

The Robosapien V2

by Jamie Samans

BIGGER AND BETTER

It's hard to believe it has been almost two years since the introduction of WowWee's groundbreaking Robosapien robot.

In that time, well over a million robots have found their way to the far corners of the globe. Mark Tilden — Robosapien's creator — even told me that there is a Robosapien at a research station on the continent of Antarctica!

The Robosapien was a huge success, a deceptively simple toy robot whose biomorphic roots were easy to see. What's more, with a little bit of creativity and a Phillips head screwdriver, the Robosapien was capable of making the transition from toy into tool, and has inspired countless hackers to use it as a platform for their projects. From university robotics labs to hobbyist workbenches in garages, the Robosapien (or as we will now refer to it, the RSV1) has been widely accepted as an excellent platform for modification.

Enter Robosapien V2, or RSV2, the next-generation bipedal robot from WowWee. Initially available only from the Sharper Image as an "Exclusive Signature Series" model (see Figure 1), I managed to get my hands on one of the first robots off of the production line and put it

through the paces.

The first thing that you notice about RSV2 is how big it is. At 22", it is a full 10" taller than the RSV1. It is huge and very impressive looking and usually people's first response to it is a rather stunned "... coooooo!" But does bigger really mean better? This is one of the main questions I hope to explore.

My initial impression is that RSV2 addresses many of the RSV1's shortcomings, as well as adding a few really neat features. However, these improvements and features come with some downsides, namely, the increased physical size, increased noise levels, and of course, an increased appetite for batteries. Also not to be overlooked is the price tag. With street prices expected to be in the \$230-\$250 range, the RSV2 is almost three times the cost of the RSV1.

Turning on the RSV2

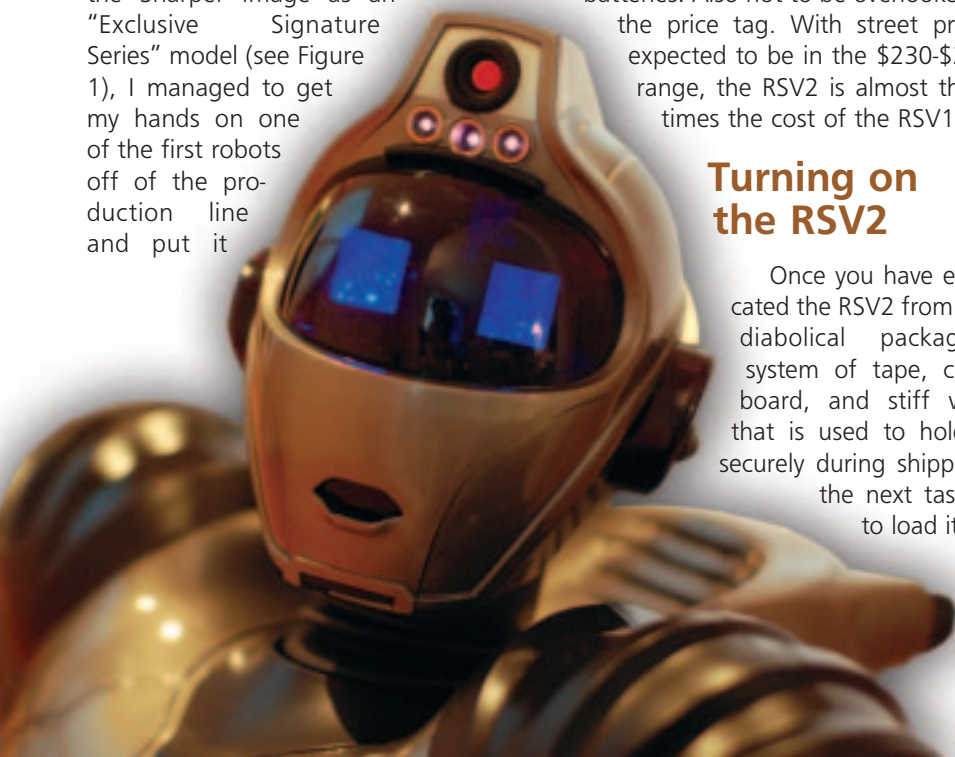
Once you have extricated the RSV2 from the diabolical packaging system of tape, cardboard, and stiff wire that is used to hold it securely during shipping, the next task is to load it up

