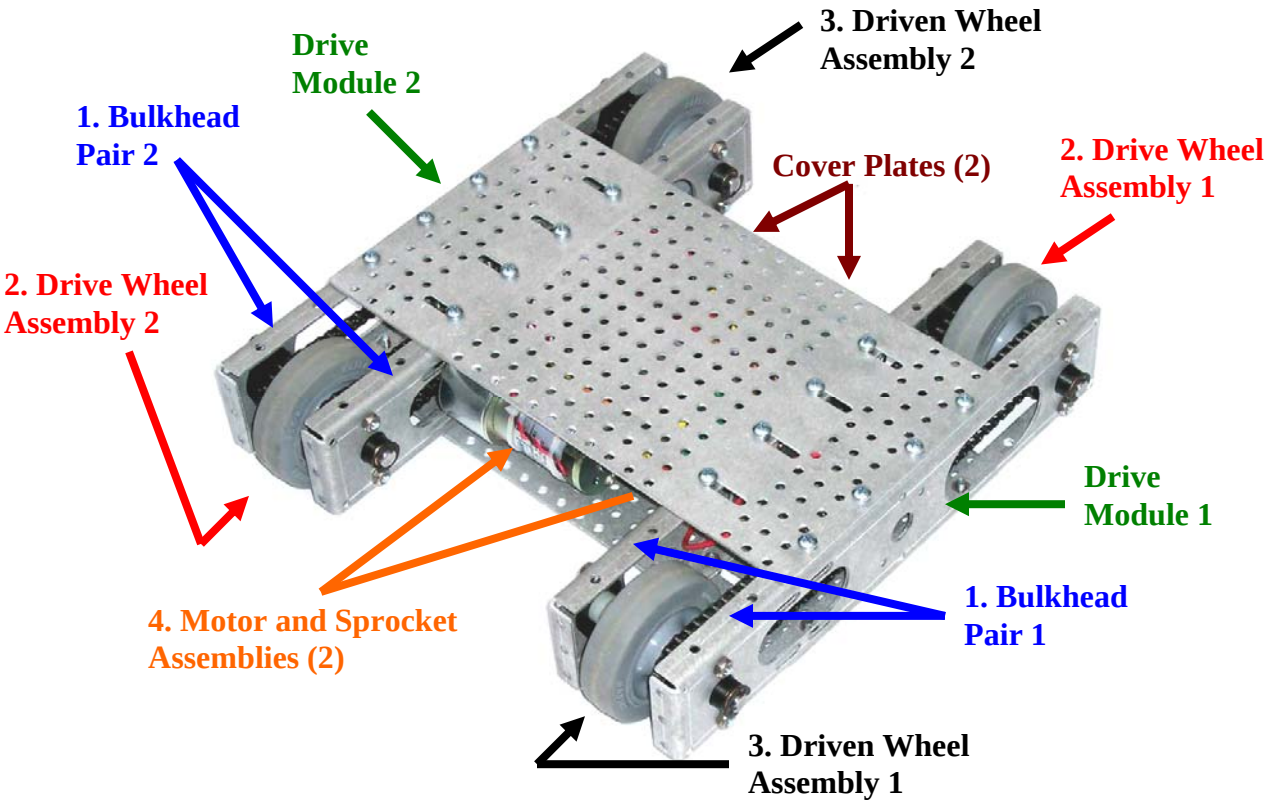
Gears
Educational Systems, LLC

The HMC Heavy Metal Chassis Construction Guide

The Heavy Metal Chassis is constructed using two identical drive modules. The drive modules are constructed using 4 mechanical sub-assemblies. The drive modules are easily integrated into a single chassis using two cover plates.



Mechanical Sub-Assemblies

1. **Bulkhead Sets** (2 required)
   There are four (4) bulkheads paired in two (2) sets. 2 students working together can construct all four bulkheads (both sets) in about 10 - 15 minutes.
2. **Drive Wheel Assembly** (2 required)
   There are two (2) drive wheel assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.
3. **Driven Wheel Assembly**
   There are two (2) driven wheel assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.
4. **Motor and Sprocket Assembly**
   There are 2 motor and sprocket assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.

Total chassis construction time for two students: 70 – 90 minutes.

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Necessary Tools

Safety Glasses
Phillips Head Screwdriver #1 pt. And #2 pt.
Allen Wrench or Hex Key (sizes .050, 1/16, 5/64, 3/32, and 1/8)
3/8 “Wrench
Wire Strippers and Crimpers
Smooth File (Small)
3/16” round file (Similar to a chain saw file)

Materials

Structural/ Mechanical

Qty.	
8	3/8” I.D. Flanged Bearings
2	PVC Chain Guides
2	10 Tooth, 25 Pitch Steel Sprockets w 0.250” Bore
6	20 Tooth, 25 Pitch Steel Sprockets w 0.375” Bore
20	#8-32 x 1/8” cup Head Set Screw
8	3/8” “E” Clip
2	25 Pitch, 100 Link Assembled Chain
2	25 Pitch, 40 Link Assembled Chain
4	Bulkhead Plates
2	HMC Cover Plates
4	4” Wheel and Keyed Aluminum Bushing Assembly
4	3/8” Dia. x 4” Long Machined Axle with Key Slot
2	Gearhead Motor (9.6 Volt, 19.7:1 Standard)

Hardware

Qty.	
52	#10-32 x 3/8" Phillip Machine Screws
2	#10-32 x 3/4" Phillip Machine Screws
18	#10-32 Nylon Lock nuts
6	#10 Flat Washers
38	#10 Lock Washers
*18	3/8” Bore x 5/8” OD x 0.125” Nylon Spacer Washers
*8	3/8” Bore x 5/8” OD x 0.062” Nylon Spacer Washers
*2	3/8” Bore x 5/8” OD x 5/8” Nylon Spacer Washers
2	3/32” x 2.3” Round Ended Key Stock
2	3/32” x 1.75” Round Ended Key Stock
1	Loctite™ 243 .5ml ampule

Electrical

1	SPST Toggle Switch
1	Switch Plate and Fasteners
1	Electronics Kit (Includes motor controllers, wire and connectors.)

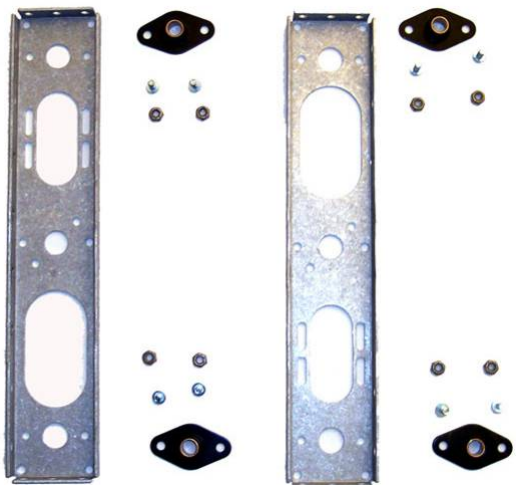
Note: In order to maximize the educational benefit to the students and minimize the time on task, it is advisable to let the students handle and identify all the HMC components and review this document before beginning the assembly of the HMC. It is especially helpful to study the illustrations at the end of this document in order to learn what the final assemblies look like and how the components, assemblies and modules are related.

** Kits are shipped with both 0.062”, 0.125” and 5/8” thick spacer washers. Use them as necessary to achieve the necessary axle spacing.*

Assembly 1
Bulkhead Sets

2 Assemblies (sets) required
Average assembly time: 2 students about 10-15 minutes

Note: Since it is necessary to assemble 2 identical modules it is helpful to assign one student to assemble a module and one student to assemble the other, identical module.

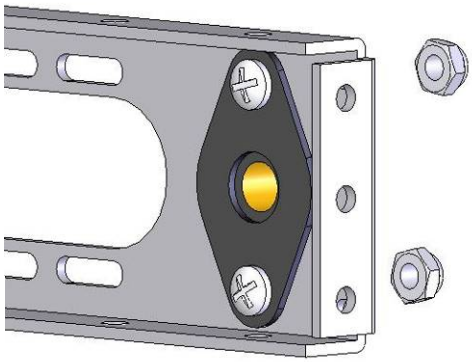


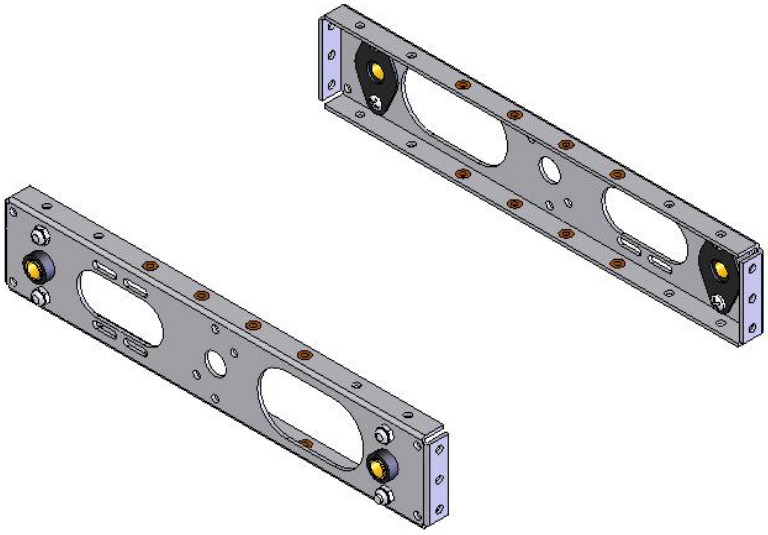
Components and Tools to Make 2 Modules

Qty.	Description
16	#10 Nylon Locking Nuts
16	#10-32 x 3/8" PH Machine Screws
4	Bulkhead Plates
8	3/8" I.D. Flanged Bearings
1	3/8" Combination Wrench (not shown)
1	#2 Phillip Head Screwdriver (not shown)

Procedure

1. Place the 3/8" I.D. flanged bearings into the mounting holes on the bulkhead as shown in the illustration below. Place the bearings through the bulkhead plates from the inside, to the outside as illustrated.
2. Attach the flanged bearings using (2) #10-32 x 3/8" Phillips head machine screws, and (2) #10-32 nylon locking nuts. Secure the nuts firmly onto the machine screws using a 3/8" wrench and a #2 Phillip head screwdriver.





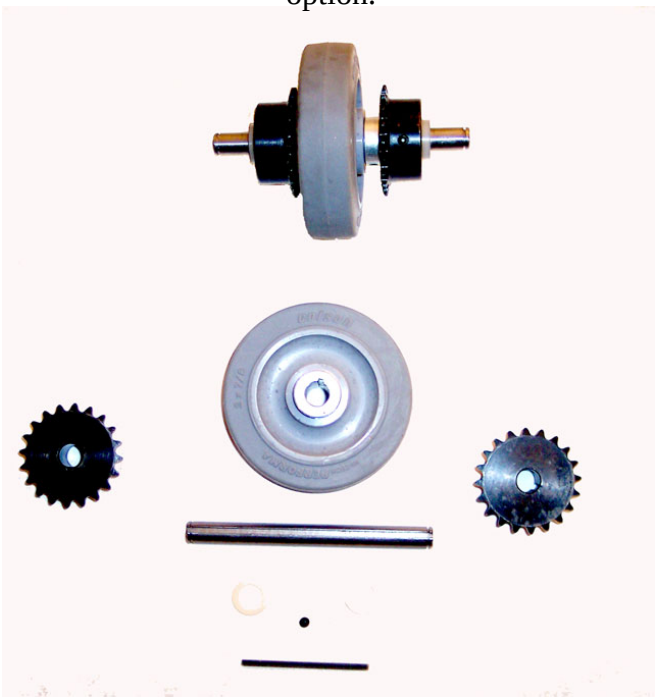
The approximate torque (Tightening) specification is about 22 -26 inch pounds. If this specification is not familiar to you then take a moment to research torque specifications online or ask someone who knows.

3. Repeat the procedure for 2 additional assemblies (4 total).

Assembly 2
Drive Wheel

2 Assemblies required
Average assembly time: 2 students about 10-15 minutes

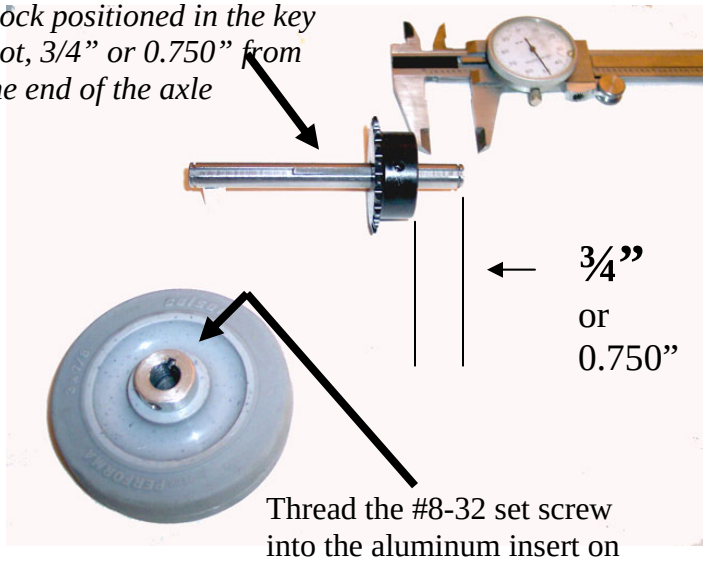
Note: Standard wheel diameter is 4". For reduced clearances, 3" wheels are an available option.



