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Brick Journal

Issue 33 • March 2015

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The Robots are Coming!

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Andy Milluzzi

LEGO Designer
Lee Magpili

LEGO IDEAS

Sean Kenney

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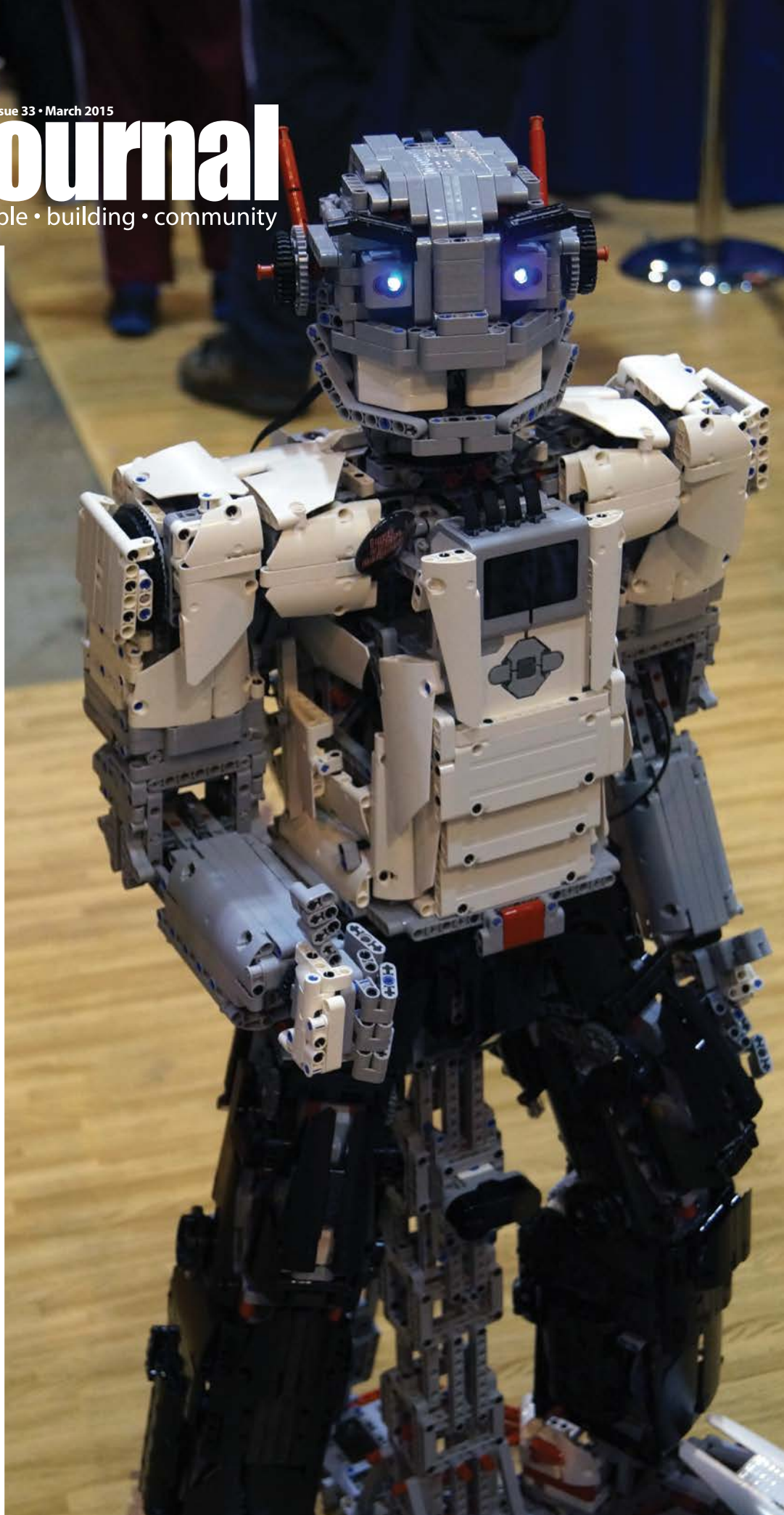

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FIRST LEGO League introduces students in grades 4-8 to real-world engineering challenges by building LEGO-based robots to complete tasks on a thematic playing surface. Teams, guided by their imaginations and adult coaches, discover exciting career possibilities and, through the process, learn to make positive contributions to society. Go to http://www.usfirst.org/roboticsprograms/fll *to get involved.*

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About the Cover:
R2-EV3 at rest.
Photo by Marc-André Bazergui.

About the Contents:
EV-AN.
Photo by Lee Magpili.

From the Editor:

Robots! We all know about them and have them somewhere in our lives, whether we know it or not. Whether it's Robby the Robot on *Forbidden Planet* or a self-propelled vacuum, robots have become a part of society. Initially depicted as fanciful machines that looked like their human creators, the robot in real life has taken on a more humble position. At least for now.

Many LEGO fans have been a little more attuned to the idea of robots because the company sells a robotics kit—the MINDSTORMS EV3 set. Besides that, some fans are a part of *FIRST*® LEGO® League, which is an international competition for elementary and middle school students. Robots have already settled in with us, it appears, as another element to build: from a brick to build, to a brick to program.

This issue is about the robot—both literal and figurative. There's two versions of R2-D2 models in this issue. One is a MINDSTORMS robot, and one is life-size and remotely controlled. Both show the creativity that LEGO builders have when they want to build. There's also an interview with a LEGO robot designer, Lee Magpili. There's other things to see too, like Tommy Williamson's toy robot instructions and Sean Kenney's nature exhibit. Have fun reading!

Joe Meno, Editor

P.S. Have ideas or comments? Drop me a line at admin@brickjournal.com. I'm open to suggestions and comments and will do my best to reply.

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Glossary

AFOL (Adult Fan of LEGO)
NLSO (Non-LEGO Significant Other)
MOC (My Own Creation)
TLG (The LEGO Group)
BURP (Big Ugly Rock Piece)
LURP (Little Ugly Rock Piece)
SNOT (Studs Not on Top)
POOP (Pieces—that can be or should be made—Of Other Pieces)
LUG (LEGO Users Group)
LTC (LEGO Train Club)
DARK AGES (usually teen years, when you drift away from building)
STUDS OUT (building where the studs on bricks face the viewer)

BrickJournal *and its staff would like to thank the LDraw community for the software it makes available to the community, which we use for making all of the instructions and renderings in this magazine. We would especially like to thank Kevin Clague for his continued upgrades of the LPub tool that is a part of the LDraw suite. For more information, please visit http://www.ldraw.org.*

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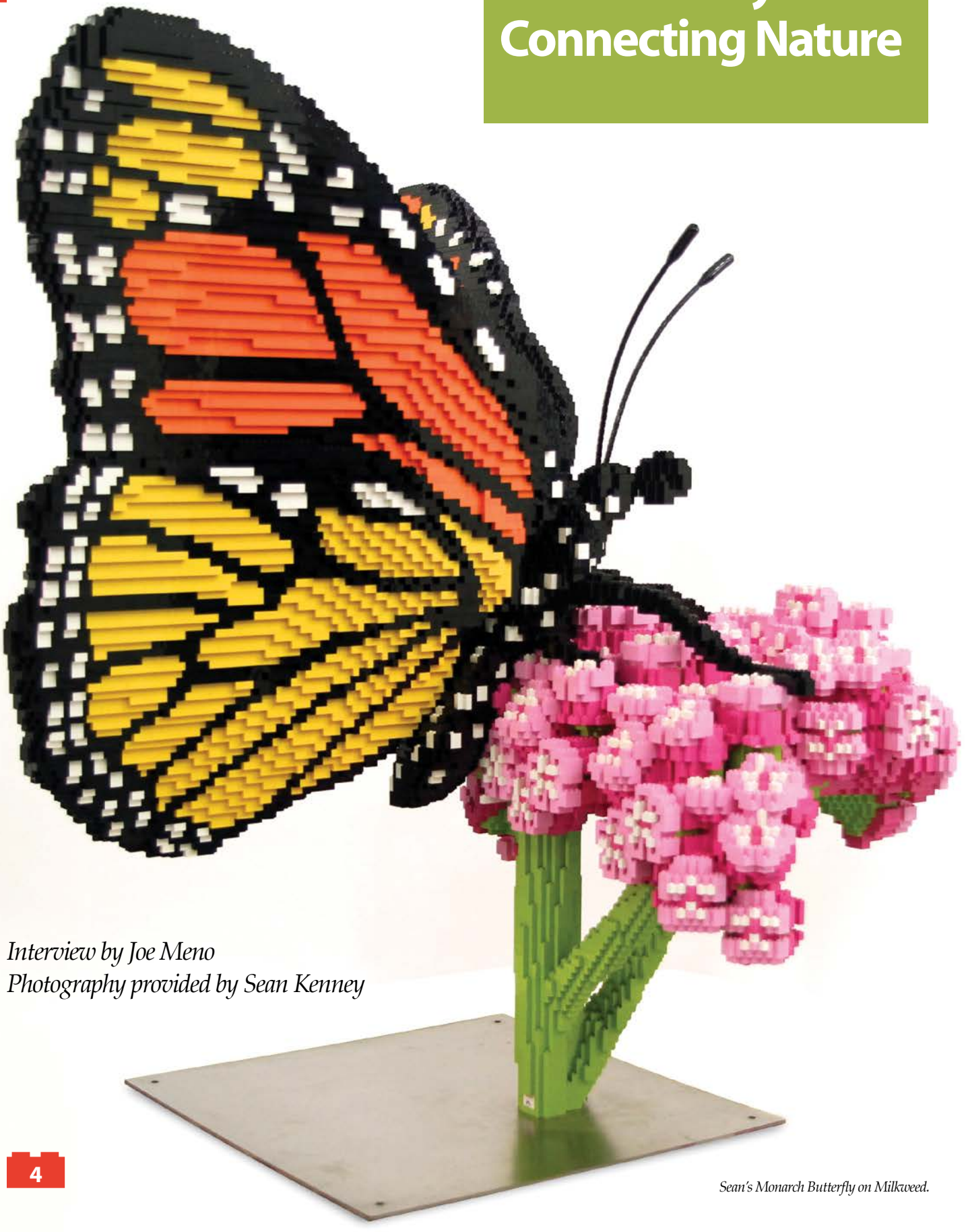
Sean Kenney: Connecting Nature



Interview by Joe Meno
Photography provided by Sean Kenney

Sean's Monarch Butterfly on Milkweed.

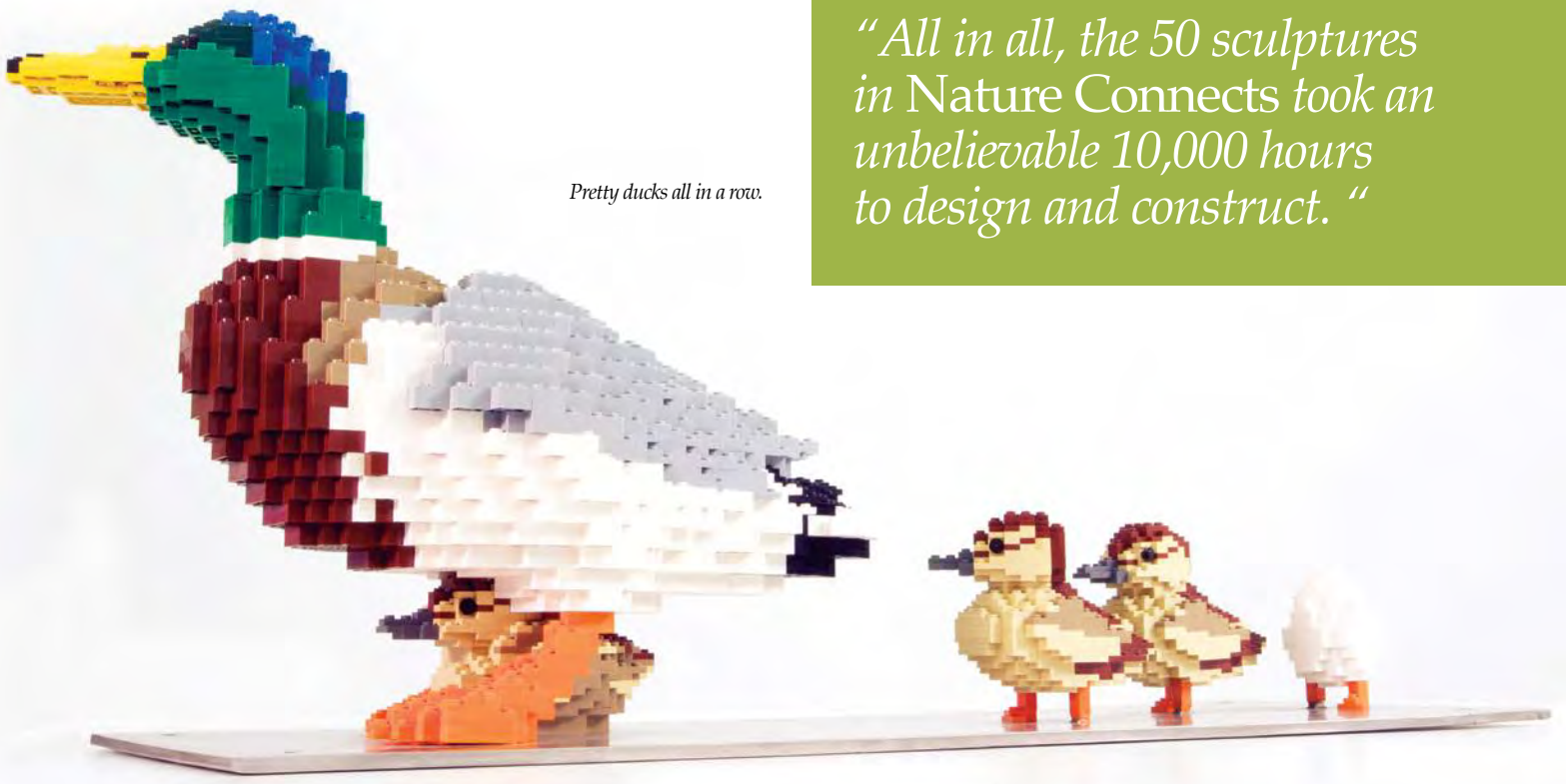
Sean Kenney is one of just a dozen people worldwide who build LEGO models professionally via a program run by The LEGO Group called "LEGO Certified Professionals". For the past 10 years, Sean has built many large-scale models for clients around the world. One of his most recent works is a display that is currently touring the United States, *Nature Connects*. *BrickJournal* talked to him about the display before the Christmas holiday.

BrickJournal: ***Who inspired you to build*** **Nature Connects?**
Sean Kenney: The show was developed in conjunction with Iowa State University's Reiman Gardens in 2011 and has been on tour since early 2012. Teresa McLaughlin, the director of the gardens, initially contacted me with the idea of producing a large outdoor display for their garden, but after lengthy discussion we came up with the idea of instead having the show tour gardens all around the world. Selecting the individual sculptures themselves are all a collaborative effort between myself, Teresa, as well as garden staff and other experts in the field of botany, insects, and animals.

Fundamentally the show is about connections. Much as LEGO pieces connect, everything in Nature is connected in an intricate balance. It is important to me that each individual sculpture attempt to illustrate some of these "connections" found in nature, whether it's a fox hunting a rabbit, a hummingbird feeding on a trumpet flower, baby ducklings following their parents on a walk, or squirrels raiding a bird feeder as the birds stand by helpless to stop them. Others showcase the beauty of nature, like a giant 7-foot-tall rose or a 5-foot preying mantis. There's also a life-sized lawn mower that visitors often mistake for the real thing... which is good for a laugh, but also shows humankind's connection to nature.

I love the way the exhibit has come out; it's really exactly how I imagined it. Seeing a sculpture installed at the botanical gardens, set outdoors and in a bed of tulips really makes the piece shine. It's nice to see a work like this be given a proper presentation.

"All in all, the 50 sculptures in Nature Connects *took an unbelievable 10,000 hours to design and construct."*



Pretty ducks all in a row.

How many models does it have?
Nature Connects includes over 50 larger-than-life sculptures the together use nearly 1,000,000 LEGO pieces. And we're always adding new pieces to the exhibit, so I've got a lot more that we're making right now.

What is the largest model?
The Hummingbird is by far the largest in size as it hovers 8 feet in the air and has a wing span of 5.5 feet! In terms of largest quantity of LEGO bricks, the Monarch is definitely the winner... I used 60,549 LEGO pieces! It has a wingspan of 8 feet but the majority of the work and bricks went into the Milkweed Plant that the butterfly is feeding from.

What was the hardest model to build?
Each presents its own challenges, of course. Building something very tall, for example, is hard because you have to stand up on a ladder or a table or a scaffold to complete it. We had to put a stepladder on top of a table just to finish the 7-foot-tall Rose!

