

“Stop the Stop Build”



As I sat and watched the 2016 Olympics while writing this essay, I was awed and inspired by the level of excellence achieved by these world class athletes. The levels of ability demonstrated are only achievable through relentless training and continuous improvement.

Unfortunately, in our sport of FIRST Robotics, these levels of excellence are not achievable. One of the primary reasons for this is that FIRST HQ maintains policies which deliberately prevent training and continuous improvement. I am referring specifically to the policies of bagging and crating robots during the competition season and the concept of 'Stop Build Day'.

These build restriction policies were originally imposed over 20 years ago in an attempt to force fairness between teams attending different events on different dates. As time has gone by, it has become very clear that, ironically, these machine sequestering policies are actually the source of some of the greatest inequalities in our sport. The majority of teams are not allowed to improve, while rich teams can buy additional advantage and work around the system.

The debate over whether to allow teams more access during the build season has been going on for many years. FIRST Robotics is unique amongst machine sports in this regard; no other contest I know of artificially restricts development in this way. Even within the FIRST Family of programs, FRC is the only program with these sorts of machine access restrictions, despite the fact that the smaller robots are far easier to change and copy.

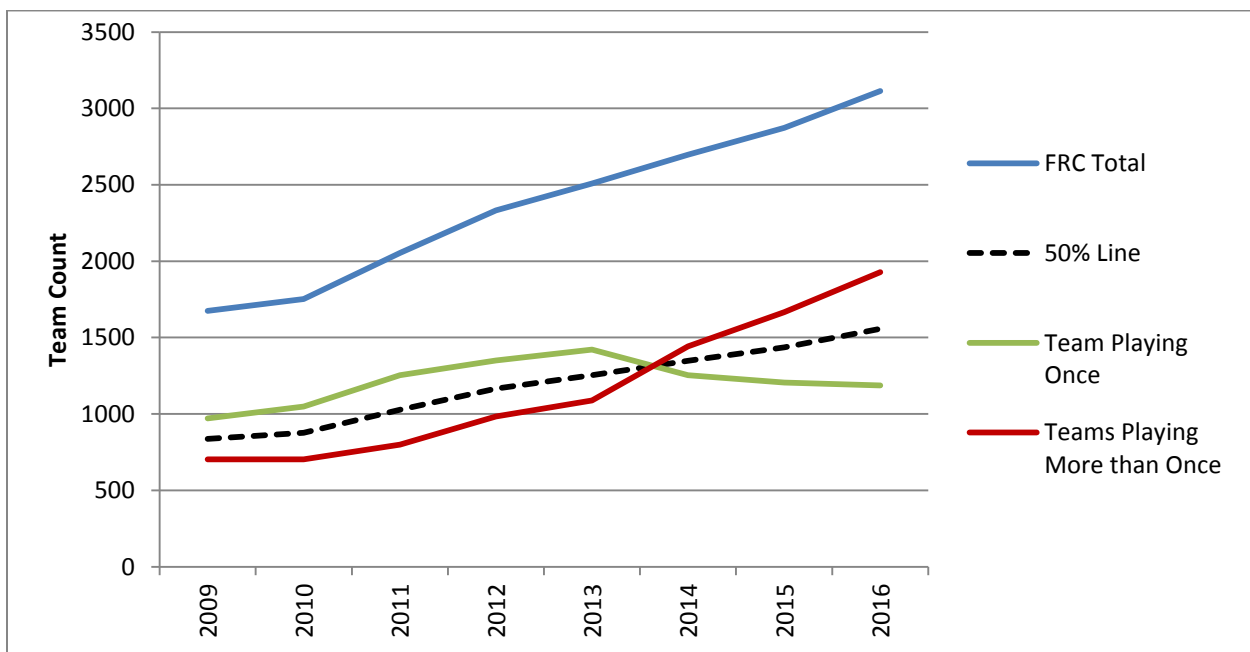
The FRC league now has over 3000 teams. The population has been large enough for many years to allow for population trend studies on many different attributes with good fidelity. While it is always possible to cite individual examples of teams who are outliers, the overall trends are undeniable. For simplicity, most of the data cited in this paper is from the 2016 competition season, since the most recent population is the largest, but the overall trends of these phenomena have been evident for at least a decade.

