DAVID R. SHIRCLIFF

Complete Plans

Step-by-Step Illustrated Details

BUILD A REMOTE-CONTROLLED ROBOT

TAB ELECTRONICS

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DAVID R. SHIELDS

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To my wife, Raye, and my children, Daniel, Haley, Ian, Margaret, and Raymond, for their support and encouragement.

ABOUT THE AUTHOR

David Shircliff is a teacher at Seneca Ridge Middle School in Loudon County, Virginia, where he teaches classes in technology education. A dedicated electronics enthusiast, Mr. Shircliff has been researching and building robots for over 20 years.

PREFACE

In recent years robots have captured the interest of more and more people. Thanks to movies and TV, the notion of the robot as a mechanical companion and servant has become a common concept. As interest in robots grew, a number of books showing how to build robots at home began to appear. These books, however, were very technical, showing how to build computer-controlled mobile platforms that are considered by most to be true robots.

My interest in robots leaned more toward the popular concept of robots as humanlike friends and servants. I did not have the technical skill or funds to build a computer-controlled robot, so I decided to develop a robot that would fit the popular image of robots and not be too difficult to complete or expensive to build. The result was Questor.

While working on Questor, I tried to develop a project that I, as a beginner, could complete with little technical skill, using tools I had in my workshop. Also, I wanted Questor to look and function like a robot butler, a form I felt best fit the friend/servant theme. For this reason I needed a people-sized robot that would have great presence. I concentrated more on form than sophistication to develop an impressive looking, but relatively simple-to-build, project—a beginner's project.

Later, when I decided to write a book about the project, I wanted to avoid weaknesses I found in other how-to robot books. This book is heavily illustrated, helping to take the guesswork out of Questor's construction. Next, the book deals only with the construction of the robot, and not the theories on which it is based. This type of information is best derived from specialty electronics and robotics books. I have included

a list of books and magazines that supply information, as well as other possible sources for robot kits and parts.

It is my hope that you will use this book not only to build your own version of Questor, but to guide you in creating your own unique robot. This way your robot will reflect your knowledge and skill as a builder. Also, I hope that your robot will be used as a test bed for other robotics projects. If you are like me, once you build your own robot, you'll always be trying to improve it.

David R. Shircliff

INTRODUCTION

One of the first questions you will have to answer when you say you have your own robot is, "What does it do?" If your answer (as mine) is, "It rolls around by remote control and serves drinks" disappoints the questioner, don't be offended. It simply means that the person asking the question knows little about the real world of robotics, the science of robots.

Before you can attempt to explain your answer to the uninformed asker, you must know a little about the subject of robots. Ask yourself, "What is a robot?" The word robot comes from the Czech word *Robota*, which means obligatory work or servitude. The word robot was first used in a Czech play called *R.U.R. (Rossum's Universal Robots)* by Karl Capek. Written in 1921, the play depicts a race of humanoid robots that turn on their masters and destroy them, a theme that seems always to be associated with robots. Figure I-1 shows a scene from the play.

The exact meaning of the term robot, even in today's technological age, is a matter of debate. Man's technical prowess makes the exact meaning elusive: manlike mechanical device; person working mechanically, without original thought; machine or device that works automatically. These definitions seem rather broad and could encompass any number of modern devices from a dishwasher to a timer-controlled video cassette recorder, without conjuring up the popular *Star Wars* notion of robots.

A second, more-precise definition is stated by the Robot Institute of America. It reads: "A robot is a programmable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks."

