Pinewood Derby -- Procedures

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Race Methods for a Shape N Race Derby

(Race Methods for a Pinewood Derby)

A Shape N Race Derby is Christian Service Brigade's gravity-powered model car race. It is similar to (some might say, virtually identical to) the Boy Scouts of America's Pinewood Derby.

This document describes ways to determine which derby cars are the fastest. It should be useful to organizers of any similar race event (e.g., model sailboat or model rocket races), since it addresses logistical issues that are applicable to any race event, and isn't tied to the specific details of model car races like the Shape N Race Derby or the Pinewood Derby.

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Introduction

The obvious (albeit superficial) goal of any model-car race event is to determine which model cars are the fastest, so that awards can be presented to the winners. However, there are other important goals which must be considered, goals related to the nature of the event as a social gathering with the parents and with the children who built the cars.

With so many parents and children involved in the event, it is critical for the races to flow smoothly. You don't want all those people (many of whom have short attention spans) sitting around waiting for something to happen. Whichever race method you use, be sure to schedule a dry run well in advance of the actual race, to make sure that everyone involved knows what's going on, and to make sure that any obvious problems are resolved before the room is filled with impatient parents and children.

Even when the race itself is flowing smoothly, those who are uninvolved with the current series of races may grow bored. Especially with large groups, consider scheduling each sub-group for its own time slot, so that people know when they need to be there. Furthermore, consider providing alternative drop-in, drop-out activities in a separate room from the race itself.

Finally, it is important to maintain fairness. Any appearance of unfairness can lead to ugly disputes; a lot of work went into each and every model car, so passionate advocacy can be expected if any car loses or is eliminated unfairly. Try to accomodate imperfections in the track, cars that need emergency repairs, the luck of the draw, human error, etc.

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Elimination Methods

The fundamental characteristic of elimination methods is that they eliminate entrants from the competition incrementally, until only the winning entrant(s) remain in the competition. A single-elimination method will eliminate entrants after a single loss; a double-elimination method, after two losses; a triple-elimination method, after three losses; and so on.

Thus, by their very nature, elimination methods create more and more entrants with no further personal interest in the procedings of the event. This can create a crowd-control problem for the event organizers. On the one hand, you can can accomodate this to some degree by postponing the final elimination as long as possible (e.g., by delaying the races between entrants that are only one loss from being eliminated). On the other hand, once first place has been determined, some people will lose interest, so as many entrants should be eliminated as possible before you run the final series of races which will determine which entrants win which places.

Another characteristic of elimination methods is that there is no fair mechanism to rank the eliminated entrants. For example, in a single-elimination race, there is no way to know whether the second-fastest entrant was the first one that lost to the winner, the last one that lost to the winner, or any of the others in between that lost to the winner. A single-elimination method will determine fairly only first place; a double-elimination method, only first and second places; a triple-elimination method, only first, second, and third places; and so on. Thus, as it becomes necessary to determine more places fairly, coordinating a multiple-elimination event becomes more and more complex.

Another characteristic of elimination methods is that different entrants will race a different number of times. With 32 entrants in a triple-elimination system, the first-place winner will only need to race 5 times. However, the third-place winner will need to race between 7 and 14 (or more!) times, depending on exactly when it is eliminated and how different groups are scheduled against each other. In a model car race, this represents a significant variation in the wear and tear (e.g., loss of lubricant) on the cars. In a model sailboat race where the entrants blow on the sails of their own boat, this represents a significant variation in the amount of physical exertion required from the entrants.

Finally, elimination methods do not accomodate unfair tracks well. Losing because you drew the slow lane still eliminates you (or moves you one step closer to elimination in a multiple-elimination race), and there is no way to recover. If your track is significantly unfair, you will need another mechanism to accomodate its bias (e.g., you could each race twice, switching the lanes for the second race).

I have described several problems with elimination methods. I admit that there is a certain appeal to using elimination methods; they are easy to understand, easy to explain to spectators and participants, and easy to run (if you don't try to fix the problems I've described). However, because of the difficulty involved in running an enjoyable, fair event using elimination methods, I prefer the final-standing methods described later in this document.

