

# **The Robosapien Companion**

Tips, Tricks, and Hacks

JAMIE SAMANS

Apress®

## **The Robosapien Companion: Tips, Tricks, and Hacks**

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ISBN (pbk): 1-59059-526-2

CIP data available upon request

Printed and bound in the United States of America 9 8 7 6 5 4 3 2 1

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Distributed to the book trade in the United States by Springer-Verlag New York, Inc., 233 Spring Street, 6th Floor, New York, NY 10013, and outside the United States by Springer-Verlag GmbH & Co. KG, Tiergartenstr. 17, 69112 Heidelberg, Germany.

In the United States: phone 1-800-SPRINGER, fax 201-348-4505, e-mail [orders@springer-ny.com](mailto:orders@springer-ny.com), or visit <http://www.springer-ny.com>. Outside the United States: fax +49 6221 345229, e-mail [orders@springer.de](mailto:orders@springer.de), or visit <http://www.springer.de>.

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*For Carla*

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# About the Author



**JAMIE SAMANS** was born August 18, 1970, and raised in Bridgeville, Delaware, a small town in the southern part of the state. A history major, he studied medieval intellectual history at Oxford University and received his BA from St. Mary's College of Maryland in 1992. In 1995 he received a law degree from Widener University School of Law and became involved in government relations, primarily working with state legislatures on a wide range of corporate tax issues. In addition to science fiction and robotics, Jamie's interests include building computers, playing guitar, and collecting vinyl records.

He currently lives in the Seattle area with his wife, Carla, and their two rescued pit bulls, Piper and Duce.

# Acknowledgments

**A** few thanks to the people who made this book possible:

My wife, Carla: For putting up with the robot menagerie that took over most of the first floor of our house while this book was being written, the late hours spent in my workshop in the garage, and all of your time spent discussing and helping me organize my ideas for this book. I think you are the most patient woman in the world!

My mother, Charlotte: For teaching me to read and the importance of the written word.

My father, Jim: For showing me as a boy that there was a whole lot more to science fiction than just the *Star Wars* movies, and for always having interesting books laying around for me to “borrow.”

Mark Tilden: For meeting me in New York, and for being such an incredible source of information for this book.

Amy Weltman at WowWee: For all of the information and marketing materials you made available to me.

Additional thanks to the crew at Apress, without whom this book *really* wouldn't have been possible!

Sofia Marchant: For keeping me motivated and on schedule. As I have told you before, if not for you I would still be taking interesting pictures and jotting down vague ideas in my notebook.

Liz Welch: For your superhuman attention to detail and your enthusiasm. Who knew that copyediting could be so much fun!

And finally, my dogs, Piper and Duce: For reminding me that as much fun as robots are, playing ball is pretty fun too. And for not chewing up any of the Robosapiens.

PART 1



# Introduction



## An Introduction to Robosapien



**Figure 1-1.** *Robosapien comes complete with remote controller, instruction manual, and a cup that it can pick up.*

**W**hat is it about Robosapien that makes it so interesting? If you are reading this book, this is probably a question that you have asked yourself at some point. Technically speaking, Robosapien is a biomorphic toy robot. In layman's terms (and according to WowWee Ltd., the company that produces Robosapien), it is a "fusion of technology and personality." Wait a second—I must admit, I paused as I was writing and referred to Robosapien as "it." Is it an it? Is it a he or a she? Or is it something else altogether? As we will see, Robosapien is in many ways an embodiment of its creator, Mark Tilden; however, the answer to a question like that is above all a personal preference. For the sake of consistency I'll refer to Robosapien throughout this book as an "it." I think that if you work your way through this book, you'll understand where I'm coming from, since one of Robosapien's most prominent features is that the robot is what you make of it. Now, with that potentially uncomfortable business out of the way, let's take a look at what I hope to accomplish.

