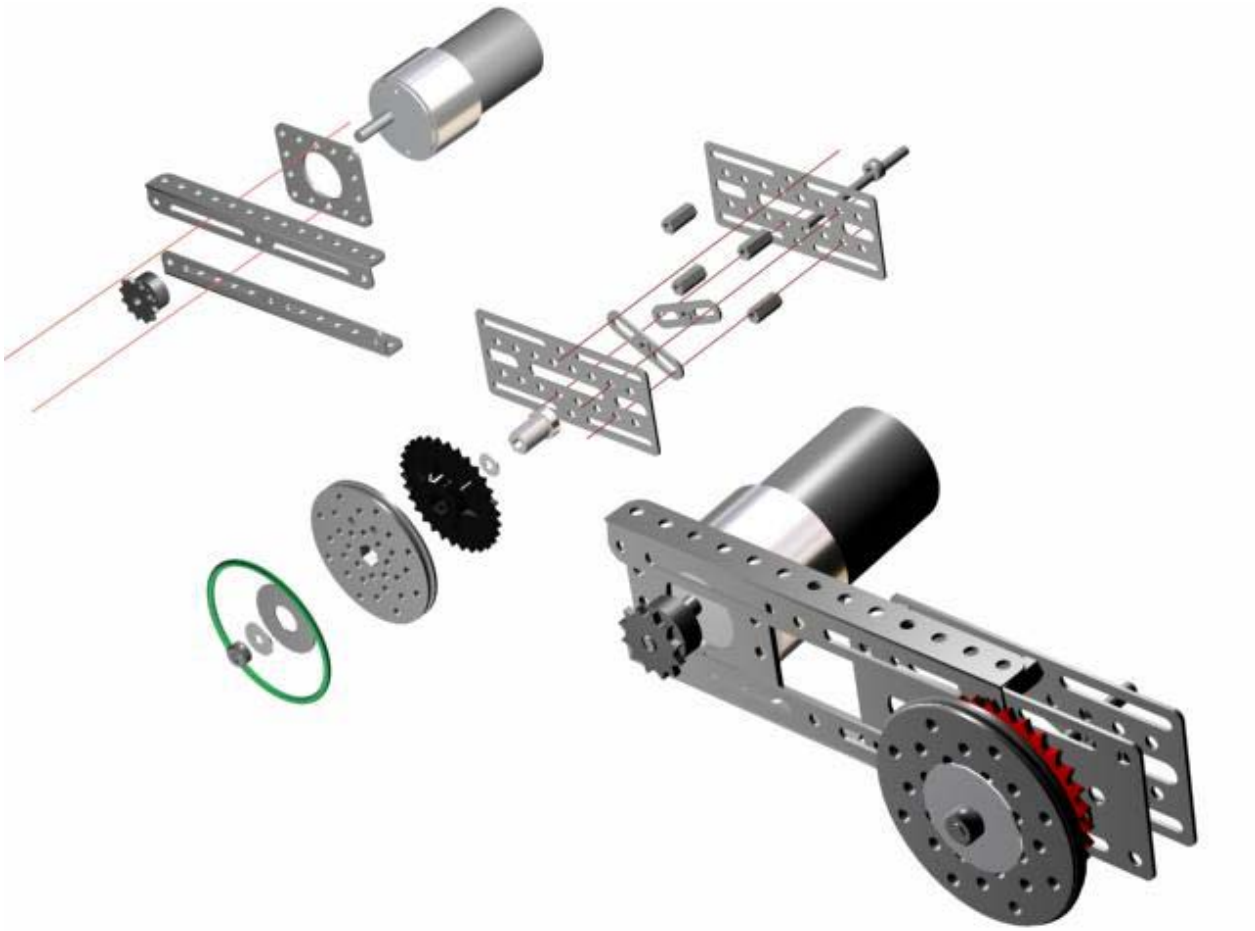
Note: On May 10, 2003 GEARS Educational Systems redesigned the Shaft Plates GIDS-SC-10003, in order to more easily accommodate the use of a variety of gear pitch and modules.

This redesign has little effect on the drive train assembly described in this document. The assembly procedure remains the same and the pictures below describe the assembly using the revised shaft plate GIDS-SC-10003 Rev 1.