The metric "OPR" is used extensively in these studies. OPR is a calculated team offensive strength value, computed using linear algebraic methods from the data set of all event qualifying matches. OPR values are calculated for each team, for each event, for the entire 2016 season in order to compile the statistics in this study. OPR is the closest statistic we have in the FRC to a true objective measure of individual team capability at playing the game. StrongHold was a good game for using OPR as a measure, since active defensive play was very rarely employed in qualifying matches. Again, for the sake of population studies, OPR is an excellent tool for identifying a variety of trends.

Point 1: FIRST has changed from an Event to a Season:

The year 2014 marked a turning point in the history of FIRST Robotics. For the first time ever in the long history of our sport, the majority of teams in the league played at more than one official FRC event. FIRST Robotics has officially transitioned from a contest in which most teams play an event, into a sport where most teams play a season.

As new district regions continue to come on line, the percentage of team playing two or more events per year now stands at 62% and rising in 2016. A full 25% of the league, 765 teams, now play 3 times or more. This trend will only continue to increase in future years. The days of “One and Done” FRC seasons are rapidly becoming a thing of the past.



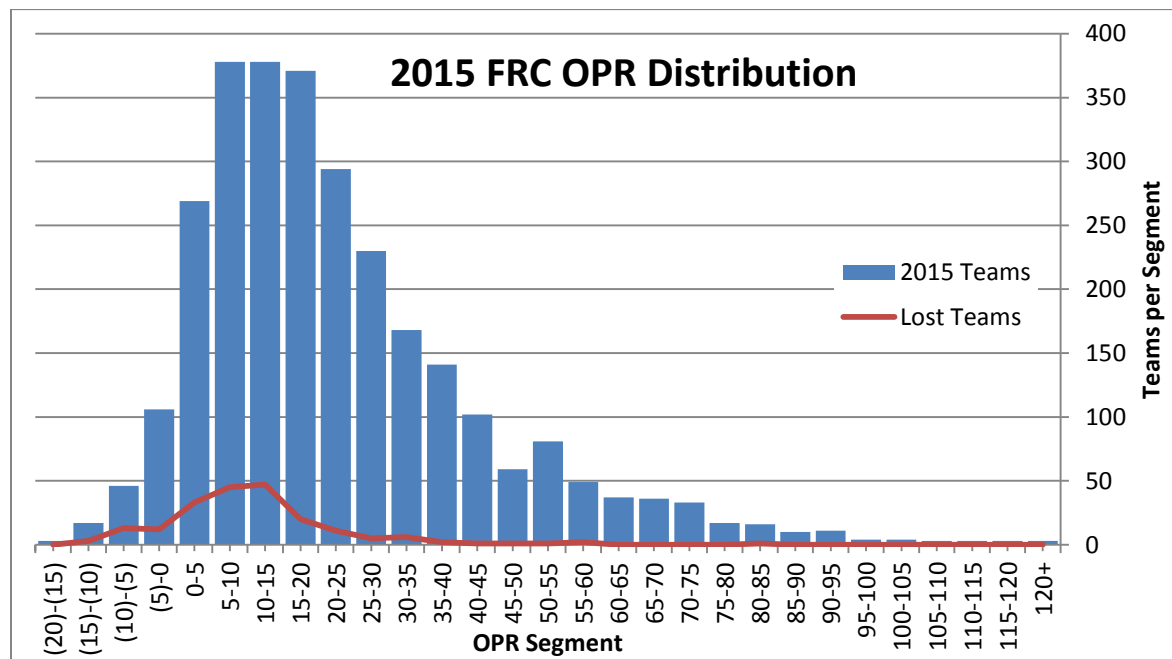
Point 2: FIRST Competition is not Media Friendly

For the past several years, the FIRSTinMichigan team has been working hard to bring more media attention to FIRST Robotics. We have been rather successful, but this has been remarkably difficult to do. One of the big reasons cited again and again by the media people we interface with is that so many of the robots are not very capable of actually playing the game, making the sport unwatchable. This low level of average performance is very much a product of the FIRST constraint system. While we all agree that the essence of FIRST is about inspiration and not competition, it is hard to ignore the fact that poorly functioning machines are not very inspiring. While some of this is inevitable in a sport with a new design challenge each year, much of this mediocrity is created by FIRST’s own constraints on the teams and thus is avoidable. Effective media promotion allows us to reach many more people, and we cannot inspire those we cannot reach.