with batteries. The RSV2 takes a grand total of 13 batteries, in the form of six "D" cells and seven "AAA" cells. Three "D" cells go into each foot and control the robot's body motors. Additionally, there is space for two "AAA" cells in each foot (see Figure 2), and these are used to power the brain.

Finally, the "video game controller" remote control takes three "AAA" cells. A nice touch: When the brain batteries become low, RSV2 will issue a warning and then shut down. A nicer touch would have been similar warnings for when the body and remote batteries become low! WowWee claims that the RSV2's batteries should last for about six hours with continuous use, and about 14 hours with light (i.e., tabletop) use.

Now that it is loaded with batteries, it's time to power on the RSV2. The on/off switch is located familiarly in the same spot as it was on the RSV1, on the left side of the robot's back. Upon powering it up, you are greeted with: "Self diagnostic initiated. I am WowWee Robotics model RSV2." That's right, this robot talks. Gone is the quaint "international caveman speech" of the RSV1. The voice is appropriately robot-like, but I swear I hear Mark Tilden's voice in there underneath all of the audio effects processing.

So, by this point you are finally beginning to adjust a bit to the size of the RSV2, and now that you have it powered up, what strikes you is the



noise. The RSV2 is just plain loud, and the voice is only part of this — its motors are also much louder than the smaller ones found in the RSV1. Since the RSV2 can move two motors simultaneously — for instance, you can raise both arms at the same time — the motor noise is sometimes doubled. Walking around on hardwood floors results in a lot of noise too, as the robot weighs around 11 pounds with batteries.

I should note that as I continue to use the RSV2, the noise doesn't seem to be bothering me as much. I don't know if it is because I am getting used to it, or if the motors needed a slight break-in period to "loosen up," or if it is some combination of the two. But it doesn't seem as noisy now as it did a week ago when I first got it. Another interesting point is that my wife thought I was crazy for saying that the RSV2 was really loud, she claims that "it sounds the way a robot is supposed to sound."

Operating the RSV2

The primary means for controlling the RSV2 is by using the video game style remote control (see Figure 3). Like RSV1, the RSV2 uses infrared signals, which means you will need line-of-sight, and if you have more than one RSV2, you will not be able to use them independently of each other, at least not while they are in the same vicinity. There are no IR command conflicts between RSV2 and RSV1 however, so these two bots can battle it out in the same room to your heart's content.

The controller takes some getting used to. At first I hated it, but with time I am learning how to use it to unleash the RSV2's full potential. I recommend a "cheat sheet" (see Figure 4) until you get comfortable with the controller setup. I feel that the controller is in no way as well laid out or as intuitive as RSV1's remote control, but what it lacks in elegance it more than makes up for in control.

Consisting of two "thumbstick" style joysticks and 12 buttons, the controller is capable of sending a total of 136 different commands to the RSV2. Walking is controlled by the left thumbstick; upper body and arm movements are controlled by the right thumbstick.



Figure 1. RSV2's box is over 25 inches tall and has a shipping weight of 17 pounds.



Figure 2. One of the battery compartments. Note the two "AAA" cells at the top.



Figure 3. The RSV2 remote control.

By using one or more of the three "shift" buttons on the controller's shoulders, you gain an incredible amount of flexibility. Using the shift buttons in concert with the buttons on the controller's face gives you access to the RSV2's "attitude" animations, as well as the programming modes.