Chances are, whatever it is that interests you about Robosapien will be covered in this book. We'll examine everything from the basics to more advanced topics. My hope is to give you not only an advanced user guide to Robosapien, but also some background information about the theories behind the machine, and to explore the ways to go beyond what comes in the box—using Robosapien as a platform for “hacks” or modifications. Finally, we'll sneak a peek at the new line of Robosapiens due out in 2005—including Robopet, Roboraptor, and the bipedal Robosapien V2.

That's a tall order, but I hope at the very least I can provide you with enough information to aid further, more detailed investigation on your own—to whet your curiosity, as they say. Or even better, to spark your creativity to come up with your own ways to use Robosapien. Curiosity and creativity. These are two words that define my relationship with this funny little robot.

In this chapter, I take a look at Robosapien. What exactly is it? What can it do? To close out Chapter 1, I'll discuss in more detail what I hope to accomplish with this book, and what you, the reader, will need to get the most out of *The Robosapien Companion*.

## What Is Robosapien?

Strictly speaking, Robosapien is a battery-operated, remote-controlled robotic toy. Standing 14 inches at the shoulder, and weighing in at 4.8 pounds (including batteries), Robosapien takes up about the same amount of space as a small house cat.

Robosapien uses four D cell batteries, which go into compartments accessed at the bottom of its feet, and the 21-key remote control uses three AAA batteries.

There is a lot more to Robosapien than first meets the eye, particularly from a technical and design standpoint, and we'll examine some of these topics in more detail throughout the rest of the book. But first, we need to figure out exactly what Robosapien is. Is Robosapien a robot, or is it a toy?

## Where Does the Term “Robot” Come From?

The term “robot” was first used by the Czechoslovakian playwright Karel Capek (1890–1938) in his 1920 play *R.U.R.* (Rossum's Universal Robots). The play is set on a remote island in the middle of an ocean, at a production facility for robots that are being sold for cheap labor all over the globe. The wife of the factory director uses her feminine charms to convince the lead production engineer, Dr. Gall, to imbue the robots with a soul. Gall complies, and the newly awakened robots quickly realize their mental and physical superiority to the human race and set about wiping out all of humanity. This is a common theme that would show up in subsequent robot fiction throughout the twentieth century.

The word itself is derived from the Czech noun “*robota*,” meaning “drudgery,” “servitude,” or “labor”; a *robotnik* is the Czech word for “peasant.”

In the December 24, 1933, issue of the Czech newspaper *Lidove Noviny*, Capek explains how the term was coined:

*A reference by Professor Chudoba, to the Oxford Dictionary account of the word Robot's origin and its entry into the English language, reminds me of an old debt. The author of the play R.U.R. did not, in fact, invent that word; he merely ushered it into existence. It*

*was like this: the idea for the play came to said author in a single, unguarded moment. And while it was still warm he rushed immediately to his brother Josef, the painter, who was standing before an easel and painting away at a canvas till it rustled. "Listen, Josef," the author began, "I think I have an idea for a play." "What kind," the painter mumbled (he really did mumble, because at the moment he was holding a brush in his mouth). The author told him as briefly as he could. "Then write it," the painter remarked, without taking the brush from his mouth or halting work on the canvas. The indifference was quite insulting. "But," the author said, "I don't know what to call these artificial workers. I could call them *Labori*, but that strikes me as a bit bookish." "Then call them *Robots*," the painter muttered, brush in mouth, and went on painting. And that's how it was. Thus was the word *Robot* born; let this acknowledge its true creator.<sup>1</sup>*

Of course, Capek's Robots (he consistently capitalizes them in the play) are nothing like the fusion of metal, plastic, and circuitry that we think of as comprising a modern-day robot, though they may have appeared so in his productions. In describing the machines and mechanisms present at the robot production factory, Capek uses terms such as "kneading troughs" and "vats," and a "stamping mill" for forming Robot bodies.<sup>2</sup> From this we can gather that Capek's vision of what makes up a robot is based on biological elements. This makes sense, considering that from a practical standpoint, human actors would be given the task of playing the robot characters on the stage. What Capek's creations do share with our modern understanding of robots is the concept that they are somehow useful. This is a key distinction to make.

