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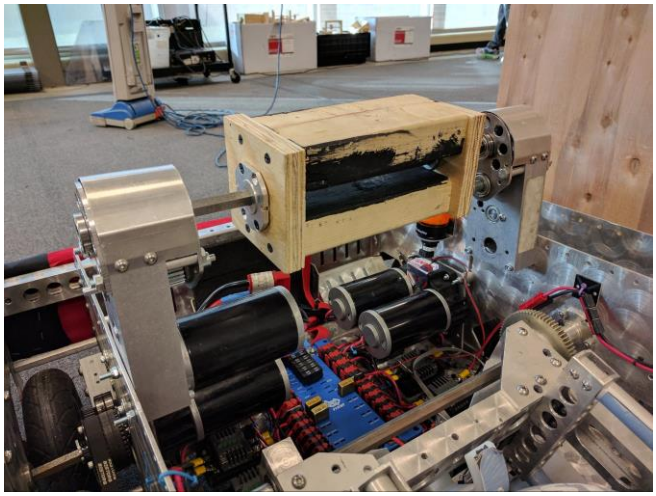
Robotics Prototyping: The Good, the Bad, and the Solutions.

After January 7th of every year, every robotics team worldwide starts the race to complete their robot - and reign champion of FIRST FRC. But, each team starts building their robots from different points; some start with QFD while others start creating strategies. Yet even with all these different starting points, every single teams' main goal is to create a robot that they can proudly proclaim is the best robot they ever made -- and in order to create such a grand utilitarian piece of machinery, almost every team goes through the dreaded prototyping system.

Prototypes are an intricate and time-consuming part of robotics. They help determine what the end product, the robot, will be, and they help shape the strategy that will be taken while playing on the field. This year on team 3641, our prototypes took an extra week and a half to finish, making us have to race to finish our robot. I was on one of the prototyping teams that was part of the delay, and while I feel that we could have done more to complete the prototype in a more efficient manner, I believe there are some simple solutions to stop this from happening next year. Our robot was good this year, but implementing these changes and altering certain parts of the prototyping system might make our robot ten times better next year.



Peer Leaders

Now all of these problems may seem either minor or obvious, but I believe that they are necessary in order to make our prototyping system better. First, having a veteran robotics member help head the prototype will not only give the system more structure, but it will also allow the freshman to learn under a peer who has done this before. The lead student's job would be to keep the project on task and make sure the prototype is made correctly. For instance, my group (the climber) was made up of first and second years who had never participated in the prototyping system. There was really no leader, and since we didn't know who our mentor was for the first couple of days, we ended up being one of the most inefficient groups, thus resulting in our prototype taking longer than anticipated, using up the extra week and a half we were given. If we had a peer leader, we would have been able to have better time management and a more solid communication system through which we could ask for help from other mentors and students.

A Peer Leader should be someone who is at least been in the prototyping system once, and also has a basic understanding of how to build a prototype. They could either volunteer

themselves or be recommended by a mentor, but they should also be aware that they may not be chosen if they don't live up to the standard needed in a Peer Leader or if we have a surplus of Peer Leaders. This is not a job that should be taken lightly, since they do control how a certain part of the robot will turn out. But, The Peer Leader is just the second-in-command to the Mentor, so if we do not have enough experienced members who wish to be Peer Leaders, then we could use veterans who are not afraid to ask for help.

Tell freshman that it's okay to be rude.

The robotics team is made up of a variety of students, and I would have never met some of my best friends if I was not in robotics, since there are students on this team from every one of the stereotypical clicks. But, most of us have one thing in common: We were taught to be polite. It was engraved in us from day one to say "please" and "thank you," and to always chew with our mouth closed. Never ask for food at a friend's house, respect your elders, the list of age-old formalities that have been imprinted into our brain seemingly never ends. In most cases, obeying these mannerisms is crucial to get anything done, but in robotics, with such a fast paced environment, it ends up getting in the way.

When I first started robotics, I was much shyer than I am now, and robotics has helped me overcome that, but my shyness almost stopped me from becoming the robotics member I am today. In those first few days on the prototyping team, I learned quite a few things, one of them being that the pile of wood over in the corner was, in fact, the scrap pile of wood, and the same went for the shelves filled with metal next to it and the yellow bins filled with screws, bolts, and a bicycle seat. But here came the even crazier part - you could just *take* things from the various scrap piles. No paperwork or permission needed, just grab what you need for your project and

go, which was a mind-blowing concept to a shy kid like me. Granted, some of the kids who joined robotics knew all of this coming in, but they also knew that a motor needed a gearbox in order to work--which, sadly, was something I also did not know. I could teach you how to play goalie in soccer, or how to read sheet music, but ask me how to build an engine and I would be speechless.

At this point, you are probably appalled by my lack of knowledge in the field of STEM, but I know that I am not the only one like this on the robotics team. This is why we need to teach freshman that it's okay to be rude, so more kids like me will end up knowing an in depth amount of information about robotics.