Using the shift buttons with the right thumbstick gives you fine-tuned access to controlling RSV2's upper body. On its own, the right thumbstick controls the head and upper body. Using the shift buttons allows you to control the robot's arms individually and together, to control just the RSV2's head, or just its hips, and so on. It seems clumsy at first, but as I got used to the controller, I discovered that it allows

RS2 M2 TX CHEAT SHEET:

Figure 4

RS2 (W2) Codes	RS2C	■	a	b	c	x	y	z	D
HEAD & UPPER BODY	STOP	SOUND SENSE ON/OFF	VISION SENSE ON/OFF	POB PROG ENTER	POS PRNG FLAY	GAT CHNGE INSTL	FREE ROAM ON/OFF	DUNK 1 DANCE	
RIGHT ARM	RESET	RIGHT ARM THROW	RIGHT LOW PICKUP	RIGHT MEC. PICKUP	RIGHT ARM GRNME	RIGHT ARM DROP	RIGHT BOWL	DEMOC 2 STITCH	
LEFT ARM	SLEEP/ WAKE	LEFT ARM THROW	LEFT LOW PICKUP	LEFT MEC. PICKUP	LEFT ARM GRNME	LEFT ARM DROP	LEFT BOWL	LID BITI ROSE	
HIPS TWIST TILT	GET JP	RIGHT KICK	RIGHT PUSH	RIGHT HAND CHOP	LEFT HAND CHOP	LEFT PUSH	LEFT KICK	FART	
COTII ARMS	CLEAR PROG	SOUND PROG	VISION PROG	MAIN PROG	EXEC PROG	GUARD MODE	CLEAR ENTRY	HIGHS	
HEAD ONLY	BILL-DUCKER END	LAUGH	IMBULT	RIGHT PLACE	LEFT PLACE	FLAN	SPARE CHNGE	HEY BABY	
HEAD & UPPER BODY	BILL-DUCKER END	ROAR	DIDDLE	FETCH MIL A REER	DANGR	CALM DOWN	HUG	BURP	
UPPER BODY ONLY	POWER DOWN	PLAY WITH RSV2	PLAY WITH RAPT	PLAY WITH PET	MANUAL N-BAL: SUN	MANUAL N-BAL: CIN	MANUAL N-BAL: WHITE	OLCH!	

Figure 4. This is Mark Tilden's own personal "cheat sheet" for the RSV2.



Figure 5



Figure 6



Figure 7

Figures 5-7. RSV2 can stand back up from a laying down position.

for quite a bit of precision. For example, the longer you hold the right thumbstick to raise, say, the right arm, the higher it will go. With PC control (or VERY nimble fingers), it is possible to have essentially centimeter precision. I felt that the lack of precise movement

Figure 8. From a sitting position, RSV2's head and arms are still controllable.



was one of RSV1's major shortcomings.

Another area where RSV2 improves upon RSV1 is in its walking ability. RSV2 features four different gaits and — depending on your floor surface — does a much better job of walking in a straight line than the original Robosapien. I tested the RSV2 on a variety of floor surfaces in my house: hardwood floors, low shag carpet, "berber" carpet, and concrete floors. RSV2 does best by far on hard surfaces. It will walk just fine on carpeted surfaces, but it is significantly slower, and because RSV2 is a bit top heavy it tends to lose its balance more on carpet and will fall over. It's almost like the springy padding under the carpet throws off the resonance dynamics required for it to do things like spin in place and turn.

However, one of RSV2's coolest features is the ability to stand back up if

it has fallen on its back (see Figures 5 through 7), although, of course, this works better on hard floors too. You can also make the RSV2 lie down on its back from a standing position, and from there command it to sit up (see Figure 8). From a sitting position, you still have full control of its head and arms.

What would a Robosapien be without attitude? The RSV2 has the same bad manners, rowdy personality, and kung fu abilities as RSV1, although it is able to articulate things better due to the fact that it is no longer burdened by the language barrier inherent in "international caveman speech." This can be either a plus or a minus, depending on your outlook. All of the old favorites are here, including an updated dancing demo, and quite a few new ones, as well.