Components and Tools for 2 modules

Qty.	Description
2	4" Wheel and Keyed Aluminum Bushing Assembly
2	#8-32 Cup Head Set Screw
2	3/8" Dia. x 4" Long Machined Axle with Key Slot
4	#25 Pitch, 20 Tooth Steel Sprockets With 3/32" Internal Broach and (2) #8-32 Set Screws
4	**3/8" ID x 5/8" OD x 0.125" Nylon Spacer Washers**
8	***3/8" ID x 5/8" OD x 0.062" Nylon Spacer Washers**
2	3/32" x 3/32" x 2.3" Round End keyways
1	5/64" (0.078") Allen Wrench or Hex Key
1	3/32" Allen Wrench or Hex Key
1	6" Flat File (Fine)
1	Dial Calipers

3/32"x 2.3" long key stock positioned in the key slot, 3/4" or 0.750" from the end of the axle



Thread the #8-32 set screw into the aluminum insert on the broach side.

Procedure

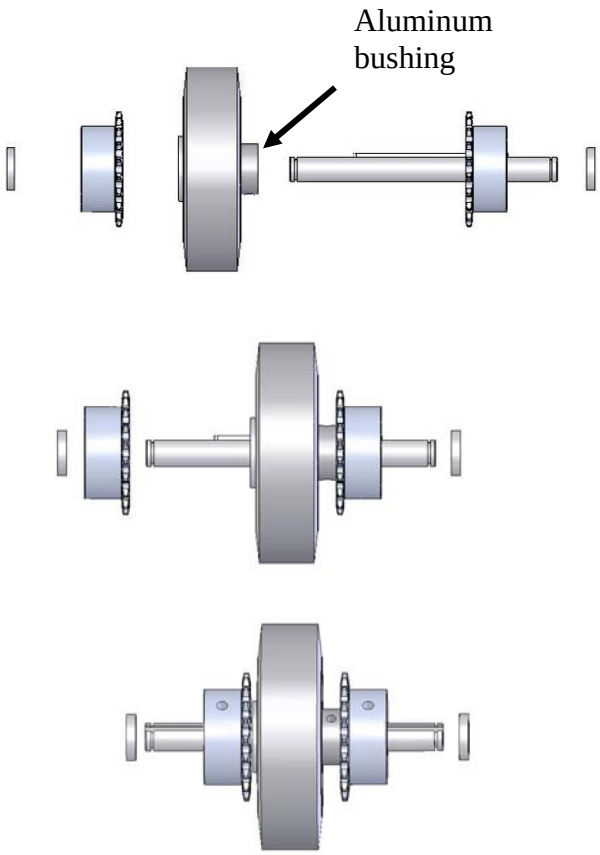
1. **Use the flat file to break the edges of the key slot along the entire length of the 3/8" dia. x 4" long machined axle. This will help ensure there are no burred metal edges on the axle key slot, and will allow the key stock to slide smoothly in the axle key slot.
2. Clean the axle key slot removing any dirt or foreign matter.
3. Insert the 3/32" x 3/32" x 2.3" (The longer of the 2) key stock into the key slot on the axle shaft. Position the 3/32" key stock so that one end is more than 0.750" from one end of the axle.
4. Slide one of the #25 Pitch, 20 Tooth sprockets onto the shaft and key stock assembly as shown. Position the sprocket boss so that it extends 1/16" past the end of the key stock and also ¾" or 0.750" from the end of the axle. Set screw must tighten onto keyway.

** Kits are shipped with both 0.062" and 0.125" thick spacer washers*

**Note: It will be necessary to "Fit" the keyway to the axle slot. This is easily accomplished by rubbing the key stock along the file to remove a few 0.0001" from the key, until it slides easily in the key slot. This only needs to be done once and it is a standard assembly procedure.

Assembly 2 continued.

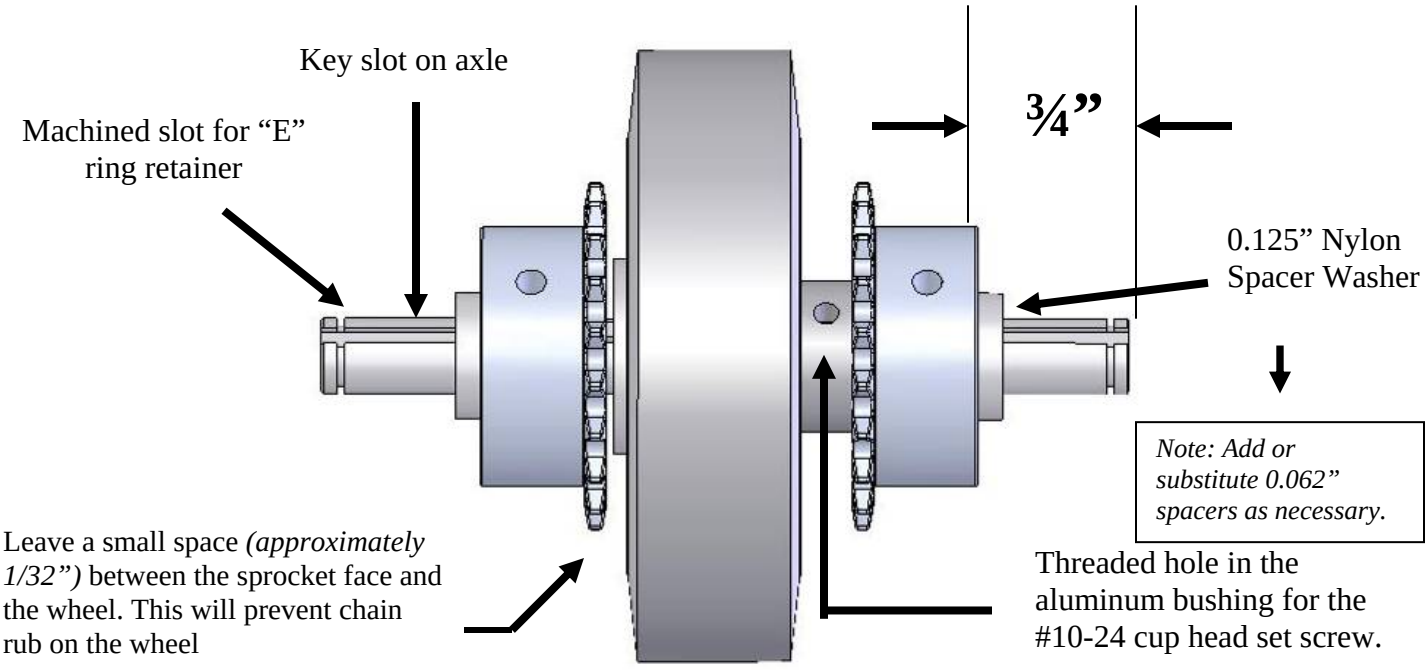
Note: Always check that the set screws are backed off before sliding any component onto the axle and key stock. Otherwise the set screw may hang up on the key stock.



5. Fasten the sprocket to the shaft by first tightening the set screw on the key stock. Then tighten the second set screw on the sprocket. Notice there are two (2) set screws on each sprocket boss, These set screws are positioned 90 degrees from each other. Use approximately 6 – 8 inch lbs of torque when tightening the set screws.

Note: If the assembly is to be left in place semi permanently, then it is advisable to use a small drop of blue Loctite® 243. on the set screws, Remember that blue Loctite® comes in a red bottle! Look it up online and learn why it is used and how best to apply it!

6. Thread a #10-24 x 1/8" cup point set screw into the aluminum bushing on the 3"or 4" wheel and bushing assembly. Be careful to consider these two steps; One: Thread the set screw into the hole that is in line with the internal broach in the aluminum bushing. Two: Turn the set screw in only one complete turn, no more. Turning the set screw in too far will cause it to hang up on the key stock and it will not be possible to slide the wheel assembly onto the shaft.



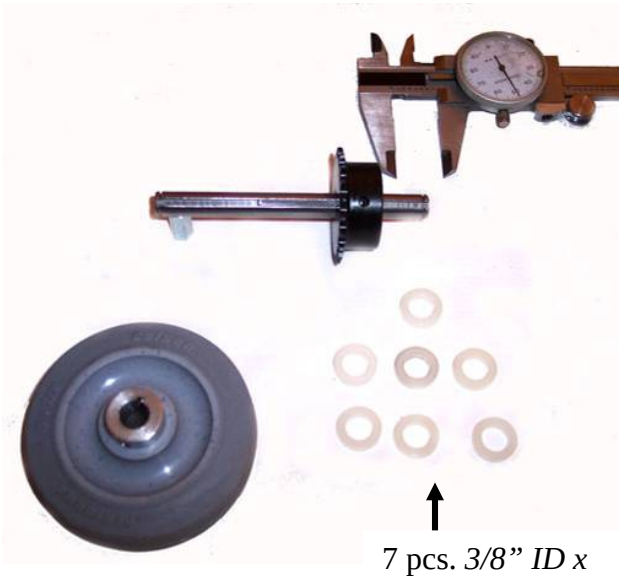
Make two (2) of the assemblies illustrated above

Assembly 2 continued

7. Slide a second #25 pitch, 20 tooth sprocket onto the axle on the opposite side of the wheel. Refer to the illustrations on the previous page. Notice the alignment of the second sprocket. The sprocket face is adjacent to the 3" caster wheel. Look closely at the large illustration on the bottom of the previous page, and notice that the face of the left side sprocket is not touching the face of the wheel. In fact the sprocket face must be secured onto the axle at **a distance of 1/32"** from the nearest face of the caster wheel. If the sprocket face is too close, the chain will rub on the wheel. If the sprocket face is too far from the face of the wheel, the axle assembly will bind on the bearing faces and the added friction will degrade the performance of the Heavy Metal platform.
8. Check that all the set screws are securely tightened and the critical spacing from the end of the shaft (3/4") and the face of the sprocket on the left side of the assembly, (1/32") are correct.
9. Add a 3/8" ID x 1/8" (0.125") or 3/8" ID x 1/8" (0.062") nylon spacer washer(s) as necessary to each end of the axle assembly.
10. Assemble another, identical unit since two of these assemblies are required to complete the Heavy Metal Chassis.

Assembly 3
Driven Wheel

2 Assemblies required
Average assembly time: 2 students about 10-15 minutes



7 pcs. *3/8" ID x 5/8" OD x*

Necessary Components and Tools

Qty.	Description
2	3" or 4" Wheel and Keyed Aluminum Bushing Assembly
2	#8-32 Cup Head Set Screw
2	3/8" Dia. x 4" Long Machined Axle with Key Slot
2	#25 Pitch, 20 Tooth Steel Sprockets With 3/32" Internal Broach and (2) #8-32 Set Screws
14	***3/8" ID x 5/8" OD x 0.125" Nylon Spacer Washers***
4	**** 3/8" ID x 5/8" OD x 0.062" Nylon Spacer Washers***
2	***3/8" ID x 5/8" OD x 0.625" Nylon Spacer Washers***
2	3/32" x 3/32" x 1.75"" Round End keyway
1	5/64" (0.078") Allen Wrench or Hex Key
1	3/32" Allen Wrench or Hex Key
1	6" Flat File (Fine)
1	Dial Calipers

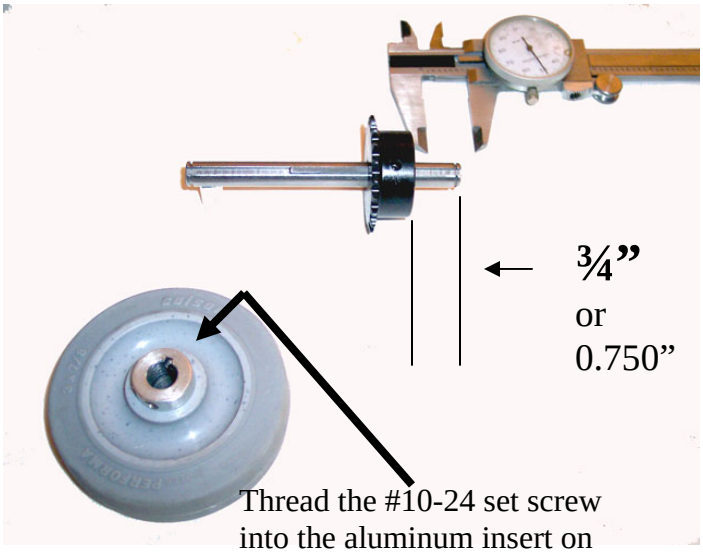
** Kits are shipped with 0.062", 0.125"and 0.625" thick spacer washers to be used as necessary to achieve optimal axle and wheel spacing and alignment.*

Note: Loose is always better than tight!