## Isaac Asimov's "Robot Visions"

The science fiction writer Isaac Asimov (1920–1992) is perhaps most responsible for how we now think about robots in modern times. In his 1942 short story "Runaround," he coined the term *robotics*, meaning the field of science dedicated to building and studying robots. But much more important, "Runaround" is the first instance we see of Asimov's famed "Laws of Robotics":

- Law One: A robot may not injure a human being, or, through inaction allow a human being to come to harm.
- Law Two: A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
- Law Three: A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.<sup>3</sup>

---

1. Taken from Dominik Zunt's excellent webpage on Karel Capek found at <http://capek.misto.cz/english/robot.html>.

2. For more information on Karel Capek and the play *R.U.R.*, please visit Dennis G. Jerz's superb website on the topic at <http://jerz.setonhill.edu/resources/RUR/index.html>.

3. Isaac Asimov, *Robot Visions* (New York: Penguin Books USA Inc., 1991), p. 126.

These laws more than anything make a great backdrop for fiction based on robotic entities. Asimov was prolific, and wrote many short stories and novels set against the backdrop of these three laws, most of which involved some sort of conflict between these laws and revisited the “robots taking over the world” (or at least extinguishing humanity) themes we see even as early as the robot’s creation in *R.U.R.*

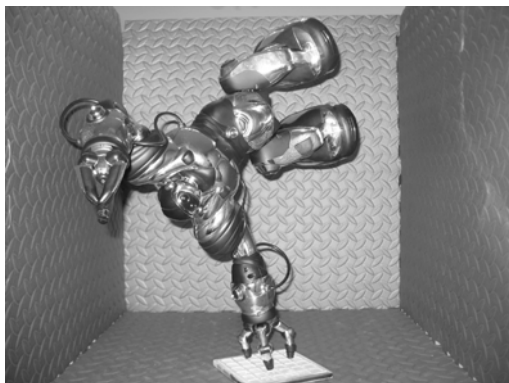
## Is Robosapien a Robot, or Is It a Toy?

Based on the writings of Capek and Asimov, I think that in order to be categorized as a robot, a machine must meet two requirements. First, it must be capable of following commands given to it by a human. And second, it must be capable of actually doing something useful.

Robosapien absolutely meets the first criterion. With its remote control, Robosapien is more than willing to execute commands sent to it from a human operator. Moreover, given its several programming modes and various sensors, it is extremely capable of following fairly complex commands. Whether it meets the second criterion is more a matter of interpretation. Capek and Asimov envisioned robots as being able to perform labor and tasks that humans usually do. The question “Can Robosapien do something useful?” is really best responded to by another question: “How do you define ‘useful?’” Sure, Robosapien is capable of entertaining, and it can pick up small objects. It can also be programmed to act as a sentry and perform other tasks. But you have to ask yourself how useful these functions are. I think for all intents and purposes, right out of the box, Robosapien is not very useful and thus falls more under the category of toy than robot. However, apply some curiosity and creativity, and you will discover that Robosapien is actually designed to be easily “hacked” or modified, which can bridge the gap between toy and tool. Later on in this book, when we begin to explore “hacking” or modifying Robosapien, we’ll see some ways to make it more “robot-like.” But for now, let’s just refer to it as a robotic toy. Throughout the rest of this book, you’ll probably find that I refer to Robosapien as a robot more often than not. That is mainly for the sake of convenience, since I really view the stock, unmodified Robosapien as a toy first and foremost.

## What Can Robosapien Do?

Yes, Robosapien can do a handstand (with a little help; see Figure 1-2). This is due in large part to its biomorphic design, which we’ll discuss in greater detail in Chapter 2.

