Chassis Innovation

Abstract

Our Robotics team made the decision to use PVC piping in the construction of our chassis. This saved weight and time; we were able to build a 15 lbs chassis in few days of construction. This also introduced some interesting challenges such as how to mount components on a round chassis and how make a chassis strong enough to weather the strain of competition.

The FIRST Robotics competition has several constraints that are meant to even the playing field and regulate the game. One which is the most common battle for our team is weight. Building a full-sized, functional robot was never an easy task for us. On top of this, we have extremely limited time to build our robot. This year, the team decided to reevaluate our choice of materials for out chassis. Over the past years, the chassis on our robot has been one of the most time consuming and heaviest parts on the entire robot. This year we decided to use PVC.

PVC was an attractive option because it was lightweight, relatively inexpensive, and easily obtained at any local hardware or home improvement store. It was also easy to work with; it can be infinitely customized by cutting it to any length and there is an immense variety of joints for angles, cross sections, and supports. Additionally, it is quickly assembled and can be completely constructed, deconstructed and rebuilt permanently very quickly. Beside the physical attributes, PVC was also easily constructed in 3D CAD software (*Figure 2*) because of its simplicity. Due to the fact that there are only various lengths pipe and joints, it can be quickly drawn and assembled to make preliminary designs for a chassis.

Designing a PVC chassis introduced several new challenges to constructing the robot. PVC pipe is round, necessitating new mounting styles. PVC was plenty strong for our purposes but it was much more flexible than traditional metal chassis. This made it necessary to use a box frame to retain rigidity in our chassis (*Figure 2*). The variety of PVC was also intimidating. There are several different thicknesses (Schedule 10, 40, 80 are common) and diameters. We decided on ¾ in. schedule 40 PVC. It was not as flimsy as schedule 10 and not as heavy as schedule 80 and the small diameter kept the footprint of the frame down.

The decision to use PVC was not easily made, veteran team members were skeptical of using plastic in the place of metal for the chassis, a component that undergoes immense stress through the duration of a competition. A prototype was built to test the validity of using PVC as a main component of the robot. When six members of the team were able to stand on the frame without significant give, PVC seemed to be a much more viable option. The decision matrix (*Figure 1*) shows the other material options and what the rankings are.

The decision to make a PVC chassis ended up being very beneficial to our team. Our team is limited by a relatively small budget and a lack of a machine shop. Because PVC is inexpensive, the chassis material did not dominate our budget and allowed the team to spend money on other escapades such as our second regional and other components for our robot. We were also able to attain a sponsorship from FlexPVC.com, getting $150 worth of PVC donated to our team. It was also very convenient to have a material that did not require a machine shop. All we needed to build PVC frames were PVC cutters and glue. With these attributes, PVC was much easier for our team to use than any metal or other material requiring the use of power tools would be.

PVC was also very handy to have in the competition setting. Our manipulator and drive system could be heavier and more complex with such a lightweight and quickly assembled chassis. The extra attention to our manipulator and drive-train gave us a competitive edge in competition, making our robot a very attractive alliance partner. PVC was also easily repairable; in two instances our chassis was broken in a collision with another robot and because of the modular nature of a PVC chassis, was fixed and ready for the next round of competition without a hitch.

In using PVC, our team made an innovation to the way the chassis of a robot could be built. PVC is a lightweight alternative to more traditional chassis materials such as steel and aluminum. PVC is very low in cost compared to metal materials as well. It is also easy to assemble and simple to work with. Furthermore, after a year of use, it has proven to be plenty strong for use in production of a chassis. With these attributes, our team hopes to utilize this innovation in the future and inspire other teams to use and expand upon our successes.