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The Single-Elimination Method

The single-elimination method is a simple mechanism for determining the best entrant. Entrants are assigned to compete against each other, and those that win progress to the next round. The process is repeated until the final entrants compete, and an overall winner is determined.

Recordkeeping can involve a formal ladder (with the winners of specific matches scheduled to compete against each other from the beginning), or matches can be scheduled on a more impromtu basis (once the entrants that qualified for each round have been determined).

If it is necessary to determine second (or even second and third) place, the entire elimination process can be repeated with the losing entrants. (This is essentially a simplistic multiple-elimination method.) This works reasonably well for a few entrants (half a dozen or so), where each iteration is fairly quick. For large groups, this is thoroughly impractical unless the entrants are first divided evenly into small groups (i.e., posts, squads, dens, sixes, patrols, or whatever name your organization has for subgroups of about half a dozen members).

Repeating the elimination process has the side-effect of making each successive round less (not more) important than the rounds which preceded it. One first place has been determined, some people will lose interest in the races for second (and third) place. This can create crowd-control problems.

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Elimination Ladder Methods

I do not like elimination ladders for race events like the Shape N Race Derby, Pinewood Derby, Raingutter Rigatta, etc. For one thing, elimination ladders become unwieldy very quickly. Once you get more complex than a double-elimination ladder for a two-lane track, ladderless elimination methods (described below) are more workable. A triple-elimination ladder for a four-lane track would be far too complex for most people to deal with.

Single-elimination ladders are easy to find (or make). Double-elimination ladders should be readily available too, since they are often used in athletic tournements.

However, note that many (if not most) athletic tournements use a double-elimination ladder that automatically gives second place to the last entrant defeated by the first-place winner, and gives third place to the winner of the losers' bracket. This is commonly accepted, but it is technically wrong. The last entrant defeated by the first-place winner and the winner of the losers' bracket should compete against each other, and the winner of that match should receive second place. The loser of that match should receive nothing; a double-elimination method cannot determine third place fairly. However, once first place has been determined, there would be little interest in a final match for second place. Furthermore, giving second place to the entrant that lost to the first-place entrant in the final match is intuitive, and third place is all that is left for the winner of the losers' bracket.

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Ladderless Elimination Methods

Many elimination systems avoid the use of ladders by simply recording the number of losses each entrant has had, and generating matches randomly among entrants who have had the same number of losses. The specific techniques for keeping track of the number of losses each entrant has had vary, but conceptually they are the same. Each time an entrant loses, it moves down one level of a hierarchy that has those entrants with no losses at the top. After it's nth loss, an entrant is eliminated. When there is only one entrant left in each level of the hierarchy, the one with no losses receives first place, the one with one loss receives second, and so forth.

To maintain suspense, it is a good idea to wait as long as possible before actually determining the winners. Eliminate entrants until each level of the hierarchy contains no more entrants than can compete in a single race, and then swiftly finalize the results with a few quick races.

In all of these methods, you will almost certainly have to schedule races for a group that is not an even multiple of the number of lanes on your track. Adjust the last few races to keep all the races as even as possible. For example, if you have a three-lane track, and you have one extra car, then the last two races should race two cars each (thus avoiding a "race" with only one car). As another example, if you have a four-lane track, and you have two extra cars, then the last two races should race three cars each (thus avoiding a race with only two cars).

Tables

One method uses tables to keep track of where each car is in the hierarchy. Cars start on the "No Losses" table, and as they lose, they move to the "One Loss" table, to the "Two Losses" table, etc. It helps if you have a "Current Heat" table from which to stage each round of races. Cars that win are returned to the table they came from, and cars that lose go to the next lower table in the hierarchy.

Don't forget to protect the cars from rolling off the tables. You can cover the tables with thick, soft cloth (terry-cloth towels work well), or you can build some kind of rack to hold the cars in place.