The *Monarch Feeding on Milkweed* is the most visually intricate model I've ever made. I spent over 160 hours just figuring out how to design the milkweed flower, which has tons of nooks and crannies and weird shapes and things. Adding to the complexity is the fact that the milkweed is two shades of pink, and LEGO does not make Pink in very many different sized pieces. Usually at this scale you need a lot of 2x4 and 2x8 bricks to keep things rigid and interlocked but, for example, the darker pink only comes in 1x1, 1x2, 1x3, 1x4, and 2x2. So the whole sculpture is basically a solid mass of tightly interwoven smaller bricks. I've never purchased so many pink pieces in my life.

Installing the show is quite a huge feat; we have three installers and a show director that work together with the local garden's facilities staff to first determine where each sculptures will be sited and how to best landscape them. Then when the show arrives (it fills an entire 55-foot long tractor trailer!) the

A hummingbird at a trumpet flower.

Sean working on the monarch butterfly.

The 7-foot-tall rose.

Roto-tiller.

installers use forklifts and Bobcats and pallet jacks to unload the truck and move the sculptures around. Some of the largest sculptures, when crated, weigh over 500 pounds!

What is your favorite model?
I do love them all of course. The Rose came out immaculately elegant, with each petal furled around the next like a real rose. Birds vs Squirrels is hysterical and animated and lively and fun, and many people don't realize the picket fence is also built with LEGO pieces. The Monarch Feeding on Milkweed is vibrantly spectacular in color and form, which surprised even myself as it was coming together. I can't say I could pick a favorite... besides, I'm still building more. Wait until you see the giant peacock I'm making! :)

How did you build the models—what planning was needed?
You've probably noticed that I say "we" a lot here (not "I"). :) I have a whole team of artists and helpers that are a big part of creating this show, there are 12 of us here at my studio building and designing models, welding armatures, etc, as well as 4 folks offsite that handle the show logistics and installations.

"The show has been on the road about 3 years and everything is robust enough that we haven't had to take anything out of the show for replacement."

We do a lot of design work up front to figure out what the sculpture is going to look like, how it can physically stand up and withstand the elements and shipping. My senior designer, Jung Ah Kim, is an illustrator and painter and has been on my team for over 5 years, designing some of the most beautiful and iconic pieces in the show, like the Rose, the Hummingbird, the Lily, and more. Geoffrey Miller was an senior assistant of mine for many years before becoming a university art instructor, and had designed sculptures like the Bison and the Preying Mantis, as well as having done a lot of the engineering drawings for the designs of our armatures. Jung Ah, Geoffrey, and I together designed all 50 of the sculptures in the show, scrawling drawings on scraps of paper, gesturing wildly, wielding tape measures, holding metal bars with LEGO pieces glued to them and pretending to be gravity, and all kinds of other crazy things that you do when you're planning such a large endeavor over many years. We designed every sculpture brick-by-brick and afterwards my team of very talented model builders used those designs and prototypes to create a glued duplicate of each. It's a lot of hard work for them to build the sculptures as sturdy and efficiently as possible, working around metal that's welded slightly imperfectly, dealing with things getting too heavy or large horizontal things that want to crack in half, interlocking bricks as tightly as possible, building support beams inside, and all kinds of other physical hurdles. All in all, the 50 sculptures in *Nature Connects* took an unbelievable 10,000 hours to design and construct.

A LEGO swallowtail.

What do you have to do to 'refresh' the models, since they are displayed outside?

Every sculpture is reinforced with a metal frame inside, which is welded to a flat metal base that can be bolted or staked down to the ground. This helps keep it rigid in transport as well as inclement weather. The sculptures are also glued brick-by-brick as we build them. Once the sculptures are done they're sprayed with a UV-protectant chemical (similar to what's used on car windshields or sunglasses) to protect the LEGO pieces from becoming brittle and yellowing. The completed sculptures are then transported in custom-built foam-padded museum-quality exhibition crates from garden to garden.

So far the show has been on the road about 3 years and everything is robust enough that we haven't had to take anything out of the show for replacement. We plan on pulling out the oldest sculptures after they've been out for 5 or 6 years and check them to see if they need repair or replacement.

Nature Connects *includes over 50 larger-than-life sculptures that together use nearly 1,000,000 LEGO pieces.*

A colorful lily.

What other projects are you working on now? How are your books going? How are your book signings?
My newest book, *Cool Creations in 101 Pieces* was just released last month and is a continuation of the *Cool Creations in 35 Pieces* idea, where I used the same exact parts over and over in as many ways as I could imagine. It's a fun departure from the giant sculptures and feels more like the fun LEGO play that I did as a kid and even when I started out as an AFOL.

I'm also still doing a lot of portraiture (mosaics) which are time consuming to draw but a lot of fun, so I never give the work to my assistants. :) I usually do about 20 or 25 portraits a year, but for some reason this year I've done almost 40 portraits and the holiday season (my busiest for portraits) hasn't even begun. (Gulp!)

What's the most enjoyable part of your job?
Answering questions for *Brickjournal*. :)
Everyone loves you, Joe!

Bunny and fox, on the hunt.

A buffalo and calf.

Preying mantis.

Brian's model Siege Knightmare with motorized cannon hands.

Brian Cooper: Building Robots Big and Small

Interview by Joe Meno
Photography by Brian Cooper and Joe Meno

Brian's Millennium Falcon.

Brian Cooper is a builder that has been around for over a decade building and displaying his models. His online name is Klaupacius and is also known for creating and releasing the instructions to the Teknomeka, a large-scale mecha frame that can be customized for many different looks. He's also done robotics and remote control LEGO models, so he was a good fit for this issue of *BrickJournal*. He took time out to talk to us.

BrickJournal: ***I know that you are one of the first-generation builders, as I went to your Brickshelf gallery online and remember the Dropsheep and the Explorovore models posted on LUGNET (www.lugnet.com). When did you start building and what was your first MOC?***
Brian Cooper: My first LUGNET MOC was a *Millennium Falcon* model I made in 2000, but I'd been building sci-fi and anime themed MOCs for many years before that. Since the late '70s, Classic Space and Technic sets provided the primary construction materials for countless space ships and giant robots. I would generally incorporate mechanisms in all my builds, not just gears for robot joints, but spacecraft with rack-and-pinion operated airlock doors and other mechanisms for boarding ramps, flight control surfaces, etc... I called it "mechanical intrigue", details that made a MOC more realistic to me. The *Millennium Falcon* had electric minimotor-operated landing gear, seemingly excessive, but it was just a longstanding tradition.

Like other people, I had a "dark age" away from building through college and my first job, but I got back into LEGO with the introduction of the LEGO MINDSTORMS set in 1998, due to its synergy of computer programming and Technic model engineering. I built a series of autonomous battle bots

Above and left is MechaGodzilla, with motorized drill hands and jaws. Below is Teknomeka 2.0 demonstrating enhanced poseability.

using the RCX units which culminated in the development of a really neat guidance system that used infrared tracking. I demonstrated these "Infradreadnaught" robots at the 1999 MIT Media Lab "Mindfest" MINDSTORMS exhibition.

How did your building lead to building mecha? And what inspired you to build the Teknomeka? How long did it take to design the current version?

After the *Millennium Falcon*, I was eager to revisit another blast from the past, giant robots, using new types of Technic parts to solve old design problems. I had always wanted to make a free-standing biped robot model with as many functional geared joints as possible. This became a long term development path that I ended up sharing in the form of LUGNET posts, my "Dark Gundam" website, and the eventual Teknomeka instructions in 2005.

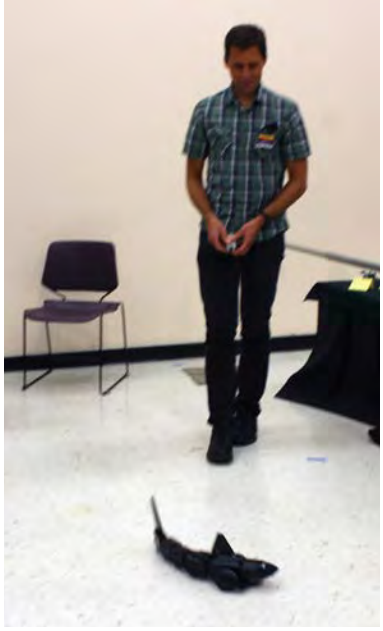
Teknomeka 1.0.

Making the Teknomeka prototype model, the CAD files and the instruction steps took about a year and included some software development I had to do in order to make a customized version of LDView (the LDraw file viewer) to render the instruction steps. I'm currently working on a version 2.0 of the Teknomeka instructions with a completely new design, and the process hasn't become easier nearly ten years later. I think if I had access to the MLCad source code I could streamline this and reduce some of the labor.

Tell us about your building of remote-controlled models, like the cubes and land sharks you have brought to BrickCon. What prompted building them? You mentioned that you wanted an interactive model for the public to play with, so you built the land shark. Both models were designed to take abuse too.

Power Functions lets you put your brain in the control loop of the robot, so you can get complex behavior out of a simple mechanism (for people who aren't programmers). This is great for audience participation exhibits. I brought a couple of Power Functions battle bots (named "Tantrum" and "Monkeypox") to BrickCon one year too see how manageable this would be. Children love being at the helm of battle bots, that's for sure. In a venue where nobody gets to play with all the cool models on display, a crowd forms instantly for

Brian's LandSharks.



Brian running a LandShark.

a chance to play with something. Another year I brought three "LandSharks" for people to pilot, which blurred the line between robot and animal with very lifelike behavior, once you started thinking like a shark and learned to "swim" the robot.

The LandSharks were really great examples of making a mechanical animal, but the last model you displayed was a mecha version of a cat. Tell us about Geo.

Geo was a commissioned art project for Ping Fu of 3DSystems. Her only requirement was that it should be a big cool looking robot, which is something I'm always up for. I used this opportunity to make my first quadruped mecha, not just for a break from the bipeds I've been building for years, but because something with four legs is more stable in the long run. For a commissioned piece you need to think about the habitat and life cycle. I had the idea to employ rounded part shininess to give a sense of high end quality and newness that is tolerant of dust accumulation. So Geo is designed to look good for a long time without having to be sealed away in a display case.

At BrickCon 2013, Geo garnered an Honorable Mention for Best in Show, indicating that it was a crossover with more general appeal than typical mecha. I would describe it more as an animoid than a mecha. It's a robot designed to mimic an animal, and it is modeled at "actual size". It's very easy to picture something like Geo being someone's pet in the future. Robot pets are low on maintenance and high on functionality. I think I'll be making more of these animoids in the future. In particular I like the process of looking at the articulation of a living thing and designing a mechanism that does the equivalent.

Different views of Geo.

If you want to find out more about Geo, including construction, you can go here:
http://makezine.com/magazine/going-big-with-legos/
or scan the QR code to the left.

R2-EV3, WALL-EV3, and EV3RSTORM on display.

Making R2-EV3:

Building the LEGO Astromech Using MINDSTORMS

Article and Photography by Marc-André Bazergui (Baz)

Marc-Andre Bazergui is one of the most well-known MINDSTORMS builders in the world having built a large WALL•E robot that has been shown at events worldwide. He is also a member of the MCP—the MINDSTORMS Community Partners, which is a small group of LEGO robotics builders that work with the company at events. Some of his work can be seen online and in the packaging of the LEGO MINDSTORMS set.

Since WALL•E, he has been working on another project that has been seen now in the past few months—a working R2-D2 that uses only MINDSTORMS and LEGO elements. This wasn't an easy project, and here, Baz (as he is known by his friends and fans) talks to BrickJournal about how he built his R2 unit.

After having so much fun and making so many people happy with my latest creation — the transforming WALL•E5 — I started looking for something new that might get the same instant recognition from the public. A Dalek model I built was not it (I guess being Dr. Who's and the human race's worst enemy wasn't helpful)—I needed something more lovable. It became clear: I needed to build an R2-D2 model.

Starting a Droid Factory

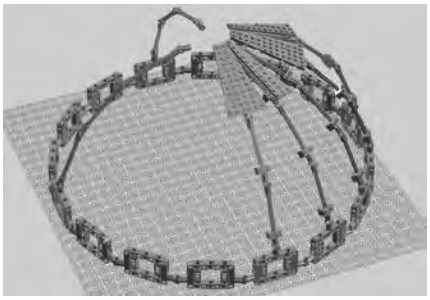
Admittedly, Artoo turns out to be my favorite character in the *Star Wars* movies, and I've been thinking about building him for a while. Since 2012, I have been pushing the idea to build a large-scale transforming R2-D2, using a network of NXT MINDSTORMS programming bricks connected by a Dexter Industries XBee controller. It was also going to be a joint venture between several MCP (MINDSTORMS Community Partners) around the world. I had Mark Crosbie working on programming, Eric Steenstra sharing his Meccanum wheels, Vassilis Chryssanthakopoulos sharing his omniwheel design, and Jildert De Wachter and Mathieu Pedneault helping with other structural concepts. All of the discussions and design were going on via a Facebook group and occasional Google hangouts.

This was going to be the most awesome R2 ever. I gathered all the LEGO parts I needed to start prototyping and built the skeleton far enough to start testing the leg movement for the transform from two legs to three legs. By the middle of Summer 2012, however, I discovered that the R2 unit was so big and heavy that it was collapsing under its own weight. The shoulders would not hold, even after using some techniques from some of the best MINDSTORMS builders in the world! Discouraged, I put this project aside.

Around this time, the MCP was getting more and more involved in the imminent launch of the MINDSTORMS EV3 set. I realized that making a NXT show robot wasn't a good idea, as the MCP were already getting pre-production equipment and being asked to design bonus robots for the new system.

I posted the following message on our Facebook group: "Hi all, a little update. I'm afraid the current idea for the R2-D2 has failed. I am now rethinking it from the ground up. Remember when I was presenting two possible sizes (the 9L and 7L dome)? Well, I believe the logical solution now is to start looking at a smaller scale robot and doing it full EV3." I also set up a building session with my friend Mathieu Pedneault in August 2013. With his arrival, we would try and build the new smaller scale R2-D2.

Initial prototyping for the large-scale R2 unit.



The head dome was designed first on LEGO Digital Designer.

R2 in one of its final iterations before its scale was changed. At this time, the EV3 was just launched.

WALL-EV3.

And the part that started it all.

Building WALL-EV3

Fact was, I was already working on something for a week by the time he visited. I couldn't wait for him to arrive, as a building session with a friend is so rare and so valuable. Showing up as planned, Mathieu said with a laugh (in French), "Hey Baz, it looks like you built another WALL-E!" My reply? "Oops." He's correct. I decided that I might as well build an EV3 version of my best-known robot before someone else does! I designed the tracks and basically, the base was done. With this start, Mathieu and I spent the entire day building a white replica of my WALL-e4 robot using EV3 components. It turns out that the robot looks really cool in white—we call it the Son of WALL-E, because it's like he got the shape of his dad but the color of his mom, EVE. WALL-EV3 is born!

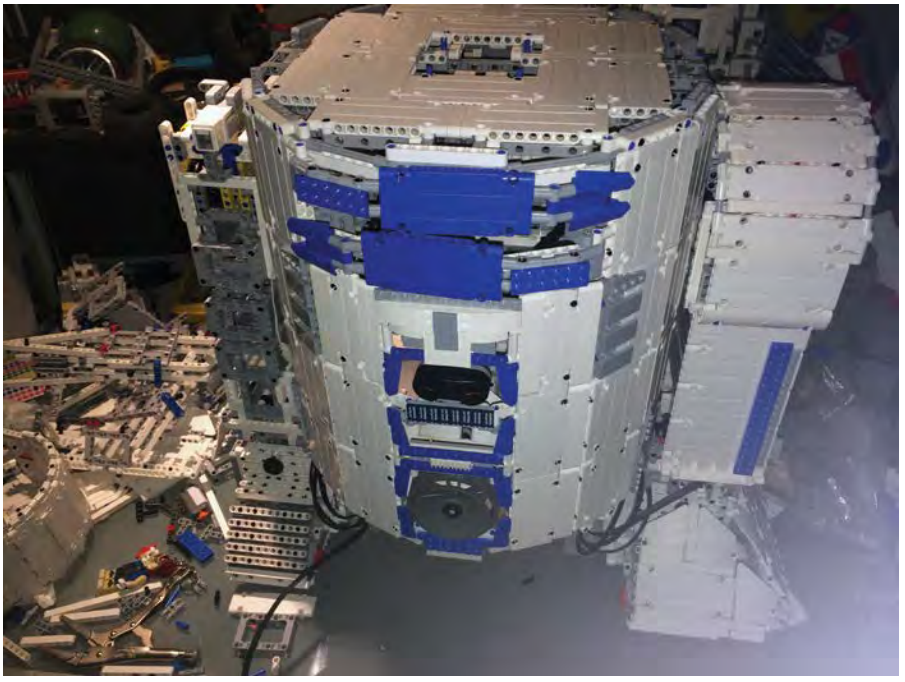
An invitation with some other MCP members to the 2013 World Robotics Olympiad took me to Jakarta to show off WALL-EV3 and inspire kids with our amazing creations. It's also in WRO Jakarta that I discovered a bin with spare parts in case we needed to fix our robots. Upon further investigation, I discover some unique, not-yet-released LEGO Technic elements! Among those is a new 3L (stud) worm gear design to fit inside the new Technic frames that happens to have very little slack! "OMG," I think to myself, "this is exactly what I need to work on my R2D2 challenge!" As a result, I grab a dozen.