Point 3: Lack of Retention = Lack of Growth

Growth is an important goal of the FIRST organization. I have heard Dean Kamen himself state on numerous occasions that he initially expected growth to be much faster than it has actually been. Again, I feel that the FRC constraint system is actually a contributor to restricted growth and the data supports this view. Between the recent seasons of 2015 and 2016, FRC grew from 2873 teams to 3114 teams. These are the number of teams who actually competed in each year, regardless of how many may have been registered. This is a net growth of 241 teams or 8.4%. However, in this same period a total of 203 competing teams quit the FRC (7.1%). So in actuality, 444 new teams were added in 2016 (15.4%) but nearly half of this overall growth was lost to attrition. We would be growing nearly twice as fast as we are if everyone who joined stayed. So the next obvious question is 'which teams quit and why?'

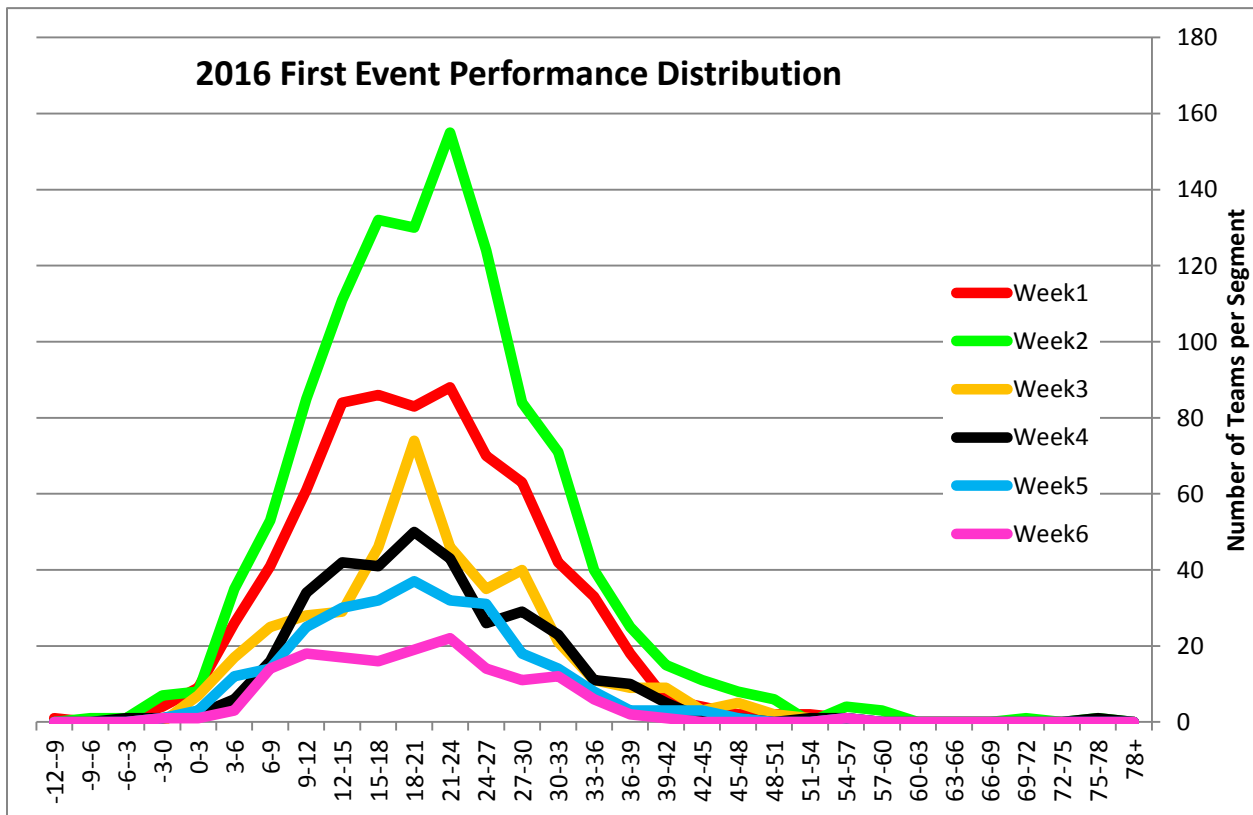
Figure (2) below is a graph showing the peak season OPR for all teams in the 2015 season, and also the curve showing the teams lost to attrition at the end of the 2015 season.