Now, when I say they should be 'rude,' I mean that they shouldn't be afraid to grab stuff from the scrap piles without telling anyone, and that they should be perfectly comfortable walking up to a complete stranger and asking them how to build this or why that isn't working. They shouldn't, however, feel like they can walk up to another team and start trash talking their driving skills or their robot's wiring. The fine line between being necessarily and productively rude and flat out mean needs to be made clear--Be rude to teammates, but not to other teams. While this idea seems quite awful and, admittedly, should not be said in the presence of a principle or any school official besides those on the robotics team, it could increase our productivity, and even though some students will not use it to its fullest potential, having that knowledge in the back of their minds could make them even better members.

The Tactical Plan

The first day we were introduced to the tactical plan, I knew that it would have helped us be more efficient if it had introduced at the beginning. Not only would it have made us keep on

time, but it also would allow us to see when something needed to be done. Although, since the tactical plan was introduced in the middle of prototyping, it didn't have as strong of an effect.

I believe the best way to implement the Tactical Plan would be to start creating it during kick-off. Since we will have the entire team there, we could split up the tasks and have a group with a mixed amount of veterans and rookies create a tactical plan. It wouldn't have to be official by the end of kick-off, but having a rough outline would really help us get a jump-start on creating the Tactical plan.

Furthermore, the tactical plan should have a group of at least four or five members who make sure everyone is on time--not just one student. This will ensure that every prototyping group keeps on track, either because they are consistently reminded of the due date, or because they just want people to stop annoying them. The Tactical Plan group would be the only one I would suggest to be entirely made up of veterans; Students that have been in robotics for one year or more will have a bit more understanding of how important it is to finish on time, and they will have the necessary backbone to tell students or mentors to hurry up.

The tactical plan was a great idea, and has plenty of potential to become a vital part of prototyping and general organization among the team, but it must be implemented earlier in the year, and it also must be followed in order for it to be used to its fullest potential.

Mentors

I would like to preface this by saying that all the mentors that are part of the robotics program are great. Without them, we wouldn't have been able to build prototypes, let alone an entire robot. They spend eight hours at work, then drive to our school to help us work on our robots for another 4 hours, some even after their children have graduated. What they do is phenomenal and I am truly grateful for that.

With that said, the intended purpose of this section is to improve the mentor's effectiveness, and, hopefully, make their jobs a little easier.

In all honesty, the mentors, even when they were trying to help, sometimes confused me. For instance, our prototype mentor would say that all we have to do is get the prototype to work, and the build team would figure out everything else when they were building. In hindsight, this wasn't the best idea, but we were short on time and it seemed like the easiest route. When I would start getting confused is when a second mentor would come up and ask how certain things, which our main mentor had told us to not worry about, would work. Then the mentor would walk away. Not only was this confusing, but it also added to my stress level to have these new things added on that I thought our prototype would not have to do. In order to stop these things from happening again, there should be a general consensus that the prototype must be just a cheaper version of the real thing--it can still do everything it needs to do, but it's made out of wood and scrap metal. While this may seem like an obvious concept, it should be specified at least once during the meeting for prototypes, just to make sure that everyone knows the types of standards they will be held to.

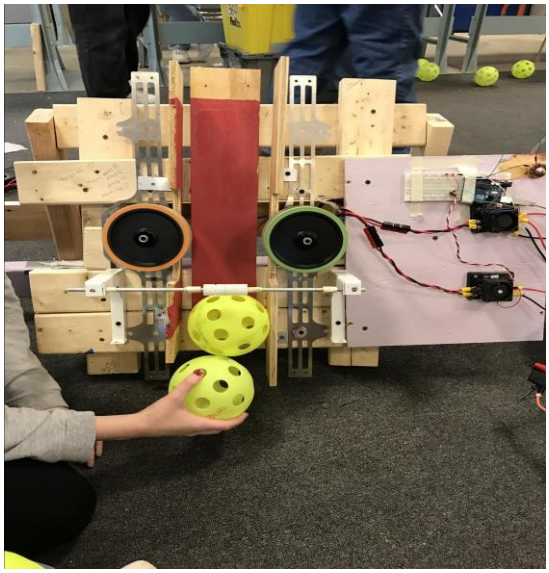
Another thing that should be implemented is meeting the mentors formally. As a new member of robotics, I knew the name of one mentor, but that was about it. So when the prototyping season came along and we were told who our mentors were, I had no clue who mine was, and others also had the same problem. I suggest quickly introducing the mentors during the prototyping meeting so that the students will at least have a general idea of who is who.

Changing the date of prototyping

Another change that could be crucial to improving the prototyping system is changing the date it is on. This year, the first prototyping meeting was on a tuesday due to the QFD the day

before. I understand that getting the prototypes going as soon as possible was necessary, but it also limited the amount of people going, which could have easily been a strategy to make sure only those who were going to participate were showing up. But, in order to make sure that we have enough people for each prototyping group, I would suggest doing it on Monday or Friday.