While more precise, it tends to be narrow and also does not parallel the popular notion of the mechanical friend everyone

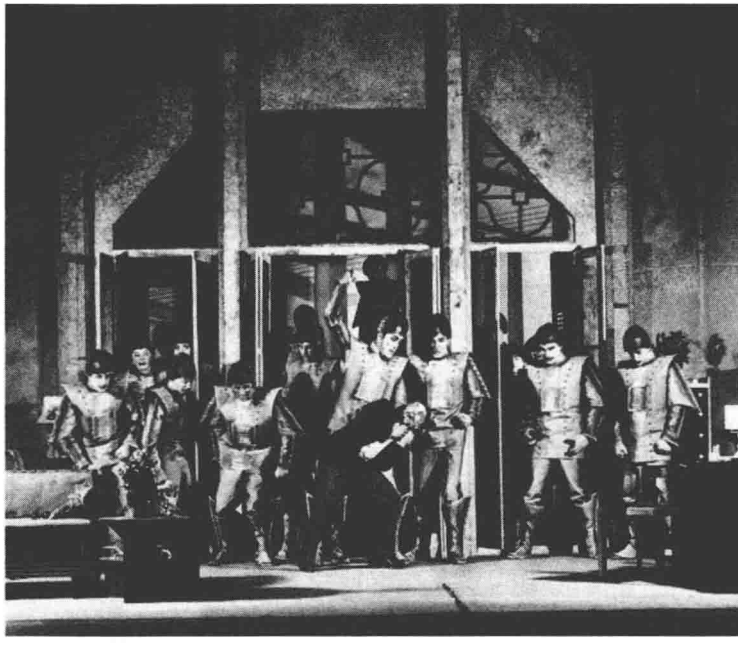

FIGURE I-1. The robots of the play *R.U.R. (Rossum's Universal Robots)* attack their human masters. *(Courtesy of New York Public Library at Lincoln Center.)*

would like to have. It applies more specifically to those types of robots at work in factories all over the world, shown here in Figs. I-2 through I-4. These assembly line type robots can do everything from welding a car (then painting it) to assembling delicate electronics components, all automatically, 24 hours a day if needed, and without a break. They don't get sick (although when they do break down, they can be easily repaired or even replaced), ask for pay raises, or any pay for that matter, and can be retrained to do another job in a matter of minutes by simply changing the job program in their control computers. If you look again at Figs. I-2 through I-4, you will see that while the device most certainly looks mechanical, it does not look like a human. Instead it takes the shape of the most useful part of the human anatomy, from a robot standpoint, the arm.

Both these definitions seem to be correct in their specific case, but there is a middle family between the simple automated device and the sophisticated computer-controlled

