First Robotics drive trains are restricted by the limited variety of motors that are supplied in the kit. Teams have to purchase expensive gearboxes to utilize most motors. Window / seat motors are too low geared to be usable. Our design overcame this problem by using a window motor with a pulley system mounted on a single plate. This accomplishes the goal while still being efficient with our space, weight and ease of fabrication.

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## The Solution

In FIRST robotics, teams encounter many challenges, some of them being size limitations, chassis design, and finally drive train. Window motors cannot be used for drive train due to its low gear ratios. Our team has the solution with our spindle drive system. This system is revolutionary and could be used by any FIRST team. This system has many advantages that can benefit any FIRST team. It is compact, easy to assemble, rigid, and has interchangeable components. This design is the future of FIRST robotics.

What is this revolutionary design you ask? The spindle drive system allows for all wheel drive while still expressing the simplicity of car steering. A single mounting plate is the foundation of this design; two oversized ball bearings are imbedded in this plate. The motor is mounted onto to the upper portion of the plate with three bolts, the shaft runs through the bearing. (Refer to figure 4and 5) We used a window motor which is typically not used in drive-trains; they are more commonly used in simple manipulating functions. Window motors are generally incapable of being used in drive trains because they do not output the speed necessary to move a 120 pound robot. We overcame this problem by using different sized pulleys to acquire the speed needed. Another motor such as a CIM could be used but we decided to use the window motor because of it compact and light weight design. A large pulley is attached to the axle which is connected to the motor with a hub. A wheel with a hub runs through the lower bearing; the wheel is on the same side as the motor. A smaller pulley is placed on the opposite side of the wheel and attached to the hub with an axle. The pulleys are connected with a belt (chain could be used also). We prefer a belt because it provides a natural slip joint in the drive train. Two pins are mounted onto both the top and bottom of the plate for our car steering purposes. Linkage is mounted on to these pins to allow for the function of car steering. This design is attached with two mounting brackets that allow it to be mounted anywhere the team deems necessary. These brackets are attached to the chassis with four bolts. (Refer to figures 1, 2, 4, 6, 7, 8)

Every year teams encounter the reoccurring obstacle of size restrictions. One of the many advantages of this revolutionary design is that it is extremely compact. (insert reference to pic.) This streamline design has two pulleys, a belt (or chain), two bearings, a mounting plate, two axles, two hubs, a motor, and a wheel all within the dimensions of 4 1/2” x 6” x 12” compared to a standard tank drive system with the dimensions of 6”x 20”x 9”. The spindle drive system is much more efficient in solving the dilemma concerning space management. Mounting the motor directly above the wheel and connecting them through a pulley system made this design area efficient. While this design is compact its assembly was also straight forward. (Refer to figures 4, 5, 7, 8)

While there are relatively more parts in this design than a tank drive for example, the process of assembly is simplistic. Everything you need with the exception of the mounting plate

can be acquired through your kit, McMaster, or a local hardware store. The pulleys that we ordered from Andy Mark came equipped with set screws that we used to attach the pulleys to the axles. Holes in the hubs are tapped to allow for set screws, which anchor the axles into the hubs. Bearings that are imbedded into the plate can be held in place by set screws as an extra precaution, but this is not necessary. The hub that is connected to the wheel that comes in your kit and is connected to the wheel with bolts in the holes provided. The hub of the motor is connected by a set screw; this hub is also provided in the kit. The axles can be made of rod that is provided in your kit. This assembly is very straight forward which leads to a rigid structure. (Refer to figure 6)

The spindle drive system is rigid and robust. The simple structure and assembly contributes to the overall strength. The large bearings that were used in this design are meant to encounter loads over a hundred times greater than what they encountered in this task. The 3/8 inch mounting plate provides an extremely solid foundation to anchor the various components. The very compact and tight configuration does not have any parts that protrude from the main structure that could be easily damaged. This configuration also leads to less wear on the bearings. The bearings have large diameters reducing tortional load. These bearings are normally designed to encounter radial load and can withstand much more then what they encountered during competition. This design is practically indestructible and also has components that are interchangeable. (Refer to figures 3, 7)