There are many (correct) ways to effect a working assembly. Do not try to interpret these directions too literally. Instead, try to understand how an assembly works and how you can make that assembly work more effectively. One important assembly technique is to HAND TIGHTEN or LIGHTLY TIGHTEN all components and modules that make up a mechanism. This will allow you to "Feel" the fit and prevent the axles from binding on misaligned bearings.

The graphic below is intended to help you understand how the newly revised Shaft Plate (GIDS-SC-10003 Rev 1.) is used for the same purpose as the previous revision. Compare this graphic to the one above in order to understand how easily the parts are interchanged.

Note: The bushing Brackets are turned at opposite angles to one another to improve the clearance between the bolt heads and nuts.



Organize the Tools and Materials

The construction of the drive trains and mobile chassis can be completed quickly and with minimal frustration and mistakes by taking the time to read through the directions and readying the necessary tools and materials before beginning the assembly.

Performance Tip. Organize the materials; Obtain boxes or plastic container measuring at least 12”x16”. Use these containers to store the drive train and chassis components throughout the building and testing cycle. A box of this size can hold a finished mobile platform.

Required Tools

Safety Glasses
2-3 Phillips Head Screwdrivers
5/16” Combination Wrench *(For the Stand Offs)*
3/8” Combination Wrench
6” Needle Nose Pliers
Tubing Shears or Sharp Shop Scissors
Wood Cutting Board
Bench Vise
Hack Saw *(For Cutting Axles)*
5/64, 6/32 Allen Wrenches or Hex Keys
Dial Calipers and Tape Measures
Wire Strippers
Wire Nuts or Solderless Connectors
On/Off Electrical Switch and 12V Battery
Soldering Iron
File

Materials

Use the GEARS-IDS online catalog of parts and components to identify the following components.

Structural Components

2 6x9 Flat Plates GIDS-SC-10002
4 13 Hole Angles GIDS-SC-10006
2 M15 Motor Mounts GIDS-SC-10009
4 Bearing/Shaft Plates GIDS-SC-10003
4 Bushing Brackets GIDS_SC_10010
2 3” Hex Wheels GIDS-SC-10014
2 4” x 3/16 Axles GIDS-SC-10018
2 30 Tooth x #25 Pitch Sprocket
2 10 Tooth x #25 Pitch Sprocket
1 M13 Motor Mount GRDS-SC-10008
2 7 Hole Angles GIDS-SC-10007
1 Caster Assembly GIDS-MC-10005
2 3/16” Hex Adapters GIDS-SC-10013

Hardware

4 3/16” Shaft Collars
10 #10-24 x ¾” Stand Offs GIDS-SC-10015
40+/- #10-24 x 3/8” PH Machine Screws
6 #10-24 x ¾ PH Machine Screws
20+/- #10 Nuts and Lock washers

Electrical

2 2” Gear Head Motors GRDS-MC-10001
1 SPST Toggle Switch
1 12 volt x 1.2 Amp. Hr. SLA battery
2’ Red 16 AWG stranded wire
2’ Black AWG stranded wire
Assorted wire nuts

Performance Tip. Go to www.gearseds.com to download a complete catalog and description of **GEARS-IDS™** Invention and Design System components. This will help you locate the parts.

