

COMBAT ROBOTS

Complete

EVERYTHING YOU NEED TO

BUILD!
COMPETE!
AND
WIN!

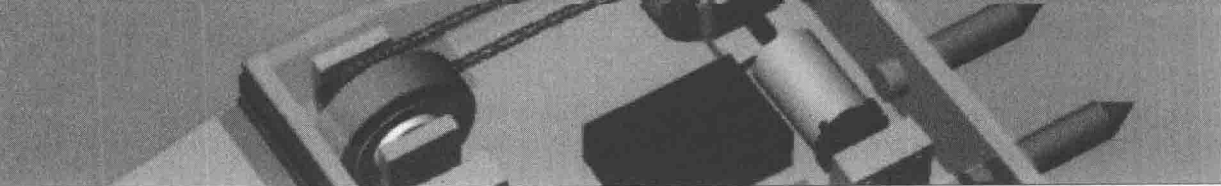


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Chris Hannold

TAB
ROBOTICS





COMBAT ROBOTS COMPLETE

***EVERYTHING YOU
NEED TO BUILD,
COMPETE, AND WIN***

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藏书章

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COMBAT ROBOTS COMPLETE

Dedication

To Mom and Dad for your undying love and support.



INTRODUCTION

If I were asked to describe building a battling robot in one word, that word would be *balance*. To build one of these things you have to balance your ideas and dreams with your time, ability, and money. You must balance speed with power. You must balance materials and weight limits. You must balance complexity with simplicity. In every aspect of the design and build process you must make trades between two or more desirable features. An old saying sums it up. “It’s your choice...Fast, Cheap, or Reliable. Pick two.” Balance is the key to building an effective, lasting robot. However, luck and driving skill have a lot to do with winning.

Building a battling robot can be a difficult, rewarding, educational, and really fun prospect. *Combat Robots Complete* was written to help you understand exactly what it takes to turn ideas into a functioning machine, and to answer a lot of the questions a person new to fighting robotics would ask without the burden of knowing all the physics, engineering, and math involved. I’m not saying there is no physics, engineering, or math in the book. I will attempt to present and explain a lot of the ideas behind building a battling robot, certain concepts are covered and explained in a simplified manner that may leave out details that would appear in engineering texts. Most of that isn’t necessary to enjoy building and competing battling robots anyway. Like someone once said, “It ain’t rocket science!”

No matter how hard you try, you cannot build an effective combat robot without having some mathematics skill. Calculus isn’t required, but a good background in algebra, geometry, and unit conversion will get you a long way. I’m not writing a mathematics text, but throughout the book I will go through some basics in math and unit conversion that will

help you figure out what kind of motors you need, what kind of batteries you need, what kind of gearing you need, and other important aspects of bot building. If you can substitute your values for the values given in the examples, you should do well.

Costs

Lots of people wonder how much money it takes to build a fighting robot. The answer is that it depends on the builder, his/her experience, his/her knowledge of the subject matter, and his/her wallet. When building a battling robot, there are lots of expenses. The best way to minimize them is to have a clearly defined plan and proceed according to it. Then you will most likely still be over budget. One major expense that most people forget to include in fighting a robot is the cost to compete. This cost includes the entry fee to the competition, hotel fees, rental car fees, airfare, robot shipping, meals, and any parts you may need but don't have for repairs during the competition. You can cut all that cost out, build a fighting robot, and stay home fighting the neighbor's trash can or chasing their cat—but that's not why you are reading this book. You want to compete with the big boys.

You can reduce costs in many ways. Booking flights with layovers will cut your airline costs. Planning a carpool with other builders for the event will save some money when it comes to traveling while competing. The local youth hostel may not be glamorous with its wards and cots, but it is a really cheap place to stay. Most of them even have kitchens. You can save some money by buying and preparing your own food. (You may put in some late nights getting your bot working, so you need to remember to check the kitchen hours and make other arrangements if necessary.)

Any way you look at it, shipping a robot through the standard carriers is expensive. The expense grows as you ship heavier and bigger boxes. Remember that you are not only paying to ship the weight of the bot. You are paying to ship all the spare parts, all the tools, and the crate. It will even cost you to build an appropriate crate. The first time I went to a major event I was on a really tight budget. We had a 300-pound bot that needed to get from North Carolina to Las Vegas, Nevada. The night before we left, we took the bot apart, packed it into seven cardboard boxes, and checked it all as luggage on the airplane. Four of us were going and that left only one available luggage slot. One of my crew was my friend's wife. I think she put everything she owned into that one suitcase and the rest of us took carry-on bags full of clothes. According to airline regulations, each box had to weigh less than 70 pounds. We were relieved to find out that the heavy one weighed in at 69.9 pounds.

I highly advise against shipping your bot as luggage for four reasons:

- Heavy boxes put the “lug” in “luggage.” Getting to and from an airport is hectic enough without having to worry about loading and unloading all those boxes.
- You never know when an airline is going to lose your luggage. We got lucky and everything showed up in Vegas like it was supposed to but I know a few builders who have lost major parts this way.
- Airline screeners are much stricter about what they will allow inside the plane nowadays.
- It is a really bad thing to show up at an event with a robot that isn't put together. Doing so will take much of the enjoyment out of your experience. We put our 300-pound robot

together in the hotel room. It took about 20 hours—20 hours we could have spent talking to other builders and checking out the other robots.

The cost of competing is just another area where you need to compromise. You either spend some money or you spend some time. It is up to you to determine which is more valuable. Again, there are many ways to cut the costs. In fact, there are ways of building and competing for free, though it's not easy to get to that level. I'll cover those later.