Having components that are interchangeable is essential to the success of a FIRST robotics team. Without the benefits of interchangeable parts teams are liable to encounter various problems in design and construction. Our revolutionary design has multiple major components that are interchangeable. The pulleys can be switched out and replaced with various sizes in order to achieve the desired gear ratio. We applied this concept to the window motor to achieve the speed of a CIM motor. The pulleys can be replaced with sprockets for the use of chains. We found that the pulleys are much lighter than the solid steel sprockets. The window motor is also interchangeable; a CIM motor could also be used if a higher rate of speed and power is desired. If window motors are used several vital pounds will be saved. The wheels are interchangeable with any wheel that is legal in FIRST. The benefit of interchangeable parts would allow teams to use this design in years to come as the challenges change. (Refer to figure 6)

In conclusion, this design allows FIRST teams to overcome the obstacles that many will face with its compact design, ease to assemble, rigid structure, and interchangeable parts. This design allows rookie and newer teams to have an efficient design that they can rely on. This design is revolutionary and is the solution.

# Appendices

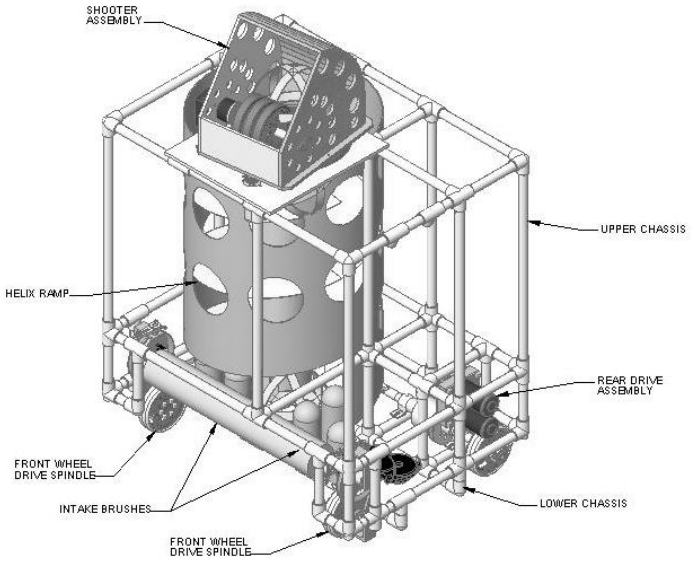



Figure 1

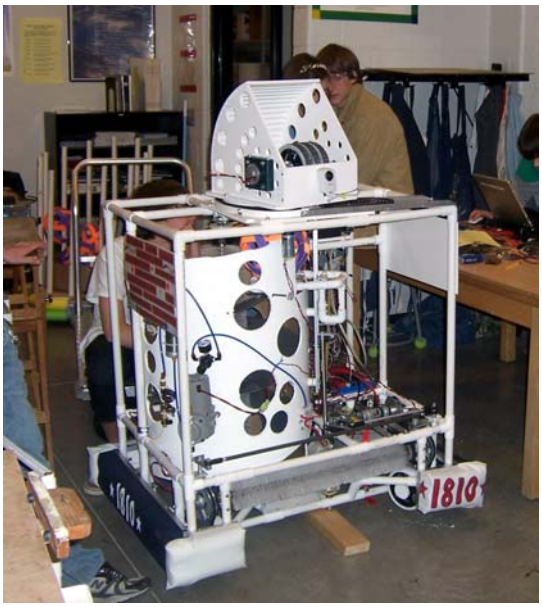



Figure 2

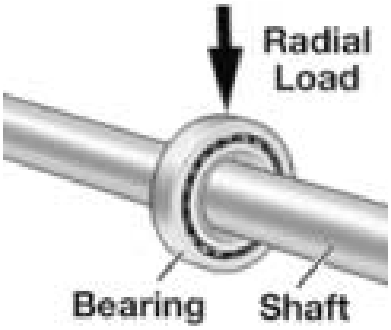



Figure 3

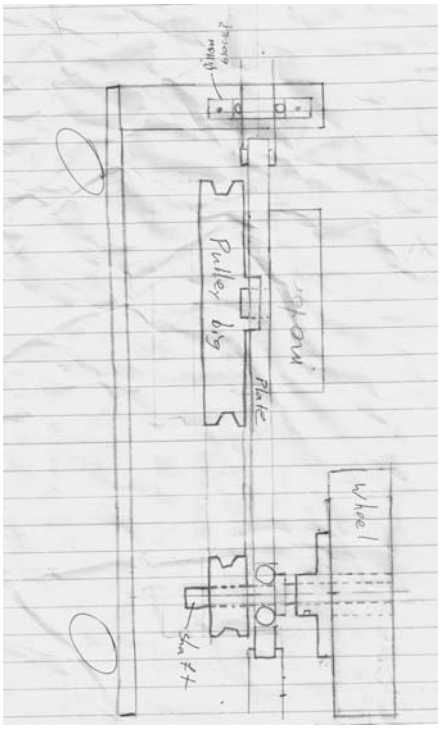


Figure 4

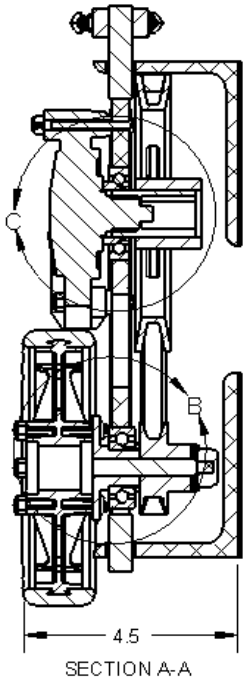
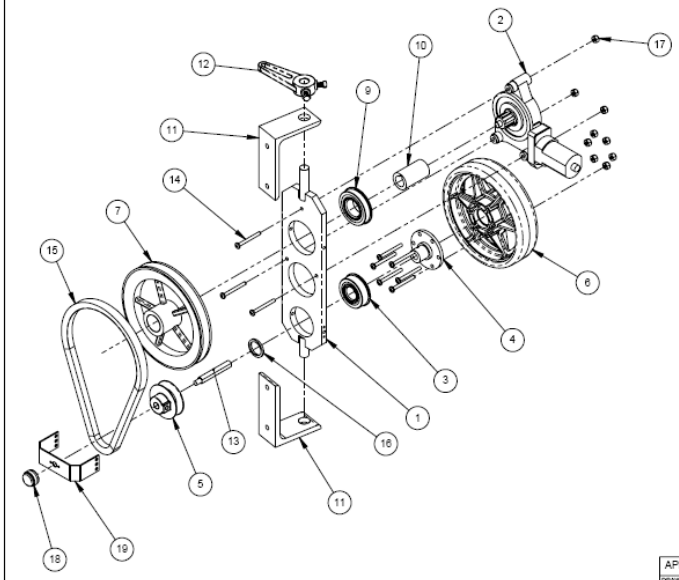