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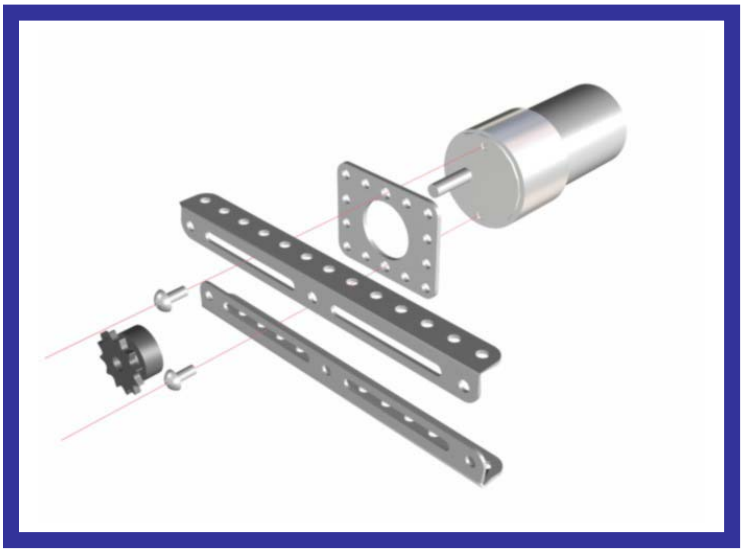
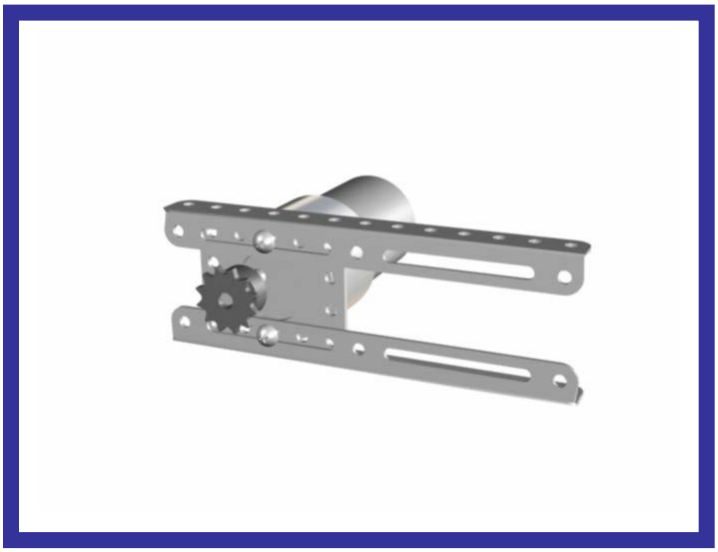
Construct the Drive Train and Chassis with these Subassemblies

Note: 2 Assemblies are required for right and left side drives.

1. **Shaft plate Assembly**
2. **Wheel, Axle and Sprocket Assembly**
3. **Motor, Motor Mount and Angle Assemblies (2)**
4. **Chassis**





Step 1

Motor Mount and Angle Assembly

(2 Required)

Study the illustration carefully, and be certain that all the components are aligned as indicated. Be certain to bolt the motor, motor mount and angles by passing a #10-32 machine screw, through the slotted side of both angles and into the motor mount and motor. Offset the motor and mount 1 hole from the end as shown.

Note: Use 10#-32 machine screws to attach the Motor and Mount. Use #10-24 machine screws for the balance of the assembly.

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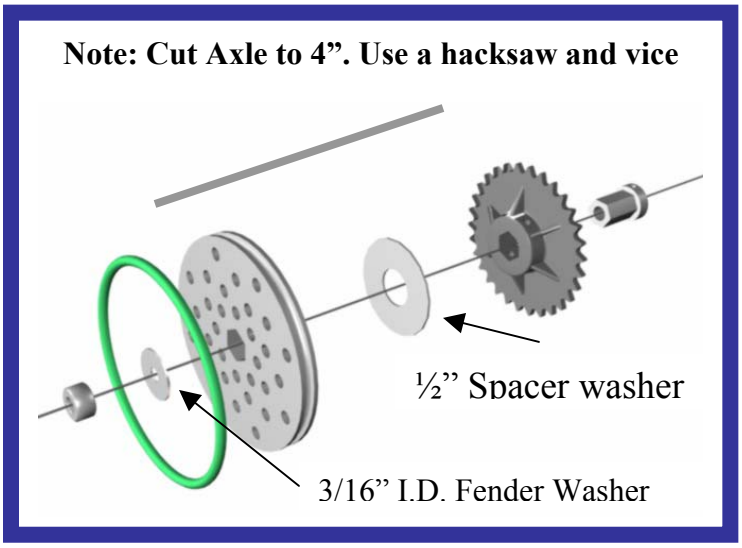
Step 2



Assemble the Wheel, Axle and Sprocket. (2 required)

Cut a 6-3/8" length of the Green Poly Cord belting for tires. These can be easily made by following the directions available at www.gearseds.com . Click on **Support**, then **Documentation.**

Cut 2, 4" lengths of 3/16" axle stock.

Use the 3/16" I.D. Fender washers and shaft collar to lock the wheel to the hex adapter and axle. Use a ½" flat washer as a spacer.

Pass the axle through the center of each component.