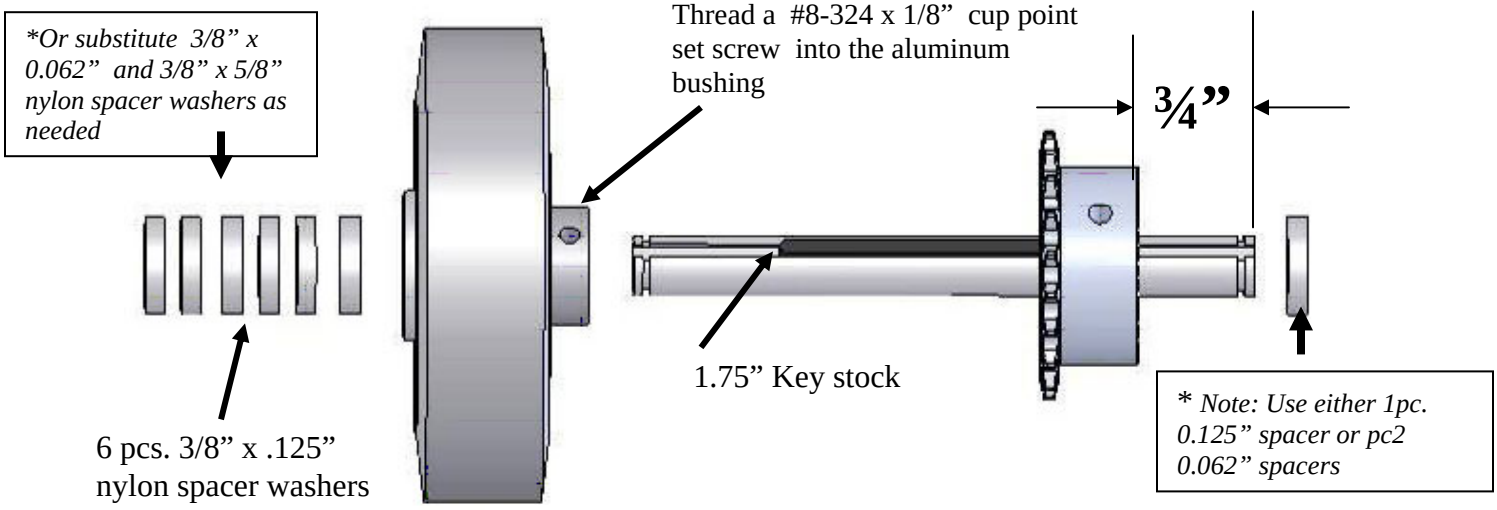
Assembly 3 continued

Procedure

1. Use the flat file to break the edges of the key slot along the entire length of the 3/8" dia. x 4" long machined axle. This will allow the key stock to slide smoothly in the axle key slot.
2. Clean the axle key slot removing any dirt or foreign matter.
3. Insert the 3/32" x 3/32" x 1.75"" (The shorter of the 2) key stock into the key slot on the axle shaft. Position the 3/32" key stock so that one end is more than 0.750" from one end of the axle.
4. Slide the #25 Pitch, 20 Tooth sprocket onto the shaft and key stock assembly as shown. Position the sprocket boss so that it extends 1/16" past the end of the key stock and is also ¾" or 0.750" from the end of the axle. The set screw must tighten onto keyway.



5. Fasten the sprocket to the shaft by first tightening the set screw on the key stock. Then tighten the second set screw on the sprocket. Notice there are two (2) set screws on each sprocket boss, These set screws are positioned 90 degrees from each other. Use approximately 6 – 8 inch lbs of torque when tightening the set screws.
6. Thread a #8-32 x 1/8" cup point set screw into the aluminum bushing on the 3"or 4" wheel and bushing assembly. Be careful to consider these two steps; One: Thread the set screw into the hole that is in line with the internal broach in the aluminum bushing. Two: Turn the set screw in only one complete turn, no more. Turning the set screw in too far will cause it to hang up on the key stock and it will not be possible to slide the wheel assembly onto the shaft.

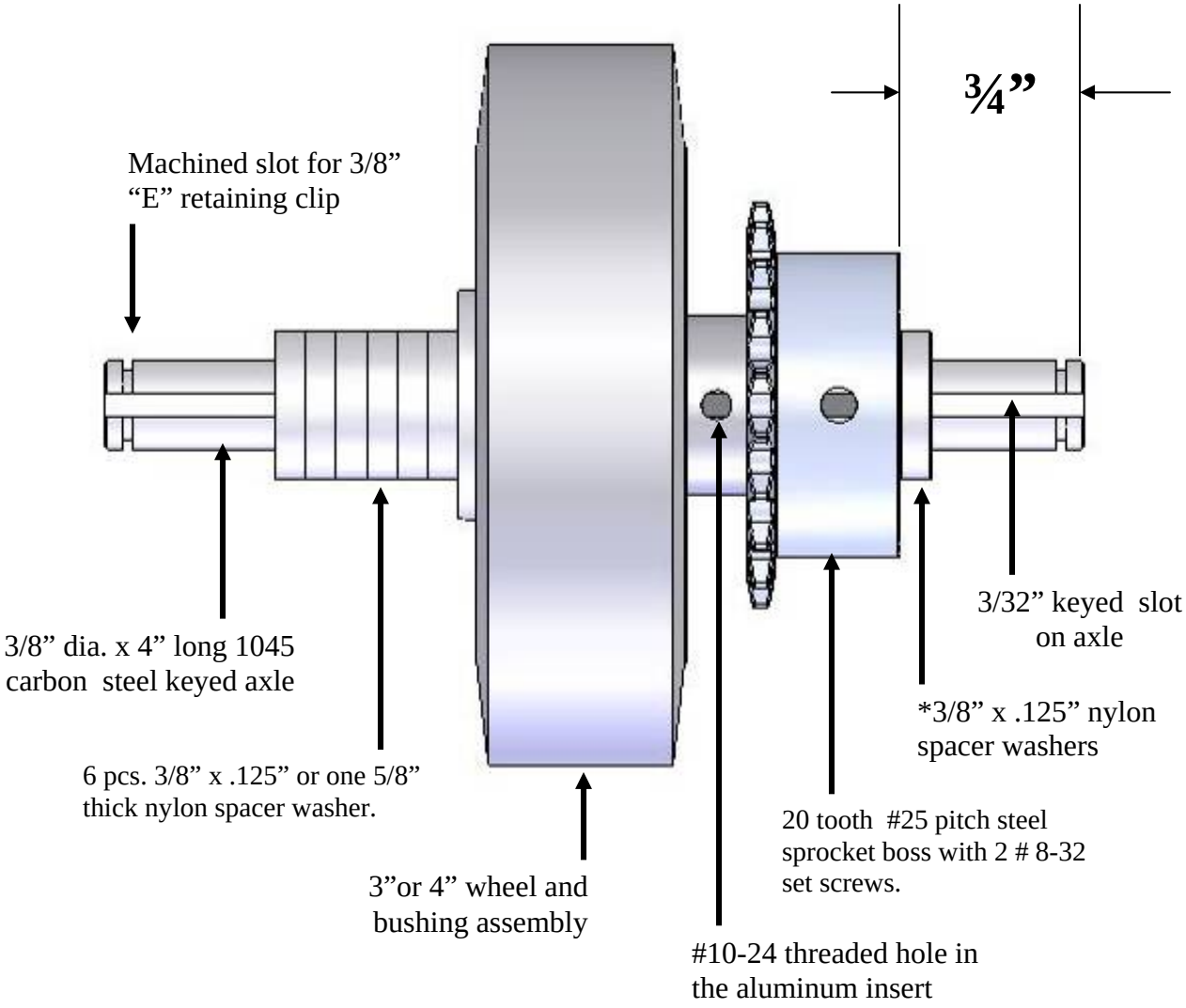


** Kits are shipped with both 0.062", 0.125" and 5/8" thick spacer washers*

*Note:If the assembly is to be left in place semi permanently, then it is advisable to use a **small** drop of blue Loctite® 243 on the set screws. Remember that blue Loctite® comes in a red bottle! Look it up online and learn why it is used and how best to apply it!*

Assembly 3 continued

7. Check that the wheel and bushing assembly is securely fastened to the axle and key stock. Slide six (6) 3/8" ID x 0.125" thick nylon spacer washers onto the shaft as shown.
8. Recheck that the sprocket boss is ¾" (0.750") from the end of the shaft and the key stock is not extending out past the face of the sprocket boss. Note: Even the slightest extrusion of the key stock past the sprocket boss will introduce unnecessary friction and wear on the spacer washer, and ultimately cause the motor and batteries to consume more energy and produce less motive power.



Construct two (2) of the assemblies illustrated above

** Kits are shipped with both 0.062" and 0.125"and 0.625" thick spacer washers. It is up to the users discretion to decide which size or combination of sizes to use to effect the appropriate spacing. Note: Loose is always better than tight!*

Assembly 4
Motor and Sprocket

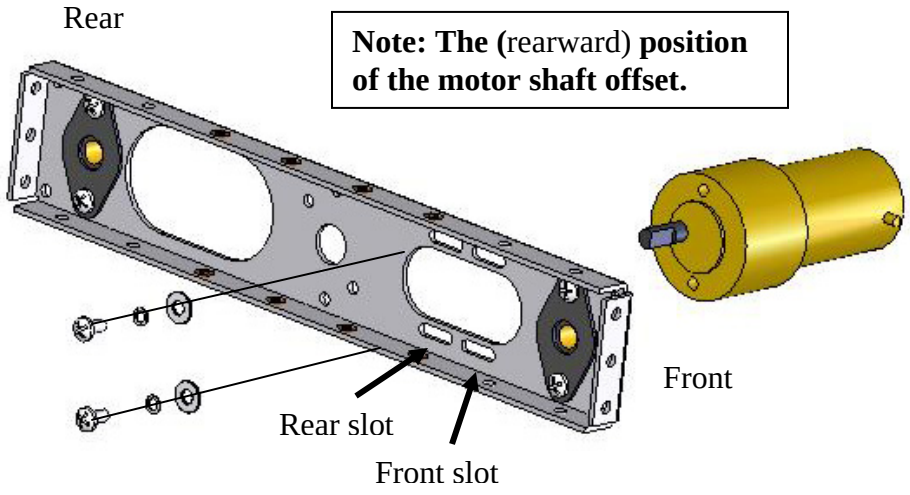
2 Assemblies required
Average assembly time: 2 students about 5-10 minutes

Necessary Components and Tools

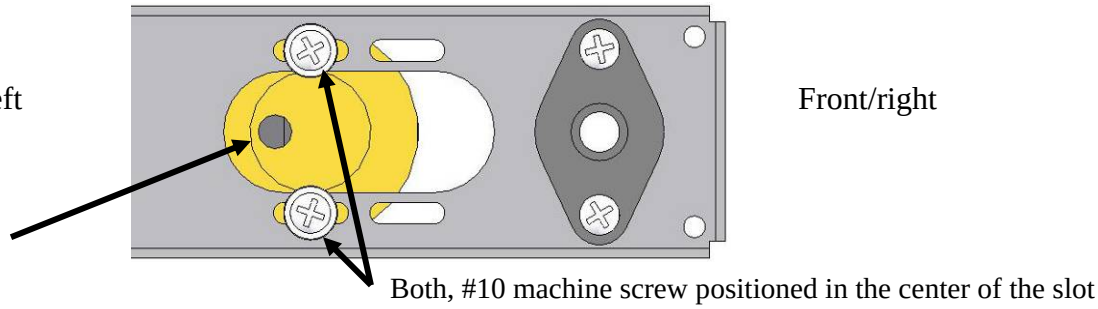
Qty.	Description
2	Gearhead motor
4	#10- 32 x 3/8" Phillips head machine screws
4	#10 lock washers
4	#10 flat washers
2	10 tooth, 25 pitch steel sprocket with 1/4:" bore and set screw
1	12" – 14", #2 point Phillips head screwdriver
1	3/32" Allen Wrench or Hex Key

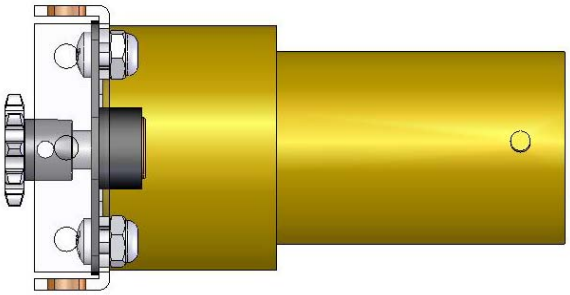
Procedure

1. Fasten the gearhead motor to the bulkhead by threading the #10-32 x 3/8" Phillips head screws, lock washers and flat washers through the **middle** of rear most slot. *Note: Always use flat washers to mount the gearhead motors. They are used to spread the clamping force evenly over a wider area.*

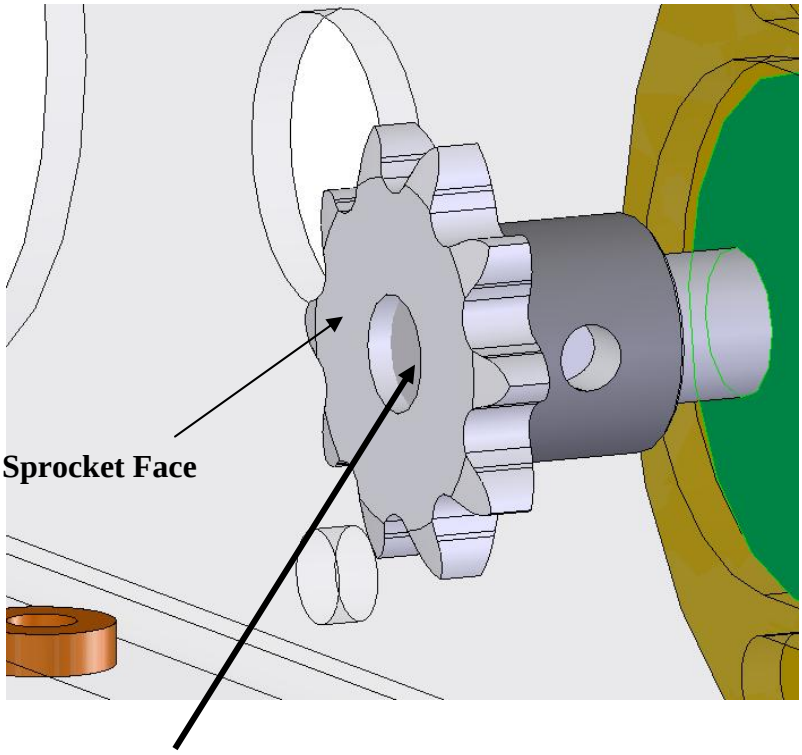


2. Take care to position the motor shaft offset to the rear (left as shown in the illustrations above and below). DO NOT POSITION THE SHAFT TO THE FRONT OR RIGHT SIDE.