Builder's Unions

In my experience, the best part of battling robots, next to building them, is getting to meet and talk to the other builders. I've made friends all over the world through robotics. Some I've met at competitions and some I've only talked to via Internet forums. The builders as a whole are a true community. This is great for a couple reasons. One, you get to share ideas and experiences. Two, you get to be a part of something that many people will only dream of doing. Everyone seems to stare in awe when I tell them that building robots has taken me to Hollywood, Las Vegas, and London, among other places. Whenever there is a big group of people, organizations tend to appear. The Society of Robotic Combat (S.O.R.C.) was the first of bot builder's unions, so to speak.

S.O.R.C. Mission Statement

First and foremost, the SORC is an organization devoted to the interests of robot builders from around the world. Where appropriate, the SORC will defend the rights of the builders to use their creations and images of their creations in any legal manner they choose. The SORC is a resource to provide education and information about the design and construction of competitive robots. Information about mechanical components, electrical components, and manufacturing techniques will be exchanged. Advances in Robotic technology will be identified and disseminated. The SORC will maintain a comprehensive set of guidelines for robotic events. These guidelines will maintain safety while stimulating creativity and impartiality.

Copied directly from the S.O.R.C. bylaws section 2.1... www.sorc.ws

To date, the major robot combat competitions have their rule sets based at least loosely on the S.O.R.C. rule sets and run their competitions according to safety guidelines originated by the S.O.R.C. The organization is also currently working on hotel and shipping discounts for builders who attend major competitions. The S.O.R.C. is not the only organization lending a helping hand to bot builders. Check on the Internet to find others. Become an active member and help make this sport grow.

Following the Rules

Many people start out imagining robots carrying flame-throwers, lasers, and even firearms. In reality, most competitions don't allow these types of weapons. If they are allowed at all, they are so restricted that they could not possibly do any damage to their

opponent. One of the first things you have to do before building your bot is to know the rules of the competition in which you wish to participate. Notice I said “know” the rules and not “read” the rules. Knowing the rules will keep you from making design mistakes and will ensure that you are allowed to compete once your bot is finished. Knowing the rules will allow you to design for that specific competition as well. Some competitions have different events with different strategies. Simply reading the rules just doesn’t cut it. Knowing the rules of the game will give you an edge compared to the builder who does not know them.

While attending an unnamed competition that required the breaking of a lot of glass, I noticed that my robot would not be able to reach the glass. Several other builders had the same problem. Evidently I did not pay close enough attention to the rules. Fortunately, we had some spare material that did the job nicely. However, some of those other builders did not have the spare stuff or a place to mount it. They ended up losing points in the competition. That could have been avoided if they knew the rules instead of simply reading them. I just got lucky because I brought a ton of stuff.

Weight Classes

The most common rule between different competitions is the weight class rule. For all the nitpickers, we should remember that weight is different than mass. Mass is constant where weight varies with different forces. The weight of a robot hovering above the scale is zero because of the forces holding it up in the air. However, the mass of the robot is the same whether it is in the air or on the ground.

Among the competitions that I know of, there are seven weight classes ranging from a few ounces up to 408 pounds. Some classes contain exactly the same weight ranges, while some classes are just similar enough to facilitate losing a few pounds to be eligible to compete in different competitions. Most competitions offer a weight advantage to robots that walk. The spirit of the rule grants the weight advantage because it is recognized that it takes a bit more to build a walking bot that can compete effectively with a rolling bot. For now, the rules dictating what exactly constitutes a walker are really still under debate. Some rules are too restrictive, and others just are not restrictive enough. Because of that and the added complexity of walking machines, only the most adventurous bot builder attempts the walker undertaking. If you are reading this book in order to start building your first bot, I highly recommend starting with a wheeled bot so that you can learn to walk before trying to run.

Very few competitions allow all seven classes. For instance, the Ant weight class is from 0 to 1 pound for rolling robots. While they are a great pastime, those robots are just too small to put into a 30-foot square arena and entertain a crowd. For now, the Ant weight class has been relegated to separate, side competitions, while the larger bots are in the big arena.

One thing to remember when it comes to a real competition is that the weight class rule should be set in stone. At least one of the TV shows will allow you to compete even if your robot is overweight. The real competitions will not do this unless you change official weight classes. However, the real competitions will allow you to try and drop the extra weight to get into the intended class.

Technical Concepts

In this book, I'll outline and discuss the major concepts behind building a combat robot. The information is not new to machinists, mechanics, and electricians, but it is finally set down in a manner that is appropriate to robot builders. I'll start out with the schematics, wiring, remote control setups, and their problems and uses. Then I'll touch on different methods of movement. Next I'll cover the popular speed controllers. Then I'll cover batteries, including SLAs and NiCds and how to charge them. After that, I'll go into electric motors and show you how to choose the right one. I'll also go into how to increase their torque for your bot using gears, sprockets, or pulleys. I will touch on pneumatic systems, getting the bot to roll smoothly, and cover the use of gasoline engines. Then we'll come to frame and armor material selection. We'll discuss the different types of weapons and defenses. Finally, we will talk about how to design your bot and model it so that we know it works. That will do it for the conceptual part of the book. After that, I will briefly discuss building a 1-pound robot and a 220-pound robot. The third and final project of the book will be Dagoth, a 30-pound bot armed with spikes and a wedge. It will not be a large stretch of the imagination to turn Dagoth into a 60-pound bot with an active weapon. Have fun.

COMBAT ROBOTS COMPLETE



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