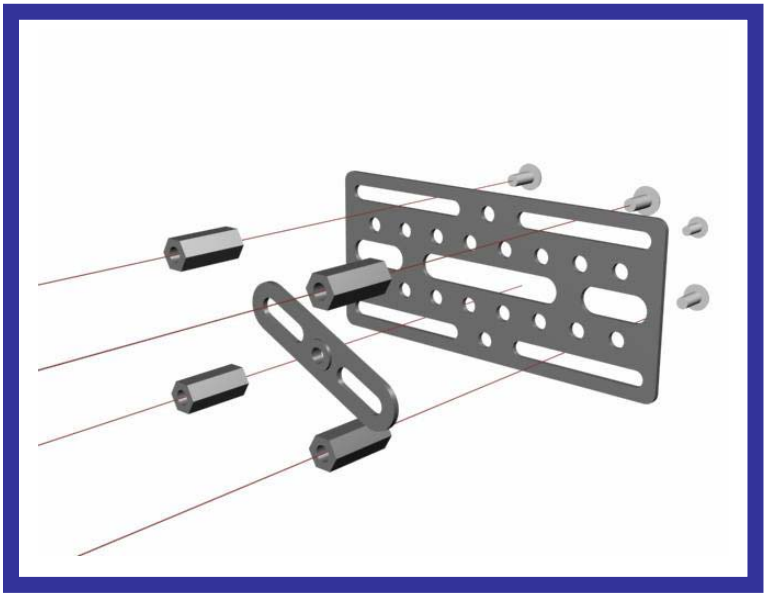
Leave the setscrews loose until the final assembly. Do not over tighten the setscrews.

Step 3a

Assemble the Shaft Plates.
(2 required)

Use four of the #10-24 stand offs to separate the plates. Attach the stand offs to the BACK plate only. Use #10-24 x 3/8" machine screws and #10 Star Washers, to attach stand offs to the shaft plate.

Do not bolt the front plate to the back plate at this time. This sub assembly will attach to the motor and angle assembly by threading machine screws through the angles, through the front shaft plate and into the #10-24 stand-offs.