Building R2-EV3

On December 2013, during my holiday vacation, I start working on the new R2-D2-EV3. In one week, I start posting videos on YouTube. After 10 days, I have a working prototype. It's not the community build I imagined initially, but at my LEGO Users Group meeting (QueLUG—Quebec LUG) I present them with a working IR-controlled transforming R2 unit.

R2-D2 was presented for the first time at FIRST World Festival and Championship in St. Louis in April 2014. From there he has been demonstrated at the International FLL Open held in Toronto, then at BrickFeté, Canada's LEGO Fan Event. LEGO Community Representative Kevin Hinkle and LEGO Designer Jamie Berard got to see the droid in action there, and I am pretty happy about that.

The robot has also been to the Maritime Robot X event at the Marina Bay Sand resort in Singapore, which was held in October. R2's last adventure for 2014 was at Prague for Café Neu Romance for the "Robots are Coming Home" event. If all goes well, you should be able to see my robots at LEGOWORLD Copenhagen in February 2015!



R2-EV3's body nearing completion. Note the foot beams—they are actually attached to treads for movement.

R2-EV3 and K-9... no wait, that's another show.

Building a Journey

As you can see, building robots is a journey on many levels. It is ever evolving and inspiration is all around. I really love going to events and seeing how happy kids of all ages get when interacting with my robots. I am told that my creations inspire others to build LEGO robots. This, in turn, inspires me back and makes me want to continue exploring the LEGO MINDSTORMS universe alongside the EV3 Community group I chat to on Facebook on a daily basis. Come join the discussion and get more LEGO MINDSTORMS inspiration by visiting my homepage and joining the EV3 Facebook community!

My home page is: http://bazmarc.ca/bazmarc/HOME.html *or can be scanned from the QR code on the left*!

The EV3 Community Facebook page is: https://www.facebook.com/groups/legomindstorms/ *or can be scanned from the QR code on the left*!

Of course, you can also see my robots in action online on Facebook! You can see R2-EV3 and his travels on https://www.facebook.com/LegoMindstormsR2D2 *or scan the QR code!*

Marc-André demonstrates R2-EV3.

Building Notes

In terms of construction, the challenge was to make a drive train that could support the droid's weight. I also had to design some shoulders and ankles strong enough (minimizing torque) to allow this heavy model to turn. Additionally there are two functioning arm/accessory doors and a fully automated head equipped with sensors to react to its environment.

With all of these functions, there are many more ideas for future improvements. I'd love to hear some you may have.

Here's the inventory of main components to R2-D2:

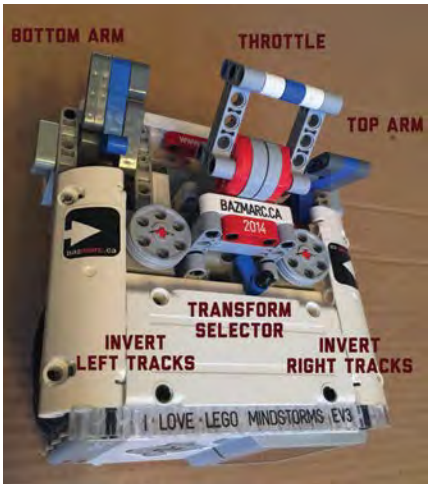
R2-D2:

4 EV3 bricks
7 large EV3 motors
7 small EV3 motors
5 touch sensors
1 color sensor
1 gyro sensor
1 ultrasonic sensor
1 IR sensor

Remote:
1 EV3 brick (for master remote control through Bluetooth)
1 large EV3 motor
1 small EV3 motor
4 touch sensors

Programming was all done in EV3-G.

R2-EV3 with his center foot open.



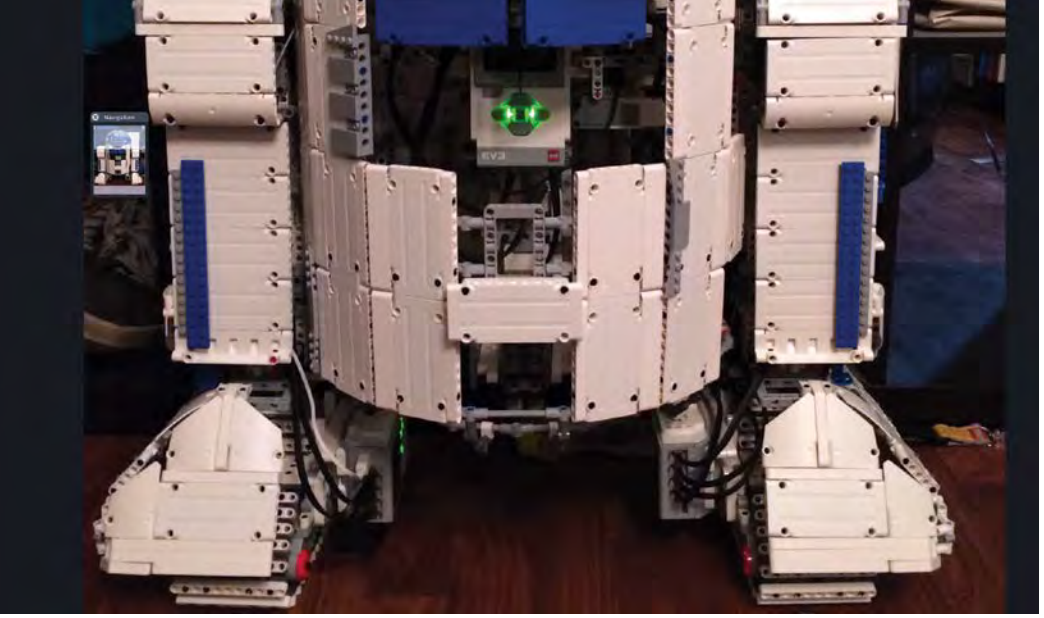
The droid controller.

Controlling R2-EV3

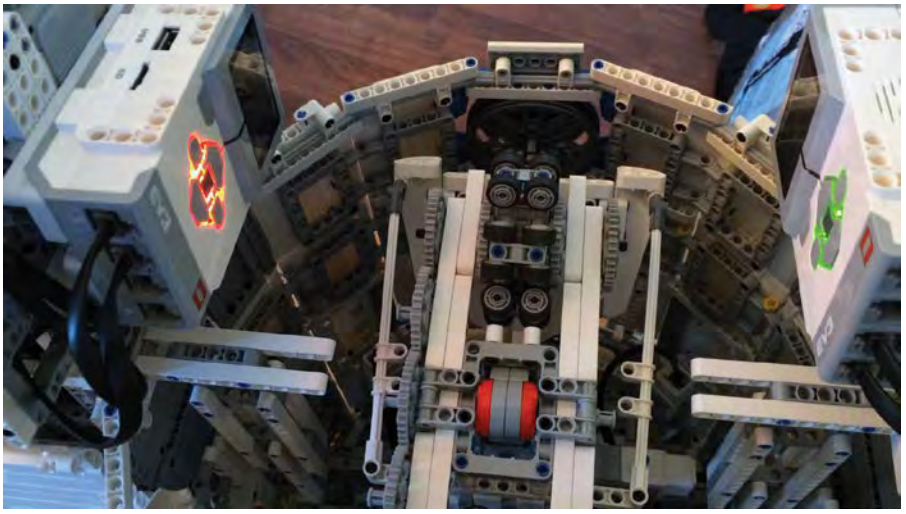
When the remote is started, it beeps until the throttle is set and the transform switch moved to the center position—both round buttons must be pressed simultaneously in order to tell the remote that it is ready. At this point, the Bluetooth handshake happens with the three other bricks in R2. A crickets sound comes from each brick during this time. The head is a separate robot from the R2-D2 body so there is no Bluetooth connection with the remote.

The throttle must be engaged in order to turn by inverting the left or the right track. You can do so by pressing the left or the right round button. Arms can be moved with the upper paddles.

The transform selector has three positions: two legs, locked, and three legs. Set it to the left to put it in two-leg mode and then press both round buttons simultaneously to activate. Lock the leg mode by moving the selector to the middle. Moving the selector to the right and pressing both buttons will extend the center leg, going to three-leg mode.

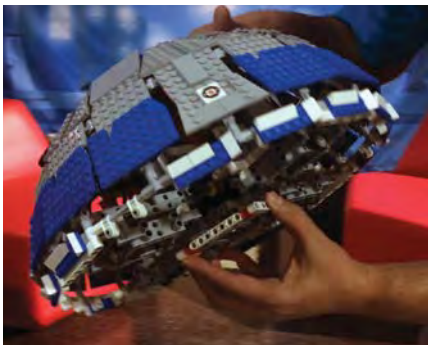


The droid's chest opened, showing one of the EV3 bricks. Two more are at his feet.

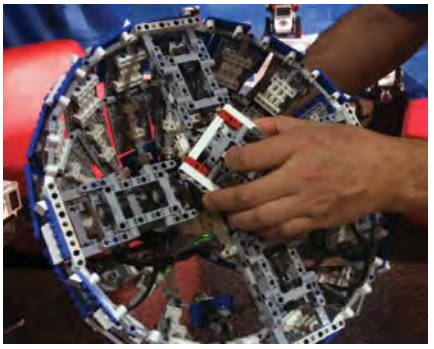


Upside-down, looking into R2's body from his feet.

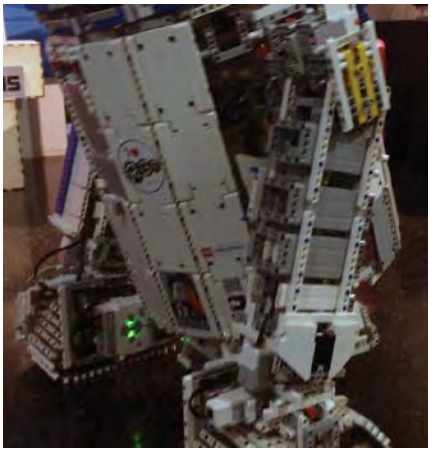
Two boys play with the droid.



R2's head from the side...



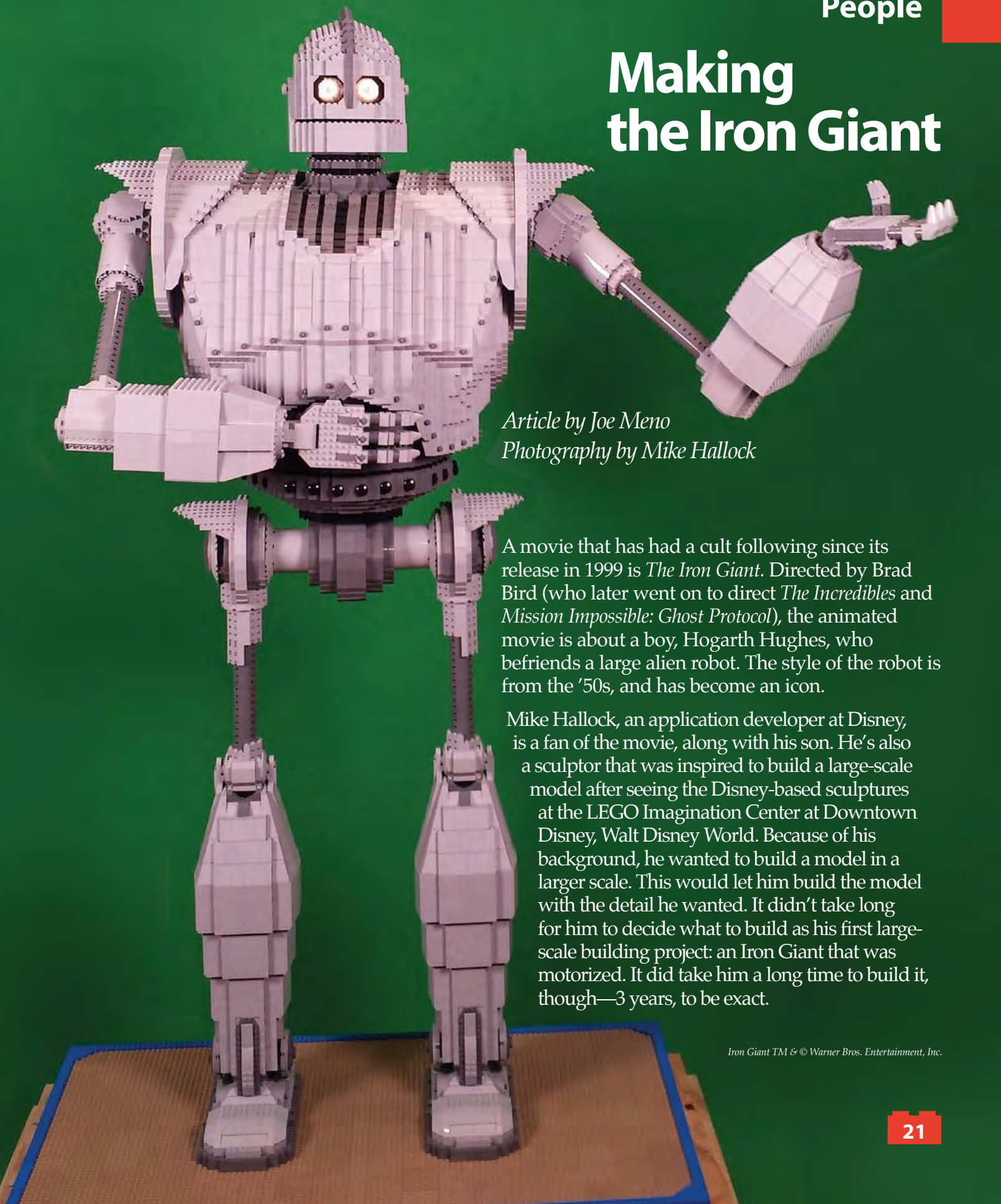
...and the bottom.



Side view showing inner workings of the leg.

Taking a pic of the droid.

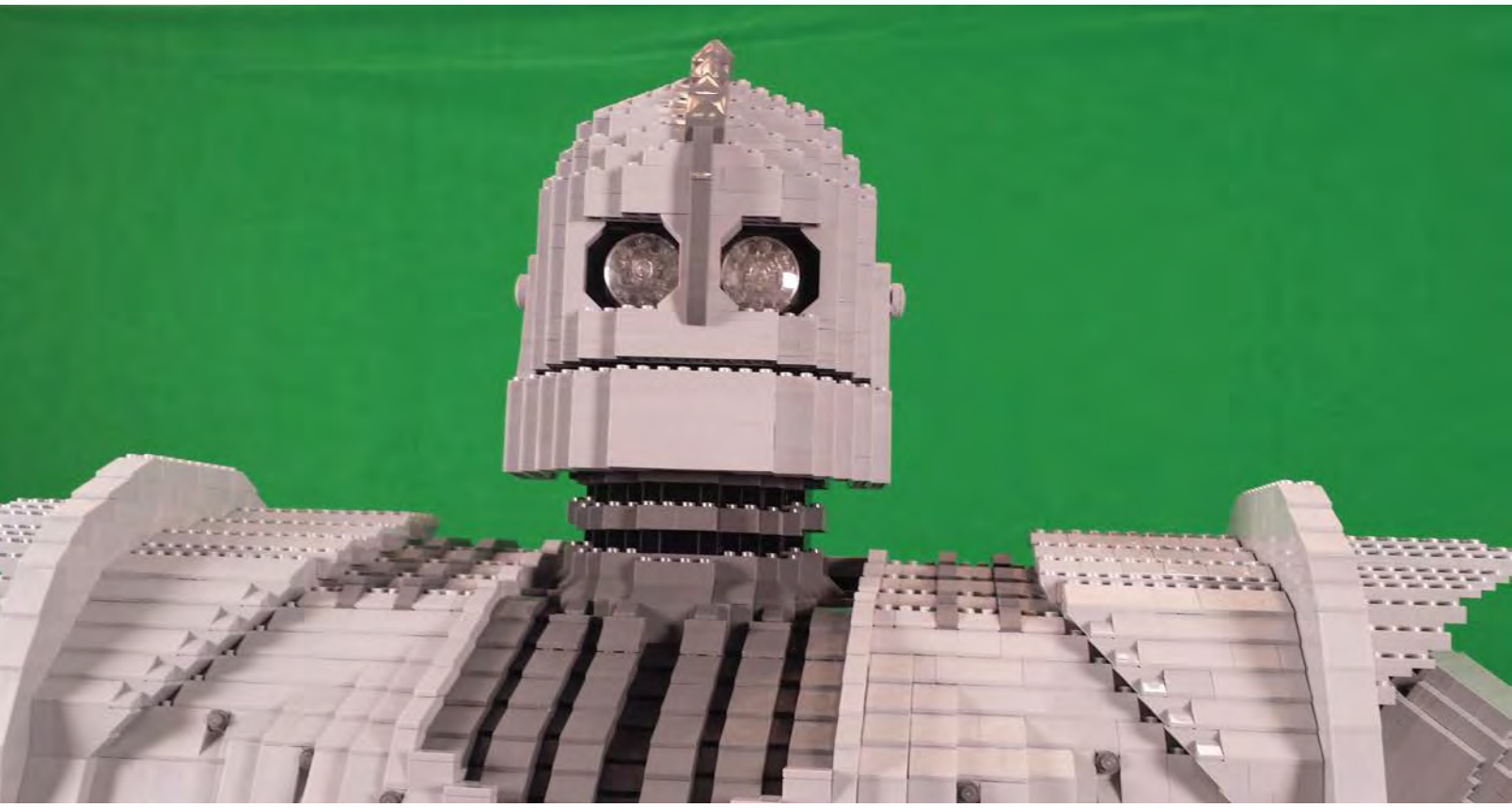
Making the Iron Giant



Article by Joe Meno
Photography by Mike Hallock

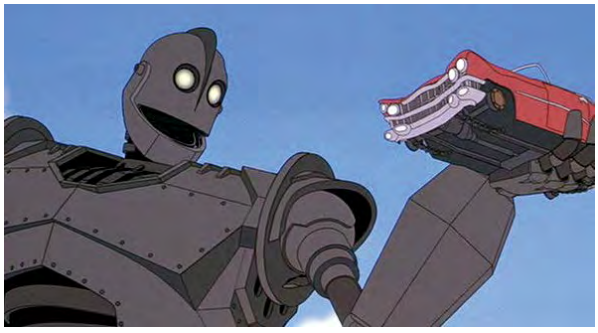
A movie that has had a cult following since its release in 1999 is *The Iron Giant*. Directed by Brad Bird (who later went on to direct *The Incredibles* and *Mission Impossible: Ghost Protocol*), the animated movie is about a boy, Hogarth Hughes, who befriends a large alien robot. The style of the robot is from the '50s, and has become an icon.