Display Boards

Another method uses display boards and numbered cards that correspond to the numbers assigned to the cars. The numbered cards are attached to the display board by hooks, hook-and-loop fasteners (e.g., Velcro®), magnets, or whatever other mechanism you find convenient. Each board has as many columns as the track has lanes, and as many rows as are necessary to hold all the numbered cards. Everyone starts on the "No Losses" board, and moves to the "One Loss" board, to the "Two Losses" board, etc.

It helps to have a second set of numbered cards attached to wristbands that are worn by the cars' owners.

Rosters

Another method uses a series of rosters. Winners are copied to a fresh "n Losses" roster, and losers are copied to the "n+1 Losses" roster, or possibly a fresh "n+1 Losses" roster. This provides a permanent record of how the race progressed, although I'm not sure why anyone would care.

Put the roster on overhead transparencies to make it easier to display to everyone involved.

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Final-Standing Methods

This section could also be called "Non-Elimination Methods". The common feature of these methods is that all races are scheduled in advance, and after all races have completed, some kind of rating mechanism is used to determine the final standing of every entrant. Thus, the crowd-control problems of elimination schedules are avoided.

Furthermore, final-standing methods typically schedule each entrant to race the same number of times in each lane. This helps minimize the unfairness introduced by fast or slow lanes, and guarantees that each entrant several races (depending on the number of lanes on your track). With a four-lane track, final-standing methods typically guarantee each entrant at least four races, and often guarantee eight or twelve races. In contrast, a quadruple elimination race guarantees each entrant only four races, although some will race many more times than that.

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The Lane-Rotation Method

I've also heard this race method called the Cross-Track Method and the California Method. This technique was used for decades by my CSB Stockade unit. It is easy to administer, given only an overhead projector and a handful of transparency sheets.

Our track has four lanes, therefore the following discussion will assume a track with four lanes. However, the method is easily adapted to tracks with different numbers of lanes; just replace the number four in the following description with however many lanes your track has.

Start with the first four entrants in the first race. In each successive race, the entrant that was in Lane 1 is removed from the rotation, the entrants in the other lanes move down one lane, and the next entrant on the roster is placed in Lane 4. When you get to the end of the roster, start over with the first entrant (which only had one race before being removed from the rotation). Stop when every entrant has raced once in each lane (the last entrant will be in Lane 1 in the final race).

After each race, record how each entrant did. After the last race, tally up the results and move the top-scoring entrants to the next round. Repeat the process until you reach the final round with only one entrant per lane. (Yes, this method does share some of the problems of elimination methods.)

You can either use golf scoring (low score wins), or you can assign more points for first place, fewer for second, and so on (high score wins).

With a four-lane track and twenty entrants, a lane-rotation race schedule will look like this:

```
             Lane 1   Lane 2   Lane 3   Lane 4
Race 1          1        2        3        4
Race 2          2        3        4        5
Race 3          3        4        5        6
...
Race 18        18       19       20        1
Race 19        19       20        1        2
Race 20        20        1        2        3
```

Scoring is easier if you use overhead transparencies for the roster, and a scoring template that looks like this:

```
          Number/Name:    Lane 1  Lane 2  Lane 3  Lane 4
Lane 1    ______________          ######  ######  ######
Lane 2    ______________  ######          ######  ######
Lane 3    ______________  ######  ######          ######
Lane 4    ______________  ######  ######  ######
On Deck   ______________  ######  ######  ######  ######
```

For each race, write each entrant's score in the open box, then move the entire roster up one place on the template. Repeat until you're done. (You'll need to copy the first three entrants to the end of the roster, since they'll return to the rotation at the end.)

After the round is complete, each entrant's scores will be lined up to the right of its number/name, ready for you to add up its final score. (You'll need to consolidate the scores of the first three entrants since some will be recorded at the top of the roster and some will be recorded at the bottom of the roster.)

Note that the "On Deck" entrant isn't actually involved in the current race; rather, it serves as a reminder that it will move to Lane 4 in the next race.