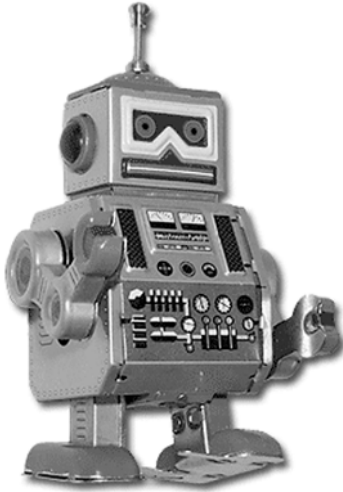


**Figure 1-2.** *It can take some patience, but you should be able to get your Robosapien to freely stand on one outstretched claw.*

For now, let’s look at some of the key functions and capabilities of Robosapien.

## Bipedal Walking

The most obvious feature of Robosapien, once you get past its rather interesting-looking claws, is its ability to walk on two legs. WowWee describes Robosapien as “the first affordable humanoid robot.” Its ability to walk on two legs is a bit of a breakthrough—this requires quite a bit of planning and synchronization between his various motors and body parts. Sure, there have been other bipedal robots, and as we’ll see in Chapter 6 these have a long history, even going back as far as tin wind-up toys in the form of robots that shuffle around on two legs (see Figure 1-3).



**Figure 1-3.** Here’s an example of a bipedal wind-up toy robot.

Additionally, more complex designs, such as The Original San Francisco Toymakers’ “Ramon the Robot” (see Figure 1-4) are also capable of bipedal walking. But none of these products have been as proficient at walking as Robosapien.

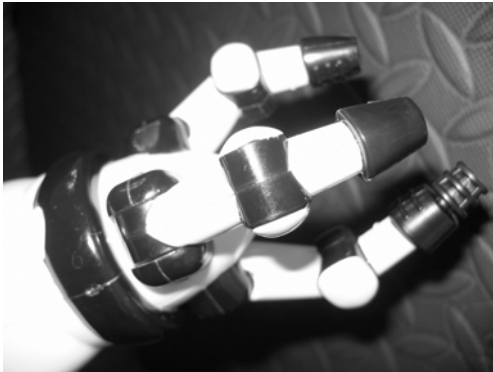


**Figure 1-4.** “Ramon the Robot” is manufactured by The Original San Francisco Toymakers.

Is Robosapien's walking ability perfect? No. In fact, Robosapien's problem with consistently walking straight is one of the main criticisms about the toy. In Chapter 6 we look at the walking mechanism in greater detail, and I provide some tips and tricks to get your Robosapien walking to the best of its ability.

## So What about Those Claws?

Robosapien has two types of hands, both with three fingers. Each hand has a touch-activated sensor, as well as an LED in the palm. The right hand (Figure 1-5), which has rounded fingers, is designed to pick up round or bulky objects such as cardboard tubes, balls, or action figures. The left hand (Figure 1-6), which features straight fingers and a rubbery gripping surface, is designed to grasp and hold smaller, thinner articles such as pencils, napkins, dollar bills, business cards, and paper.



**Figure 1-5.** *This photograph shows Robosapien's right claw.*



**Figure 1-6.** *This photograph shows Robosapien's left claw.*

## Sixty-Seven Unique Functions

Robosapien is controlled via infrared remote, and it can perform 67 unique functions, including four different ways of walking and two different ways of turning. Both arms can be moved up, down, in, and out. Robosapien bends sideways at the waist—not only does that help it reach objects on the ground, but its unique sideways swinging gait is part of what makes the robot such an accomplished bipedal walker. In addition to these basic commands, Robosapien comes preprogrammed to do some interesting combination moves in the form of kung fu, as well as several “attitude” moves that help to shape Robosapien's personality. Finally, Robosapien has two different demo modes, two diagnostic troubleshooting modes, and a musical dance program. The sidebar “Sixty-Seven Robosapien Functions,” lists the functions as described by WowWee.