One that is particularly notable is "Get your own drink" — entitled "fetch" in the manual. According to Mark Tilden, the RSV2's hands were originally designed to carry and lift a full can or bottle of your favorite beverage, but this feature had to be removed due to safety reasons. In the retail version, RSV2 is able to lift and carry things up to about five ounces. The hands do fine carrying empty bottles and cans, so the design was left in place.

At any rate, RSV2 has received a significant upgrade in its abilities to manipulate objects in its environment. It can take objects from you, give them back, pick them up from two different heights, throw them, even push and pull. I am not very good at it yet, but with some practice I think that RSV2 will be capable of a fair amount of precision. Speaking of precision, Mark Tilden tells me that RSV2's karate chops are "designed to bonk RSV1 right on the noggin" (see Figure 9).

Figure 9. RSV2 performs a karate chop on an unsuspecting RSV1. Look at the size difference!



In addition to the boisterous personality skits and increased manipulation capabilities, the RSV2 also has the ability to interact with the Roboraptor, the Robopet, and even another RSV2. I wasn't able to test these features, but it appears that the RSV2 has some limited ability to send out IR commands to interact with these other robots. This is extremely interesting from a hacker's perspective. Using the RSV2 to blast out IR signals to control an RSV1 or even a Roomba robotic vacuum would be insanely cool.

Vision and Sensors

Probably the biggest addition to the RSV2 is its vision system (see Figure 10). Consisting of an infrared radar system and a color camera, RSV2 is able to avoid obstacles, track movement, and recognize some limited colors.

RSV2's obstacle avoidance abilities are fantastic, and this is best seen in the robot's autonomous "free roam" mode. Unlike RSV1, where you had to program a complicated sequence of moves to put the robot into a semi-autonomous mode, and then wait for its finger or toe sensors to physically hit something to trigger an avoidance, RSV2 enters "free roam" mode with the touch of a single button. It does a really good job wandering around on its own, using a combination of the IR system and its touch sensors. Note that due to the size of the RSV2, you need a fairly large area for this to work. For instance, my office — which has an open area of about 5' x 6' — is too

small. It will also not recognize drops, such as stairs or the edge of a table it is standing on.

The IR system allows RSV2 to "track" objects in its field of vision. Its head and upper body will follow whatever it has drawn a bead on. If the object that it is tracking is close enough and becomes stationary, RSV2 will ask you to hand it to him. This is downright uncanny. This system also works in conjunction with RSV2's color camera. RSV2 can recognize green, red, blue, and flesh tones.

The robot comes with a green ball and a set of three red bowling pins, and can actually take the ball, tell you about its "itchy bowling arm," find the pins (if you set them up in front of the robot), and then throw the ball at them. Its aim isn't great, but when it connects and bowls a strike, it is fantastic. If there is a downside to the color vision system, it is that it requires a lot of light to operate. RSV2 comes with adjustable lighting settings (daylight, indoor yellow, and indoor white), but these really don't help very much. I think some of the first RSV2 hacks we will see will be augmented lighting systems.

RSV2's sensor system is significantly upgraded over the one found in RSV1. RSV2 has a visual sensor, a stereo sonic sensor that can tell which side the sound is coming from, heel and toe sensors on its feet, grip sensors inside its hands that can detect if it is

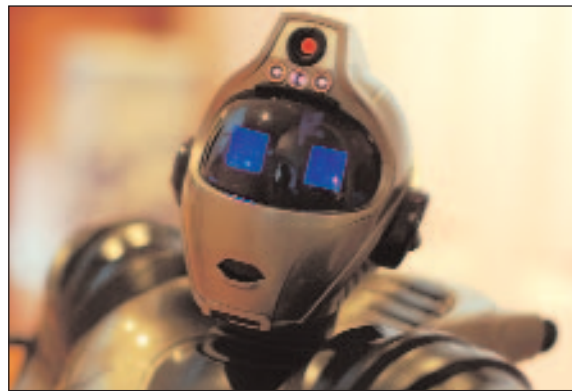


Figure 10. A close-up showing RSV2's vision system.

holding an object or not, and "gauntlet" sensors at the wrist (see Figure 11). It also has a tilt sensor that detects when the robot has fallen over.