Figure 5




| ITEM NO. | | PART NUMBER | DESCRIPTION | VENDOR |
|---|---|---|---|---|
| 1 | 1 | | -plate, spindle motor | |
| 2 | 1 | - | -Motors_Denso_262100-3030 | |
| 3 | 1 | - | -bearing, .75 x 1.75, fl, 6384K369 - 6384K369 | |
| 4 | 1 | MV09-?? | HUB, .375,KEY, MODIFIED | MILLVALLEY |
| 5 | 1 | - | - | - |
| 6 | 1 | 09-SLICK | WHEEL, 09 FIRST KIT, SLICK | ANDYMARK |
| 7 | 1 | 6245K73 | PULLEY, 6 x .5, 4L | MCMASTER |
| 8 | 2 | - | - | - |
| 9 | 1 | - | -bearing, 1 x 2, 6384K373 - 6384K373 | |
| 10 | 1 | MV09- | HUB, WINDOW MOTOR, MODIFIED | MILL VALLEY |
| 11 | 2 | - | -L Angle_AAI, SPINDLE MTG - L4x3x0.25x1.5 | |
| 12 | 1 | 6149K700 | ARM, ADJUSTABLE, .5 X 3 - 6149K7 | MCMASTER |
| 13 | 1 | - | - | - |
| 14 | 9 | - | -Pan Cross Head_AI - CR-PHMS 0.164-32x1.625x1-N | |
| 15 | 1 | - | -Belt1^spindle motor | |
| 16 | 1 | - | - | - |
| 17 | 9 | 91831A009 | NUT, 8-32 X .23, NYLOCK, SS - 91831A009 | MCMASTER |
| 18 | 1 | - | -Sensors_US Digital_E4P-250-250-D-D-D-B | |
| 19 | 1 | - | - | - |

| APPROVALS | DATE | COMPANY: MILL VALLEY | TOLERANCES ARE: | TITLE: MOTOR SPINDLE ASM |
|---|---|---|---|---|
| DRAWN - | - | | DECIMALS FRACTIONS .X ± .1 0 TO 1" ± 1/16 .XX ± .01 1" TO 12" ± 3/32 .XXX ± .003 >12" ± 1/8 | |
| CHECKED - | - | CAGE CODE: <CAGE> | ANGLES ± 1 DEG | DWG NO: MV09- REV: 1 |
| ENGINEER - | - | THIS DOCUMENT EMBODIES PROPRIETARY DESIGNS AND SHALL NOT BE DISCLOSED, USED OR DUPLICATED UNLESS SPECIFICALLY AUTHORIZED BY SUCH OWNER. ALL PATENT RIGHTS THEREIN AND HERETO ARE EXPRESSLY RESERVED. | UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | SIZE: B SCALE: 1:4 SHEET: 1 OF 6 |
| CUSTOMER - | - | | DO NOT SCALE DRAWING | |
| OTHER - | - | | | |