The trend from Fig(2) is quite clear: Teams who cannot accomplish the game objectives (i.e. build a minimally capable robot) are significantly more likely to exit the sport. The loss ratios exceed 15% in some of the lower segments, but drop effectively almost zero if moderate ability is achieved. This is consistent with the feedback we have received at FIRSTinMichigan. Teams who exit usually report that FRC is too hard, and that they have had no success at their events. It is important to note that success at events does not mean winning matches; success for many weaker teams means accomplishing the game objectives, having a working robot, and scoring some points. So, to fight attrition and improve growth, it seems we must do something help the weakest teams to build better robots.

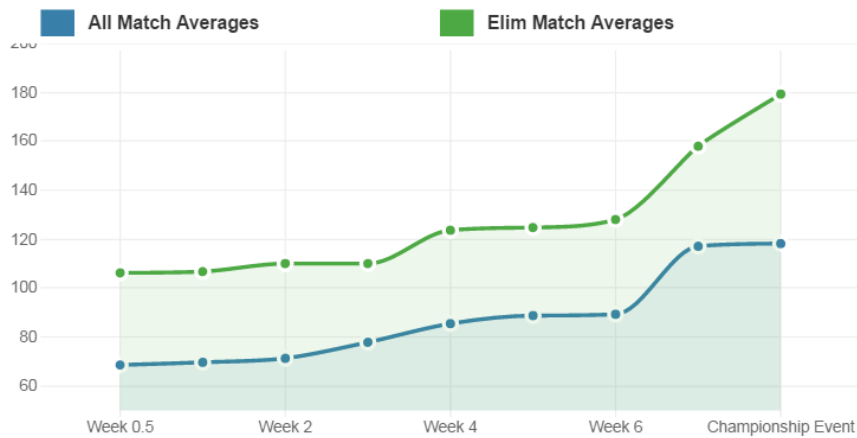
Point 4: Team do not improve if they do not play

The FIRST system requires that teams finish their robots and then wait to play. Team may wait for just a few days, or up to six weeks. Despite the ability for teams to watch matches, improve strategy, and prepare during this waiting period; the data indicates that no tangible benefit is realized by teams who wait to play later. The Fig (3) chart below shows the week by week performance distribution of all teams playing their first event in 2016. The averages of these curves all lie within a 0.6 point separation of one another, indicating essentially identical performance of all six groups, regardless of how long they have to prepare for their first event. With initial event averages of only 20 points overall, the bagging system seems successful if it is intended to hold everyone down to a low level of performance. It indeed does this very well.