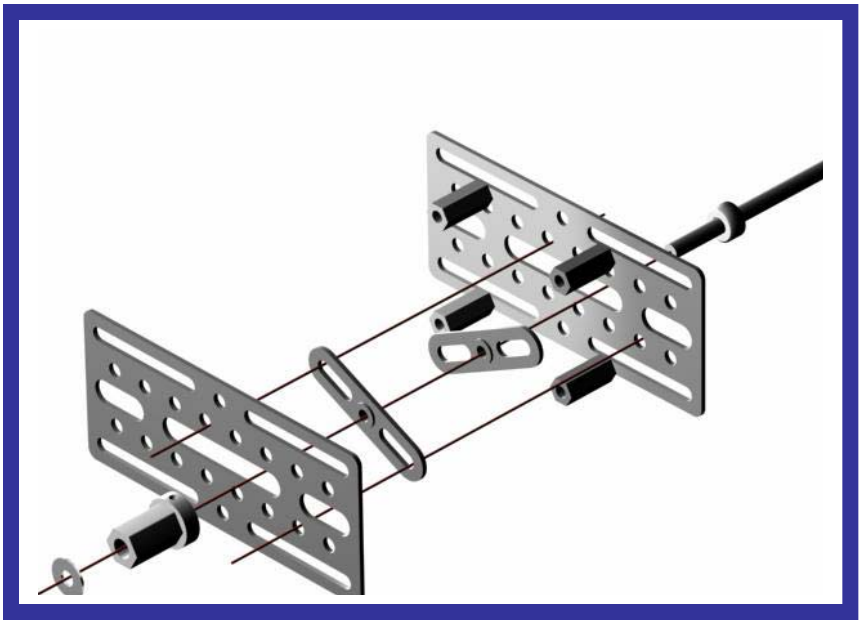


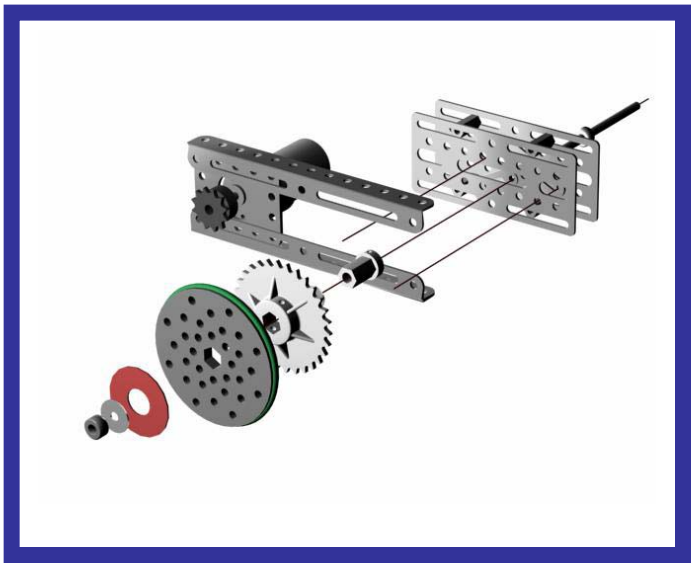
Step 3b

Bolt the Bushing Brackets to the inside of the Shaft Plates using #10-24 x 3/8" machine screws, nuts and washers.

Pass the screws through the outside of the Shaft Plates. Both Bushing Brackets are attached to the inside of the Shaft plate.

Hand tighten the screws only!





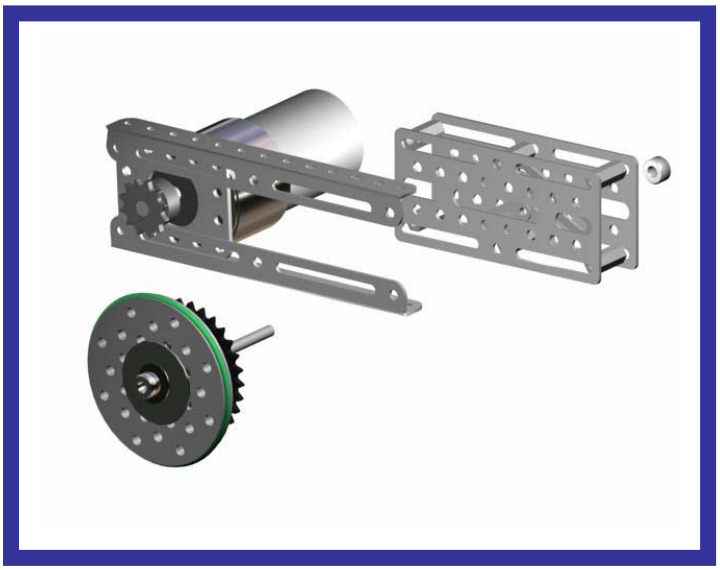
The Shaft Plates should be attached by threading four #10-24 machine screws through the 13 hole angles and into the four #10 standoffs. This is similar to how the motor and motor mounts are attached. The shaft plates can be attached anywhere along the length of the angle. This allows the length, and configuration of the chassis to be adjusted as needed.

Install the wheel and axle assembly **after** the shaft plates are bolted to the 13 hole angles.

The motor can slide along the slot in the angle. This provides for convenient adjustment of the chain.

Note: Construct subassemblies and modules by hand tightening all the fasteners. The construction of these drive train modules requires frequent adjustment. Tighten the completed assemblies only after you have ensured that all parts are fitted properly.

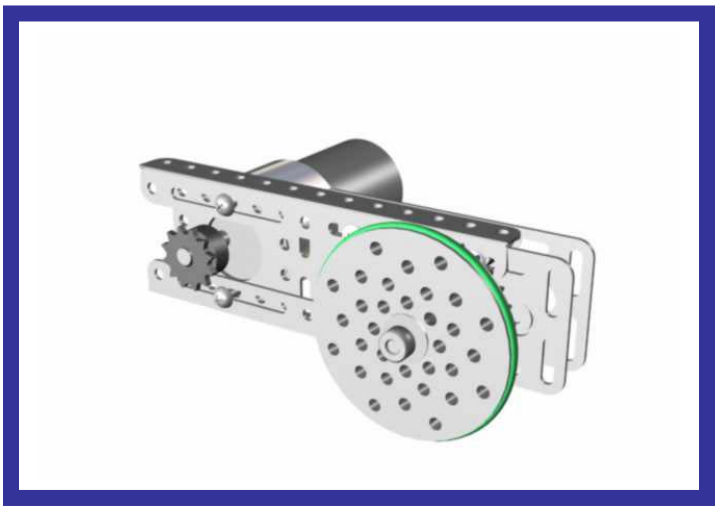
Step 4



Combine the Motor and Shaft Plate Assemblies.