3. Tighten the #10-32 Phillips head machine screws, lock washer and flat washer assemblies while keeping them centered in the slot. Use approximately 20-25 inch lbs of torque.
4. Position the 10 tooth, 25 pitch sprocket onto the motor shaft with the sprocket boss facing inward towards the motor gearbox as shown above/left. Make sure that the set screw is backed off enough to allow the sprocket to slide easily onto the motor shaft.
5. Identify the flat on the motor shaft and position the set screws directly over the flat on the shaft. Slide the sprocket onto the motor shaft and gently tighten the set screw onto the flat of the motor shaft in such a way that the sprocket face extrudes 0.025" beyond the end of the motor shaft. Use the tail end of the dial calipers to make this measurement. (See below/right)
6. Tighten the set screw on the flat of the motor shaft to hold the sprocket in the correct position (0.025" past the end of the motor shaft).
7. Once the sprocket has been positioned, remove the set screw and place a small drop of blue Loctite™ thread locker onto the set screw threads. Thread the set screw into the sprocket boss and tighten firmly to approximately 12 inch lbs. Be careful to check the sprocket shaft offset and maintain the 0.025" specification. Use dial calipers to measure and confirm the distance.



Be careful to position the face of the sprocket so that it is offset approximately 0.055" - 0.075" from the end of the motor shaft. One set screw must be secured to the flat on the motor shaft. Use a small drop of Loctite™ thread locker on each set screw for best results.

Drive Module Construction
1.) Integrate Motor/Sprocket and Drive Wheel

2 required. Average assembly time: 2 students about 10 minutes per assembly

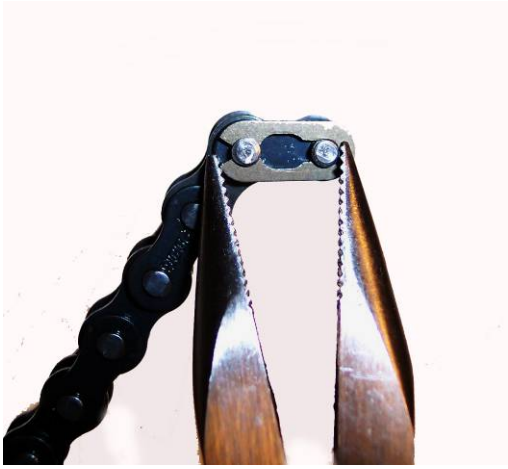
Necessary Components and Tools

Qty. Description

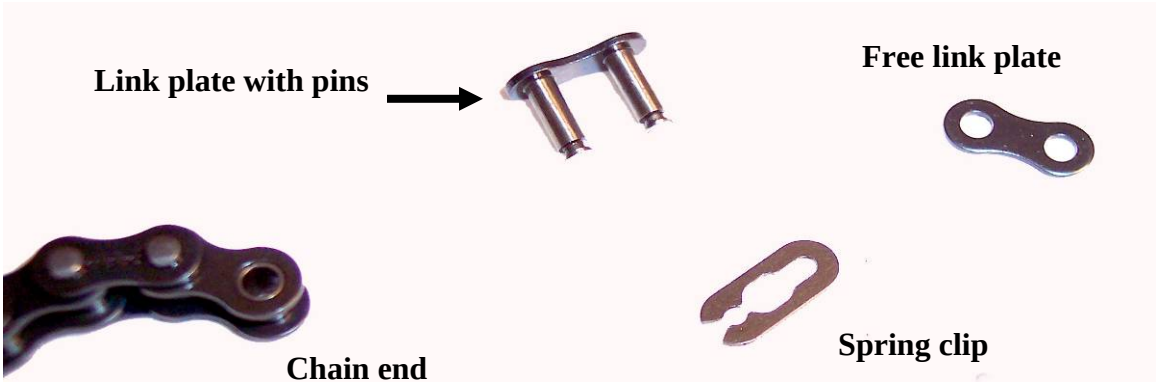
2 Pre-made motor and Bulkhead Assembly (See step 7-8)
2 Pre-made Drive Wheel assemblies (See step 3 and 4)
2 Pre-made bulkhead assemblies. (See step 1 and 2)
2 #25 pitch, 40 link, chain assembly.
2 #25 pitch connecting link (on chain end)
1 Pair (Small) needle nose pliers (not shown)
1 Small (Jewelers' size) flat screwdriver
2 "E" retaining clip (not shown)

Procedure for Fastening Chain with a Connecting Link

Note: If the chains are pre-assembled move to step 5

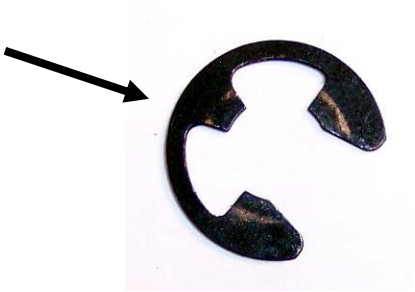


1. Assemble the 42 link chain *(this is the shorter of the two chain lengths*) into a continuous loop. It will be necessary to remove the connecting link from the end of the length of chain. There are several ways to do this. On way is illustrated below
2. Use a pair of small needle nose pliers to simultaneously grip one end of the chain pin and one end of the spring clip retainer on the connecting link.
3. Slowly squeeze the pliers closed in an effort to slide the retaining clip to the right, and off the front pin. Then disassemble the connecting link. The connecting link is comprised of three parts; Link plate with pins, free link plate with oversized holes and a spring clip.

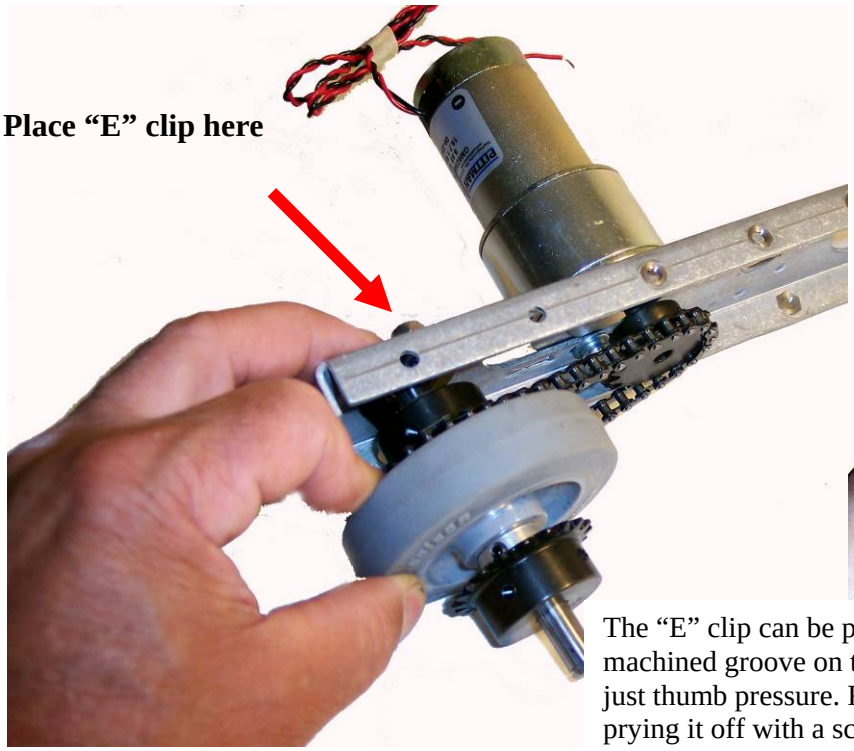


4. Use the connecting link to attach the two ends of the chain in a continuous loop and re-assemble the connecting link using the pliers to slide the spring clip onto the pins.
5. Wrap the 40 link chain around the motor sprocket and the drive wheel sprocket as shown below. Make certain there is a 3/8" ID x 0.125" thick nylon spacer washer on the bearing end of the axle.
6. Insert the axle into the flanged bearing and fasten an "E" (retaining) clip onto the end of the axle to hold the axle in place (See illustrations below).

"E" Clip



Place "E" clip here



The "E" clip can be pushed into the machined groove on the axle end with just thumb pressure. Remove it by prying it off with a screw driver.

2.) Integrate Driven Wheel and Chain

2 required**.** Average assembly time: 2 students about 10 -15 minutes.

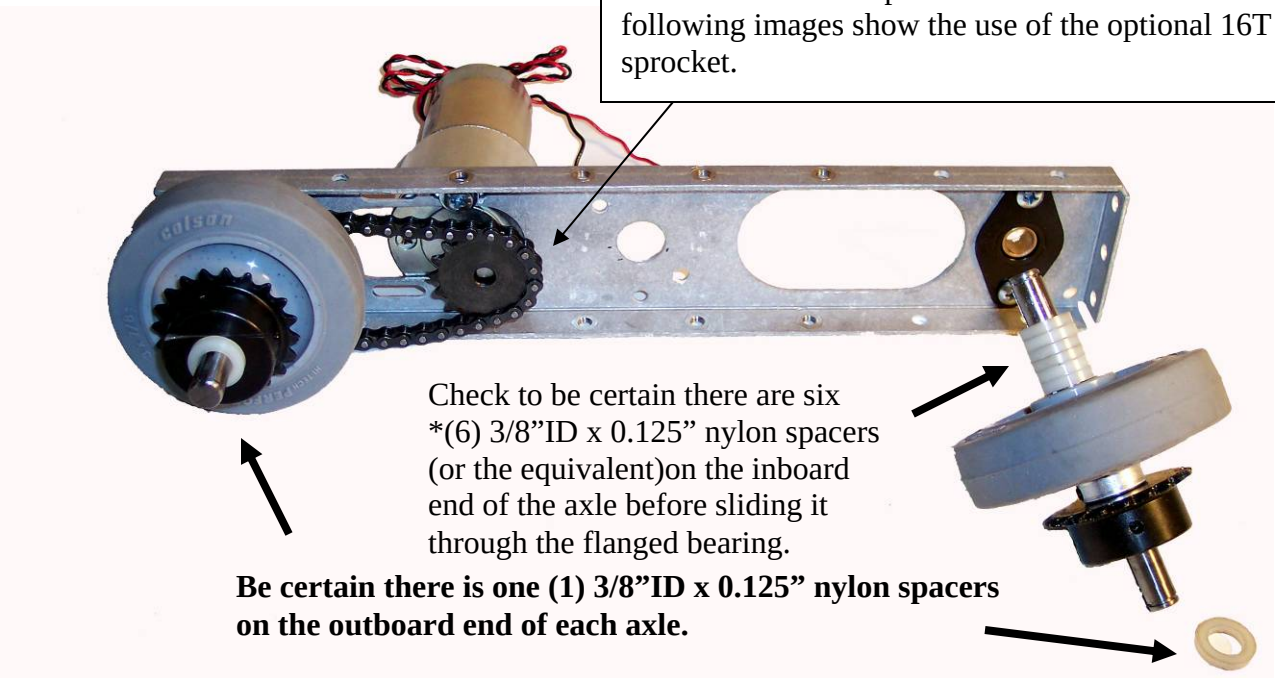
Necessary Components and Tools

Qty. Description

2 Pre-made motor, bulkhead and drive wheel assembly (See 9-10)
2 Pre-made driven wheel assembly (See steps 5 -6)
2 100 link,#25 pitch chain assembly.
2 #25 pitch connector link
2 Pair (Small) needle nose pliers (not shown)
1 Small (Jewelers' size) flat screwdriver (not shown)
1 12" – 14", #2 point Phillips head screwdriver (not shown)
2 Pre-made motor, bulkhead (see 1-2) (not shown)
6 "E" retaining clips (not shown)

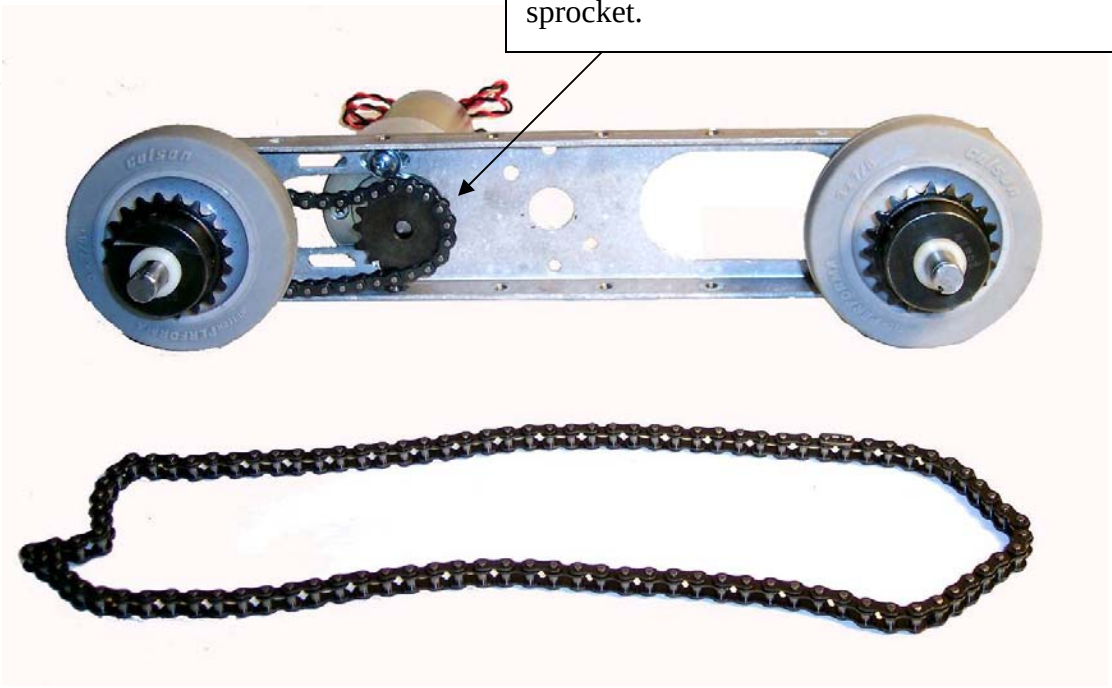
Procedure

1. Fit the driven wheel assembly to the pre-made motor, bulkhead and drive wheel assembly (See 9-10) Be certain that there are six (6) 3/8" ID x 0.125"or 12 3/8" x 0625" thick nylon spacer washers on the inboard end of the axle. Guide the axle end through the flanged bearing and secure it with an "E" clip.