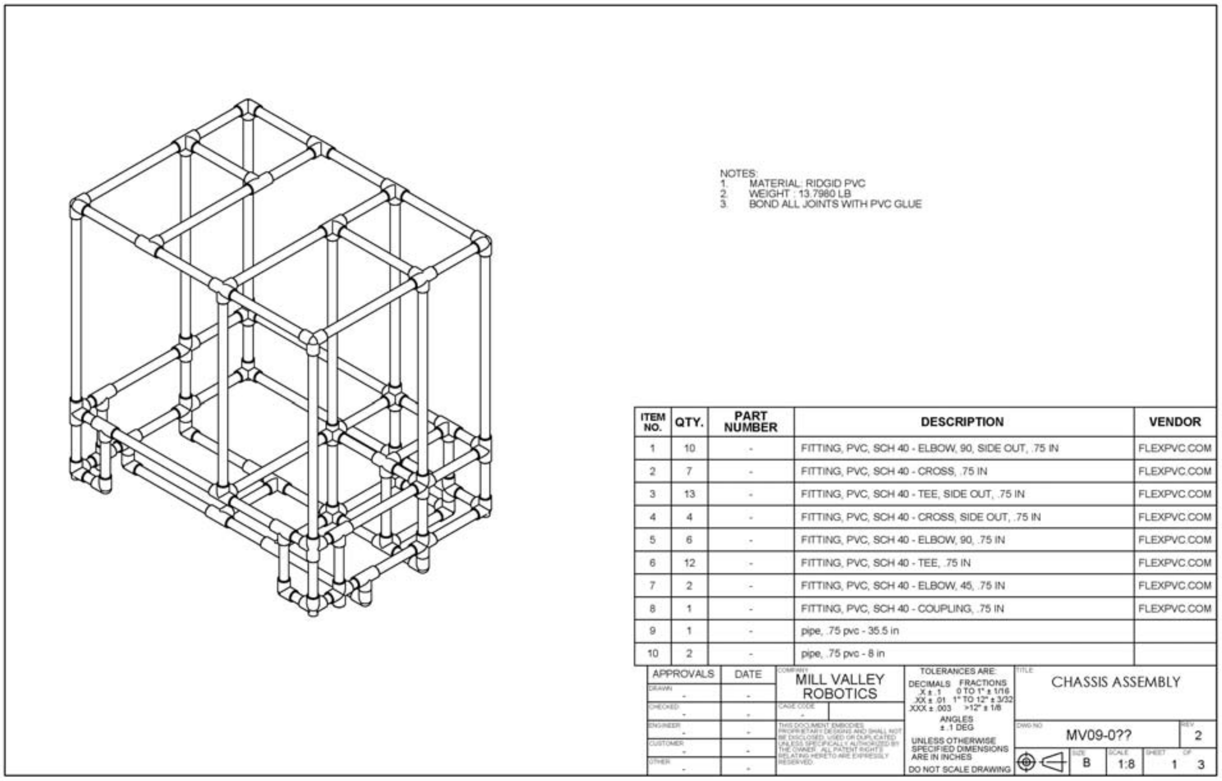
Figure 1

PUGH DECISION MATRIX

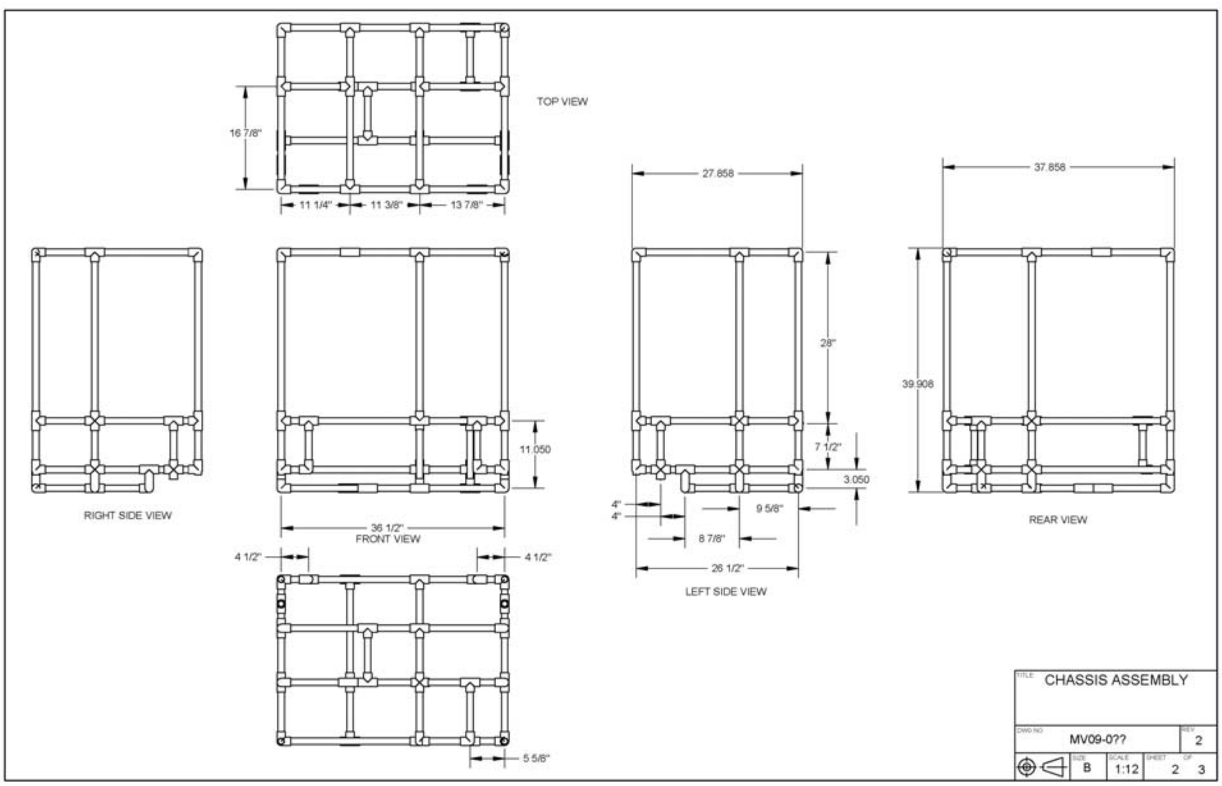
Frame Material

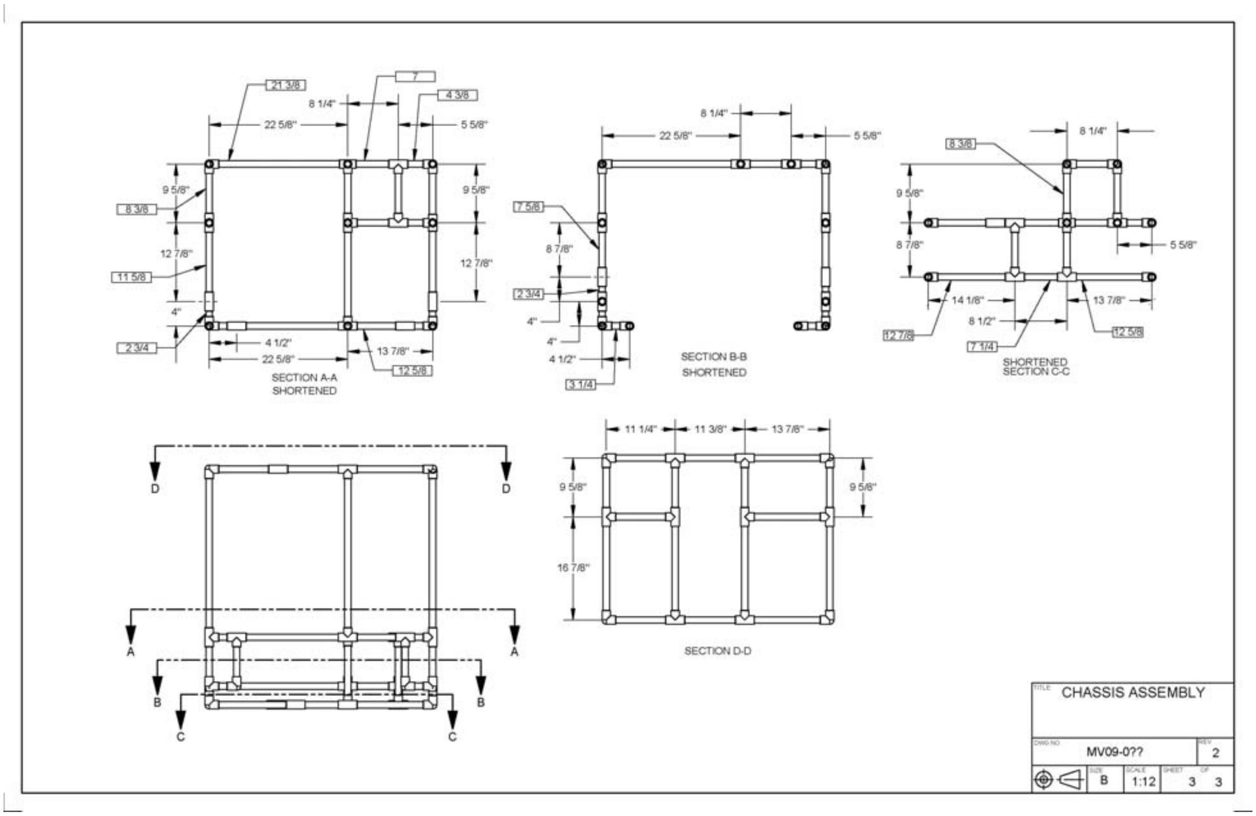
NEEDS	RELATIVE NEED RATING	OPTIONS: Kit Channel (bolted)		Square Tubing		Round Tubing (Al)		Round Tubing (PVC)		T-Slot		Bar Angle (bolted)		Kit Channel (welded)		Bar Angle (welded)			
Cost	2	8	16	2	4	3	6	6	12	1	2	4	8	7	14	5	10		0
Weight	9	4	36	2	18	3	27	8	72	1	9	6	54	5	45	7	63		0
Strength	3	6	18	3	9	5	15	4	12	8	24	1	3	7	21	2	6		0
Durability	8	5	40	4	32	3	24	7	56	8	64	1	8	6	48	2	16		0