Integrate these two sub assemblies by bolting the shaft plates to the angles as shown. Be certain the machine screws pass through the angle slots and into the shaft plate assembly.

Step 5



Caution: Never hold the chain with your fingers while attempting to separate a link. If the screwdriver slips, it could easily cause a puncture wound. Always use pliers to hold and separate the links.

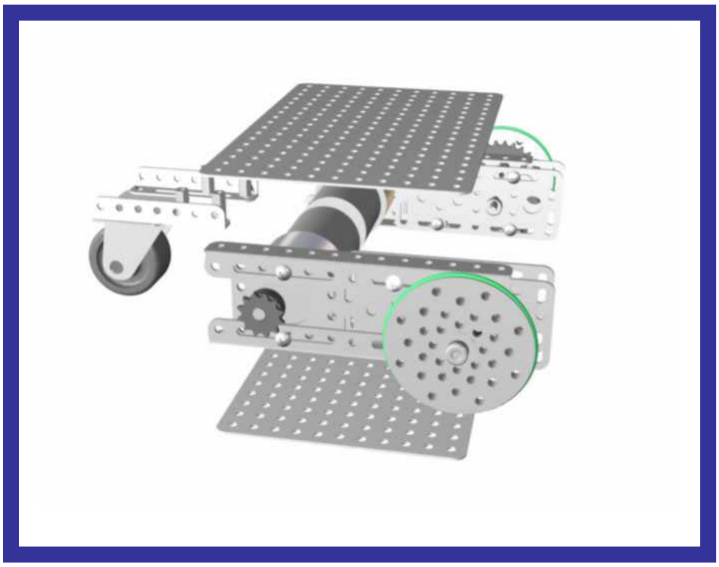
Attach the Wheel and Axle Assembly

Attach the wheel and axle assembly by passing the axle through both bushing brackets. Use a 3/16” shaft collar on each end of the axle to retain the wheel and axle sub assembly.

Attach the chain. The chain links can be separated using a jeweler’s screw driver and a small pair of needle nose pliers. Hold the chain firmly on a cutting board with a pair of needle nose pliers. Carefully separate the links with a jewelers screw driver.

Step 6

Create a Mobile Chassis



Use two 6”x9” plates as shown, to easily construct a mobile chassis.

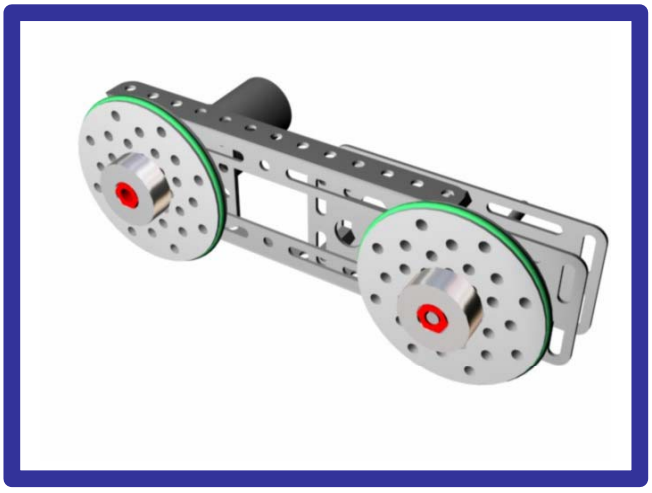
There are many ways to configure a mobile chassis using this drive train configuration.

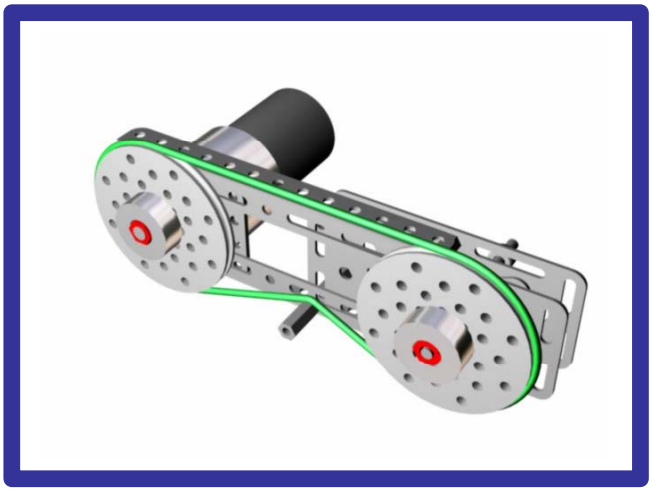
Note: 2 wheel drive chassis work best if one or two casters are used.