## SIXTY-SEVEN ROBOSAPIEN FUNCTIONS

- |                                    |                                     |   |
|------------------------------------|-------------------------------------|---|
| 1. Right Arm Up                    | 25. Right Hand Throw                | 47. Right-Hand Strike 2                                 |
| 2. Right Arm Down                  | 26. Sleep                           | 48. Left-Hand Sweep                                     |
| 3. Right Arm In                    | 27. Left-Hand Thump                 | 49. Talk Back   |
| 4. Right Arm Out                   | 28. Left-Hand Pickup                | 50. Left-Hand Strike 1                                  |
| 5. Tilt Body Right                 | 29. Lean Forward                    | 51. Whistle   |
| 6. Left Arm Up                     | 30. Left-Hand Throw                 | 52. Left-Hand Strike 2                                  |
| 7. Left Arm Down                   | 31. Listen                          | 53. Bulldozer   |
| 8. Left Arm In                     | 32. Forward Step                    | 54. Right-Hand Strike 3                                 |
| 9. Left Arm Out                    | 33. Right Turn Step                 | 55. Oops!   |
| 10. Tilt Body Left                 | 34. Backward Step                   | 56. Demo 1  |
| 11. Turn Right                     | 35. Right Sensor Program Execute    | 57. All Demo  |
| 12. Walk Forward                   | 36. Master Command Program Execute  | 58. Power Off   |
| 13. Stop                           | 37. Wake Up                         | 59. Roar  |
| 14. Turn Left                      | 38. Reset                           | 60. Left-Hand Strike 3                                  |
| 15. Walk Backward                  | 39. Left Turn Step                  | 61. (SELECT) Return to RED Command Functions            |
| 16. Right Sensor Program           | 40. (SELECT) Advance to ORANGE Keys | 62. Demo 2  |
| 17. Sonic Program                  | 41. Left Sensor Program Execute     | 63. Dance Demo  |
| 18. Left Sensor Program            | 42. Sonic Sensor Program Execute    | 64. <, < Combination "Right Walk Turn"                  |
| 19. Master Command Program         | 43. Right-Hand Sweep                | 65. >, > Combination "Left Walk Turn"                   |
| 20. Program Play                   | 44. High 5                          | 66. Forward, Forward Combination "Slow Walk Forward"    |
| 21. (SELECT) Advance to GREEN Keys | 45. Right-Hand Strike 1             | 67. Backward, Backward Combination "Slow Walk Backward" |
| 22. Right-Hand Thump               | 46. Burp                            |   |
| 23. Right-Hand Pickup              |                                     |   |
| 24. Lean Backward                  |                                     |   |

## Interactive Reflex System

All of the commands listed in the sidebar can be arranged together via Robosapien's "interactive reflex system" (or programming modes), and the robot can be set up to react to both touch and sound through its four individual programming modes. Robosapien's four program modes include a "master program," a "sonic program," and left and right programming modes that react to the sensors in its claws and feet (see Figure 1-7).



**Figure 1-7.** *Touch-sensitive sensors on the front of Robosapien's feet allow it to react when it bumps into things.*

All told, Robosapien is capable of remembering 84 total steps—as long as you don't turn it off. Robosapien's memory is wiped each time you shut off its power. Robosapien communicates through a series of grunts that WowWee has dubbed "international caveman speech." These grunts are not particularly helpful, but they add a lot to Robosapien's unique "personality."

## What Does This Book Hope to Accomplish?

I hope with this book to provide you with the means to get the most out of your Robosapien. On its own, this book will give you some background information on the theories and the mechanics behind Robosapien, some simple projects you can do on your own to make Robosapien even better, detailed programming information, and a good hard look at Robosapien's capabilities.

Beyond this, I hope to change your perception of Robosapien, and challenge you to think of it as less of a toy and more of a platform. This is, in my opinion, the secret of a long-lasting relationship with your Robosapien. I feel that, as a toy, Robosapien can get boring pretty fast. Once you have run it through the various routines a few times and mastered the remote control, you may find yourself asking, "Well, what else is there?"

By looking at where Robosapien comes from and what it can do out of the box, and by giving you some ideas about where you can go using Robosapien as a platform for hacks and modifications, I hope to provide you with many more hours of discovering exactly what else there is when it comes to the Robosapien.