*Note: It may be necessary to substitute 0.062" nylon washers to accomplish the same spacing. Since each assembly is somewhat unique, it will likely be necessary to substitute different combinations of nylon spacers to achieve optimal wheel placement as well as chain and sprocket alignment.

Note: The 10 tooth sprocket is standard. The following images show the use of the optional 16T sprocket.

2. 

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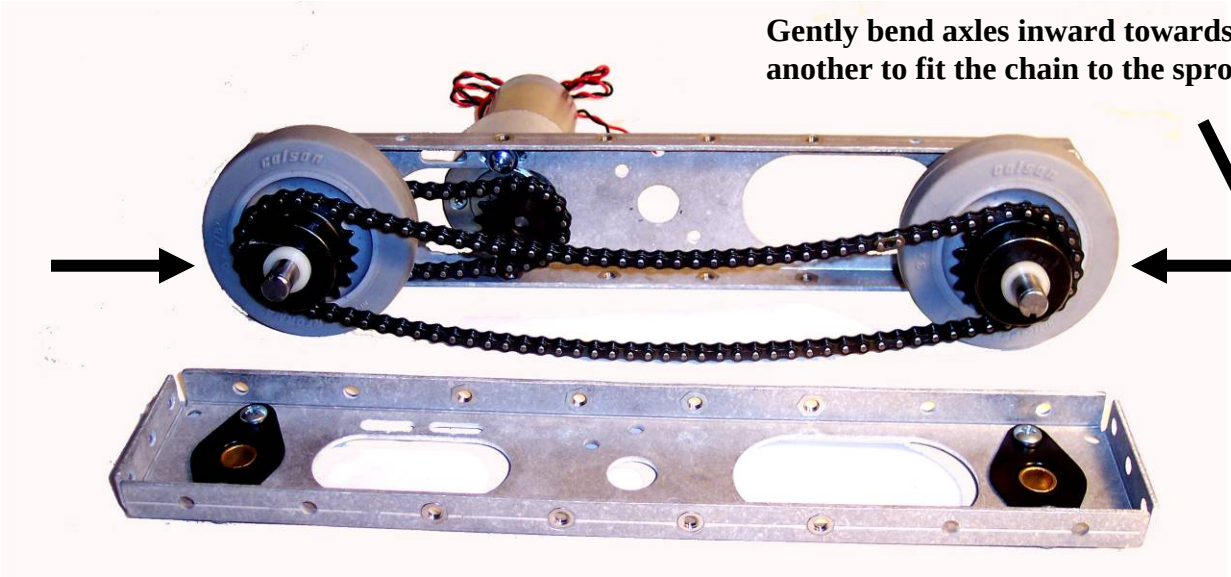
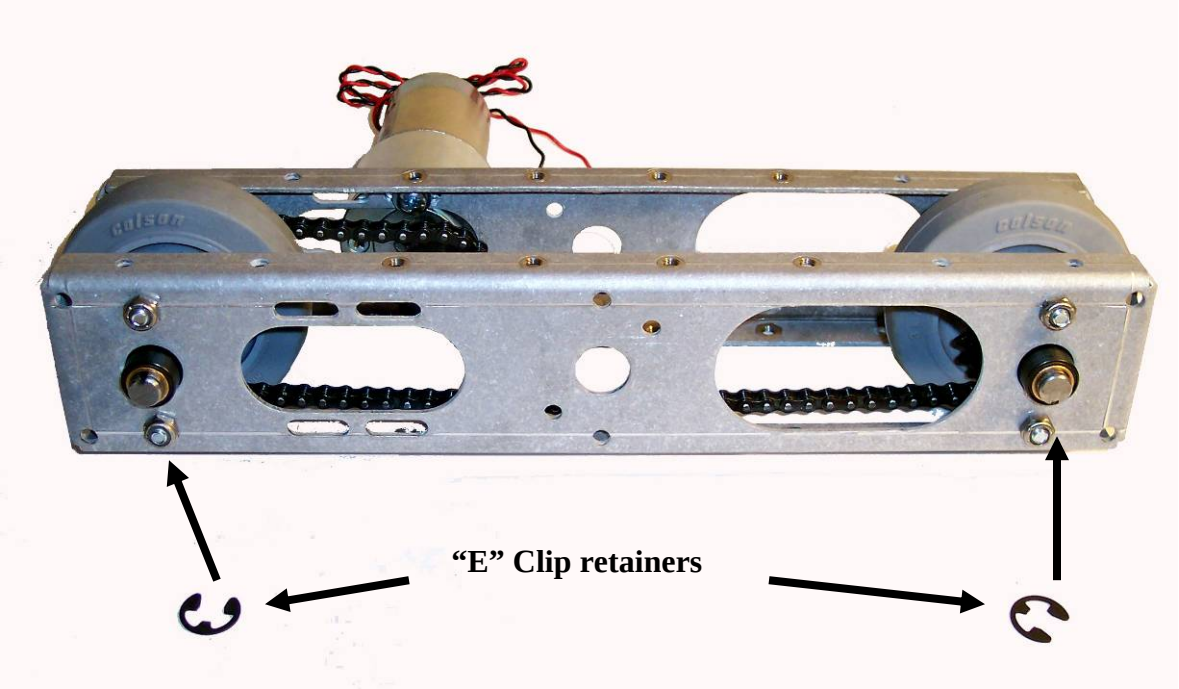
tch, 100 link chain using the connecting link on the end of the chain. See instructions for disconnecting and connecting the link and chain in Assemblies 9-10.

3. With the two wheel assemblies positioned in the flanged bearings and secured with “E” clips; bend the axles towards one another as shown. The flanged bearings are self aligning bearings, and they allow for up to 5 degrees of axial rotation. Bending the axles brings the sprockets closer together making it easier to fit the 100 link chain to the sprockets.



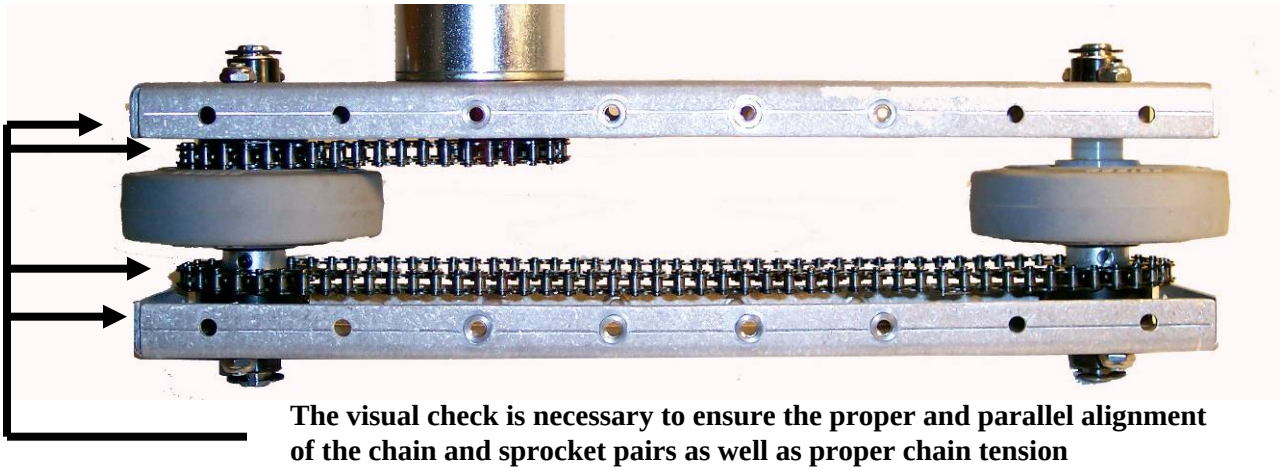
4. After the chain has been fitted to the sprockets, bend the axles outward and slide the axle ends into the flanged bearings on the outboard bulkhead assembly.

5. Secure the axles onto the outboard bulkhead using the “E” clips as illustrated in 9-10.



Note: The “E” clips are designed to be fitted and removed by hand. If it becomes necessary to fix them more permanently, simply pinch them with a pair of needle nose pliers so they conform more tightly to the shaft.

6. After completing the initial assembly of the drive module, it is necessary to perform both a visual check and a operational check to ensure correct alignment and tension of the chain and sprocket pairs. The visual inspection ensures the paired sprockets are parallel and on the same plane, and that the chains are running straight with respect to the sprocket pairs. An easy way to do this is to look at the drive module assembly from directly above. Visually line the chains up with the edges of the bulkheads and check to see that the chain path and the bulkhead edges are parallel. If either of the chain and sprocket pairs are not running straight and true, then the module will need to be disassembled and the necessary components repositioned in order to ensure correct (parallel) chain drive alignment.

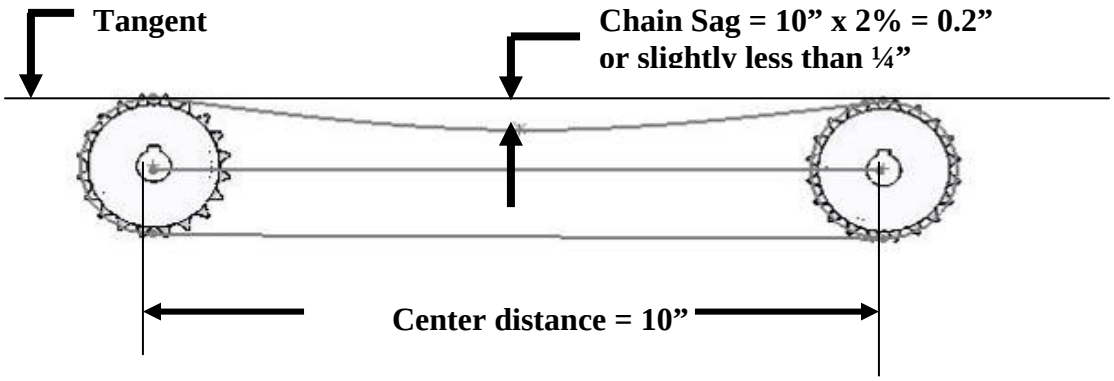


The visual check is necessary to ensure the proper and parallel alignment of the chain and sprocket pairs as well as proper chain tension

7. Proper chain tension can be determined by measuring the chain sag as follows.
   A. Rotate the paired sprockets so that the bottom chain chord is tight.
   B. Measure the amount of chain sag from the center of a reference line tangent to each of the paired sprockets.
   C. The measured amount of chain sag should be at least equal to two or three percent of the tangent length between the sprockets.

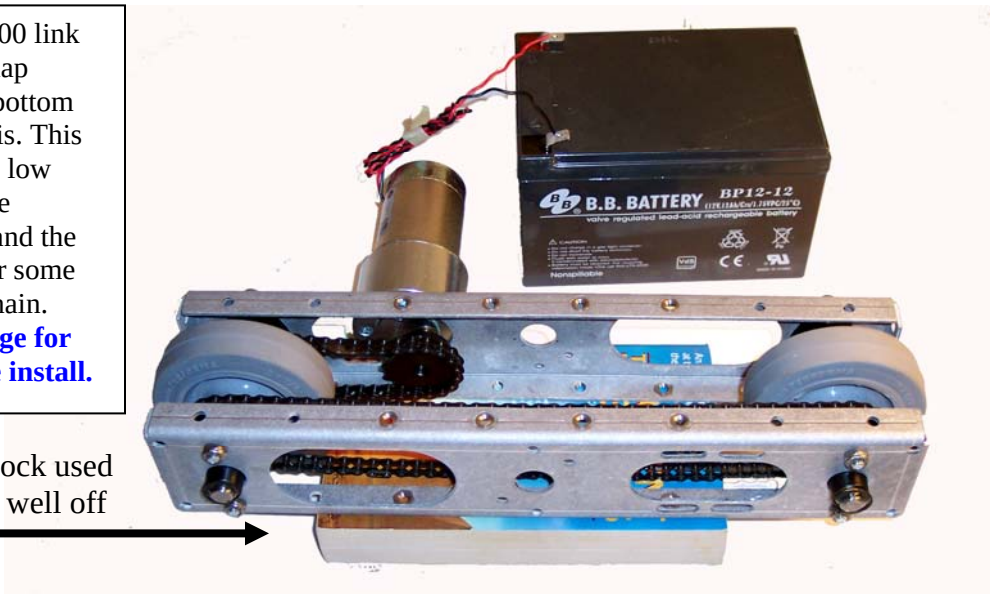
Note: The motor and drive wheel chain tension can be adjusted by loosening the motor mounting screws and sliding the motor along the mounting slots on the bulkhead. The drive and driven wheel axles are on fixed centers and the correct sprocket distance and chain tension has been predetermined.