The illustrations below demonstrate how the 10 tooth motor sprocket can be replaced with a hex adapter and wheel making a four-wheeled mobile chassis.

Get Creative and Test Different Drive Systems

By substituting and changing some of the components you can create a 4 wheel drive mobile chassis. By adding a continues drive belt you can improve performance significantly.





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Wiring an On / Off Switch

This on/off switch circuit can be built quickly and easily. Using this circuit will allow you to perform some simple tests that will help you evaluate the tractive forces developed by this drive train and chassis. By placing weights at different locations on the chassis you will be able to experiment with the effect that weight distribution has on traction and stability of the drive train and chassis.

ALWAYS TURN THE ROBOT SWITCH OFF BEFORE HANDLING OR PICKING UP A POWERED MOBILE CHASSIS.

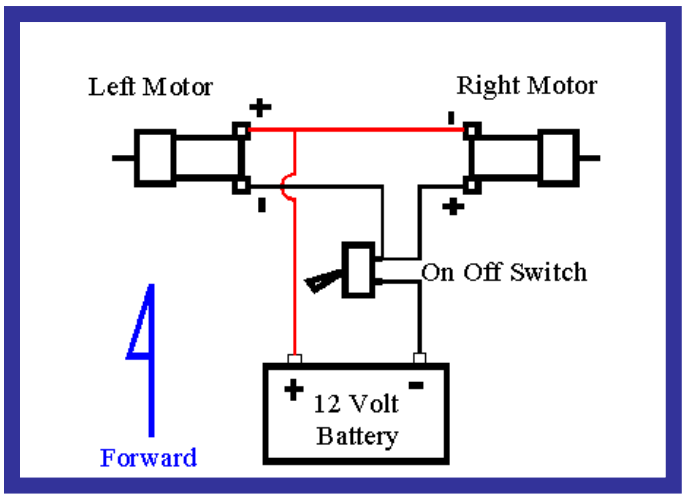
Wiring

There are several methods of attaching wires to the switch and motors.

1. Soldering: This method is best for permanent installations. Soldering can be dangerous. Soldering should only be done with a responsible adult supervisor present.
2. Solderless connectors: These are the preferred means of attaching wires and cables to components like motors, switches and bus bars. Solderless connectors come in many styles. Common types include butt, fork, ring and male/female spade connector styles. You can purchase Solderless connectors and the required crimping tool at any local hardware store.
3. Wire nuts: Wire nuts are the best choice for connecting wire ends together when frequent assembly and disassembly is required. Wire nuts are available in several sizes. The wire nut size depends on the gauge and number of wires being connected together. Wire nuts are also available at local hardware stores.

The Circuit

Creating and operating this circuit will help participants understand that current direction (Polarity) affects the rotational direction of fixed magnet DC motors.

