Chapter 26

Racing Against Time

Solutions in this chapter:

- Hosting and Participating in Contests
- Going as Fast as Possible
- Combining Speed with Precision

Introduction

This chapter opens the third section of the book, where we explore the world of MINDSTORMS robotics contests and challenges. The three chapters that make up this section are mainly based on our direct experience, accumulated while attending competitions organized by the Italian LEGO Users Group (ItLUG). We won't be discussing the specific details of the contests we participated in, instead we'll be providing you with a good starting point for more general considerations.

The first section of this chapter is about robotic contests in general. We will explain what robotics contests are all about, from the definition of the rules up to the course of competition. For those of you interested in participating in LEGO robotics contests, we'll give you some hints about how to find a LEGO Users Group not far from where you live.

In the later sections of the chapter, we will introduce contests related to pure speed, as well as those demanding great amounts of mechanical and programming acumen. There are many different kinds of contests and challenges. Because of this, we grouped them into three categories: contests based on speed, contests based on strength, and contests based on ability. These categories are not absolute, because most of the competitions require a mix of these capabilities. For example, a line following contest is mainly about speed, but each robot is also required to run without departing too much from the line. Nevertheless, we tried to sort a few typical contests into the categories previously mentioned because in our opinion this helps in focusing on their key points.

Hosting and Participating in Contests

A contest offers many opportunities to learn new concepts and build some experience. We can identify at least four main phases of participating in a contest, each one requiring extensive usage of your know-how while contributing to your knowledge base. They are:

1. **Defining the rules** Participating in this phase depends on whether you are the one who organizes the contest, or part of a group that does. Unless you're deciding on your own, this will prove a very creative moment, where the group develops a list of rules, adjusting them until it feels they are meaningful and consistent. A set of rules always has a specific purpose (whether declared or not), which has been chosen to test the ability of the competitors on a specific field. The "legislator" should take care to close any possible loopholes that might allow a contestant to

escape the main difficulties of the contest, which requires that he/she imagine all the possible approaches to the problem.

2. **Studying the rules and deciding on a strategy** From this moment on, you are in the competitive arena, and must find a strategy to beat your competitors. Don't limit your choices to what the organizing committee expects you to do. In our experience, most contests have been won by people who found a very original way to interpret the rules without violating them.
3. **Building the robot** This phase will very likely present some surprises to you. Implementing your desired strategy, you'll discover new constraints and opportunities you hadn't thought of while imagining your robot. As for programming, we strongly suggest you stay with simple but solid strategies. Only when you're sure the basic behaviors work as expected, should you add in the more sophisticated components, making sure not to introduce bugs in the previous code. You can't imagine how many matches you can win by simply not getting too fancy!
4. **Attending the contest** This is the most exciting moment—on the field, testing your ability against your competitors'! It's also the moment to learn: study the other robots and their strategies; observe the course of the matches. Don't be frightened to ask for explanations and details, most of the builders are usually more than happy to describe their creatures. All that you learn will be useful for other contests, whether run on the same set of rules or not. One last suggestion: never throw in the towel before the end, anything can happen during the event. The strongest competitors aren't always crowned winners.

We imagine some of you are thinking right now: okay, very interesting, but where do I find a contest that isn't light years from home? Remember, the Robotics Invention System is a tremendous success. With a bit of luck you may find an already organized LEGO Users Group in your area. Many exist in the U.S., Canada and Europe, covering most regions and major metropolitan areas.

Use the Internet to search for other MINDSTORMS fans. The best resource is the LEGO Users Group Network (LUGNET), which lists dozens of local groups. Many of them also have their own Web site, which shouldn't be difficult to find using any search engine. Once you've found a group, or some individual users, there's no certainty that anyone's going to leap up and organize a robotics contest from time to time. But you, yes you, can be the one to get the ball rolling (or robots rather).

Last but not least, try to attend some *remote* challenges, contests that don't require your presence in person. Usually all you send are some pictures of your robot, a copy of the software, and a short description of how it works. In code-only contests, this concept is pushed to the extreme limit: the organizing committee distributes the plan of a standard robot, and all the competitors send their own code via e-mail. The design of the robot is usually simple and doesn't require any special or rare parts, so that a large number of competitors can replicate the robot at home to debug and test the code.

LUGNET is the best place to find information about contests of all sorts, as most local groups advertise the contests they organize there. Usually they refer you to a Web site where you can find all the details about the time, place, and rules of the contest. Some user groups require a small admission fee for each robot, which funds the prize for the winner. Events are characterized by a very friendly atmosphere, and you'll be welcomed even if you just go to watch.

Optimizing Speed

The first challenge we'll describe here concerns pure speed. Don't make the mistake of thinking speed is purely trivial and poses few challenges in terms of robotics. We've been proven wrong on this score ourselves. Even a straight-out speed race promises surprises.

Drag Racing

A starting line, a finish line, the fastest robot to cover the distance wins. Described in these terms, the race sounds a bore. But stay tuned, and take a closer look at the implications of this definition.

The speed of a vehicle is affected by a number of factors: motor power, gear ratio, mass, friction. Using electric motors, the maximum power you can apply to your racecar depends on the kind and number of motors, and the current you supply them. There's only one kind of motor in MINDSTORMS, which forces upon us a simple rule: use as many motors as allowed.

As for their supply of energy, the rules should outline some restriction, like the adoption of the same kind of batteries for all the competitors (e.g., standard commercial alkaline batteries). Should this not be carefully stated, someone could take advantage of a custom battery setup—which is exactly what happened during our dragster race!

Inventing...

A Very Special Battery Combination

Marco Berti won the first ItLUG robotic competition using eight NiMH batteries fitted inside the RCX. He needed eight because NiMH cells are rated 1.2V instead of 1.5V like the standard AA batteries. With eight cells he got 9.6V, a voltage just a bit higher than those supplied by fresh alkaline batteries, but tolerated by the RCX and the motors. What's unusual about rechargeable NiMH batteries is that they supply more current than alkaline ones. Electric power is proportional to voltage multiplied by current, so he definitely got more push for his motors. To fit eight cells in six slots, he used four standard AA size, and two 2/3 of AA combined with two 1/3 of AA. Those smaller batteries supply the same voltage and current as their bigger brothers, only for a shorter time.

Be very cautious in experimenting with custom battery setups: voltages higher than what the RCX is rated for can permanently damage your unit.

As for the gear ratio and mass, which have a strong influence on the acceleration rate of your vehicle, here is a short list of tips:

- The shorter the gear, the shorter the time it takes to reach the maximum speed. The problem is that a short gear also has low top speed. You have to balance the two effects, and the optimal choice depends also on the length of the race: favor acceleration on short tracks, and maximum top speed on longer ones.
- Build your robot in a way that allows easy replacement of the gears, so you can experiment with different ratios in a time-efficient manner.
- Keep the gearing pared down to the essentials—remember that each stage adds some friction. There's no need for a differential gear, since the dragster travels on a straight run.
- The diameter of the wheels has its role in the conversion of power to speed. If you substitute the wheels of your car with ones half the diameter in size, you get the same effect as if you had reduced the gear ratio by a factor of two.

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