The chain tension check for the GEARS Heavy Metal Chassis is illustrated below.



8. An operational check can be made by setting the drive module on a stable platform such as a book, or wood block and energizing the motor by connecting it to a 9-12V battery.
   Note: It is always advisable to have two people perform the operational check. The drive module wheels should not be in contact with any surface or object. Never hold the module while it is being energized. Keep hands free of the rotating chain and sprockets

Note: The 100 link chain will slap against the bottom of the chassis. This is due to the low profile of the bulkheads, and the necessity for some sag in the chain. **See next page for chain guide install.**



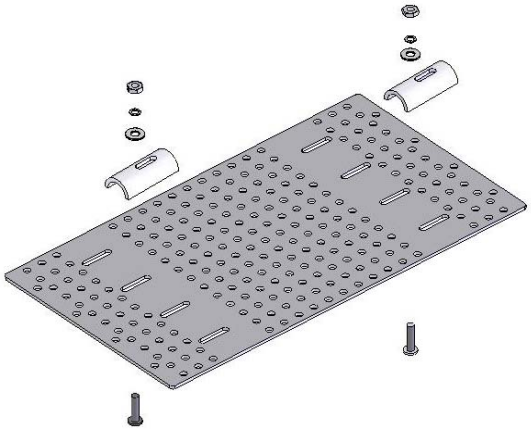
Book or wood block used to lift the wheels well off any surface →

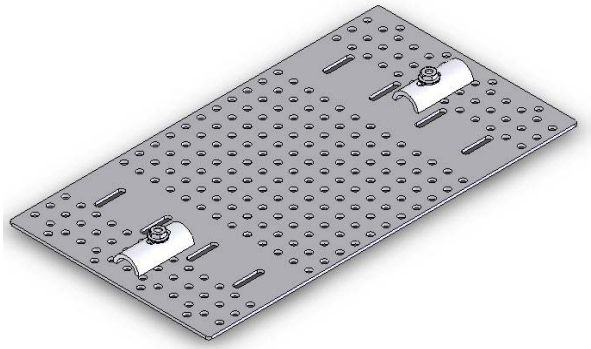
3.) Chain Guide Installation

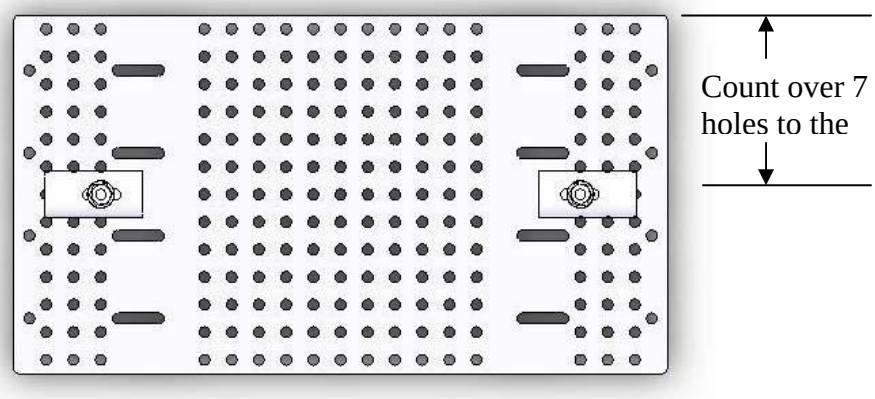
(2 required) (Average assembly time: 2 students about 5 minutes)

Components and Tools

Qty.	Description
2	PVC Chain guides
2	#10-32 x ¾" Phillips Head Machine Screws
2	#10 Flat Washers
2	#10 Lock Washers
2	#10-32 Hex Nuts







Roller chains run more efficiently when they are loose. Tight chains drag on the sprockets and waste battery current through increased frictional losses and heat. Since the HMC bulkheads were designed to have a low profile, the chain sag allows the chain to bottom out against the bottom chassis plate. This is not in itself a problem, but it does create an unpleasant slapping sound during rapid changes in direction.

To alleviate the sound, a PVC chain guide is fastened onto the **bottom chassis plate only** during installation. The illustration below shows the initial position of the chain guide. Final adjustment can be made when the chassis is assembled, and the guide can be tightened in place. Pay close attention to the position of the chain guide with respect to the hole pattern as shown.

4.) Chassis Integration

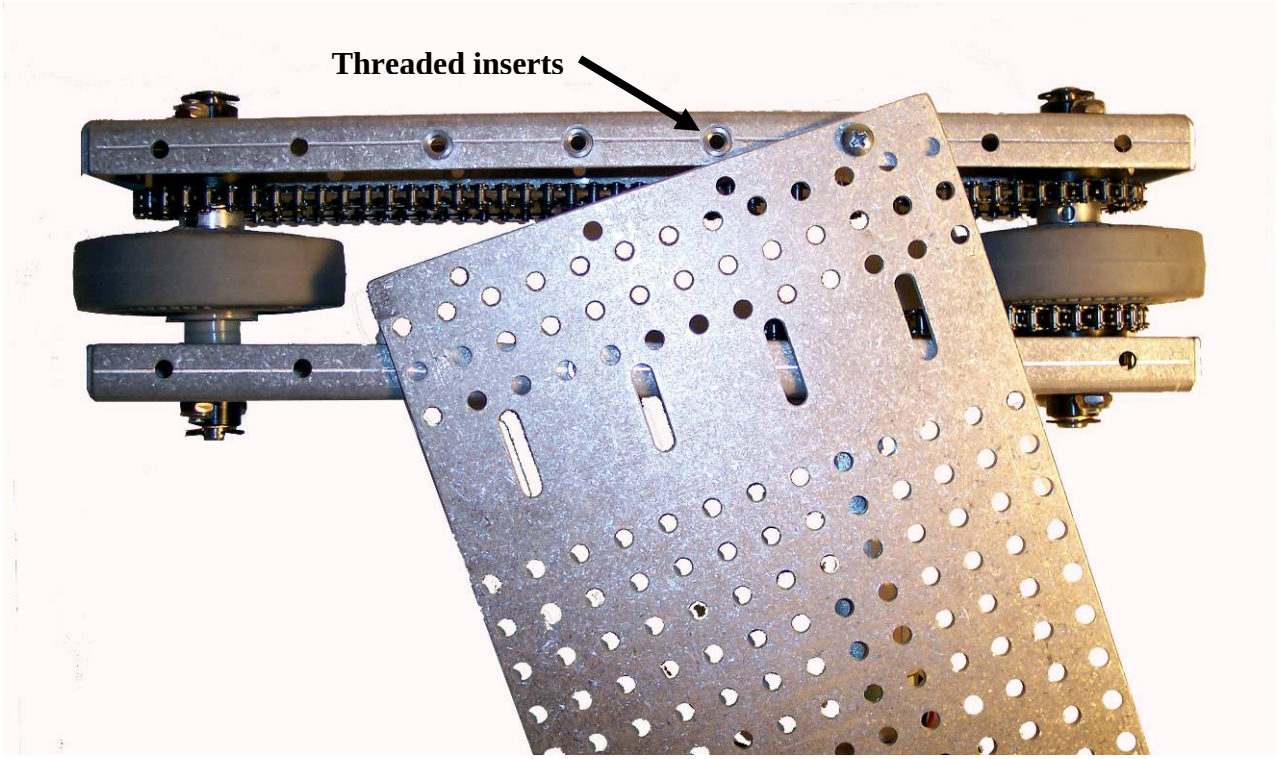
Average assembly time: 2 student about 10 -15) minutes)

Necessary Components and Tools

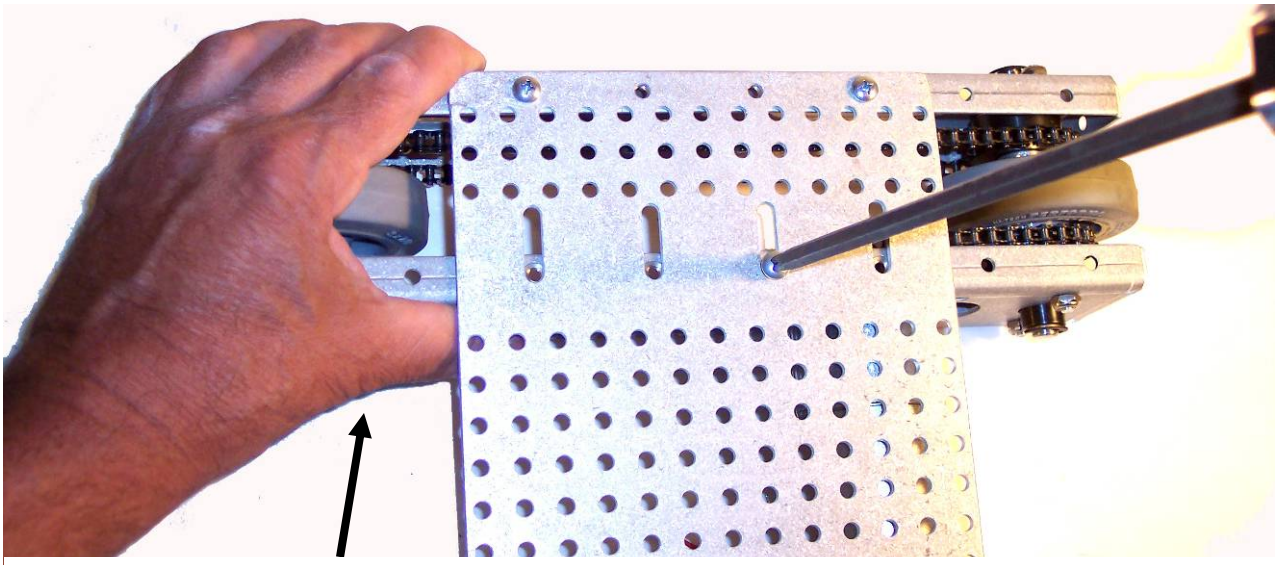
Qty. Description
2 Pre-made drive module (See 11-12)
2 Cover plates
32 #10-32 x 3/8" Phillips head machine screws
32 #10 lock washers
1 12" – 14", #2 point Phillips head screwdriver (not shown)
1 3/16" diameter rat tail file (Not shown)

Procedure
Note: This is the final step in the mechanical assembly of the Heavy Metal chassis. It will be necessary to fit up the completed machine, check and adjust fits and interferences and then remove one of the cover plates in order to wire the motors and control components. However, assembly and disassembly is quickly and easily accomplished since the Heavy Metal chassis makes efficient use of threaded inserts to secure the cover plates.

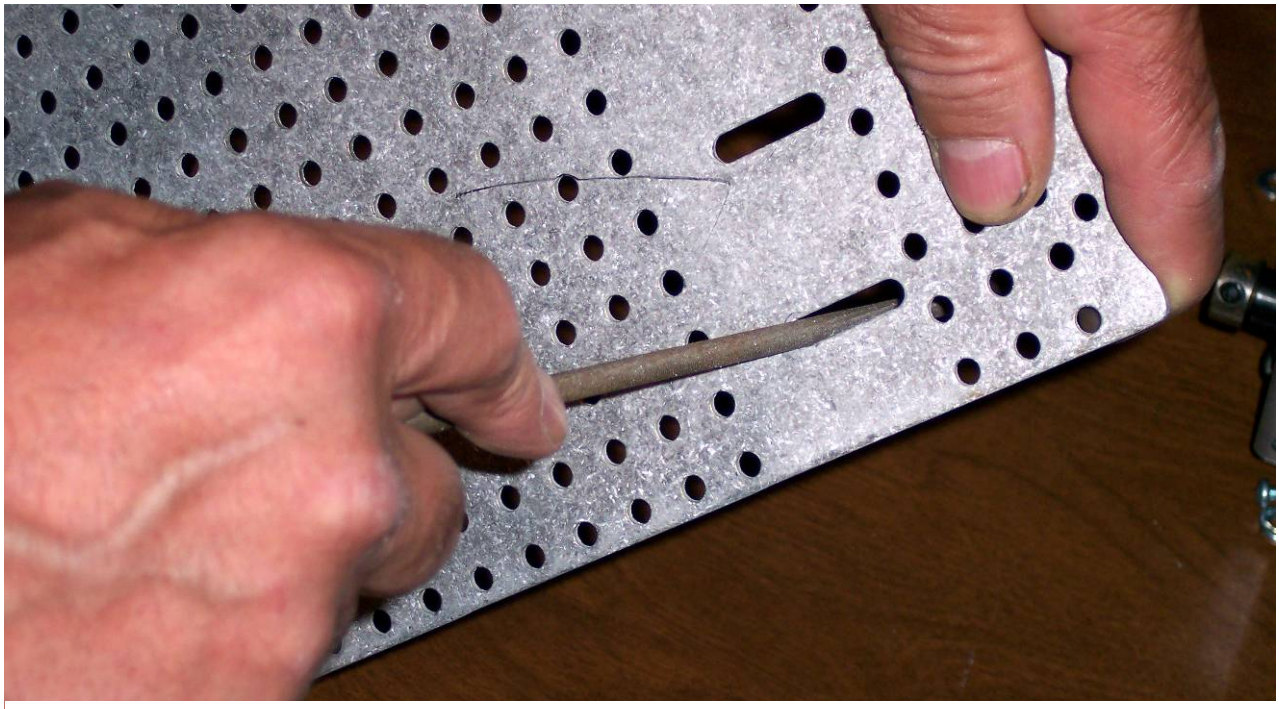
1. Align the 4 outside holes of the cover plate with the 4 outboard threaded inserts along the top of the bulkhead and attach the cover plate with 4 machine screws and lock washers. Do not tighten the screws at this time.