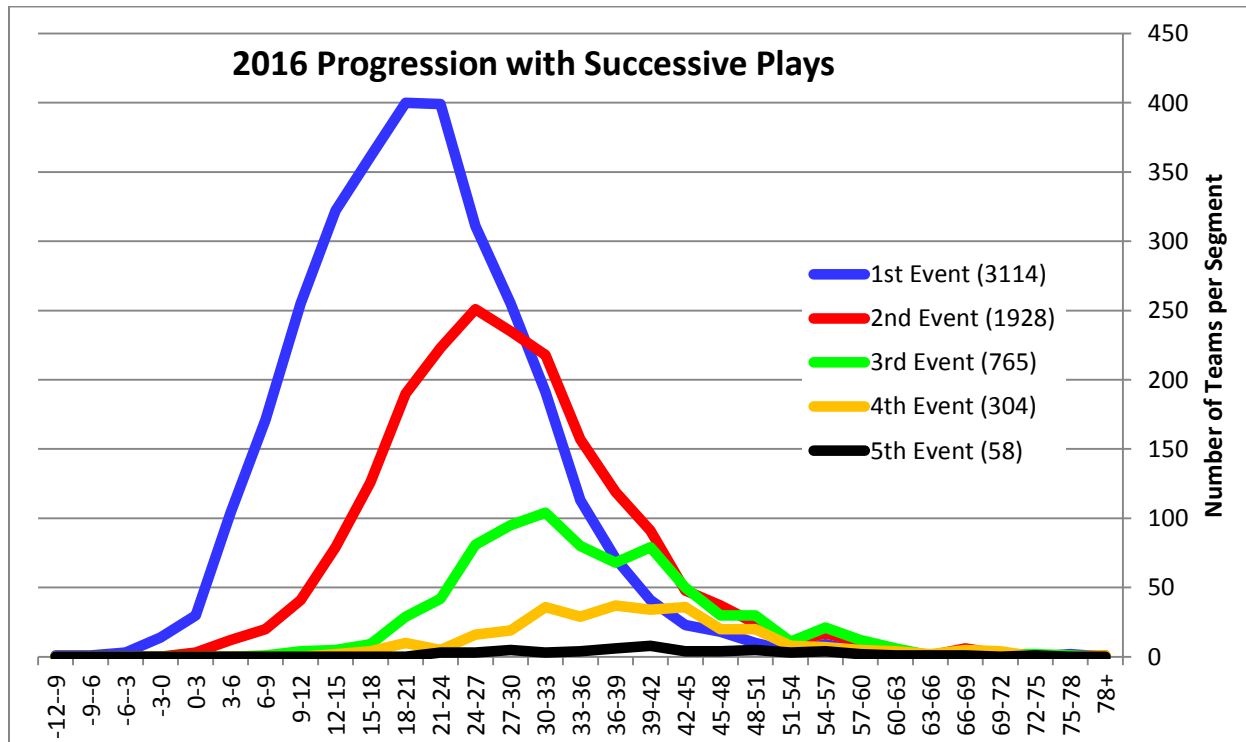
Unfortunately, in a world where most teams now play more than once, this represents a serious disadvantage for teams who play their first event later in the season. As we will discuss later, teams improve the more often they play. Average qualifying match scores increased by more than 20 points from week 1 to week 5; putting most first play teams at a significant disadvantage in later weeks. The only way bagging would be fair in this context would be if every team at every event were synchronized to have played the same number of events.

Average Match Score By Week



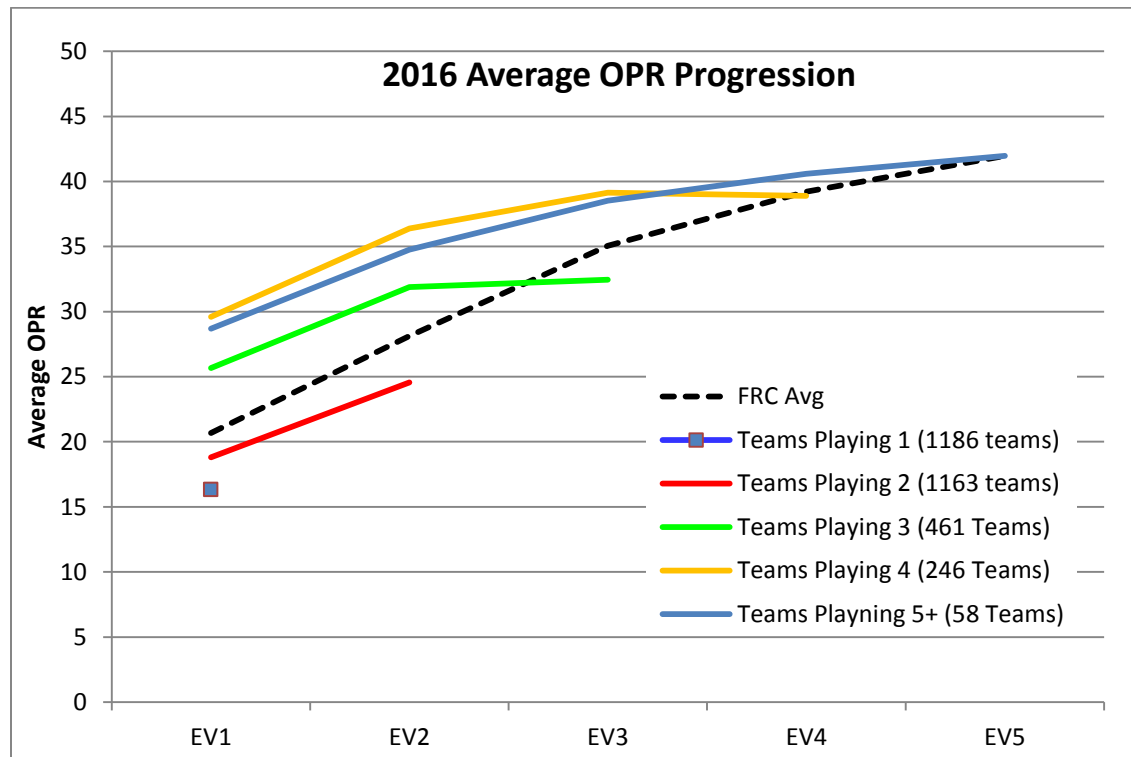
Point 5: Teams get better when they play with their robots.