Mike Hallock, an application developer at Disney, is a fan of the movie, along with his son. He's also a sculptor that was inspired to build a large-scale model after seeing the Disney-based sculptures at the LEGO Imagination Center at Downtown Disney, Walt Disney World. Because of his background, he wanted to build a model in a larger scale. This would let him build the model with the detail he wanted. It didn't take long for him to decide what to build as his first large-scale building project: an Iron Giant that was motorized. It did take him a long time to build it, though—3 years, to be exact.



Head detail of the Iron Giant.

A look at Hogarth and his car, both in LEGO (above), and from the 1999 film (below).



Before that, he was a LEGO builder for his church group, the Oakland Presbyterian LEGO User Group. There, he built and designed models for summer camps at the church. Currently, he is working on a minifgure-scale amusement park with rides, including a octopus lifted using Star Wars mini vehicles for ride pods. Another project he built was LEGO basketball shooters for a David and Goliath themed program.

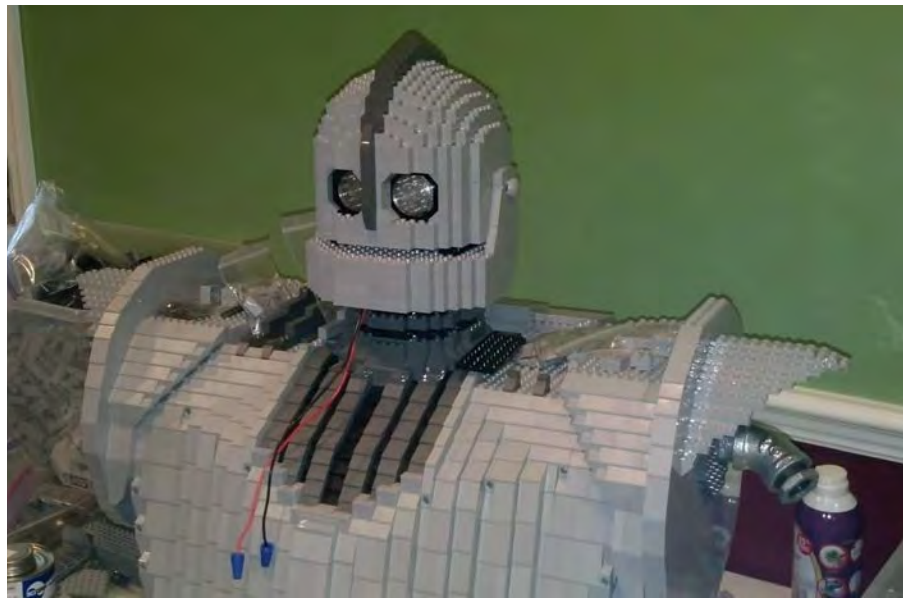
But nothing compares to the Iron Giant. Literally. Standing at 5 feet tall, this model is at 1:10 scale, which is double the building scale used at the LEGOLand parks. The robot is motorized to spin at the torso, following a scene where the Giant picks up and spins a 1959 Cadillac Sixty-Two convertible with Hogarth inside.

Mike got reference images of the Iron Giant from screen captures of the movie. He also used photos of an Iron Giant toy for more angles he couldn't get from movie footage. For the car, Mike looked up auto photos online of that specific model. From there, it was a process of building prototypes of sections. Once a section was finalized, building a glued version was then done. Gluing was done to keep the robot from breaking apart, especially since it moves.

Because of the stresses of spinning and weight support, the model actually has a steel armature in the legs. A turntable is placed on top and a variable speed motor was installed. The torso also has conduit for the arms and wiring for the Giant's eyes, which light up. The switch for the motor is at the base of the model and allows for speed control. They eyes are operated by remote control. The model is LEGO bricks and elements covering a metal skeleton, much like a LEGOLand model. The result is a wonderfully accurate Iron Giant.

It took three years to make this Iron Giant, almost as long as it took to make the actual movie!

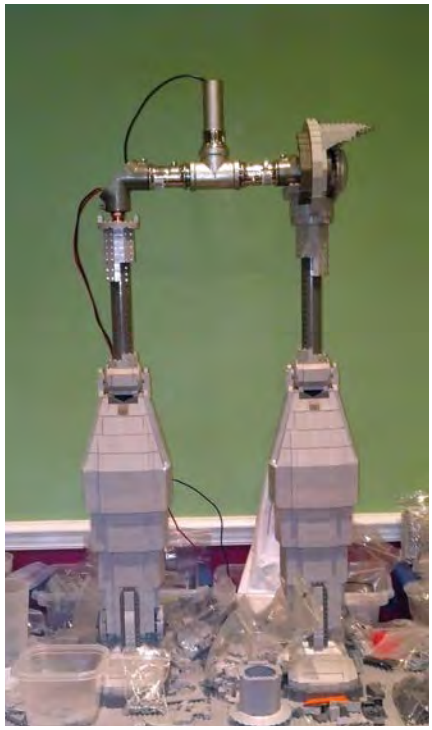
The hardest part of building this was making arms that could support weight, especially the car and Hogarth. Making the Giant's curves from the square LEGO bricks was also a big challenge. However, for Mike, that also was enjoyable. He had the most fun building and rebuilding the head to match his reference. For him, this was a sculpture and LEGO was a medium, like clay, to model the robot.



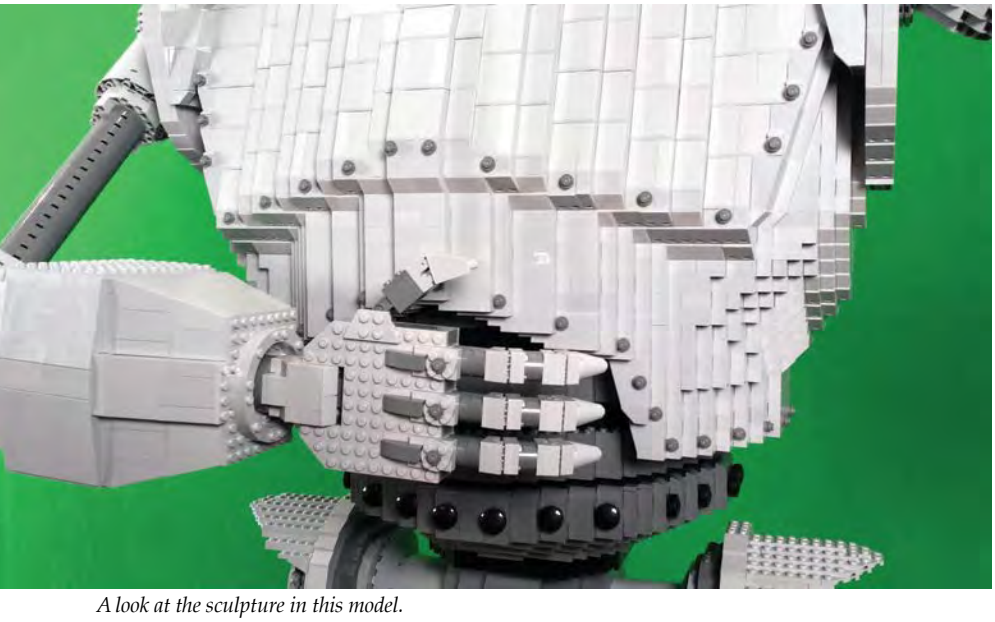
The Giant's head and torso nearing completion.

The torso in progress.

The legs of the Iron Giant in progress, showing the armature being eventually covered by LEGO sections.



Mike Hallock showing part of his work.



A look at the sculpture in this model.

The Iron Giant, at press time, has only been displayed at Mike's church, but that will soon change, with the model debuting at nearby fan events. Mike has already started on his next project, which will involve using a MINDSTORMS NXT to operate a billboard that can change images. He's thinking about using it as a background to the robot, so the billboard will be another large undertaking.

For Mike, though, that's the way he likes to build.

For more information on the Oakland Presbyterian LEGO User Group, you can go to their Facebook page at: https://www.facebook.com/pages/OPLUG-Oakland-Presbyterian-LEGO-User-Group/270322853096980?fref=photo or scan the QR code above.

If you want to see a video of the Iron Giant in motion, you can go to http://youtu.be/dOnSulMKjgA or scan the QR code to the left.

Shin detail.

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Growing up with LEGO: My Journey to Becoming a MINDSTORMS AFOL

Article by Andy Milluzzi
Photography by Joe Meno

Everyone has a unique connection to the AFOL (Adult Fan of LEGO) community. AFOLs come from all walks of life, all sorts of backgrounds, but have one thing in common: the desire to create with the iconic LEGO bricks (or beams). I can't say I've ever completely shared my LEGO story, either in print or otherwise. Parts of my story are probably very unique, but I think the underlying passion is something we can all relate to.

It all started with a story, I really don't remember. I was too young, but I have heard it countless times over the years from my mother. As a child I loved to build; LEGO of course was my favorite toy (although I liked, and still do like, model trains). I was maybe 3 years old and my mother came in and saw me building a LEGO set. She said, "Andy you're going to be an engineer someday." To which I replied, "But mom, I don't wanna drive a train."

During the 2010 FIRST® LEGO League World Festival at Atlanta, Georgia, there was a meeting of the LEGO MINDSTORMS team with the MINDSTORMS Community Partners, a network of fan builders that helped the LEGO Group with MINDSTORMS design and programming. Many of the people in this photo are among the best MINDSTORMS builders and programmers in the world. Andy Milluzzi, the author of this article, can be seen at the top center in the light purple shirt. Other builders seen here that Andy mentions include Marc-André Bazergui (front row, right end), Steve Hassenplug (center with the dark gray shirt), John Brost (back row, sixth from the right end), Jay Kinzie (back row, fifth from the left end), Bryan Bonahoom (back row, eighth from the left end), Ron McRae (back row, sixth from the left end), Laurens Valk (front row, third from the right end), Lee Magpili (third from the left edge) John Hansen (back row, fourth from the left edge), and Steven Canvin (center, between Laurens and Steve.

I honestly can't remember a time where I didn't have (or want) LEGO bricks as a kid. I am sure I was not alone. It was great family time (and just recently, my father is getting back into building with LEGO bricks). However, I had another passion: electronics and computers, a derivative of LEGO blocks, so to speak.

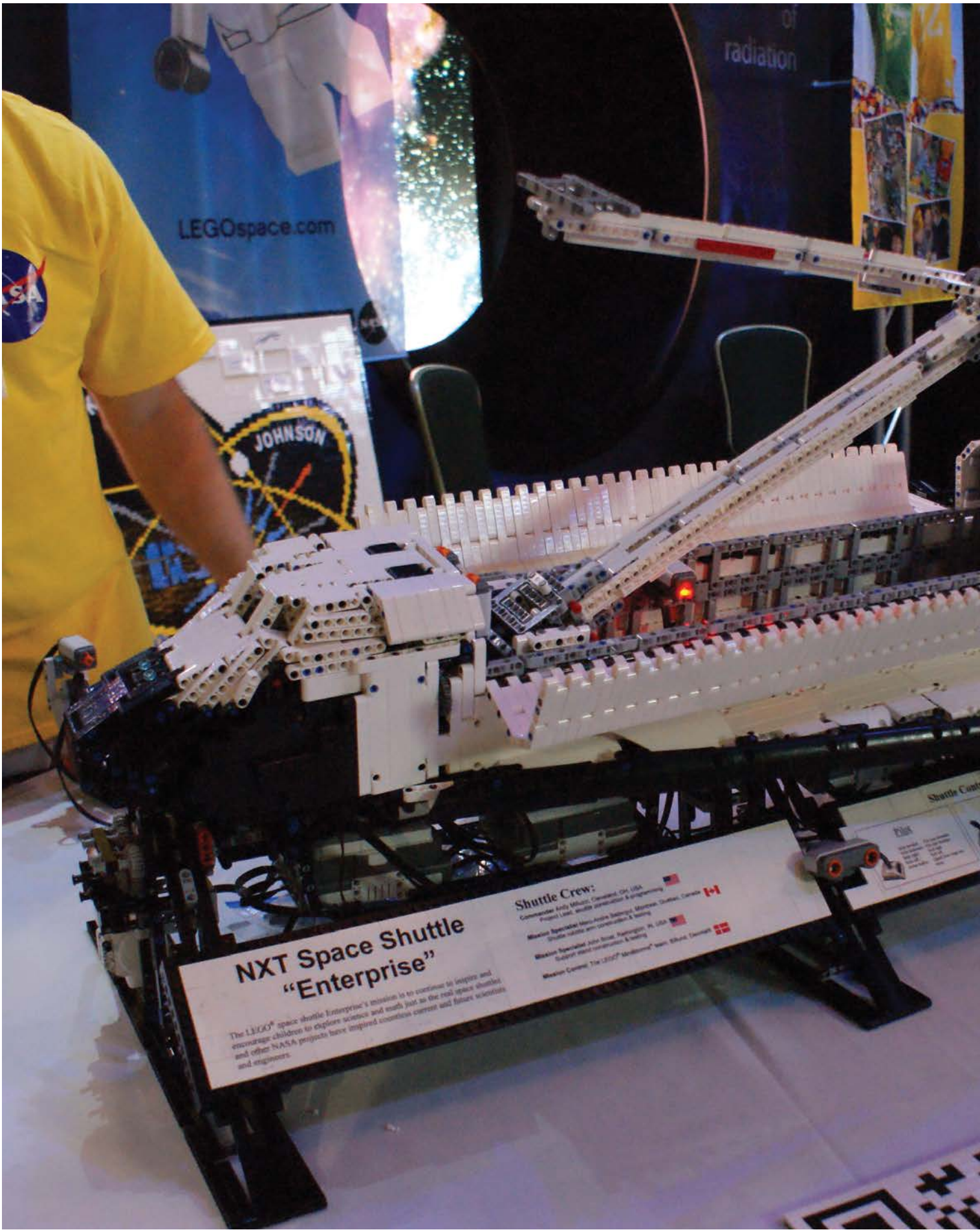
In 1998 those two worlds collided. When LEGO MINDSTORMS (LMS) was first introduced, I took to it like a duck to water. I was far from an expert, but that didn't stop me from trying to build and create bots. I vividly remember building the Mars Explorer add-on for it with my dad and showing him all the cool stuff LMS could do. Sure, the RCX was simple by today's standards, but it opened a whole new world to me. I quickly discovered the extensions the AFOL community made. The work of people like Steve Hassenplug, John Barnes, Philippe Hurbain, Ralph Hempel, and David Baum (and countless other notable MINDSTORMS AFOLs, the list could go on for pages) made a huge impact in what I did with my free time. They might not have known it, but they inspired me to be an engineer. (Although my mother maintains I was going to be an engineer all along.)

Time progressed and just before I graduated high school, LEGO MINDSTORMS NXT came out. It added fuel to the fire, so to speak. The advent of digital communications and additional processing power enabled new creations. Case Western Reserve University in Cleveland, Ohio hosted an annual LEGO robotics competition for high school students. My senior year it was based on the DARPA Urban Challenge for autonomous navigation. Long story short, after weeks of developing software, I led my high school to victory. (The video of the NXT navigating the course is actually one of the first videos I posted to YouTube.)

It wasn't long before I started my B.S. in engineering at Rose-Hulman Institute of Technology. Little did I know, that move to Terre Haute, Indiana would completely change the next chapter of my life.

College is a transitional time for everyone and I was no exception. I moved into my dorm room with my NXT kit and started to emulate those who I looked up to. I got into creating my own sensors. In writing this piece, I actually came across an email chain with Philippe regarding creating a color sensor. I was becoming a member of the MINDSTORMS community, and it is that great community that helps so many people around the world, that makes the platform what it is today.