Unfortunately, each car races against the same opponents repeatedly, which is unfair to the cars next to the fastest car in the race (this is similar to being matched against the fastest car in a multiple-elimination race). The way to reduce this scheduling-related bias in the lane-rotation method is to adjust the point cutoff to allow more entrants to move to the next round, and then to mix up the entrants in the next round so that everyone encounters new opponents. You'll have to choose an acceptable balance between fairness and the number of rounds required to determine the top four finalists. For example, to accomodate the situation of the third-fastest entrant being sandwiched between the first- and second-fastest entrants, you'll need to allow entrants with a 2nd-3rd-3rd-2nd record into the next round.

A minor issue is that, even though each entrant races four times, all of those races are one right after the other (except for the first three entrants, which race at the very beginning and then again at the very end). Furthermore, if you schedule multiple rounds (e.g., quarter-finals, semi-finals, and finals), you'll end up with uninvolved entrants just as with the elimination methods.

Also, most cars will race for the first time against cars that have already raced once, twice, or thrice. I'm not sure how unbalancing this is on average, especially since the difference is minor. Some cars will slow down in each successive race (as they lose lubricant), while others will speed up in each successive race (as their wheels and axles "break in").

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Elapsed-Time Methods

If you have a track with a timer, you can run every entrant once in each lane, add up the total of the elapsed times for each entrant, and simply compare the total elapsed times. The lowest total elapsed time wins.

Tracks with timers are more complex and expensive than tracks with simple first-second-third finish gates. From a human-factors perspective, some of the excitement of each race is lost when everyone knows that the actual results of the race are irrelevant, only the elapsed time of each entrant. However, these methods are extremely fair. The actual race schedule can be generated with the lane-rotation method, or with any other method that guarantees that each entrant will race once in each lane.

Especially for a large regional derby, an elapsed-time method may be the best choice (assuming you have a track with a timer) because it avoids any hint of unfairness, and because it avoids the need for multiple (quarter-final, semi-final, final) rounds.

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Round-Robin Methods

Round-robin schedules match every entrant against every other entrant the same number of times. The schedule used during the regular season for most sports is a round-robin schedule; every team plays every other team once (or possibly twice, once at home and once away).

While it is easy to generate round-robin schedules when only two opponents compete in any given match (1 vs. 2, 1 vs. 3, 2 vs. 3, etc.), it is more difficult when more than two opponents compete in a given match. It helps a lot to restrict the number of entrants to a number that works out evenly. To use such a schedule with fewer entrants than called for, simply assign numbers to the entrants randomly, and then assign the left-over numbers as byes. Using byes to fill out the schedule doesn't compromise the fairness of the results much, as long as your scoring system treats byes as entrants who always come in last place. Still, it is better to avoid using a lot of byes.

Here are several round-robin schedules. Each schedule assigns each entrant to each lane the same number of times, and follows a simple incremental progression. Other schedules are possible; most of them are much more complex.

Three-Lane Round-Robin Schedule (Racing Once Per Lane)

On a three-lane track, each entrant will race three times, against two new opponents in each race. Thus, each entrant must have six opponents, and you need exactly seven entrants total. Here is a sample seven-entrant, three-lane schedule.

	Lane 1	Lane 2	Lane 3
Race 1	1	2	4
Race 2	2	3	5
Race 3	3	4	6
Race 4	4	5	7
Race 5	5	6	1
Race 6	6	7	2
Race 7	7	1	3

Three-Lane Round-Robin Schedule (Racing Twice Per Lane)

On a three-lane track, each entrant will race six times, against two new opponents in each race. Thus, each entrant must have twelve opponents, and you need exactly thirteen entrants total. Here is the first round for a sample thirteen-entrant, three-lane schedule.

	Lane 1	Lane 2	Lane 3
Race 1	1	2	5
Race 2	2	3	6
Race 3	3	4	7
...			
Race 11	11	12	2
Race 12	12	13	3
Race 13	13	1	4

The second round follows the same pattern, except that the first race involves entrants 1, 3, and 8. Together, the two rounds form a complete schedule where every entrant races in each lane twice, and competes against every opponent once.