In order to get prototypes, QFD, and the Tactical Plan started and done as soon as possible, we could do a room rotation. QFD could be in the main room, the Tactical plan could be in the computer room, and the prototyping could be done in the CAD lab. Every 1-2 hours, the rooms would rotate. Each group would only do a part of each task, so that every group would get a chance to work on each thing.. If this room rotation process seems to hectic, an easy alternative could be having the QFD, Prototyping, and Tactical plan on Monday, Tuesday, and



Wednesday; then we could tell the team when we are doing each.

Sub-groups

This year, during the prototype season, the shooter group divided into three different teams, each with their own type of shooter. This was a good, considering it gave us options, but the problem was that some of the most skilled people on the team were all working on different versions of the shooter, and there were no veterans anywhere else. The talent on our team was unevenly spread, whether it was caused by the sub-groups or not. This is another reason why having a peer leader is important--they will be the one person on the team who knows how to build a prototype, thus guaranteeing that every team has at least one experienced member. This will, hopefully, make the groups more efficient and allow the rookies to learn more under their peer leader. With this method, teams could still have sub groups and other teams could still have experienced members.

Classes

Let's face it, even if you have graduated from high school or are still in it, we all remember those days where we would daydream during classes, or sometimes even sleep! The classes were boring to our teenage minds when we would much rather be outside or playing a video game. For most classes, not paying attention was fine--the material would be taught to us at a later date or we were so good at the subject that it didn't really matter. But with the classes for robotics, we only had the one, long two hour night to try and cram the material in our head and memorize it. I'm not saying I didn't like the classes, they were fun and it was nice to learn something that was directly applicable to careers, but the fact that it was just a one night class just didn't work. That is one thing that high school does well--they drill material into your brain until you can recite it by memory. When we started to discuss our places of failure later in the year, the mentors agreed with this point, saying that the classes didn't give us enough time to apply the concepts and reinforce the material.

I understand we only have the mondays of the first semester to train and teach, but if the classes were more (dare I say it) like school, there would have been a definite improvement in prototypes. People would have a general idea of what to do, and the mentor or peer leader could make sure they were doing it right.

In order to fix this, we could still have the regular classes, but then everyone chooses the class that they liked the most and the mentor teaches them up until kickoff. The mentor could pick a day or two after school that works for them, and train their students on that subject. This way the students can do what they like and they will be able to apply it. Not only would this method be teaching the students how to do things more effectively, it would also give us an opportunity to learn material in a different way, which could help us adapt faster to different teaching methods in the future.

The Reason I liked Prototyping

For a total of ten pages, I have ragged on our team's prototyping system, only stopping short of calling it a "loser." But, while it did have its flaws, there were quite a few upsides to the prototyping system.

Firstly, being able to choose your group was great. While it did end up hurting us in the long run, it was nice to be able to go through this slightly stressful experience with a group of friends. In order to keep this implemented in the prototyping system, I suggest having the Peer Leader and Mentor for each group chosen before letting other teammates sign up for a prototype.

Another good thing about the prototyping system was that it gave us hands-on experience with building parts of the robot and gave everyone a chance to have a say in how the robot was built. Although this step had varying types of effectiveness on different groups, it is still nice to know that a part of the robot was based on a design that you and your group came up with.

The last good thing about the prototyping system is that it gave us real consequences for when we didn't deliver a good enough prototype. If our prototypes were late or inefficient, it would affect how the robot turned out. They try to apply this kind of consequence in school by using grades, but there are many opportunities to bring your grade back up, so it loses its effectiveness. While some people could argue that it teaches us that there is 'no room for mistakes,' I believe that it teaches us that mistakes are okay, even if it causes bad consequences. Even though we didn't make it past states this year, we lost with a smile and sat in our pit watching movies, which was pretty awesome. Maybe if our prototypes had been better this year we could have went to worlds, but that is in the past and it feel like most of the team understood this and quickly moved on--showing that our team embraces gracious professionalism.

So, even though the prototyping system has plenty of flaws, what doesn't? The traditional school system--which I have abnormally praised in this paper--that has been in place for over a century still has plenty flaws, some of which seem irreparable. But it still works. This prototyping system worked, and it opened my eyes to something that school has never even come close to showing me. The prototyping system showed me what it would be like to have a job, and it taught me that making a mistake wasn't the end of the world. It showed me how to stand up for myself. If you asked my parents to describe me before the robotics season, they would describe me as 'shy' or 'a follower,' but after the season--even just after prototyping--my parents could proudly describe me as someone who can take charge, who isn't afraid to start conversations. Sure, this season has taken a turn for the worse in some member's eyes, but for me, it taught me something that no sport or college course could even touch. This team has taught me how to be me.