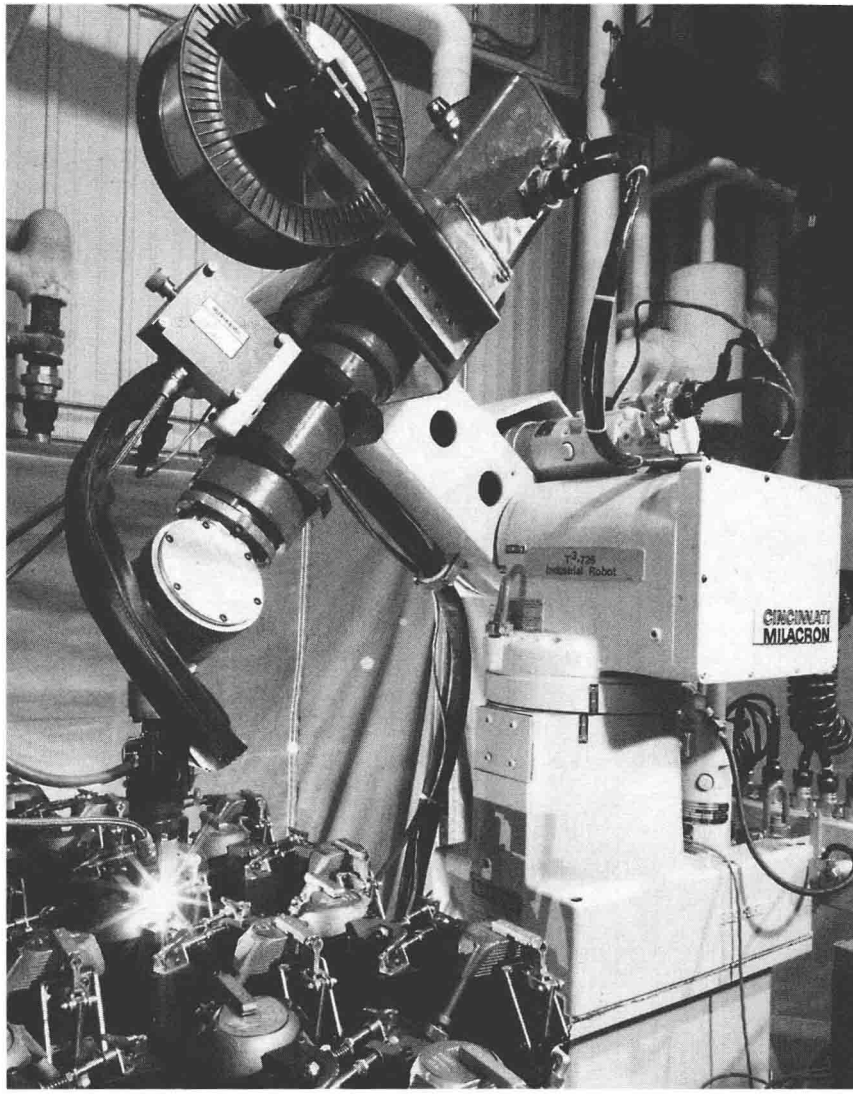

FIGURE I-2. An industrial robot. (*Courtesy of Cincinnati Milacron.*)

manipulator. This middle family is that of the show robot or showbot. Questor, the robot outlined in this book, is a member of the showbot family. Figures I-5 through I-8 picture examples of commercial show robots.

A showbot in most cases has no computer brain. Instead it is controlled via a remote control system operated by a person somewhere out of sight. You might have seen or heard of a

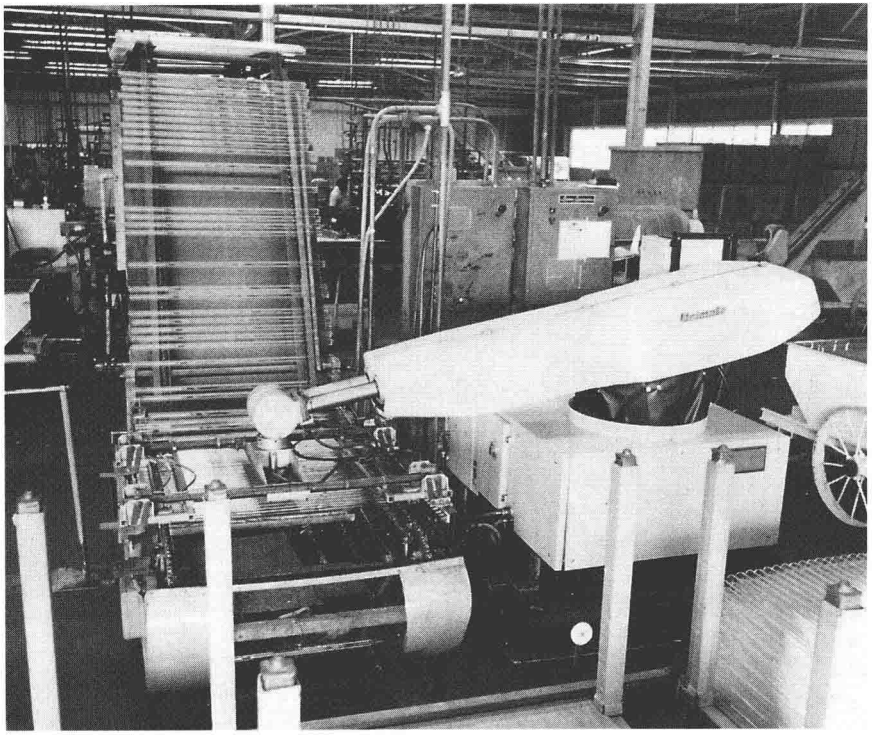

FIGURE I-3. Robots are best used for repetitive tasks like stacking. (*Courtesy of Unimation Inc.*)