This point seems obvious, but this statement has never been quantified in any way I have ever seen. We will quantify this now. As the season progresses, scores go up with each passing week and average team capability goes up accordingly. The Fig (5) graph below clearly shows this improvement trend. With each successive competition event, teams improve in their ability to play the game.



To reiterate an earlier point, this improvement represents a distinct disadvantage for teams who play late in the season. If all other things are equal, a team playing for their first time at a late season event with a team playing their 3rd event is at an average 15 point per match disadvantage in 2016. If only teams had a way to remain competitive while not playing at actual events. In other sports teams train and practice in preparation for their events, but in the FRC, teams must simply wait.

To illustrate this in another way, chart Fig (6) below shows the progression of the league average as teams play more and more events. The group average more than doubles from the first event to the fifth event.

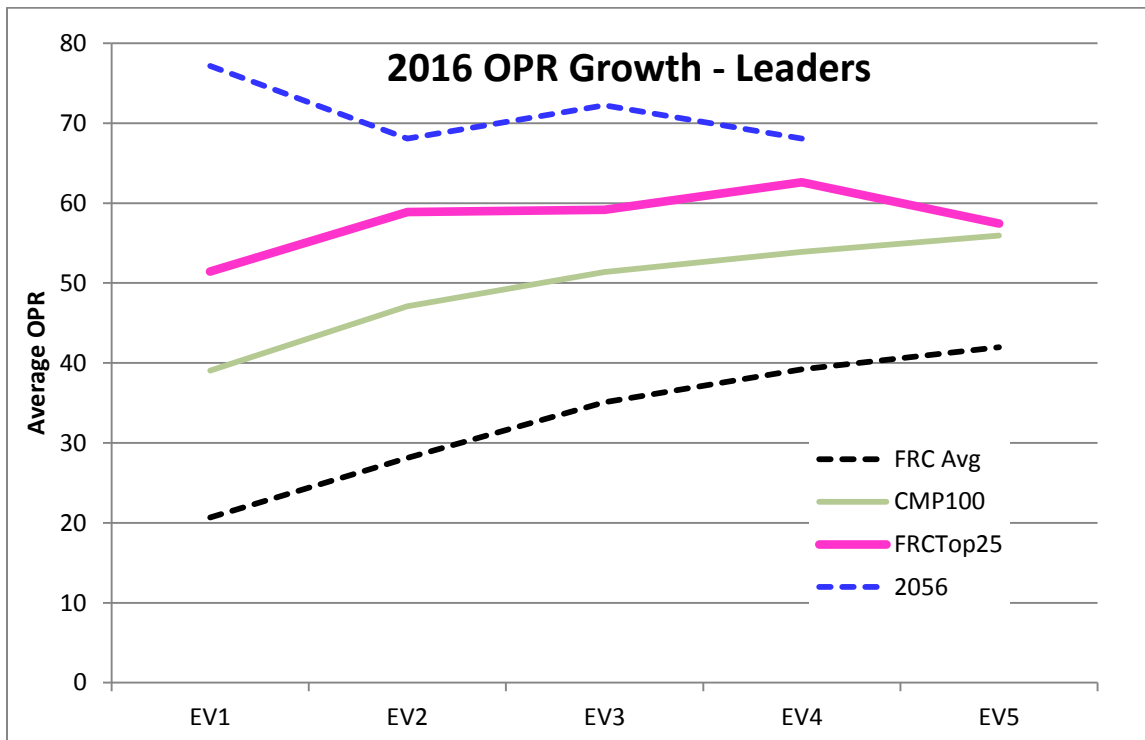


Point 6: Don't worry about the Leaders

There is a false belief in the FIRST community that the Stop Build policies somehow hold the strongest teams back, and without these limits, the 'rich' teams would be able to run away with the competition and no one else would be able to compete. In reality, this is already happening, and is perpetuated by the Stop Build policies. The leaders start the season ahead of the rest and maintain this lead the entire season. Let's review this claim by looking at 3 examples of elite teams or groups of teams.