It was around this time I crossed paths with Xander Soldaat. We both were working with Deepak Patil at Mindsensors.com. There were many Skype sessions discussing how to use the various suite of sensors. I also met Jay Kinzie, a fellow student at Rose-Hulman and a MINDSTORMS Community Partner (MCP). I worked on quite


LEGOspace.com
JOHNSON
NXT Space Shuttle
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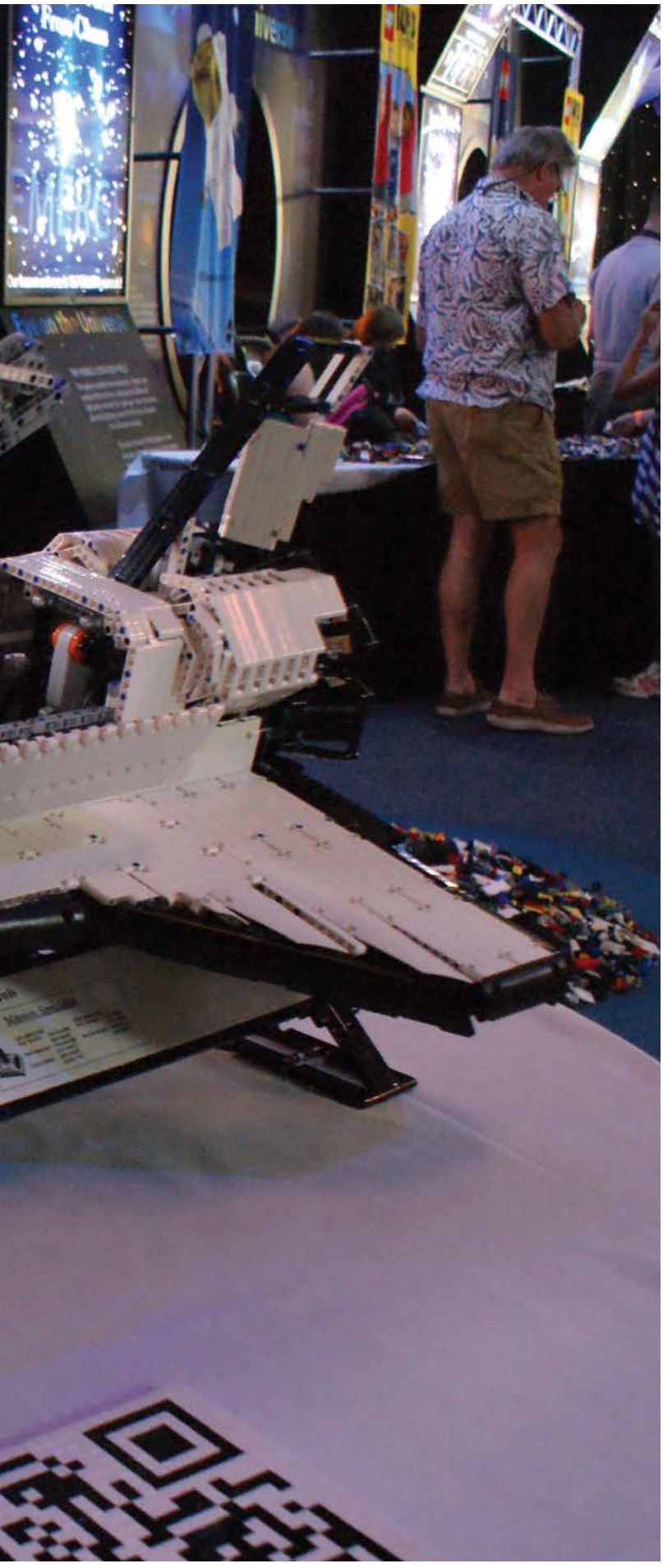
Shuttle Crew:



a few projects with Jay, mainly helping with the programming aspects. As a young AFOL, I had certainly found my interests in the LEGO universe and a supportive community to support me.

With time I began sharing my knowledge. The "LMS" label on my Gmail says I have over 5,000 email conversations (assuming all of them got the label). When there was a public call for MCPs, I applied. Come December of 2009, I got an email inviting me to join all those who I looked up to as a MINDSTORMS Community Partner. Little did I know that many MCPs happened to live very close to me. Steve Hassenplug and John Brost were about two hours north, Bryan Bonahoom an hour east, Ron McRae three hours northwest, and of course, Jay Kinzie fifteen minutes down the road. I am not sure I can verbalize the feeling of meeting and becoming friends with people who inspired you. I think I realized this the most when Steve Hassenplug brought Monster Chess to a LEGO days I helped organize at the Terre Haute Children's Museum. It is something to look up to a group of people, but it is a world more when they are excited to see your ideas and support you.

This brings us to 2010. 2010 was big, getting to meet all the AFOLs, going to LEGO World in Zwolle, the start of my LEGO MINDSTORMS Space Shuttle project and meeting one amazing friend.

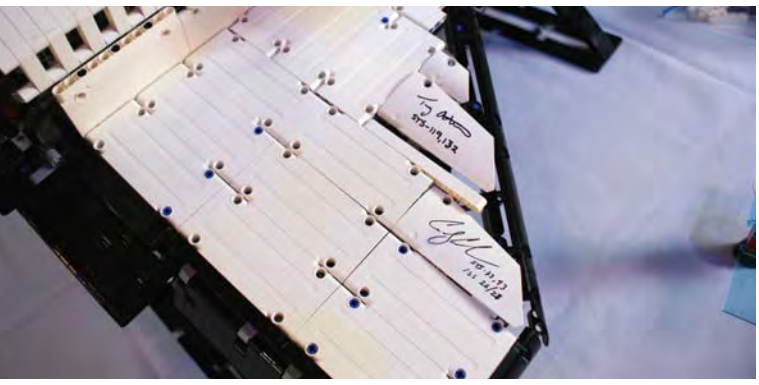
If you are currently active in the LEGO MINDSTORMS Community there is one person *everyone* knows. While many call him Baz, his real name is Marc-Andre Bazergui. In 2010, a large group of MCPs (including almost all mentioned above, plus people who would later become close friends such Joe Meno, Lee Magpili, Steve Barker, John Hansen—and I am probably forgetting a bunch—and of course the fearless leader, Steven Canvin) met at FIRST Championship Event in Atlanta, GA. Baz was already famous for his Wall-e. We were both new to the MCP and that started a wonderful friendship.

Later in 2010 I got to venture to LEGO World where I met more members of the MINDSTORMS community. I finally got to me people like Xander and Philippe in person. In addition I met many new faces such as Laurens Valk, Martyn Boogaarts, Daniele Benedettelli, Jetro de Chateau, Will Gorman, and so many others! LEGO World was also the place where I first suggested the Shuttle MOC. Steven Canvin asked me to flush it out a bit more, but with the Space Shuttle fleet retiring in 2011, there was a bit of a time crunch.

After making it back in the USA, I started to talk over the idea with a few people. John Brost has an amazing talent for building super strong Technic models and it was ultimately John that built the base that moves the orbiter. Breaking into seven pieces for transport, it was a marvel of engineering. While the entire Shuttle MOC has a mass around 15 kg (about 33 pounds), the orbiter is about 8 kg on its own. John created a base that could rock this monster MOC +/- 45 degrees.

NXT Shuttle Enterprise as seen at Kennedy Space Center at the Grand Finale in 2011 (the Space Shuttle's final launch).

A look at the Shuttle from behind.



Wing panels signed by astronauts Tony Antonelli (top) and Cady Coleman.

Controls used for the Shuttle (top) and the Canadarm (bottom).

Remember that friend Baz in Canada? Well, our first MOC together was the Shuttle. Since the real arm on the Space Shuttle came from Canada, it was only fitting that Baz take lead on that project. The arm on a real Shuttle orbiter does not work in gravity, but since we could not launch ourselves in orbit to demo this MOC, Baz had to overcome this challenge. Not only did Baz figure out the engineering to make it happen, he did it in under a month's time and had it shipped to the USA.

My part of the project was the orbiter itself. I leveraged photos, blueprints, anything I could get my hands on to create the iconic space plane. As I built, I brought the MOC to several IndyLUG meetings to get feedback on the design. The talented AFOLs of IndyLUG made several suggestions that really enabled the Shuttle to be such a great MOC.

Software was completely on me for this complex MOC (6 NXT controllers, 11 different functions, lights, remotes, etc.). Walt Disney Imagineering has always been an interest to me and for the Shuttle I decided to approach programming like they do for their audio animatronics. The Shuttle has each action defined. Sensors are used to create limits. Mechanical systems are tested with a workout routine. Come April 2011, the Shuttle was done and thanks to Steven Canvin, we had it on display at Yuri's Night Hampton Roads sponsored by NASA Langley. This also happened to be the 30th anniversary of the Space Shuttle Program. All the hard work paid

The interior of the Shuttle bay. The touch sensors at the front are for stopping the bay doors from closing too far. The red light sensor detects when the arm is stowed in the bay.

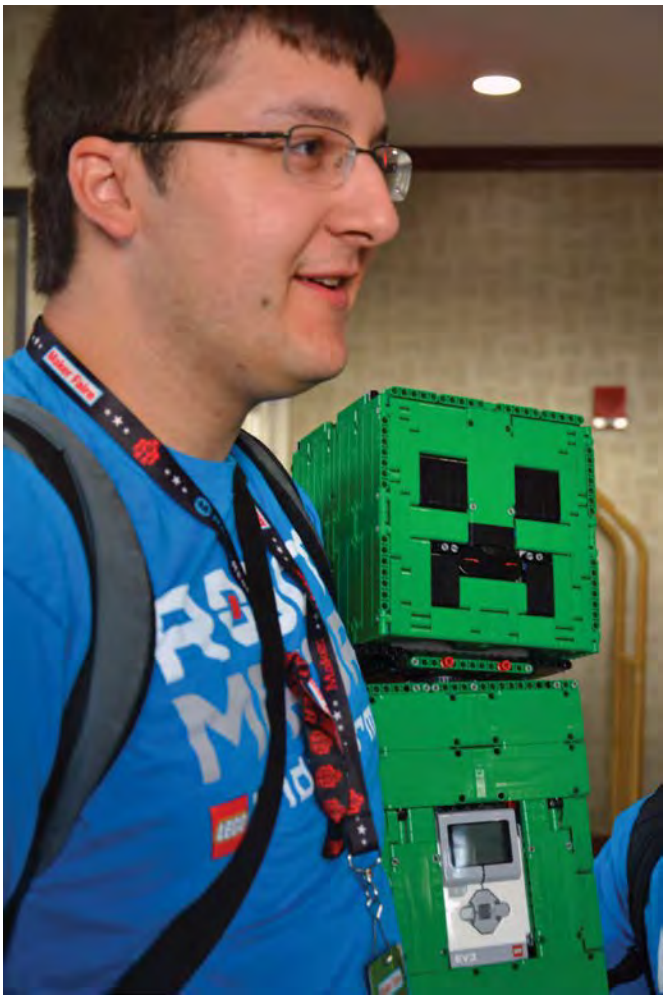
off. Later that year, the Shuttle ventured with me, Steven Canvin, Joe Meno, Will Gorman, and my mother, to NASA Kennedy Space Center for STS-135: The Grand Finale.

Saying the LEGO MINDSTORMS Space Shuttle is interactive or moves isn't really doing it justice. Sure, it has a "show mode" where it just rocks and moves the arm. But the real fun of the Shuttle comes in giving people the controls. The cargo bay doors open and close. There are sensors to ensure the arm is both parked and doesn't move while the doors are opening. As mentioned the Shuttle rocks side to side and uses a gyro and accelerometer donated by HiTechnic to keep it stable. All the control surfaces (flaps, rudder, elevators, etc.) move. And of course Baz's Canadarm has two joints and can be controlled by a remote. Finally it lights up, both the main engines and forward thrusters. It is truly exciting to see in action!

Since the initial event, the LEGO MINDSTORMS Space Shuttle has clocked over 2000 miles traveling across the country. It has its own shipping box and travels via UPS. Kjeld Kristiansen even got his hand at controlling it during a FIRST Championship event in St. Louis. To say I am proud of the Shuttle MOC is an understatement. It stands as a testament to great friendships and the culmination of a great journey.

A look at the Shuttle engines.

You can find out more about the NXT Shuttle at its Facebook page: http://goo.gl/Ltk5Ge or by scanning the QR code at the left.



Andy and his buddy Creep3r after a busy day at World Maker Faire 2014 at the New York Hall of Science, Queens, NY in September 2014.

Crafting a Creep3r

Article by Andy Milluzzi
Photography by Lee Magpili and Joe Meno

Saying, "Minecraft is popular" probably isn't doing it justice. Minecraft is everywhere, from the original PC video game, to Xbox, to clothing, to now LEGO sets. For many, it is an outlet of creativity and a learning tool. It is simply fun. Ask anyone; Minecraft is "digital LEGO bricks".

As an engineer, I often see challenges in relating complex problems and ideas to kids. Minecraft is a way to catch their interest and relate on something they're familiar with. This past year, I encouraged my *FIRST* Robotics Competition team to use Minecraft to learn Boolean logic. This works well for high school students, but how do you engage people of all ages with something complex like robotics?

As a LEGO MINDSTORMS Community Partner, I know the power LEGO MINDSTORMS has to inspire and enable some of the coolest projects. It seemed like a natural fit to use LEGO MINDSTORMS EV3 to being a Creeper to life! And so was born Creep3r.

The idea first came in speaking with LEGO representatives at the 2014 *FIRST* World Championship. Everyone was excited. The challenge became figuring out how to actually construct the bot and defining how the robot would interact with people.

Creep3r really brings out the performance of a single EV3 brick. In defining what Creep3r should do, it quickly became clear that was one hallmark behavior that had to work. So it is sort of a given that a Creep3r needs to walk around and be able to turn his head, but really a Creep3r needs to explode.

What does it mean for a LEGO robot to explode? This question was the hardest challenge of creating Creep3r. I went though several iterations. At first, I thought I could make it explode by launching Zamor Spheres, 1x5 beams, or 2x4 bricks. While cool and exciting to watch, this would mean it would take forever to clean up after each explosion. Having done countless public shows, I knew this wasn't realistic.

The next thought was to engineer Creep3r so it was supported by only a few pins. These pins could be pulled out, causing the robot to collapse. While again cool, this really limited size. I knew I wanted it to be big enough to recognize from a distance. A big robot would have too many supports and would trade strength for this feature. Designing the bot for transport and durability would be nearly impossible.

Finally I settled on the idea of "explosion doors". The idea being that several large doors could be opened and bricks could fall out, or the bot could change color. This solution seemed to balance the needs of strength, size, and explodability (a critical metric for a Creep3r).

Movements were easier to define; with a single motor driving the explosion, the other three motors ports of the EV3 could be assigned. Two motors were required for the ability of the Creep3r to move, leveraging tracks and some green Technic 5x11 panels. One medium EV3 motor could drive the head. Sensors ended up being a bit more complicated.

Unlike most EV3 robots you might build, Creep3r had to hide its sensors. A creeper in the game does not have any arms or really any way of interacting with Steve (the character from Minecraft) except for seeing him, hissing, or exploding. Seeking out Steve is what creepers do and EV3 has the perfect solution to seek and find: the IR sensor. Like a set of eyes, the sensor can tell where an object is relative to the sensor. Hiding the sensor was a bit more difficult as the eyes for the model would be larger and set apart, so I had to be clever.

The head of a creeper is iconic and making sure it looks correct

is key to recognition. The only possible place to hid the IR sensor is in the Creep3r's mouth. By inverting the IR sensor and supplementing it with a few black Technic elements, I created a mouth that closely resembles the image from the game. This also set the scale for the MOC.

The wonderful thing about Minecraft is that everything fits on a grid. A creeper, or Steve for that matter, is easy to scale. Using this grid and the size of the prototyped mouth, I was able to estimate an eye size of about 5x5 modules (studs). With the eyes and mouth created, I filled in the area between with green 5x11 panels and beams. With the face defined, creating the rest of the head was easy. In order to keep the weight down, the head is hollow and lots of panels were used. The last step of the head was to integrate a Technic turntable in the base so Creep3r could emulate the distinct way a creeper searches for Steve.

With the head complete, and an idea of how to make the Creep3r walk, it was time to create the body. The drivetrain and EV3 supports were easy given the countless robots I have created. The real challenge was to make it fit inside the width and length requirements. Unfortunately the EV3 had to be placed way above the drivetrain to allow for easy access and room for the leg supports. This raised the center of gravity, making the robot less stable. Couple that with the large head, high above the tracks, and Creep3r stability became a problem.

Weight is always an issue and Creep3r required a throwback to the LEGO MINDSTORMS NXT Space Shuttle John Brost, Marc-André Bazergui, and myself created in 2011. The Shuttle MOC used a frame of H and D frames with 5x11 panels covering it. This provides great strength, but minimal mass. Creep3r is no different. The body is largely H and D frames in a lattice to provide support, and allow skinning. This also enabled the explosive doors to be hung off the regular pattern of connection points.