2. Align the 4 slots on the cover plate with the 4 threaded inserts on the inboard side of the bulkhead. In order to do this, it may be necessary to gently squeeze the bulkheads together. If the squeeze force necessary to align the cover plate slots with the threaded inserts becomes too great, it will add unnecessary friction to the drive system. To alleviate this problem increase the length of the slots by filing them with a 3/16" diameter round or rat tail file similar to those used to sharpen a chain saw (see the illustration below). When lengthening the slot becomes necessary, it is usually only a matter of increasing the length by 0.015" - 0.025".



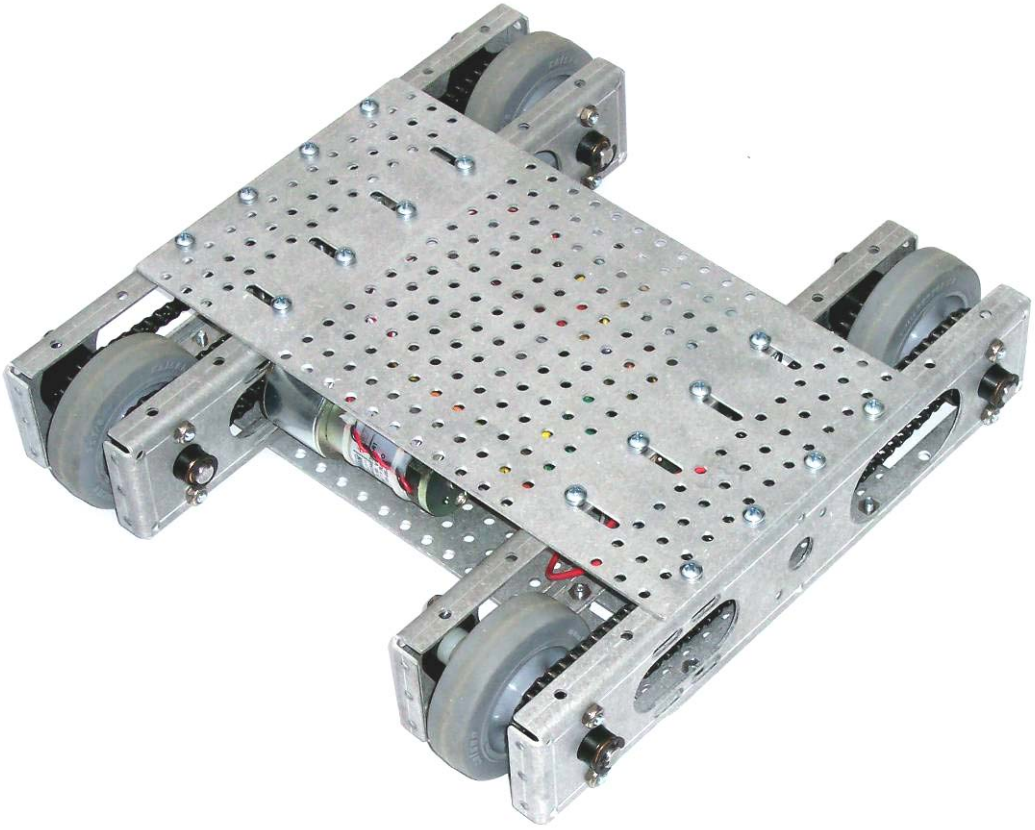
Gently squeeze the bulkheads together to bring the slots and threaded inserts into alignment.



If necessary, lengthen the slots by filing them with a 3/16" round file

3. Repeat the process described to attach the second drive module and the second cover plate. When both cover plates have been attached and the Phillips head screws have been tightened to approximately 22 -26 inch pounds of torque, it will be necessary to check the drag on the drive train components. Excessive drag is usually caused by too much squeeze between the bulkhead plates, or a misalignment in the drive train components. To test for excessive drag simply hold the completed chassis and turn the wheels by hand. First one side, then the other. Compare the force needed to turn them. The force should be equal, and it should "Feel" smooth and loose. The only force you will be turning against are the forces of the chain drives, the gear box friction and the magnetic drag of the motor on the steel armature plates. Less drive train drag means better performance, smoother throttle response and longer run times from a charged battery!

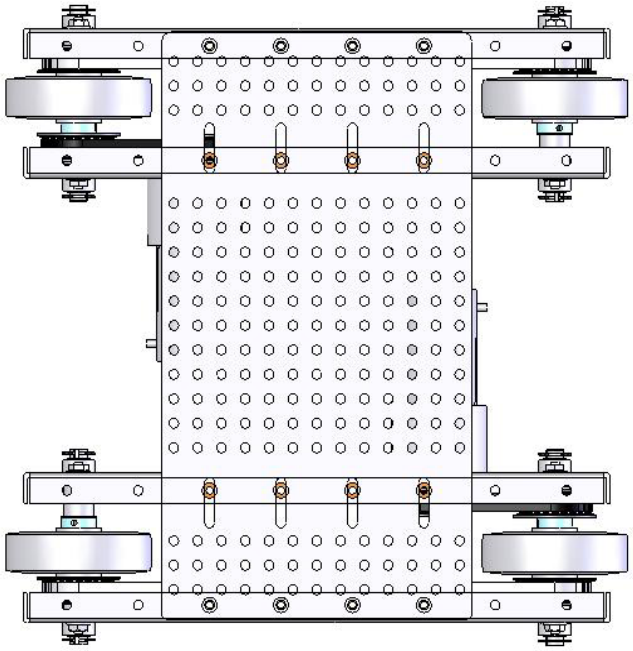
The Completed HMC Chassis Assembly

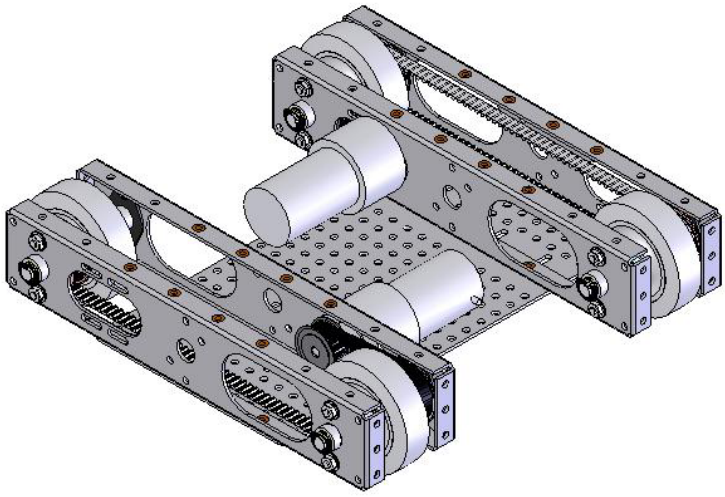


HMC Shown in Multiple Views

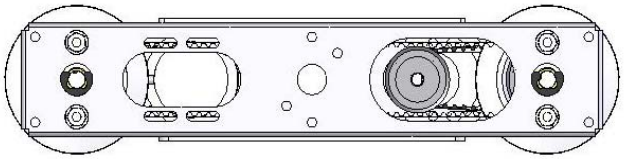
Note: This version is shown with XL timing belt option. The XL timing belt and pulleys are interchangeable with the standard #25 pitch chain and sprocket components.

Top View

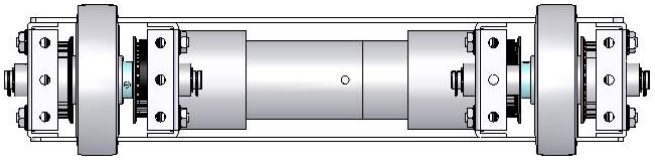




Isometric View



Front View

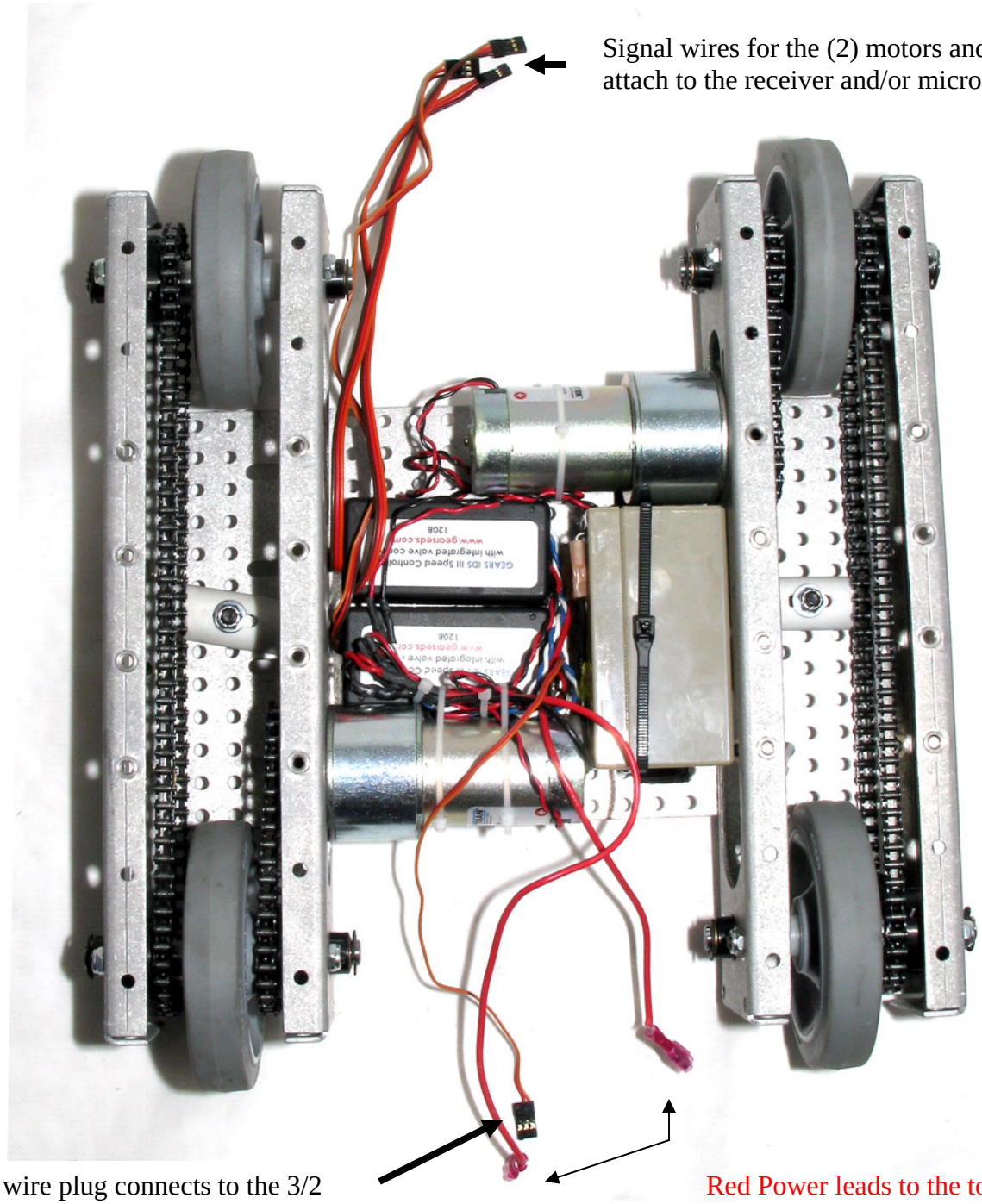


Right View

The Isometric view is shown with the top plate removed in order to more clearly illustrate how the assemblies are related.