Round-Robin Schedules for More Lanes (Racing Once Per Lane)

A similar round-robin schedule for a four-lane track would require thirteen entrants (four races per entrant times three opponents per race, plus one). The first race would involve entrants 1, 2, 4, and 10.

A similar round-robin schedule for a five-lane track would require twenty-one entrants (five races per entrant times four opponents per race, plus one). The first race would involve entrants 1, 2, 5, 15, and 17.

A similar round-robin schedule for a six-lane track would require thirty-one entrants (six races per entrant times five opponents per race, plus one). The first race would involve entrants 1, 2, 4, 9, 13, and 19.

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Chaotic-Rotation Methods

Chaotic-rotation schedules are similar to round-robin schedules. The main difference is that chaotic-rotation schedules relax the requirement that each entrant race against every possible opponent the same number of times. This flexibility makes it much easier to generate chaotic-rotation schedules than round-robin schedules.

My CSB Stockade unit has been using a home-grown chaotic-rotation method since 1996. It is extremely popular with both the boys and their parents. Here are some of the advantages of chaotic-rotation methods.

- Like other final-standing methods, they accomodate fast/slow lanes well.
- Like round-robin methods, they avoid scheduling entrants against the same opponents repeatedly.
- They maintain intrest because each entrant's races are generally distributed throughout the event, and each race matches new opponents against each other.
- Like other final-standing methods, they use a pre-determined race schedule, so the starting-gate crew can operate very efficiently.
- Since they require no final or semi-final (or quarter-final, etc.) rounds, they leave more time to schedule races for everyone, fast and slow alike.

Chaotic-rotation schedules are generally created in advance by a computer program. The program can generate schedules randomly, but it is better to create the schedule more deliberately, assuring that entrants race in each lane the same number of times, that entrants race against different opponents, etc.

One system that creates such a chaotic-rotation schedule is called the Stearns Method (named after Dr. Dick Stearns, the mathematician and game theorist who developed it for Pack 37 of Niskayuna, New York). Software for the Stearns Method is available as freeware.

Here is the basic algorithm of the program I wrote to generate chaotic-rotation schedules. For each race, for each lane, determine which entrant is the most "appropriate" one and assign it to that lane for that race. To determine how "appropriate" each entrant is, use the following prioritized rules (the most important rules are listed first).

1. Never schedule an entrant to race against itself. (Yes, this seems

obvious, but it must be specified explicitly.)

2. Schedule entrants for the same number of races each.
3. Given the above, schedule entrants in different lanes as much as possible.
4. Given the above, schedule entrants against different opponents as much as possible.
5. Given the above, avoid scheduling entrants in two consecutive races. (Sometimes you can't avoid rushing a model vehicle from the finish line to the starting gate for the next race--especially when you have fewer entrants--but it helps the event run more smoothly if you avoid it as much as possible.)
6. Given the above, select entrants that have been scheduled for fewer races so far. (This helps spread an entrant's races throughout the derby event.)
7. Given the above, select entrants randomly.

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Schedule-Free Racing

This may sound heretical to some, but you might consider running a derby with no race schedule. Just have the entrants line up with their model vehicles in hand, in whatever order they want, and let them race against whomever they want. After each race, they can get back in line immediately, or wait for a friend who is still in line (so they can get in line together and race against each other the next time). You just need one adult per track to load the cars into the starting gate and release them, plus leaders and parents to provide crowd control. Multiple tracks and refreshments will help keep entrants and spectators occupied.

You can run the derby like this without any official awards. If your derbies have come to focus too much on the awards, and not enough on the children's experience of building something with a parent or leader, then maybe its time to just have fun and not worry about trophies and ribbons.

If you still want to present awards, you can get results similar to those of the chaotic-rotation methods by using this system and recording how well each entrant does during its races. Limit each entrant to the same number of races by distributing the same number of race tokens to everyone; have the starting-gate crew collect tokens each time an entrant joins a race. Officials at the finish gate can keep track of the race results, or they can place stickers on the cars themselves (blue=1st, red=2nd, etc.). Or perhaps you can combine your derby night with a family carnival, and award carnival tickets. Be creative!

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