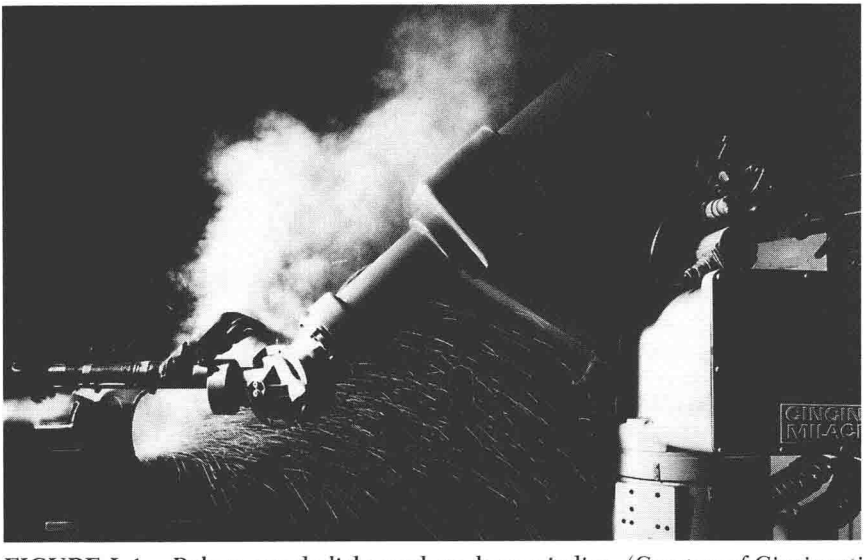

FIGURE I-4. Robots can do light work such as grinding. (*Courtesy of Cincinnati Milacron.*)

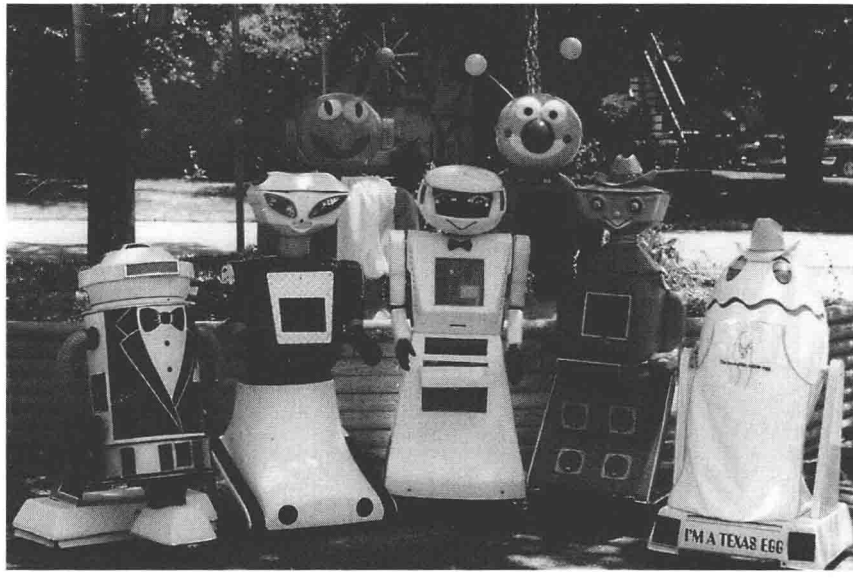

FIGURE I-5. Showbots come in many shapes and sizes. (*Courtesy of Ken Zaken, Robots 4 Fun.*)

showbot entertaining groups of fascinated people in shopping malls or on TV as characters in movies. I even read about a showbot delivering a speech at a college graduation. Showbots, however, can be adapted for use in the home.