Fig(7) below again shows the FRC league average OPR growth for 2016 in dotted black with 3 other curves.

The CMP100 team group is the group of the highest scoring 100 teams attending the 2016 World Championship. As you can see from the plot below, this large group of teams begin their season with an average capability only slightly below the entire league average at the end of the season....they start already as good as the entire collective gets. As a group, this top 3% set of teams stands at least 15 points per match ahead of the rest of the FRC. Rotation within this elite group is low, with over 70% of teams from the prior year is typically represented in the new current year.



Next is the FRCTop25 as tabulated by the FIRSTUpdatesNow team. While selection of this group is somewhat of a popularity contest, inclusion in this group correlates very strongly with success in competition. The pink line representing this top 1% group is even further separated from the FRC averages, starting their season on average over 30 points ahead of the population. Clearly, hands off restrictions do nothing to hold these teams back. Almost without exceptions, these teams all build multiple machines each year, and keep improving every day while everyone else is simply waiting.

Finally, let's look at team 2056 – OP Robotics. With the longest winning streak in the history of the FRC, 2056 is arguably one of the very best teams in the world. 2056 began their 2016 season literally at the peak of possible performance. At their very first outing, this team was already operating at the very limits of what is possible with an FRC robot playing Stronghold. Nothing FIRST did to put build restrictions in place had any effect on this team and a few other like them. So clearly, the data shows that the rich teams are not at all limited by the current build rules. These rules really only serve to maintain the gap between the rich and the poor.

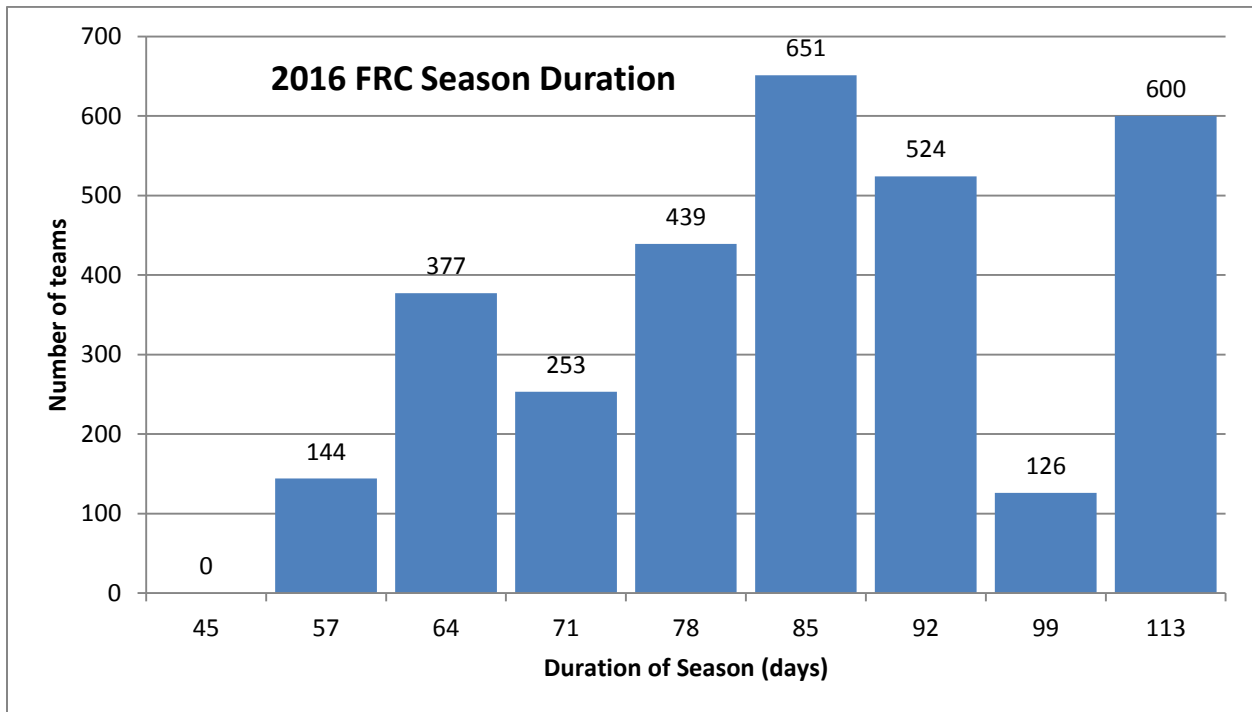
Point 7: The FRC season is NOT 6 weeks.