Programming

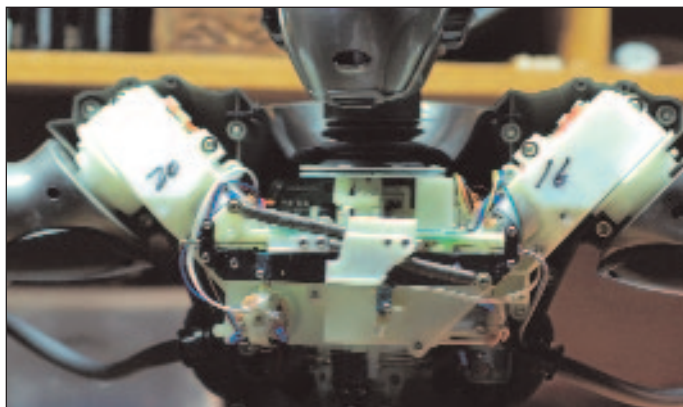
In programming the RSV2, again we see a system that is in many ways very similar to the RSV1, but with significant upgrades and additions. The most noticeable upgrade to RSV2 is the ability to save your programs in memory, even after you turn the RSV2 off.

Besides the memory upgrade, RSV2 also has an entirely new programming system (in addition to reactive sonic and vision programs, and a main program mode). This new programming system is called "puppet mode" and allows you to program the RSV2 manually by moving its upper body into different positions. You can also combine upper and lower body movements (such as walking, turning, or even karate kicking) by using the foot sensors to input moves.

Figure 11. RSV2's "gauntlet" touch sensor on the robot's hand.



Figure 12. Inside RSV2's chest cavity. Note the silver "tendon" — this is linked to the side-to-side movement of the head and controls the opening and closing of the hand.



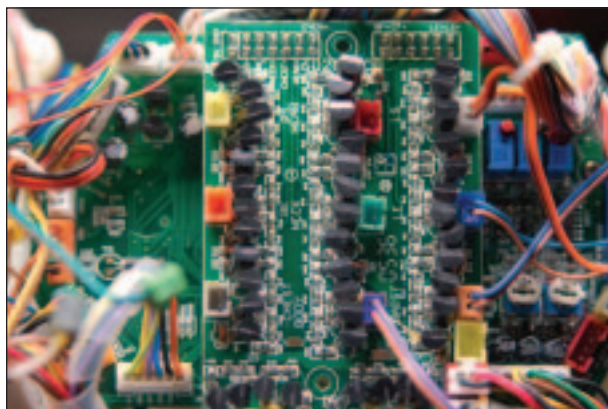


Figure 13. This photo shows RSV2's driver board. It would appear that the 44 transistors make up 11 H-bridges to control the 11 main motors. RSV1 had a dedicated motor driver chip.

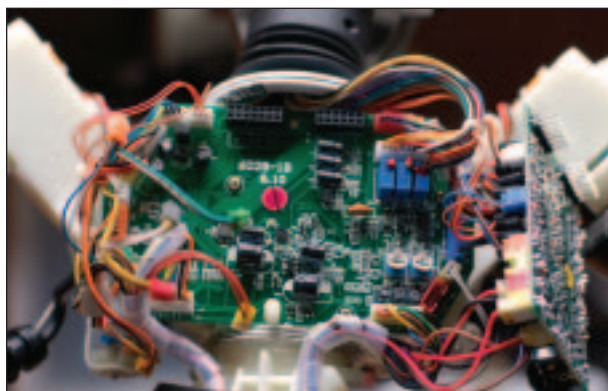


Figure 14. This is the main circuit board which resides underneath the driver board. The underside (not shown) contains two chips; both are covered in an epoxy blob like the CPU for RSV1.