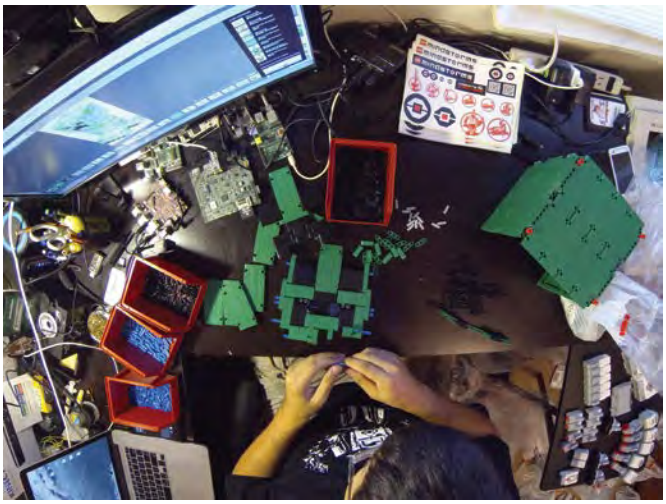
The frame and skin concept also addressed the issue of portability. With support from LEGO on the project, there were already several events planned, most noteworthy World Maker Faire in New York City. Creep3r would need to be shipped or travel in a small carry-on. Naturally, things break in transit and leveraging this building technique would be key to fixing Creep3r quickly.

With the physical construction of Creep3r almost done, there was one last design consideration to make. I knew Creep3r would need to reset quickly after explosions, but also had to limit the way it would reset so it wouldn't get caught in an endless loop of explosions. In order to ensure the doors are closed, I used a couple of light sensors. Finally to trigger the reset, I added two touch sensors to be pressed by the operator. That's four sensors and four motors accounted for. Creep3r is mechanically done.

With any robot, the magic comes in the software. Since Creep3r uses common Technic parts and only one EV3, I wanted to make sure the software was also very easy and accessible. The natural choice was EV3-G. Creep3r has a few personalities. First is the classic autonomous mode that looks for an object, goes to it, begins to hiss and then explodes. This is probably what you expected, but makes for a boring play experience.

The natural solution would be to make Creep3r more interactive. Since the IR sensor can also read the IR remote, it seemed like a cool idea to allow children to control Creep3r. It was quite fun to see kids at World Maker Faire, driving Creep3r around.

The last personality would address having Creep3r on display. Knowing that Creep3r would live mostly on the table, having it move around is complicated. This personality allows Creep3r to drive a bit after detecting a person, but stay on the table. After a few people he begins to hiss and explode.



Andy documented the entire build by mounting a GoPro above his desk. Here he is experimenting with the design of Creep3r's head.

Using a support frame and skin technique, the robot is able to be both light and strong enough for easy transportation.

With Creep3r nearly done, you can see the "explosion" doors on the body and IR sensor built into the mouth. Watch the full design and build at: http://goo.gl/eKMePy

Kids of all ages loved interacting with Creep3r at World Maker Faire 2014 at the New York Hall of Science, Queens, NY in September 2014.

Creep3r recharging after a busy day at Brickworld Tampa in October 2014.

Creep3r is one of my favorite MOCs. I have created a few Creep3rs now and each one is a joy to build. What originally took me a few weeks to make, can now be constructed in the better part of a day. Creep3r has made a few appearances so far, including Maker Faire Orlando, Brickworld Tampa, and of course, World Maker Faire. 2015 will be an exciting year for Creep3r. One Creep3r is already up in Canada with Marc-André to share with the MINDSTORMS Community in his area. Creep3r is a hit with people of all ages. Hopefully this will inspire you to create your own! You can check out YouTube for videos of Creep3r in action.

You can watch the design and build of Creep3r at http://goo.gl/eKMePy *or scan this QR code.*

You can also watch Creep3r at World Maker Faire at http://goo.gl/fmPsZJ *or scan this QR code.*

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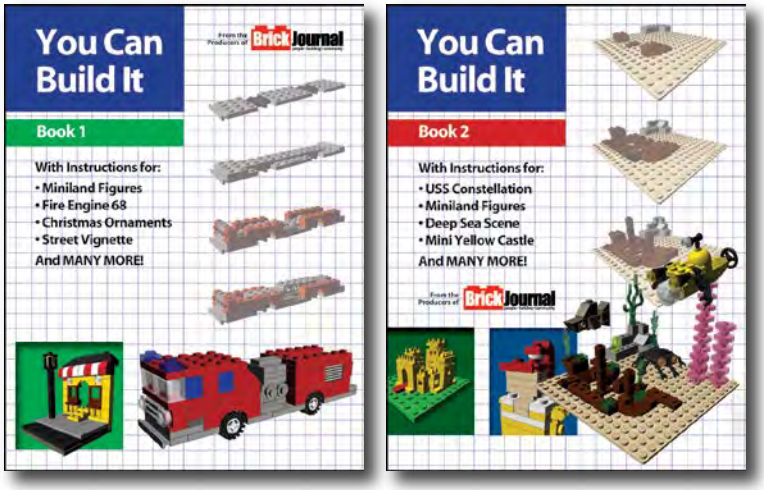

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Lee Magpili: A LEGO Educator

Article by Joe Meno

Photography provided by Lee Magpili and the LEGO Group

The LEGO® MINDSTORMS® set is different things to different people. To the majority of LEGO builders and the public, it's a complex and somewhat intimidating set that combines building models with computer programming. To a few unique builders, the set is a gateway to building models that go beyond the usual static model to one that can move and even react to different things.

The LEGO® Group has focused the MINDSTORMS sets for use in schools as a way to teach science and technology. LEGO Education is a branch of the company that creates and provides resources for classrooms, including dedicated MINDSTORMS sets and curriculum. Lee Magpili is a MINDSTORMS model designer for LEGO Education. Since 2010, he has been creating models of creatures and more recently, scientific devices.

Lee with the models he built for LEGO Education.

"If you want to be a designer, don't forget to keep
I know I am not the best builder

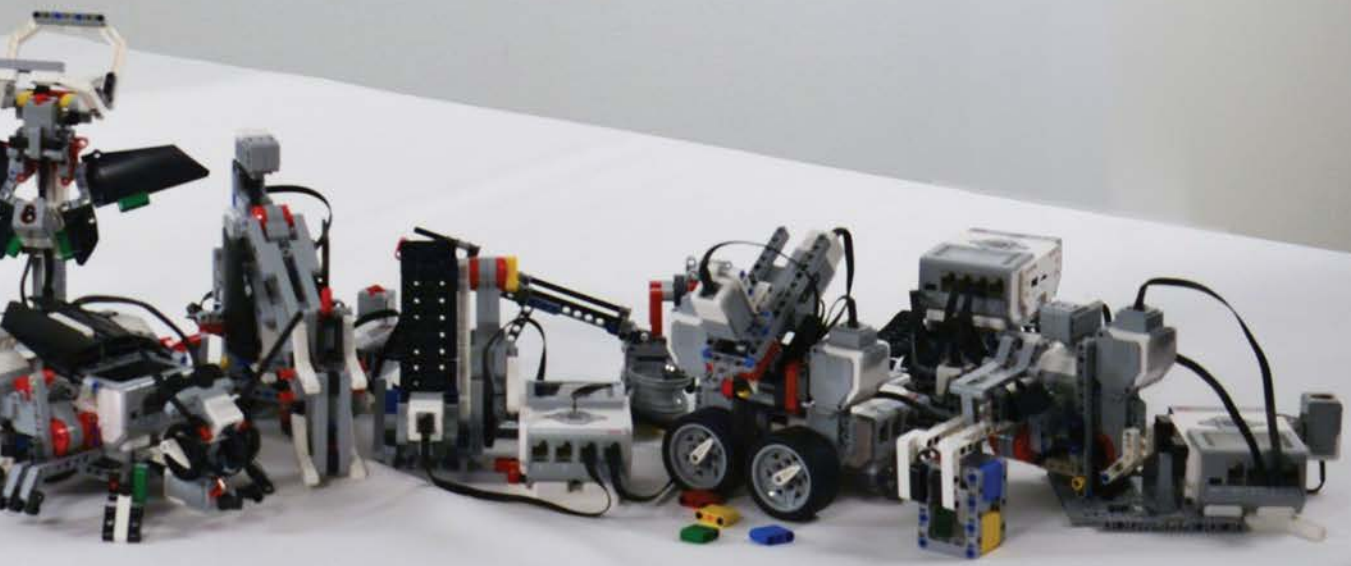
His history with LEGO began when he worked at the LEGO Store from 2004 to 2006. When he left, he recalls, "I had a good relationship with the company and was eventually called to work on a branding activity at Toys 'R' Us in Christmas 2008. That led to me getting invited to the US LEGO office in Enfield, CT in 2008 for the ten-year anniversary of MINDSTORMS."

In that time, he had already been introduced to *FIRST*® LEGO® League and was starting to do workshops at The Town of Ramapo Challenger Center (previously known as the Lower Hudson Valley Challenger Center). He created a LEGO Robotics program for the center that is still going on now, and also started a *FIRST*® LEGO® League team there. Lee also did a freelance building job in Enfield.

By 2010, he was contacted by the LEGO Group to work, and he went to Billund, Denmark (the LEGO Group's headquarters) in May of that year to meet the design team. Over the next five weeks, Lee covered five tables with models he built. He explains, "For me, it was like being in a candy store!" For LEGO Education, it was the beginning of a beautiful relationship.

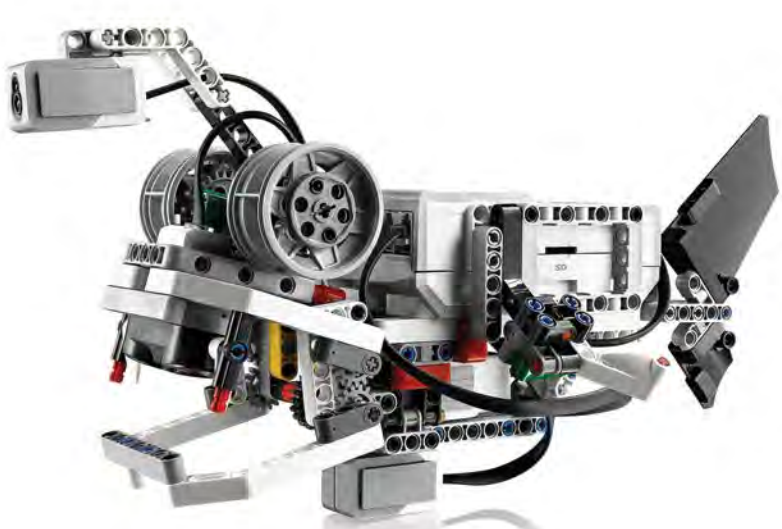
LEGO Education's MINDSTORMS set is different from the set sold at retail stores. The Education Core set has a different assortment of parts and sensors and a rechargeable battery, but no programming software. Software is available from the LEGO Education site, as well as supporting materials, such as curriculum packs. These packs are different lessons and models that can be used to teach and demonstrate design or scientific principles. Currently, there are three sets: Design Engineering Projects, the Space Activities Pack, and Science Activity Pack. For each pack, there are a selection of models that are not seen anywhere else. Also, LEGO Education has an expansion set that adds some more new parts and new models.

Lee designed the models for the Design Engineering and Science Activity sets. The Design Engineering set is project-based, with three sections: Make it Move, Make it Smarter, and Make a System. Building is based on modules or building ideas. As an example, one of the models is a LEGO rendition of a Venus Flytrap. Lee explains, "The design brief for this model was not to build the model literally, but to create a programmable robotic creature that could sense light and dark conditions in the environment. This creature would also respond with different behaviors for each condition." Lee's first impression was to build some type of flower.



mastering your art and being humble about it. in the world. I'm always learning."

The Design Engineering Venus Flytrap.



The Design Engineering Lanternfish.

The jaws of his flytrap are also the jaws of another model in the set: a lantern fish. The leaves of the flytrap are the fish's fins. This is no coincidence, as Lee built all the models from a selection of 31 modules he designed. Sensors are also in modules or added independently, so in the Venus flytrap's case, when a light is shone on the model, a light sensor opens the jaws. Inside the jaws, a touch sensor quickly closes the petals when tripped.

The flytrap's 'bite' created a few problems for Lee. He recalls, "There was a safety issue with the open gears at the mouth's hinge—because students are told to intentionally put their hand in its mouth to get caught." The solution was to place a white beam over the gear teeth. That wasn't the only problem though. Filming the plant biting for the LEGO Education video took a few tries for Lee to keep from getting his hand caught!

With the 31 modules, Lee built a total of 15 models, and ended up having to build them all at the same time. This made building, especially building the Venus Flytrap, really fun. Looking at all the models, one can actually see that all the models are built out of all of these modules. For Lee, it turned out that the parts built themselves. He built the modules with different actions, like tracks and parallel arms, because a lot of people don't know how to build these. The idea is to take these modules and build them on the EV3, which has a frame built on it with more holes to connect to.

Other models had different beginnings. The fish started off as a hippopotamus. "What kind of animal has that kind of mouth?" Lee asks. He had to use every module more than once as much as possible. As a result, thinking of different animals to use the modules became an interesting challenge.

As Lee explains, "We ended up with the fish because I could use the modules over and over again." Pointing to the fish's rear, he asks, "This is the tail and the fin, right? This is a leg that is used in three other models, including an insect and a turtle, so this module is used all of the time." He continues, "The eye is used in the ball moving model (another model in the pack) to catch the ball. I really had to be versatile in creating modules."

Lee's favorite model of the pack is the gorilla. "I saw it right away in

my head!" he exclaimed. The design brief was to design and build a robotic creature that can interpret two signals from a user and respond to each signal with a different behavior.

Lee explains, "We had to make something that could take inputs. I had made the head first, as everyone wanted to make those eyes (from the ultrasonic sensor). I actually used the same module from the insect: the ultrasonic sensor with two #1 Technic axle connectors attached to the back. I modified it for the gorilla. I made the lips from two L beams, which was an easy connection, but a wierd build. The gorilla has a very defined face and a lot of character. I used the lines between the beams to give it an angry look—a gorilla look. This is very much how cartoon gorillas are drawn, with a black face and gray mouth, so I already had that going for it."

There are some other cool things about the gorilla in terms of design. Using panels to make giant forearms for the model is just one of the things Lee did to give it character. 4 x 6 angle beams make the big rounded shoulders. For the feet, Lee had to make them big enough so the gorilla wouldn't fall forward, so he built a big front toe for them.

What makes the gorilla so different from other MINDSTORMS models is that the EV3 panel is not on the front. Lee debated with his design team about where the EV3 should be. If the panel was down in the front, the gorilla would be glowing in the belly, so a user would have to stick their hand under the arms to turn it on, which didn't make a lot of sense. The battery also gave the gorilla's chest shape.

Even then, Lee notes, "You can see the modules in it, like the feet and the legs. Add a panel for the front and one for the toe, which makes it a very easy build, which is okay, right? What you want in this is a simple model to build but difficult to program."

As for the requested responses, Lee went beyond the two. The gorilla actually has three: one where he does a little drumming on the ground, another when he' shown a yellow item (a 'banana'), and a final response where he says "bye." Each one uses one of the gorilla's three sensors, but rotation sensors in the motors allow for two more possible sensors for use. In total, the gorilla uses only two motors and three sensors. With this, though, a student can make separate behaviors based on how its sensors are activated.

Lee's gorilla at rest (left) and waving (below).

The gorilla head-on.

Lee's puppy for the Educational Core set, waiting for a treat.

Behaviors took on a role with one of Lee's most sophisticated robots, which is part of the Education Core Set. The design brief was to build something cute and appealing to both boys and girls. Lee's initial ideas included a rabbit, a cat, and a puppy. The puppy was chosen because it's universally recognized, and puppies can be trained. Rabbits and cats can't be trained. The puppy ended up influencing a lot of the material that went into the EV3: the eyes that are shown on the screen and the puppy sounds and growls all were designed for this model.

For the puppy, Lee went a different direction with the head: "I always thought the EV3 brick—it's called the brain, right?—should be the head of the robot. We had the perfect raised screen, so it had a head shape already. I didn't want to put it in the chest like everything else. Next, we figured out the features of the puppy: a user can feed the dog and pet the dog. The user has to set the puppy up to sit to start."

When it starts, the puppy stands up and the user can pet or feed the dog with a bone with colored edges. If he is fed too much (by moving the bone close to the color sensor at the mouth), he will lift his leg and pee. If he is petted too much (by the touch sensor on the back), he gets angry and growls. When left alone, he gets bored and falls asleep. If the user feeds and pets the puppy the right amount of times, he'll bark and jump. All of this is programmed behavior developed by a member of the MINDSTORMS Community Partners, Daniele Benedettelli.

Lee comments, "I try to tell people that this is the most advanced model we have and all it does is sit and bark. But there's a lot going on in the programming to make it happen. A small example is that every time the puppy is started, the number of petting and feeding he needs to be happy is randomized. Also, the pet counters and the feed counters work in parallel without interfering with anything else."