The myth of the 6 weeks is a lie. It always has been, it always will be. This myth is part of the FIRST marketing message but it is not actually true for the competitors. Everyone knows this but few people talk about it openly. I honestly think that this myth has been perpetuated because it has been quoted so often that many people actually believe it despite all the evidence to the contrary.

The duration of the FRC season spans, at minimum, from the day of kickoff until the Saturday of a team's final competition event. In the shortest scenario, the season is 57 days, in the longest, 113 days. For the average team, the duration is 85 days. Thus the policy of the 45 day build season makes the average team waste nearly half of their annual period waiting instead of improving. For teams making it into the FRC Championship, the build season represents only 40% of their total FRC season duration.

In the case of the well-resourced teams at the top, we take full advantage of the fact that the season is 113 days long, and we use every bit of this time to our maximum advantage. We do this because we can afford to build multiple machines each year and we never stop training and improving. Those who cannot afford to do the same cannot really hope to keep up. The current limits help the rich to maintain their lead.

Ask 67, 118, 148, 254, 987, 1114, 1678, 2056, and other top teams about their season schedule and you will soon see that these teams are who they are because they never stop working. These teams are the inspirational leaders in this sport. Many of them do not work on FIRST for 113 days per year; they work on FIRST nearly 365 days per year. Everyone wants to be like these top teams, but few can afford to. FIRST has the power to change this.



Conclusions and a Proposal:

So what have we learned from all this?

1. FRC has morphed from an event to a season and is not what it once was.
2. FIRST competition is not very media worthy in its current state which limits inspiration.
3. Most of our attrition comes from weaker teams which hurts overall growth.
4. Teams do not improve if they do not use their robots.
5. Teams do improve if they do use their robots.
6. The current restrictions do nothing to hold back the leaders.
7. The FRC build season is not actually six weeks for the top teams anyway.

Given all of this, it appears obvious that it is time for the Bag Day policies to go. It seems inevitable that this must eventually happen. These habits are clearly now hurting us more than they have ever helped. However, despite this, I understand the reservation surrounding changing policies which have been in place for 20 years. There is fear of overwork, fear of arms race type escalations, and other realities which should not be easily dismissed and no data exists within the FRC to allay these fears. This is why I recommend an intermediate transitional step.

I recommend that FIRST adopt a policy which allows ALL teams are allowed a standard 8 hours of unbag time EVERY week throughout the competition period. This will allow all teams to pursue continuous improvement efforts, work in their own shops, and a host of other benefits currently only afforded to rich teams from district regions who play very frequently. The "open every week" policy will eliminate much of additional advantage gained by teams who play early and often. At the same time, the limited weekly access time will prevent most of the issues which have been raised which would be associated with a truly unrestricted build / competition season. Teams would have the choice to spend a few evenings per week to use this time or to just work on open weekends. Using this time is obviously optional for all, just like all time in the current build season. No one ever has to work on their robots if they do not want to.

If this transitional step delivers positive results, FIRST can then use data from this trial, along with team feedback, to decide whether to eventually completely remove all robot access restrictions in the future.

FIRST HQ has the power to make our world a much better place; all they must do is decide to do so.



"The price of inaction is far greater than the cost of making a mistake." - Meister Eckhart

About the author: Jim Zondag is a 20 year veteran of FIRST Robotics. I am team leader and head coach of the Killer Bees Robotics team, and I am a co-founder of FIRSTinMichigan. I am associate producer of the RoboZone television series featuring weekly FIRST Robotics Competition. I have been studying FIRST Robotics statistics for about 15 years; it is a bit of an obsession.