Formability	1	1	1	4	4	7	7	8	8	3	3	5	5	2	2	6	6		0
Adaptability	6	8	48	4	24	5	30	7	42	3	18	6	36	1	6	2	12		0
Simplicity	5	8	40	2	10	5	25	6	30	1	5	4	20	7	35	3	15		0
Build Time	7	7	49	3	21	6	42	8	56	4	28	5	35	2	14	1	7		0
Availability	4	8	32	3	12	2	8	7	28	1	4	6	24	5	20	4	16		0
			0		0		0		0		0		0		0		0		0
			0		0		0		0		0		0		0		0		0
TOTALS>	316		**280**		**134**		**184**		**316**		**157**		**193**		**205**		**151**		**0**

Figure 2



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	VENDOR
1	10	-	FITTING, PVC, SCH 40 - ELBOW, 90, SIDE OUT, .75 IN	FLEXPVC.COM
2	7	-	FITTING, PVC, SCH 40 - CROSS, .75 IN	FLEXPVC.COM
3	13	-	FITTING, PVC, SCH 40 - TEE, SIDE OUT, .75 IN	FLEXPVC.COM
4	4	-	FITTING, PVC, SCH 40 - CROSS, SIDE OUT, .75 IN	FLEXPVC.COM
5	6	-	FITTING, PVC, SCH 40 - ELBOW, 90, .75 IN	FLEXPVC.COM
6	12	-	FITTING, PVC, SCH 40 - TEE, .75 IN	FLEXPVC.COM
7	2	-	FITTING, PVC, SCH 40 - ELBOW, 45, .75 IN	FLEXPVC.COM
8	1	-	FITTING, PVC, SCH 40 - COUPLING, .75 IN	FLEXPVC.COM
9	1	-	pipe, .75 pvc - 35.5 in	
10	2	-	pipe, .75 pvc - 8 in	




SECTION A-A
SHORTENED
SECTION B-B
SHORTENED
SHORTENED
SECTION C-C
SECTION D-D
CHASSIS ASSEMBLY
MV09-0??
2
B
1:12
3
3