Lee continues: "It's meant to be a teaching robot. I would love it if a teacher built this with their kids and went through some of what the programming could be. It's very advanced. It's also like when you pet it, what happens? He becomes appreciative. If you pet him a number of times he growls. That's like real life. If you give a dog too much attention and you are touching it too much, it gets grumpy. That happens in this robot. Give him the right amount of love and attention and he will love you. When you do that, the pet and feed numbers are reset and get randomized again."

The end result met the design brief very well. When the puppy was being used in a photoshoot, the kids loved playing with it, because they could actually interact with it. That, to Lee, was a success.

Success also comes from another direction for Lee. Not only does he build models for LEGO Education, he also builds for himself. For him, it's a release: "I can't do my regular work if I don't do these models. I think, like all fans or as an artist, if you don't build to release this kind of stuff, the small stuff will be incredibly difficult."

Lee's work as a fan started in Technic and Bionicle, so it wasn't that big of a change for him to build in MINDSTORMS. One of his first builds when he started at LEGO was a Technic version of Brian Cooper's Teknomeka, which was constructed in gray and was unskinned. Another model he tried to build was a life-sized human being. Lee has a life-size set of legs in the office that used six NXTs. They were inspired by some Gundam (anime) figures he made, and were built while he was working with the puppy.

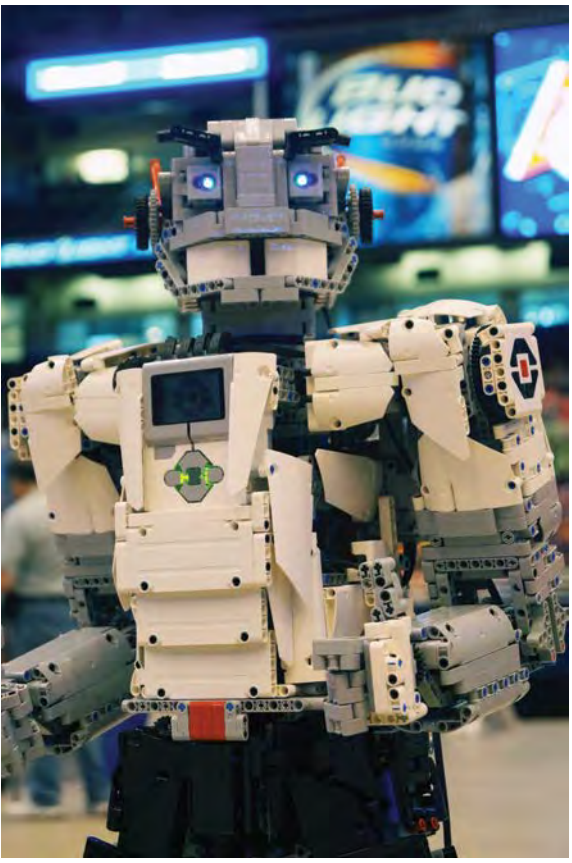
The life-size experience would come in handy when Lee was asked to build EV-AN. LEGO Education's brief was this: Build a model that could stand next to a ten-year-old and be a ten-year-old robot. His inspiration for EV-AN was initially the independent comic character Atomic Robo, with big eyes, no mouth and gray body. "I had help from my boss, who wanted it to be more friendly. EV-AN gained a smile and clothes by the time he was first shown." Since then, he has been photographed and seen in the LEGO Education catalogs and website. In Korea, they made a life-size cutout of him. Ultimately, Lee got to keep EV-AN.

Lee's humanoid robot, in progress.

EV-AN is actually remote controlled, and he's fully actuated. "Every joint is motorized. The lights in his eye change color and he has expressions on his chest. His hands are poseable, but not motorized. He's a greeting robot, so we take him around and say hi to people and take pictures. He was designed to be photographed and has a very expressive face. As a result, he's very photogenic and looks fantastic in photos."

EV-AN, seen at an event.

EV-AN seen close up.



Lee's other artistic builds are dragons. His best-known dragon (but not his first) is Valentine. Named for the day he was released, Valentine's Day, the dragon was a project that Lee asked a couple times to do. Lee had to ask because he was using preproduction EV3s to run the dragon. He was allowed to build the dragon, but only on the condition all of its parts were returned. Valentine became a dragon that was sculptured, could breathe, and roar! It used six EV3 bricks and 21 motors to come to life. When he had to take apart the dragon, Lee discovered that one of the prototype EV3 bricks was numbered 214—Valentine's Day. Lee still has that brick.

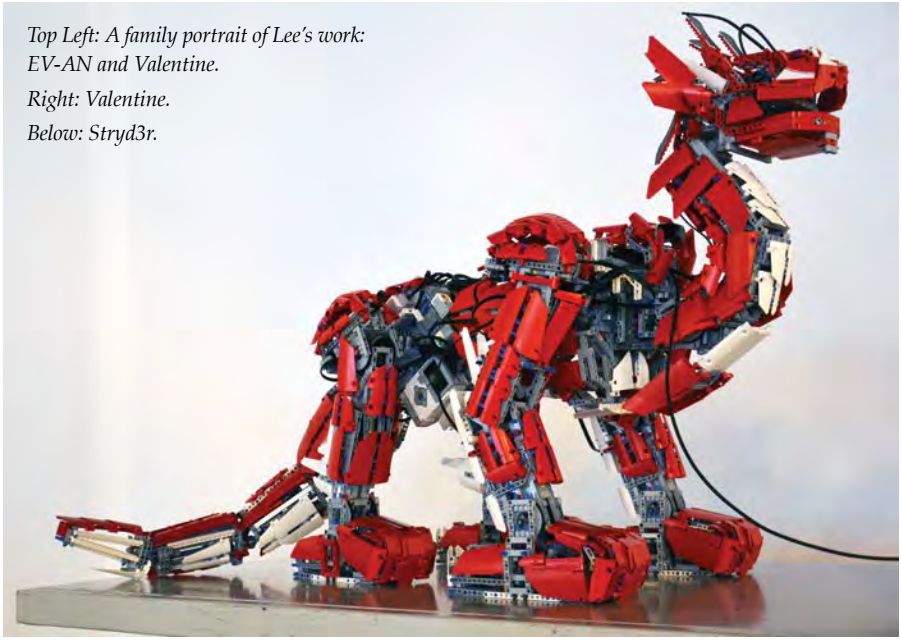
His most recent dragon is Stryd3r. Beginning with sketches, Lee wanted to make sure that everything moved and Stryd3r walked. The present version of the dragon uses linear actuators to walk, but only one motor to run for two actuators. Its slow speed, though, has a couple of positive things: it's a wonderful lumbering speed and Stryd3r's foot goes off the ground high enough that Lee can put his hand under it.

With dragons and robots, where is Lee going? What advice does he have for would-be LEGO designers? He reflects, "I'm at the point where I can start taking all the dreams I had when I came in and put them into practice. You come into LEGO with your own kind of goals and there's things you want to teach kids. Now I get a chance to really get to do that. I wonder how many kids were affected by the EV3 this year—it's very cool to be part of that."

Top Left: A family portrait of Lee's work: EV-AN and Valentine.

Right: Valentine.

Below: Stryd3r.



"I got my job because I really enjoy this stuff. I got an engineering degree because I enjoyed playing with LEGO and I wanted to make better stuff. Stick to your gut on things you have a passion for. Eventually you'll find yourself having the same mission statement as someone else: reaching as many people as possible or as many kids as possible, inspiring the builders of tomorrow. It's a cliche coming from LEGO, but I get to express myself using my toys in this medium. Very few people get to do that."

"If you want to be a designer, don't forget to keep mastering your art and being humble about it. I know I am not the best builder in the world. I'm always learning. I love to learn also, so part of learning is teaching and understanding you don't know anything. You need to inspire kids or yourself to say, 'This is a shape you can do with LEGO'."

What are Lee's next projects? He replies, "I'm working on Big Green, another dragon. I hope to have it done by LEGOWORLD in February. If not, I'll have Stryd3r."

He closes with a tease: "I have some other stuff that is very exciting, but I can't talk about it. It's very cool."

Just like his robots.

You can see more of Lee's work at his Flickr gallery: https://www.flickr.com/photos/1brick *or scan this QR code.*

Lee is also an active contributor to the LEGO Education Community. You can meet him here: https://community.education.lego.com *or scan this QR code.*

LEGO® Education Community

For more information on LEGO Education, you can go to https://education.lego.com/en-us/

Stryd3r taking a step. The linear actuator can be seen as the vertical element deep in the chest.

L3-G0 on the go!

L3-GO:
the LEGO R2 Unit

Article by Shawn Steele
Photography by Joe Meno and Shawn Steele

Many MOCs are great models: wonderful art, amazing Technic builds, ingenious MINDSTORMS constructs and the like. People admire them, ask questions, and are fascinated by details, but most sit on a table to be admired. When the MOC is a character, then the interaction changes. L3-G0 is no longer just a LEGO model, but to the kids he's actually R2-D2. They can talk to him and he'll beep back. Tease him and he'll follow them around. Exhibiting L3-G0 is unlike any other MOC we've built. Way more effort, but rewarding.

Like most of our builds, deciding to build L3-G0 was happenstance. Wondering what we might build next, we saw the R2-D2 Builder's Club droids at a convention and thought their builds were pretty cool. We even toyed with the idea of making our own "real" droid. But that seemed "hard" and "expensive," so we let it lie until one day we realized (duh) that we could make him in LEGO. Joining the R2-D2 Builder's Club was the easy part.

Planning

L3-G0 required a ton of planning. LEGOLand has static R2-D2 models, but they use a big stack of studs-up bricks. We wanted our Artoo to be able to move and talk, spin his dome and more. With those goals in mind, a hundred-pound mass of bricks didn't seem very practical. Another goal was to be screen-accurate. The R2-D2 club plans are based on tons of research by dozens of club members and were a great help. (JJ Abrams hired a couple members of that same club to build droids for the new *Star Wars* movie, so those were definitely the plans we were looking for!)

Once we had the germ of the idea, it took a bit to get serious. While the family was out of town, I started a study in LEGO Digital Designer (LDD), primarily to see if the project was at all feasible. I began with a foot and its challenging angles. Another challenge was the Holoprojector on the dome with its detail. I forgot I was just planning a few tests and kept going with the LDD models.

The club drawings are designed for CAD/CAM systems, not LEGO, so I needed LEGO-compatible plans. Dimensions were converted from inches to studs and plates, and I drew grids to LEGO brick scale over many of the blueprints. The grid enabled correct positioning of the details. The result is a very precise model, with most details being screen accurate to a fraction of an inch.

When Lara returned a couple weeks later, the plans were mostly complete and we decided to go ahead. It took another week just to organize and order the bricks, with the same challenges of any other MOC. Some bricks we used in LDD are rare or the wrong color, so substitutes had to be selected. Tricky bits needed extra brick for alternate approaches. The model lacked some structure; we ordered extras to cover that as well. The initial LDD drawing was 14,529 bricks. The final model is closer to 16,000 parts.

Pure LEGO

Individual sections were built first out of "pure" LEGO, modified as needed, and added to the complete model. Most components deviated significantly from the original LDD model in the end.

For his first BrickCon appearance, L3-G0 was complete and built from the bottom of the body to the tip of his head. His

construction was similar to other MOCs, with a MINDSTORMS EV3 spinning his dome. Most builders wouldn't hesitate to use the LEDs, a couple rubber bands, or their home Surface to play sounds. The lazy susan for his dome may have pushed it a bit, but he was basically a normal MOC.

By the end of the weekend, the middle of L3-G0's barrel was full of rubber dust from the EV3 motor's tires.

Structure

From the very beginning it was obvious that L3-G0 could not be an entirely LEGO/MINDSTORMS build. The EV3 dome spinning was fun as a pure "LEGO" experiment, but clearly he was going to need bigger motors than those MINDSTORMS provides. And if just moving the head destroyed the LEGO tires, what would happen moving the whole body?

We weren't sure how much our Artoo would weigh, but typical Astromech builds are 100lb to 350lb (or more, 45kg to 160kg). That's far more than a typical MINDSTORMS motor is going to want to move, even geared down to a crawl.

Taking cues from the R2-D2 Builder's club and other common robotics systems, we evaluated different ideas and designs. Astromechs are built in many different ways, so we homed in on the concepts that might work for our droid. Quite early on we realized that weight matters: the heavier the droid, the bigger the motors you need to move it. Bigger motors require bigger batteries, and all that makes him heavier. With that in mind, much of his structure is designed to try to keep his mass down. Even the batteries are high-tech low-weight units. As it turns out, L3-G0 is a lightweight at 60lbs (almost 30kg).

In addition to the motors and power requirements, 60 pounds is a lot of brick to support on three legs. Look around LEGOLand and you'll see steel structural supports for the models. Our R2-D2 hopefully won't have kids climbing on him, but he has to run around show floors. Typical Astromech builds use a wood or aluminum frame, and we went with a mix. Unfortunately, LEGO bricks are thicker than standard club finishing materials, so none of the "standard" club parts would exactly work for us. Though everything in L3-G0 is heavily influenced by club thinking, the design is entirely unique.

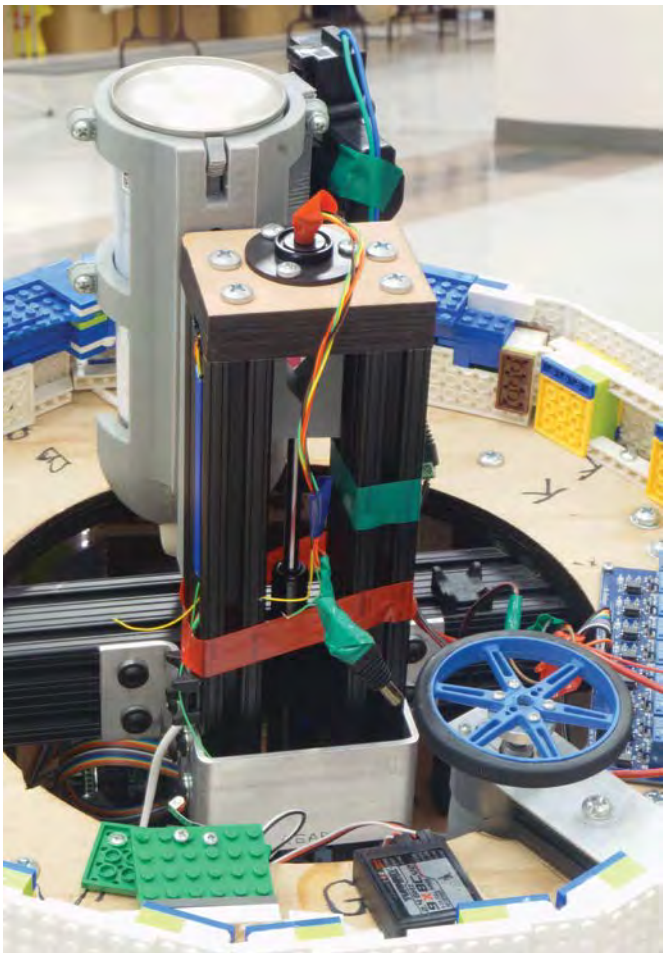
L3-G0's body has three wooden disc frames to help hold the outer shape. I was fortunate to have a laser cutter available to cut those discs. Vertical poles of aluminum t-slot was machined with more mundane tools to connect the discs. Between the shoulders is a big aluminum beam that also supports a shaft for the center leg. The outer legs are also aluminum t-slot, bolted to the center beam through a plywood disc at the shoulder. Together with more laser-cut frames for his feet, that completes his "skeleton."

The shoulders are one of the more interesting structural challenges. With motorized outer feet pushing all that mass around, there's a lot of torque in the shoulders. LEGO would snap. Indeed, even the wooden shoulder plates of the test skeleton failed when I tried to get the frame across a parking lot to the car.

Another big pain point is the center foot. The standard thin club shells allow more room for the casters to work, but we had less room because of the LEGO "footprint." That means that L3-G0's front wheels are closer to the center of mass. Astromechs are actually fairly unstable (ask George Lucas),

L3-G0 at BrickCon 2013.

A look at the droid without his head dome. The silver cylinder is an aerosol can for L3's mister (yes, the droid can spray a fog). In front of it is the core beam with the center leg support. Looking inside the back panel, you can see the battery in the rear. The right foot is open to show the motor, which is the round black part attached to the center metal plate.



A closer look at the domeless head. The actuator that drops the center leg can be see in the center. The blue wheel rotates the dome.

Another look at the foot and its motor.

and even that slight distance leads to an unfortunate increased tendency to faceplant.

The ankle pins are another trouble spot, though fortunately L3-G0's ankles are holding up. Most R2-D2 builds have fixed angles, but L3-G0's feet rotate freely at the ankles with the idea of eventually being able to switch to two-legged mode. He gets a steel bolt in each ankle pivot, as a Technic pin just isn't gonna cut it.

Beyond the Brick

At BrickCon, L3-G0 was a fairly "pure" LEGO MOC. People thought it was a cool model, but we wanted to get him off the table and into the crowd. We wanted a real Artoo.