This book lays the groundwork to construct one such home showbot, Questor. (See Figs. I-9 and I-10.) Questor was designed to look like and function like a butler. There is a drink dispenser built into his arm and a vacuum port in his mobile platform. I felt these two functions are what most people expect a robot servant to do. The arms, which help promote Questor's humanoid shape, are nonfunctional; they serve only to hold the serving tray. The hands are made of two auto drink holders. A button located on the wrist (the area above where the hands are bolted on) controls the drink dispenser.

His head is a lamp, and there are two headlights on the front of the mobile platform. These lights not only help the operator guide the showbot at night, but they are very useful during power blackouts. There is also a 12-volt direct current (dc) cigarette lighter plug on the side of the base. This is used to run battery-powered appliances such as portable radios or TVs off the robot's batteries.

FIGURE I-6. The Six-T showbot can blow up balloons! (*Courtesy of The Robot Factory.*)

A horn located on the lower part of the front body panel announces Questor's presence. I plan to add a tape recorder for prerecorded messages. This is something you could consider designing into your showbot. Finally, his body panels and arms were painted to look as though Questor is wearing a tuxedo jacket, and a light-up bow tie completes the look.

I also designed Questor so he could be built using tools found in a home workshop and parts available in local hardware and electronics stores. However, there are a few parts you will have to order. The following list of what I've determined are "must buy parts" shows items you will need to purchase before starting construction. The address for a parts supplier, Herbach & Rademan Company, is listed in Sources in the back of the book.

FIGURE I-7. Showbots can also be soft and fuzzy. (*Courtesy of The Robot Factory.*)

Must Buy Parts

2 12-volt dc motorized wheels

2 6-volt, 8-amp solid gel batteries, with charge kit

2 10-ohm, 25-watt potentiometers

Note: The drink dispenser motor and vacuum system kit can also be ordered from Herbach & Rademan. The rest of the parts needed for each phase of Questor's construction will be listed in the beginning of each chapter.

All of Questor's various components, except for the remote control system, are powered by a 12-volt dc battery system. Questor can be controlled by either a control box connected to the base by a cable or a wireless remote control system. The

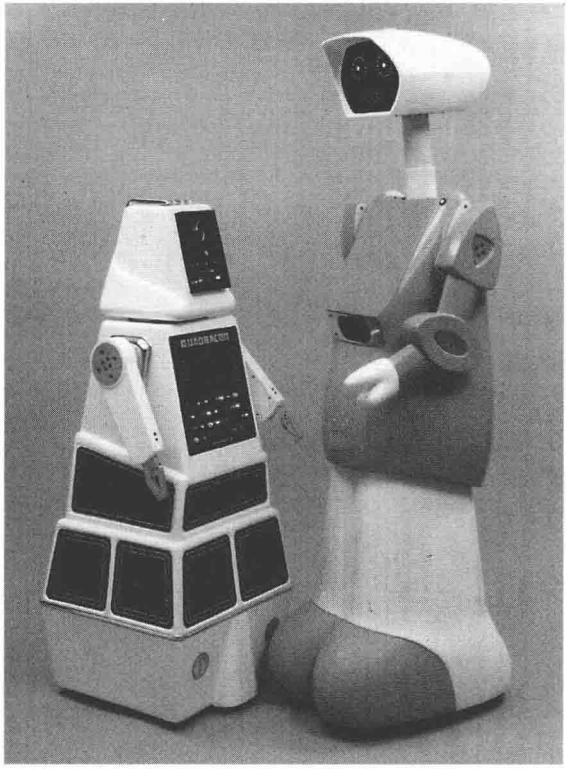

FIGURE I-8. Quadracon and friend Peeper. (*Courtesy of Pelican Beach LLC, successor to ShowAmerica Inc.*)

remote control system, as are the rest of the parts, is a standard off-the-shelf item.

At this point, you should read through the book to familiarize yourself with the diagrams, photographs, parts lists, and overall format. Once you plan your showbot, you can order the "must buy" items. You are now ready to enter the fascinating world of robotics.