Figure 6

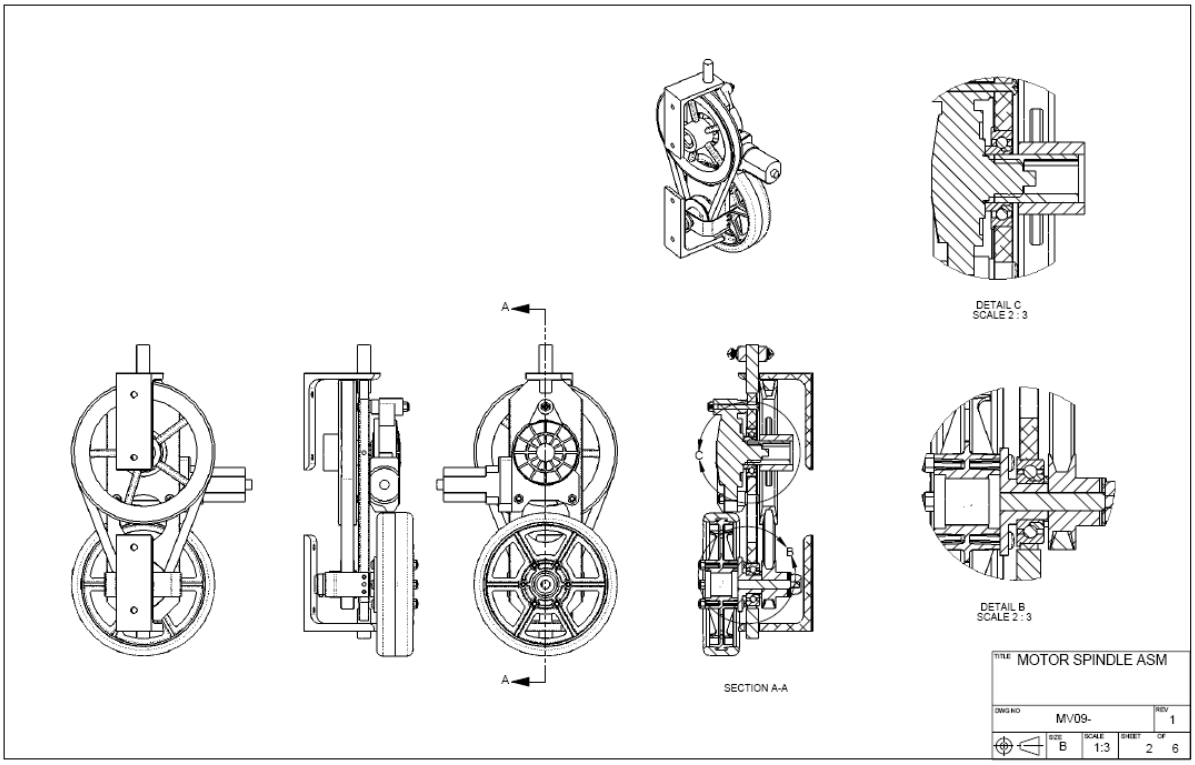



Figure 7

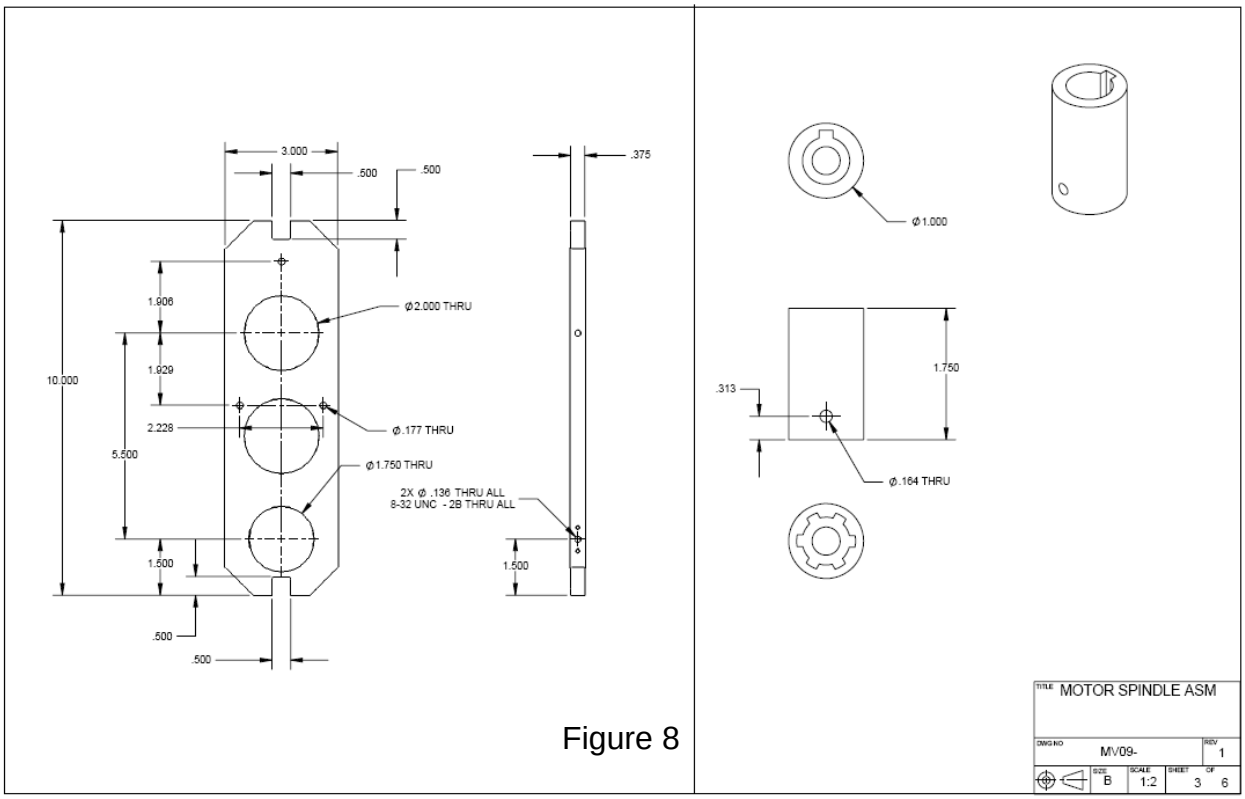