## What Will I Need to Get Through This Book?

I had originally titled this section “Materials Checklist and Safety Precautions,” but that is a bit ambitious. This book endeavors to give you the best experience with your Robosapien out of the box, with no modifications or tools needed. From time to time I’ll suggest some easy modifications that you can do to improve your Robosapien’s performance, and the last few chapters will concentrate on beginning modifications that will require you to open up the robot and void your warranty. But my goal is to make this book as accessible as possible to everyone, including those of us who are not electronics experts.

### A Robosapien Robot



**Figure 1-8.** *You want me to do WHAT with this screwdriver?!*

The number one item you’ll need to work your way through this book is, of course, a Robosapien robot. The author in me hopes that I can make this book so captivating that you could read through it and find it interesting even if you don’t own a Robosapien. But the realist in me knows that an accomplishment such as that is probably beyond my (or anyone else’s) reach. Although you won’t need a Robosapien to work through the chapters on the development of Robosapien and the theories of biomorphic robotics that control it, having one handy will help you understand some of the concepts presented a little bit better. And while no one except the people at WowWee have the version 2 Robosapien (at least at the time of publication), which is called “V2,” having a version 1 Robosapien and understanding its abilities can only help you understand the significant upgrades planned for V2.

## Your Own Curiosity

Beyond a Robosapien, you'll also need a sense of adventure as well as a sense of curiosity about not only *what* Robosapien can do but *why* it can do it. There is a lot more to Robosapien than just its motors, circuitry, and plastic shell.

## Outfitting Your Work Area

Robosapien is designed to go almost anywhere, and for the most part you'll be able to enjoy this book anywhere that Robosapien is capable of going—and even some places where it can't go. However, if you choose to enjoy a chapter or two of this book while relaxing on a raft in your pool, I suggest that you leave Robosapien on dry land!

If you plan on exploring the interior of Robosapien, and doing some of the simple hacking projects I outline throughout the book, a decent work area is essential (see Figure 1-9). It should be well lit and relatively clutter free, and provide you with a comfortable place to sit while working on Robosapien. It should be quiet and out of the way; the last thing you want is to take a break from working on Robosapien only to wake up and discover that your sibling/parent/spouse/cat/dog has accidentally (or otherwise!) disturbed your progress. You should have an area large enough to not only hold Robosapien and your tools, but that also allows you to lay out parts and components as you remove them (should you choose to do so). Finally, I prefer an area where distractions are limited. I use an old desk out in my garage.



**Figure 1-9.** *The author's robot laboratory is in his garage.*





**Figure 1-11.** *You don't need a lot of tools to work on Robosapien, but you can never have too many.*

All that is needed to take most of Robosapien apart is a simple Phillips head screwdriver. You should already have one of these, since you also need one to insert Robosapien's batteries in his feet and remote control. Small precision-style flat-head screwdrivers can help you get into places that are glued together, and "Exacto" knives, generically referred to as hobby knives, can help you in a lot of ways too. A good drill, as well as a high-speed rotary tool like a Dremel, can also come in handy. A hot-glue gun can also be useful, as is a variety of tape and glues. A set of wire cutters and a wire-stripping tool can come in handy as well. I also like to use a modeler's tool referred to as a side cutter or a sprue cutter. This tool is designed to cut plastic model components off of the "sprue," or the frame that they come on when you buy the kit. I also use a "miner's style" headlamp, which you can find in most camping supply sections. Since it is worn just above your eyes, it directs the light down directly onto what it is you are working on, and helps you illuminate things, particularly in small, cramped spaces like the interior of Robosapien.

As we'll see in Chapter 13, where I present a pictorial guide to taking the Robosapien apart, everything is very clearly labeled on the inside, and most of the wiring is connected via connectors. Still, when working on anything electronic, a decent-quality soldering iron as well as an inexpensive digital multimeter will save you a lot of time. More on these items later.

Finally, no workspace is complete without a pad of paper and a pen, or better yet, a hacker's journal. Keeping a list of what parts you remove, and the order in which you remove them, can come in handy if you forget where something goes or how to put a piece back

together. It is also a great place to keep a running tab of ideas for future projects, things that might only come to you while you have Robosapien partially disassembled.