ROBOT BASICS

But first, a review of the basics.

The construction of a remote-controlled robot, while not easy, need not be difficult. My motto when designing and building Questor was "keep it simple, stupid" (KISS)! The

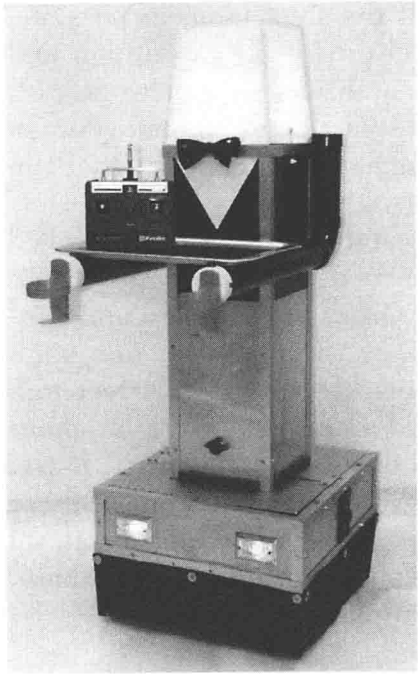

FIGURE I-9. Questor the robot servant (front view).

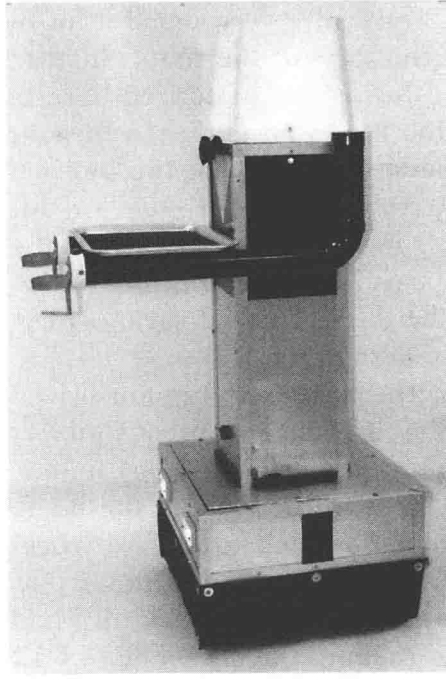

FIGURE I-10. Side view.

best strategy is to use as many off-the-shelf items as possible. As your confidence and skill level grow, you can design and build your own components. In addition, as you work with different materials, such as wood, plastic, and metal, you will learn the properties of each and how you can use them in your own robot designs.

When I first started to design and build remote-controlled robots I used a very simple motorized wheel assembly taken out of a toy car and made bodies out of poster board and construction paper. Figure I-11 shows the plans for one such robot. I tried to make these robots life size, 3 to 4 feet tall. They were fun to design and build and taught me a lot about what would work without being expensive to construct. If you are a first-time robot builder, I suggest that you try one of these paper robots. Whether made of paper or wood and metal, all my robot designs have four basic subsystems: a motorized base, a remote control system, a power supply, and a body.

MOTORIZED BASE

The motorized base for your robot can be the most difficult subsystem to design and build. You can save yourself a lot of trouble if you design "around" this part of the robot. Instead of designing the robot first and fitting the motorized base to your design, design and build the base first and then fit your robot body to it. The base generally holds all of the internal parts or "guts" that make your robot work. In Questor, for example, the base has the wheels mounted on it as well as the batteries (which can be quite heavy) and the control system. That is why he looks the way he does. The old saying "form follows function" is true in robot design, too.

The most important part of the base is the motor-driven wheels. This is where many (myself included) robot builders have the most problems. Do yourself a favor and buy motorized wheel units. A supplier is listed in the back of the book. These units already have a motor mounted to a drive wheel and usually the assembly is in a frame you can modify to attach to your base. With Questor's motorized wheels all I had to do was design a way to mount them to the base. Figure I-12