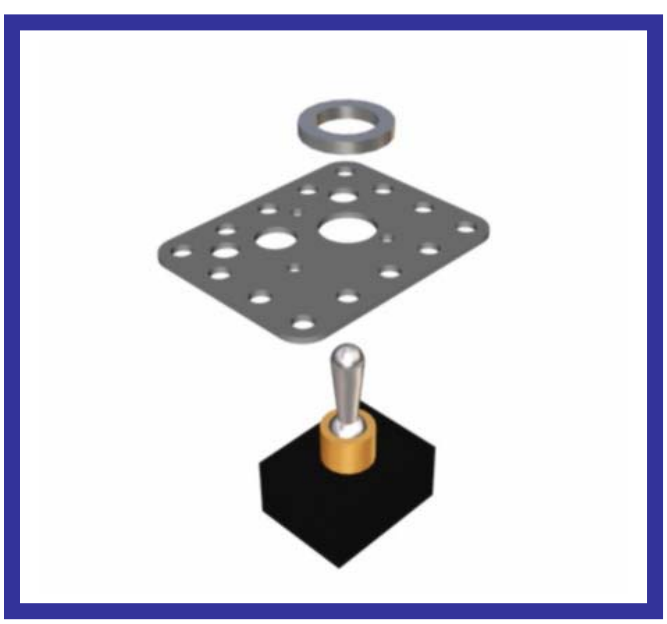


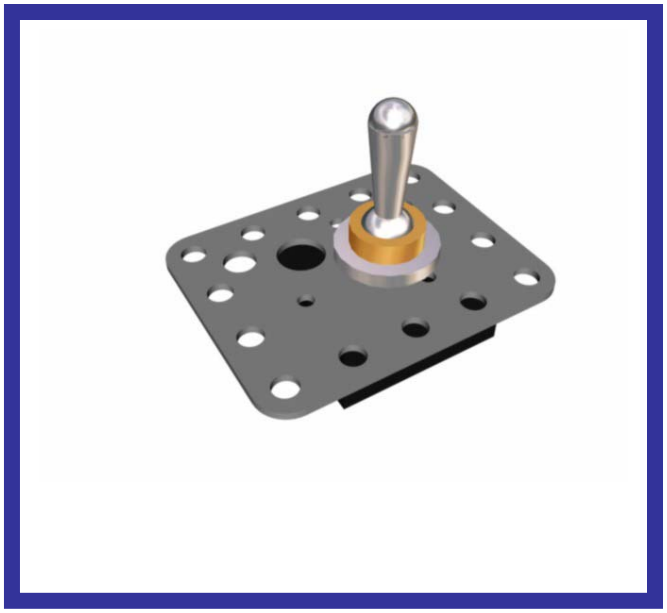
Note: These motors are fixed magnet DC motors. Right and left side motors turn in opposite directions. The direction of a fixed magnet DC motor is determined by the polarity, or direction of the current through the motor.

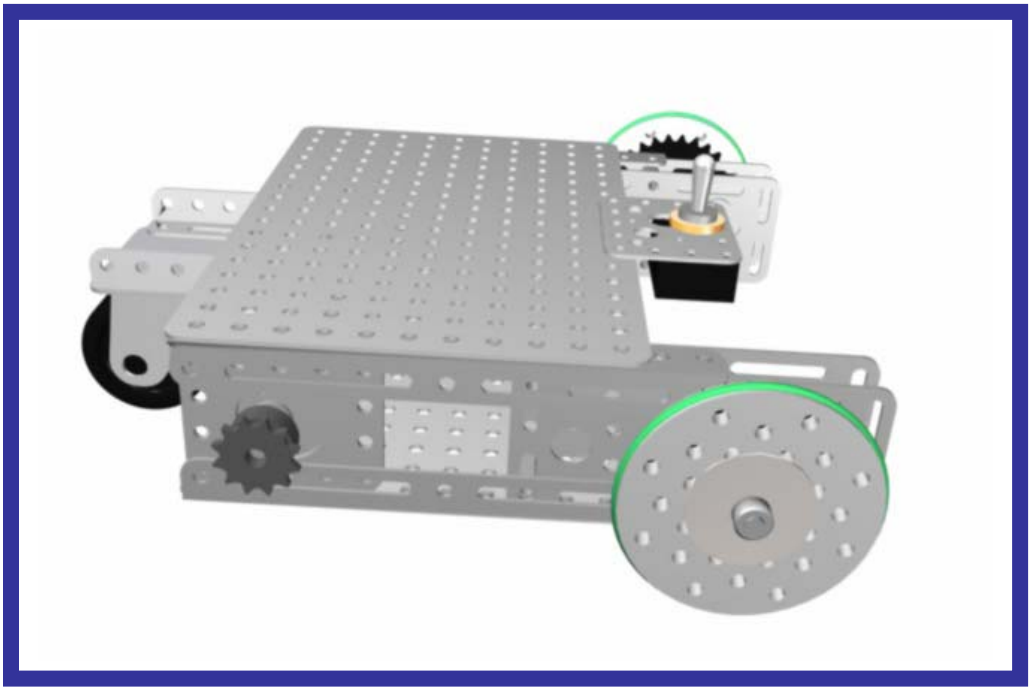
The motors are wired in parallel with the battery. The current through the right motor is reversed, causing the motor to turn clockwise. The current through the left motor is normal and results in a counter clockwise direction. This results in a mobile chassis that will move forward when the switch is turned on.

Building a Switch Plate

The M13 motor mount plate is designed mount industry standard motors and toggle switches. The illustration below provides an example of how to build a switch plate that can be quickly and easily attached to any machine chassis.







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