I don't recommend that you rush out and buy all these tools before you start working on your Robosapien. Start slowly, and just take its shell off a few times to familiarize yourself with the interior of Robosapien before you move on to further disassembly. Gather these tools as you find that you need them, and not only will you not break the bank, but you'll be ready to use them.

## Safety Precautions

The most important thing you'll need to protect is your eyes, since they will be open (or at least I hope they will be open) throughout your work. I recommend a good set of goggles that you can keep in your work area. These take a little getting used to, but I think you'll find that putting them on becomes like second nature. I recommend getting a comfortable set. They might cost a bit more, but they'll also be higher quality and more comfortable. You have only one set of eyes, so it is important that you protect them at all costs.

Although nothing we'll work on is capable of starting a fire, it is still a good idea to keep some sort of fire protection near your workspace. For small battery-powered items like Robosapien, a fire extinguisher is probably overkill—a decent container of water is usually all you need. (It also comes in handy if you get thirsty!) If you plan on regularly using really hot tools, such as soldering irons and hot-glue guns, you may want to invest in a small fire extinguisher.

## Summary

The Robosapien robot is by all accounts something that is greater than the sum of its parts: a remarkable toy that combines high tech with low tech, complexity with simplicity, and humanistic traits with robotics. It is amazing to learn all that went into creating this robot. Let's start our journey by looking at Robosapien's creator, Mark Tilden, and some of his ideas that have revolutionized not only the toy industry but theories of robotics as well.



# Robosapien: A Robotic Family History



*(Photo courtesy of WowWee Ltd.)*

**Figure 2-1.** *Robosapien's creator, Mark W. Tilden, appears here with some of his friends.*

**I**n this chapter we'll look into the background of Robosapien: its creator, Mark Tilden (shown in Figure 2-1), and his theories of BEAM robotics, on which Robosapien is loosely based. We'll close the chapter by looking at some of the various types of Robosapiens on the market, and the awards and accolades that Robosapien has received.

## Mark W. Tilden

Prior to the release of Robosapien in 2004, Mark W. Tilden was primarily known as the founder and chief proponent of BEAM robotics. Born in 1961 in Stroud, Gloucestershire, England, he moved with his family to Canada when he was two years old. He built his first robot at age three out of wood scraps and rubber bands as a Mother's Day gift. Later projects included a Meccano (a construction toy similar to Erector sets) suit for his cat, numerous school science-fair winners, and in the early 1980s a complex hack on the Tomy OmniBot (see Figure 2-2), an early wheeled toy robot.



**Figure 2-2.** A complex hack on the Tomy OmniBot was one of Tilden's early projects.

*In 1982 I got my first Tomy OmniBot. I opened it up and I found out it was mostly empty space. I filled it with a home built 68000 [an early home automation system based on an 8 MHz processor], and the best visual apparatus I could find. I programmed it from my Atari, I was really hoping I could get this thing to do all this stuff. And I found myself falling into every pratfall that anyone who's ever done artificial intelligence has fallen into. Unless something looks like a man, you cannot tell if it is moving correctly. What sort of body language can you get from a wheel? It's very hard to tell when it is crashing.*

—Mark Tilden, February 13, 2005

Tilden attended the University of Waterloo, receiving his master's in systems engineering, and got a job as a design engineer in the Math Department at the university. Still intensely interested in building and hacking robots, in 1989 he attended a lecture by Massachusetts

Institute of Technology (MIT) professor Rodney Brooks. Dr. Brooks developed what is known as *subsumption architecture*, a biologically inspired approach to programming robots for performance in uncertain, or unstructured, environments. The aim of this approach is to build robots that rely on reactive sensors attached directly to motors rather than relying on complicated, processor-based computer brains.

About this time Tilden began laying the foundations for BEAM, eventually founding the International BEAM Robot Games in 1991. These were a series of competitions open to anyone and their robot, as long as the robot was not derived from a kit or bought prebuilt. Robots were judged on sophistication of behavior, novelty of design, efficiency of power source, and quality of hardware innovation.