Integrating the HMC Chassis with the Pneumatic Module

This section is provided for students and teachers who use both the GEARS- Pneumatic Module and the HMC Chassis in their engineering program



Signal wires for the (2) motors and the 3/2 solenoid attach to the receiver and/or microcontroller

2 wire plug connects to the 3/2 solenoid on the pneumatic module

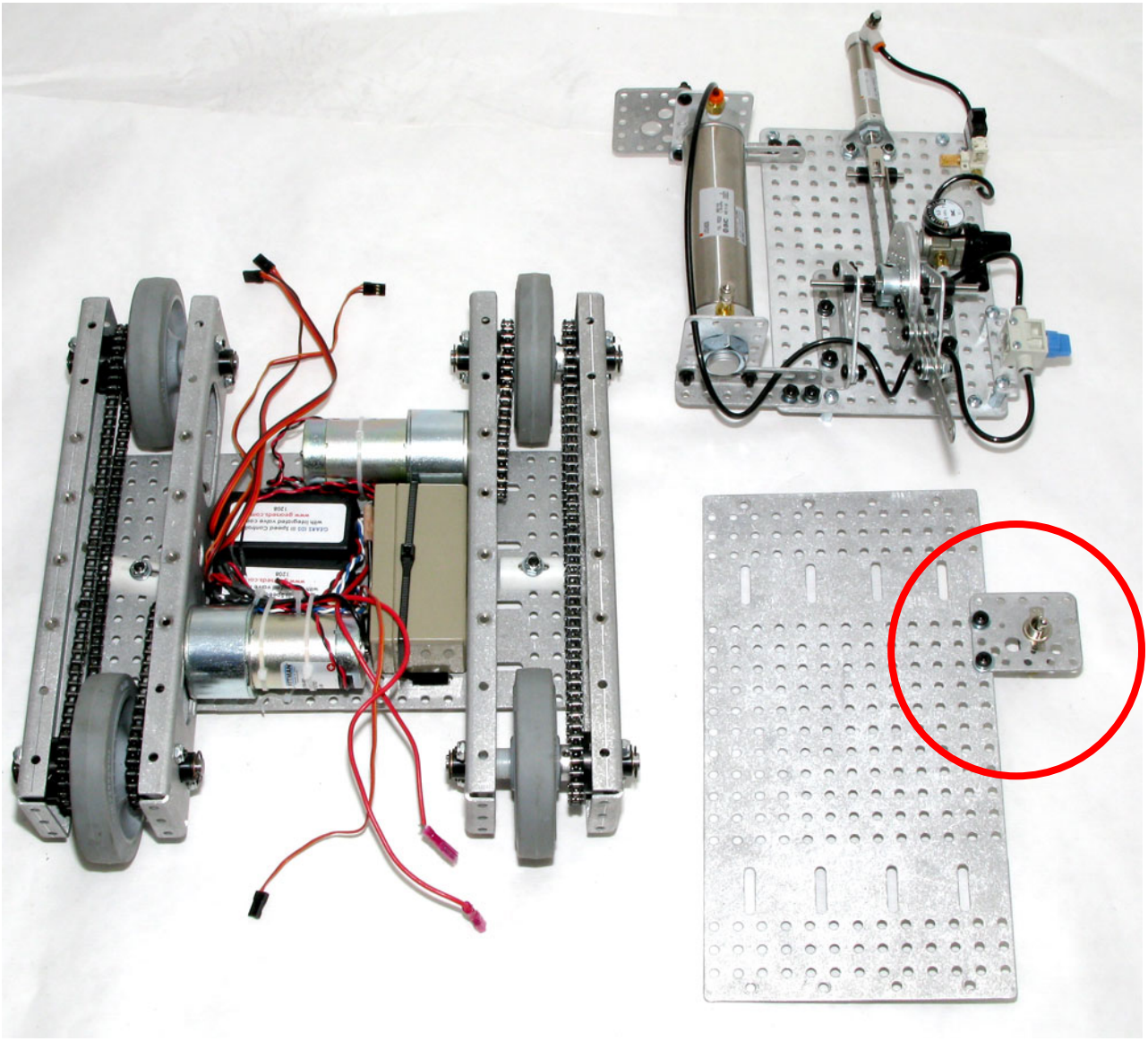
Red Power leads to the toggle switch attached to the chassis top plate

The image above illustrates how to position the GEARS-III motor controllers and the battery. They are both secured in place with either Velcro or zip ties.

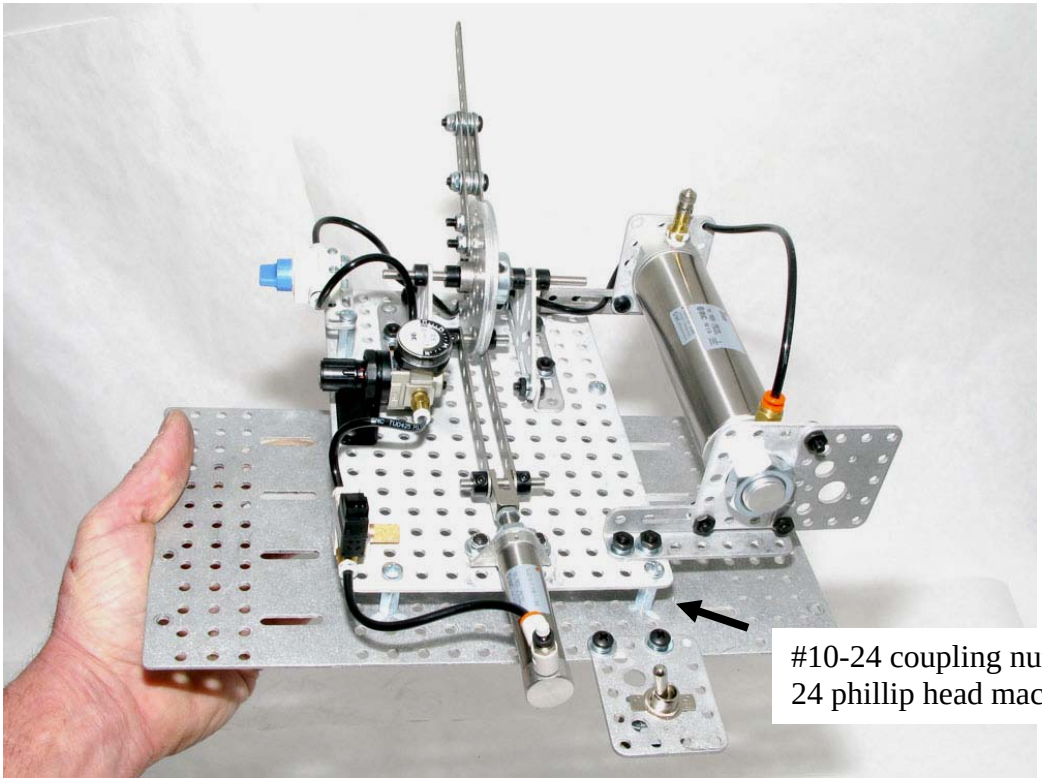
The image below illustrates the completed chassis, the chassis top plate and the pneumatic module prepared for integration. This example is wired using the GEARS III, 2 channel controllers

Note: The SPST toggle switch, switch plate and mounting hardware have been attached to the chassis top plate. See **red** circle below.

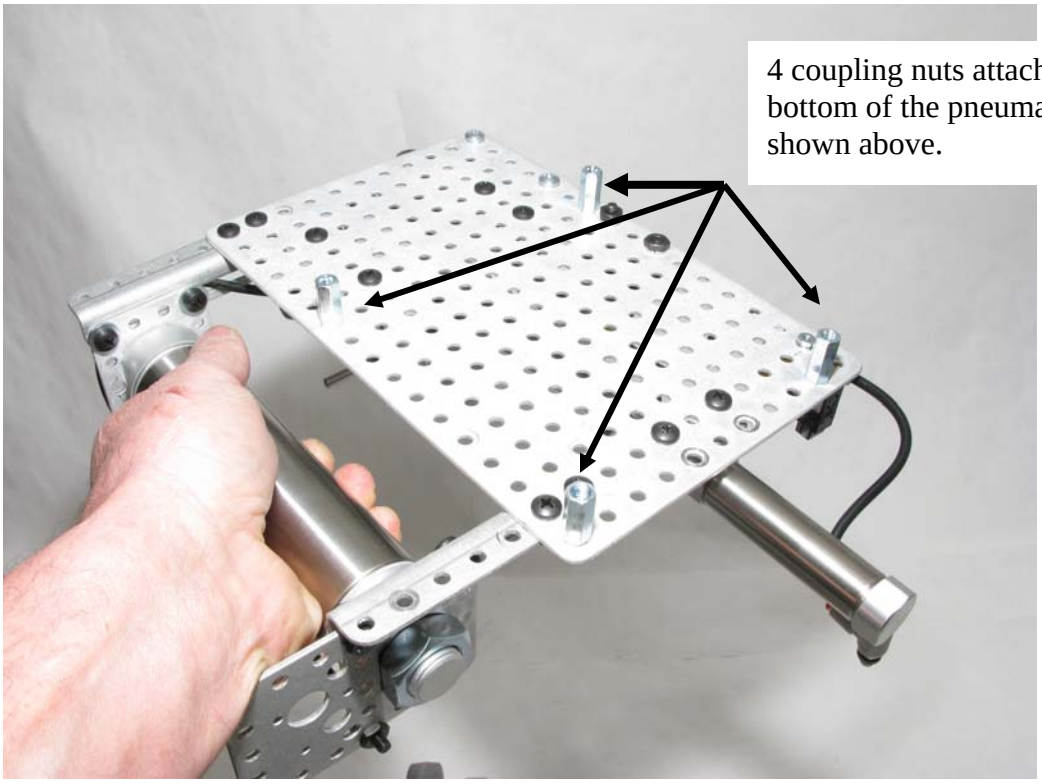
For information on how to complete the wiring of the motor controllers, battery and switch, please refer to the appropriate wiring instructions included separately with the HMC product.



The image below shows the pneumatic module attached to the chassis top plate. This is done using (4) #10-24 coupling nuts, and (8) #10-24 phillip head machine screws and lock washers.



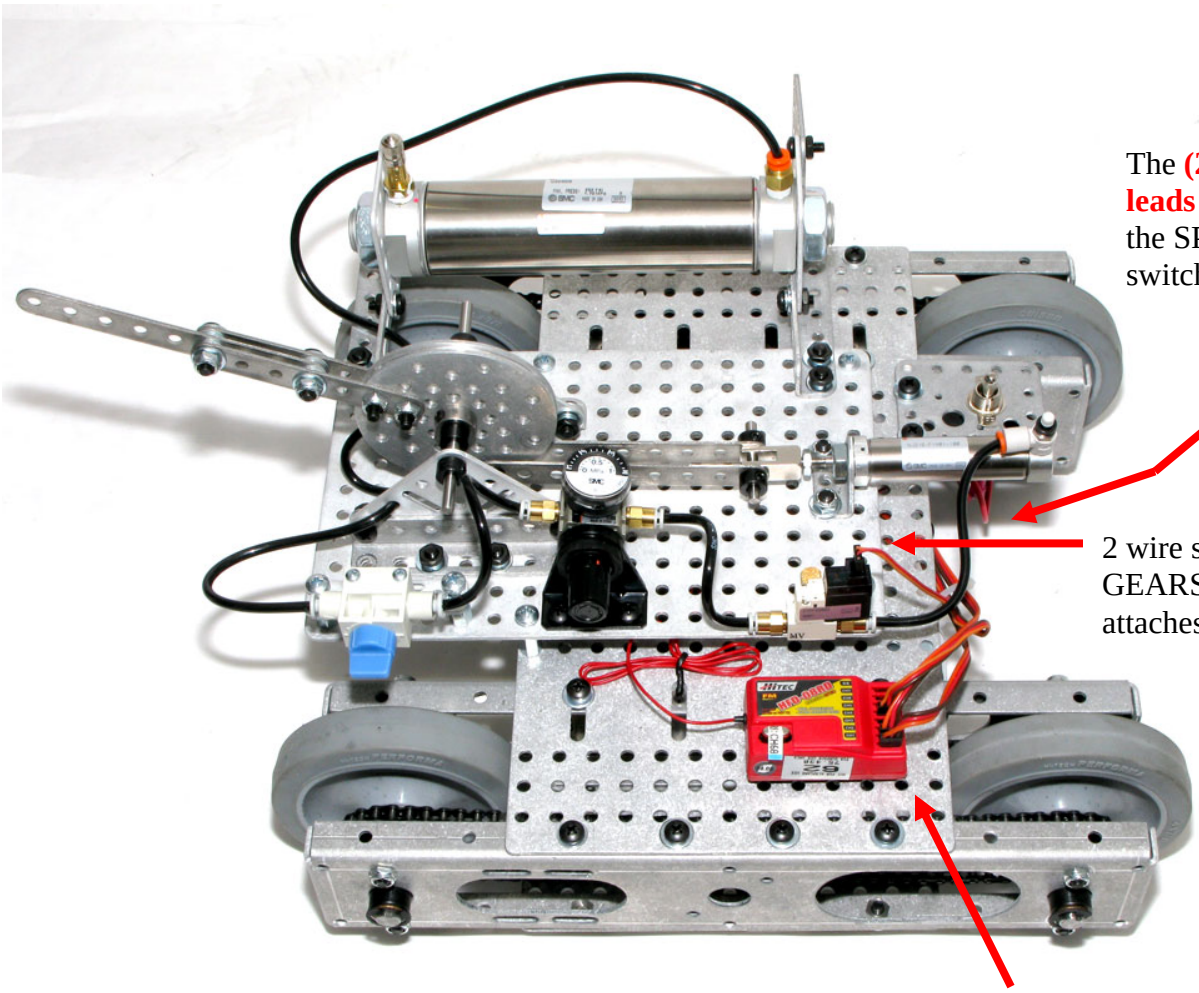
#10-24 coupling nut and #10-24 phillip head machine screw



4 coupling nuts attached to the bottom of the pneumatic module shown above.

The Integrated HMC Chassis with the Pneumatic Module

The image below shows the chassis top plate and pneumatic module assembly integrated with the HMC chassis.



The **(2) red power leads** are connected to the SPST toggle switch.

2 wire signal wire from GEARS controller attaches to the solenoid

Signal wires from the (2) GEARS III motor controllers are shown connected to an RC radio receiver. The motor signal wires are connected channels 1 and 2.

The pneumatic solenoid signal wire is attached to channel 4.