Like a lot of the new things with the RSV2, puppet mode takes some practice to perfect. Puppet mode has three individual modes: main positional, which holds 14 steps (though the manual says 12), and left and right positional which hold five steps each and are activated by quickly pressing one of the foot or gauntlet sensors twice.

Beyond this, programming the RSV2 is very similar to the RSV1, but with more available steps. The main

program mode and both reactive programs (sonic and vision) each hold 20 steps. This is significant, as the RSV2 has the ability to use conditional subroutines just like the RSV1. Meaning, you can program a 20-step routine into the sonic sensor, and then fill all 20 steps of the master program with your sonic program routine, resulting in a 400 step program! But it gets even better.

You can fill the reactive program modes with subroutines that you have stored in the main puppet mode program (press the "x" button on the remote to store a positional program as a single call). The

result of programming all of these subroutines simultaneously is 14 x 20 x 20 or a 5,600 step program. This is not mentioned in the manual, for the obvious reason that in executing a 5,600 step program, the batteries (or the motors and/or motor drivers) would probably die before it was able to complete it. The author strongly recommends that you do not try this with your RSV2 ... but it is nice to know. Think of it like the speedometer in your car: mine goes up to 200 mph, but I would never drive the car that fast!

About the Author

Since winning SERVO Magazine's "Hack-A-Sapien" contest in 2004, Jamie Samans went on to write the Robosapien Companion: Tips, Tricks, and Hacks, published last summer by Apress. Featuring a lengthy interview with Robosapien's creator, Mark Tilden, as well as exclusive development photographs from Tilden's own personal collection, the book looks at not only where you can go with your Robosapien, but where Robosapien comes from.

Hackability

Hackability of the RSV1 was one of its biggest draws. Over the past year and a half we have seen basically four types of hacks to the RSV1: cosmetic, enhancement, brain replacement/augmentation, and bolt-on peripherals. All four will be possible with the RSV2, and with its vision system, color camera, improved sensors, and more precise movement capabilities, I think

we will see quite a few interesting projects based on the RSV2.

For example, Mark Tilden told me that 56 MHz DSP doing all of the color-blob image processing has a USB port. Another interesting hack would be to add a motor to each hand to optimize pick up speed and reliability (it currently uses a tendon system based on head movement — see Figure 12). Additionally, since RSV2 uses IR, it should be easy enough to port over the new commands and use a PC or a PDA to control the robot.

These hacks will take time, but remember that it took almost six months before we started seeing some of the better hacks for the RSV1. Another obstacle to hacking the RSV2 could be the complexity (see Figures 13 and 14). Although like RSV1, RSV2's boards are labeled reasonably well, and many of the connections are socketed, so this may or may not be an issue. Time will tell. The main obstacle I see to hacking the RSV2 is the cost. It's one thing to fry a \$69 RSV1; it is another thing altogether to accidentally fry a \$250 robot.

Conclusion

In many ways, RSV2 is very similar to its predecessor. From the diabolical packaging system used to keep the robot in place during shipping, to its attitude and bad manners, from the conditional programming logic to the nicely labeled circuit boards, there is no mistaking that RSV1 and RSV2 are related. Does RSV2 have some drawbacks? Of course. I think that the cost, size, battery consumption, and lack of any sort of connectivity hurts it. To some, the similarity to RSV1 — in the sense that they are both programmable remote control toys — might also seem like a negative.

So is bigger really better? I think that it is. I feel that the RSV2 is a worthy successor to the RSV1. WowWee seems to have listened to a lot of the complaints with the RSV1 and remedied them with this release, and they threw in some cool new features, too. Like RSV1, it will take some creativity and curiosity to transform RSV2 from toy into tool. But when has that ever been a bad thing? **SV**