In 1992 Tilden's theories were beginning to gather attention, and he was invited to speak alongside Dr. Brooks at the Artificial Life III conference in Santa Fe, New Mexico. Never one to travel lightly, Tilden showed up with a menagerie of his robot creations and encouraged the attendees to play with them. "Here it is. Play with it. Make your own conclusions," he told curious onlookers.

Calling himself a "nobody" prior to attending the conference, Tilden walked off with three of the conference's five awards: best innovation concept, best presentation, and the environmentally conscious award. His creations also attracted the attention of a man he later said he thought was "the town derelict"—in fact, he turned out to be Brosl Hasslacher, a theoretical physicist from nearby Los Alamos National Laboratory.

By 1993 Tilden had left his job at his alma mater and was brought into Los Alamos as a research scientist in the Physics Division. He was brought in under what he refers to as "the genius clause" since he did not have a PhD.

*So what happened is that I get down there and I basically say two things: I don't have the credentials, so I could have said "Hi, you have to believe me." (Laughs.) So I promised that I would only ever say things if I had something that actually worked. Boy did that do me both good and bad. Good: I was able to build things successfully that are now still working in museums and various places across the country. Bad, because there are an awful lot of people, primarily roboticists, who have their entire reputation based entirely upon virtual presence. "Oh one day the robots will basically take over. Do you have any evidence? Well no, but my toaster is hostile!"*

—Mark Tilden, February 13, 2005

While at Los Alamos, Tilden continued his research into BEAM theories, consulting for NASA; DARPA (the U.S. Defense Advanced Research Projects Agency); the U.S. Army, Navy, and Marine Corps; and JPL (Jet Propulsion Laboratory), to name a few. All told, Tilden estimates that he did work for over 30 different governmental agencies.

While working at Los Alamos, Tilden got the opportunity to work on several interesting projects, including a Mars rover, snakelike robots that were to be used to detect land mines (the robot was even capable of continuing the mission if part of it was destroyed by an explosion), and secret projects that he says he can't talk about for another 20 years.

But things were not as smooth as they could have been. Many scientists did not like his biologically derived robotic principles, because, like anything in nature, they can be somewhat unpredictable. This didn't sit well with researchers at NASA, for instance, where "it was all about mitigation of risk."

*Basically what happened when I moved down to New Mexico, I was thinking that I would be able to get in tight with the artificial life guys. Because obviously that's what I was doing: I was building self evolving mechanisms that are capable of doing real work in the real world. But I wasn't playing by their rules. That's just it. As soon as you start measuring against their stuff, they suddenly realized: "Ok, well, we can't support you, because unfortunately you are invalidating all of our theory."*

—Mark Tilden, February 13, 2005

One late night in 1999, Peter Yanofsky, president and cofounder of WowWee Ltd., a Canadian toy company based in Hong Kong, was flipping through the channels and caught a documentary on the Discovery Channel called *Robots Rising*. In this film Tilden talks about his theories, and there is one memorable scene that features a time lapse of Tilden building a fully working BEAM robot from spare parts—with no plans—in less than 20 minutes. Yanofsky, an inventor himself, immediately saw the potential that Tilden's ideas had for toys. He sent Tilden a ticket to Hong Kong, and the two men met to discuss the potential of incorporating Tilden's robotic theories into toys. Before long WowWee hired Tilden on as a consultant.



**Figure 2-3.** *By the time he started consulting for WowWee, Mark Tilden already had Robosapien in his sights. (Photo courtesy of WowWee Ltd.)*

Tilden's first major project with WowWee, and his introduction to the toy industry, was the B.I.O. Bugs (see Figures 2-4 and 2-5), which were released in fall 2001. Following this, in summer 2002 he built the first Robosapien prototype and began the two-and-a-half-year journey to get Robosapien to market. We'll come back to Robosapien in a bit. First, let's take a look at some of the fundamentals of BEAM robotics.