Figure 8

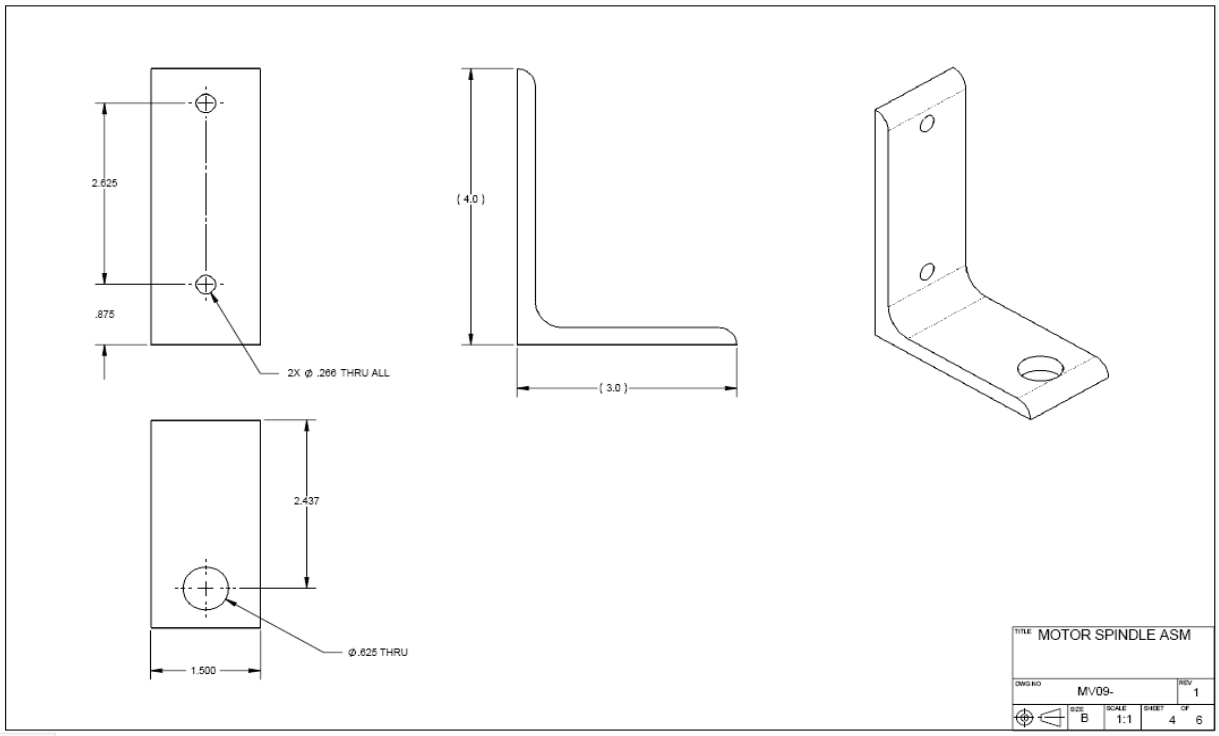



Figure 9