An interesting thing happens once you've gone beyond the brick. At some point you realize that LEGO is a modeling material. The Master Builders at LEGOLand know this, but it was a shift of mindset for us as we built L3-G0. Most builders occasionally use bits of non-LEGO in their MOCs, perhaps fishing line to make something fly, a rubber band for mechanical uses, or a box to fill space under a hill. Making the leap to a modeling material is somewhat freeing.

From the beginning it was obvious that we were going to have to break some boundaries. Aside from the obvious structural challenges and a wood and metal frame, it was clear that some parts would need Kragle (*glue, if you haven't seen* The LEGO Movie — *the Editor*). While L3-G0 stayed in one piece at BrickCon, at his first LUG meeting, he spun his head fast enough to throw off the Holoprojectors, which shattered on the floor (fortunately it's LEGO and repairable). At a high school science fair, the remote was hijacked, and centripetal force pretty much caused the dome to implode.

In addition to nasty vibrations running around a tradeshow floor, there are kids' poking fingers, selfies taken patting his head and squashing the panels, accidental kicking of his feet, and the rare faceplant. Since he's all LEGO, we can fix him faster than most of the other R2-D2 builders. So far his worst mishap has only kept him from his fans for 20 minutes or so.

Because of the harsh conditions, most people assume L3-G0 is completely Kragled. There is a lot of glue; however, most of our R2-D2 is just snapped together. Only the proven trouble spots get subjected to Kragle. Two big reasons are that it's a pain to glue everything, and that we have to be able to make repairs. Kragle doesn't help in a bad fall, or if the shoulder joint needs replaced. For example, even though his feet, and particularly the front foot, are often banged into, we need to be able to remove the foot shell, so it has little glue and we just fix it when it gets dinged up.

Another way we went beyond the brick is to (gasp) cut the LEGO. This was only done as a last resort for under 1% of his parts, but several of his bricks have been modified. Particular pain points were the angles on the foot shells, which proved impossible with stock LEGO brick (photos of LEGO's R2-D2 feet are excruciating to me after working so closely with accurate plans). The aluminum bones in his outer legs also don't allow quite enough room for the interior panels, so the hidden side of those bricks next to the aluminum have been trimmed. Another example is a brick on his head that LEGO makes in the right shape, but not the right color.

Printing LEGO

So now we're thinking beyond the brick, but Kragle doesn't fix everything. L3-G0's barrel has twelve panels, connected with 30 degree hinges. At BrickCon we used LEGO hinges. Even reinforced, the hinges were a weak spot, clearly not strong enough to run around a show floor. There isn't an appropriate solid 30 degree part in LEGO, so after trying some Technic ideas, we investigated 3D printing. Our first printed bricks help keep the correct angle for the barrel panels. Once we did that, new uses for the printer revealed themselves.

With an aluminum t-slot frame, we had to figure out how to attach the LEGO brick to our skeleton. That was solved with specially designed bricks that slide into the t-slots and then snap to a normal LEGO brick. Additional bricks were printed to attach L3-G0's body panels to the wood frame. They click on like normal and are then screwed into the wooden frame. Another very important place we use 3D bricks is to replace the vehicle door type hinges used in his dome and feet; the hinges wear easily when he's moving and are easy for excited people to smash. That's solved by printing rigid bricks with the built-in hinge angle, sometimes with a wider attachment area as well.

Altogether he ended up with over a hundred custom printed bricks, all used behind the scenes. Many fit very well, but we chose to print with ABS plastic so that the Kragle would work better if needed. We also posted most of the brick CAD files on Thingiverse for other people to use if they have a printer and want funny-shaped LEGO.

Robotics

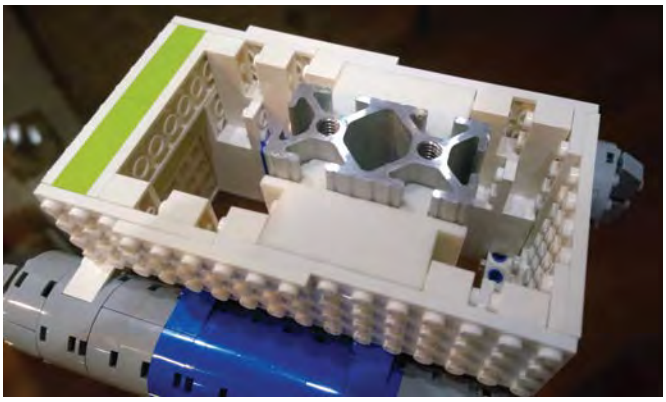
The R2-D2 Builder's Club has fairly standard and accurate ways to provide lights, sound, and movement to an Astromech, but most of those are overkill for a LEGO build. Again, most everything is custom. He started primarily remote-controlled, but he has been upgraded to Windows on dual Galileo microcontrollers in his head and body.

His controls are an R/C transmitter configured to drive like a tank. The outer feet have 100W scooter motors, each driving four wheels with a chain drive. Yes, he's eight-wheel drive! Unfortunately that means the wheels have to slip when he turns sharply; however, it also makes it easier to make him wiggle. The R/C is also hooked up to his dome.

A second little remote hooks up to a device that plays back specific MP3 files. He could make hundreds of sounds, but we only need a few dozen sounds and music clips. At BrickCon the Surface and Jambox could barely be heard, even at full volume (it's disconcerting how loud a convention floor is). So now he has his own little amplifier and car speakers. He sounds good enough that I ended up using L3-G0 to listen to music during most of the rest of the construction!

One bit I'm really happy with is the LED lights in his dome, which were a good confluence of LEGO and robotics. Unlit there's a grid of translucent 1x1 LEGO plates in each logic display. The brain in his head blinks a few RGB LEDs, yet the LEGO plates make it look like there are hundreds of lights in the displays.

We've barely tapped the potential of his computer power, so he'll probably do more in the future.



A look inside the leg above the angle, showing the aluminum core and the 3-D printed parts that were used to attach the LEGO shell.

L3-GO showing off his lights.

L3-G0 poses with some new friends.

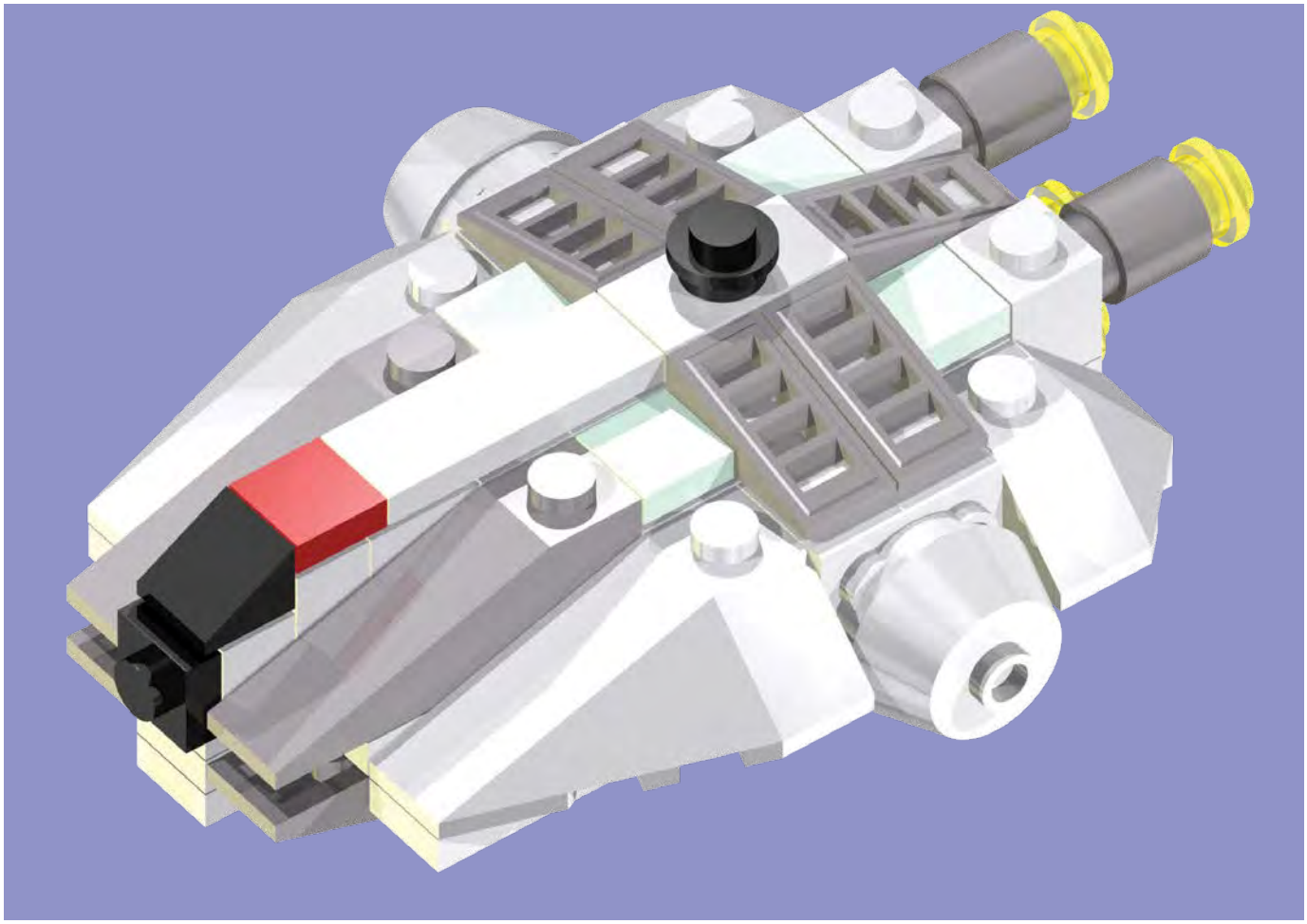
Conclusion

We've built other MOCs that have been well received, but being able to show off our LEGO R2-D2 is something special. Kids in particular love him and he always draws a crowd.

There's more information on the building of L3-G0 on his blog including more technical details about his construction and electronics. You can go to http://L3-G0.com *or scan the QR code at the left.*

L3-G0 also has his own YouTube channel with fun videos of him at cons, and more information about his construction. You can go to http://youtube.com/myL3G0 *or scan the QR code on the left.*

The 3D printed LEGO parts mentioned are available on Thingiverse at http://thingiverse.com/kresty. *Their QR code is at the left.*



Star Wars Rebels: MINI Ghost

Design and Instructions by Christopher Deck

With the new *Star Wars Rebels* series, we are looking forward to new and exciting *Star Wars* technology, being revealed during the process of the series. In this issue we want to take a look at the main characters' primary starship, the *Ghost*, a modified Corellian VCX-100 light freighter. An official set by the LEGO® group (set no. 75053) has already been released, as well as some miniatures in the style of the recent "Microfighter" series (sets 75028-33). I am glad to build a mini model of the *Ghost* together with you this issue.

The freighter resembles a quite compact design with many slopes and angles. While the ship looks like an ordinary transport and a common mini model, it has two separate stud inversion sections. This way we can add slopes from both sides of the hull in a perfectly symmetrical manner. About 20% of all pieces used are slopes and wedges, which is quite a lot and makes the "Ghost" more than just a box with engines. Let's hope to see more interesting vehicles from the brand new *Star Wars Rebels* series. I wish you happy building and I'll see you next time!

You can view Christopher's webpage by going to www.deckdesigns.de or scanning this QR code!

Parts List

(Parts can be ordered from Bricklink.com by searching by part number and color)

Inner Spine

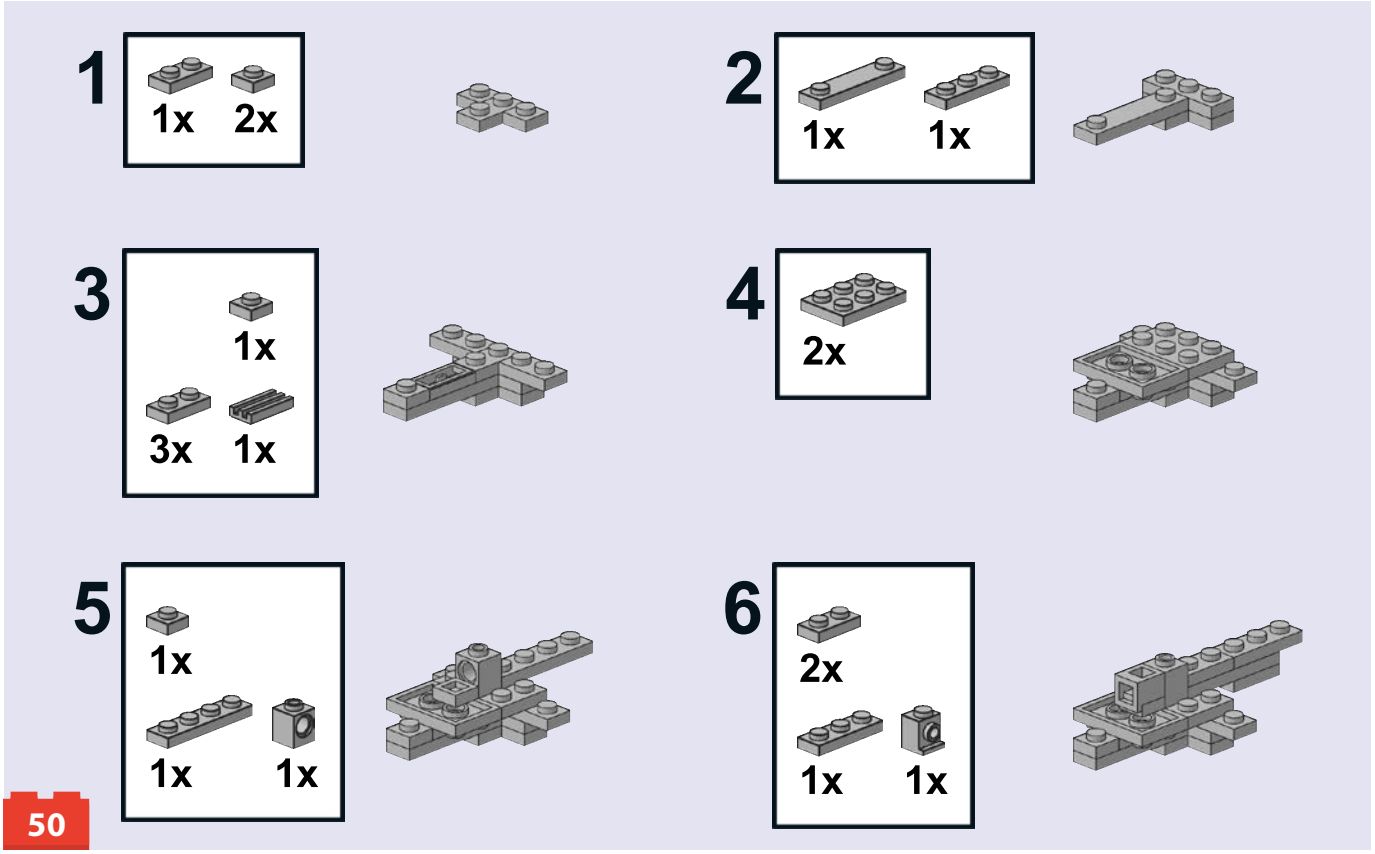
Qty	Color	Part	Description
3	Light-Bluish-Gray	4070.dat	Brick 1 x 1 with Headlight
1	Trans-Black	3024.dat	Plate 1 x 1
4	Light-Bluish-Gray	3024.dat	Plate 1 x 1
1	Trans-Black	4073.dat	Plate 1 x 1 Round
6	Light-Bluish-Gray	3023.dat	Plate 1 x 2
1	Light-Bluish-Gray	3794a.dat	Plate 1 x 2 without Groove with 1 Centre Stud
5	Light-Bluish-Gray	3623.dat	Plate 1 x 3
1	Light-Bluish-Gray	3710.dat	Plate 1 x 4
1	Light-Bluish-Gray	92593.dat	Plate 1 x 4 with Two Studs
2	Light-Bluish-Gray	3021.dat	Plate 2 x 3
1	Light-Bluish-Gray	43710.dat	Slope Brick 2 x 4 Triple Left
1	Light-Bluish-Gray	43711.dat	Slope Brick 2 x 4 Triple Right
1	Light-Bluish-Gray	61409.dat	Slope Brick 18 2 x 1 x2/3 Grille
4	Light-Bluish-Gray	60477.dat	Slope Brick 18 4 x 1
1	Trans-Black	54200.dat	Slope Brick 31 1 x 1 x 0.667
1	Light-Bluish-Gray	6541.dat	Technic Brick 1 x 1 with Hole
1	Dark-Red	3070b.dat	Tile 1 x 1 with Groove
1	Light-Bluish-Gray	2412b.dat	Tile 1 x 2 Grille with Groove
1	Light-Bluish-Gray	63864.dat	Tile 1 x 3 with Groove

Outer Shell

Qty	Color	Part	Description
2	Light-Bluish-Gray	44728.dat	Bracket 1 x 2—2 x 2
2	Dark-Bluish-Gray	3062b.dat	Brick 1 x 1 Round with Hollow Stud
2	Light-Bluish-Gray	87087.dat	Brick 1 x 1 with Stud on 1 Side
2	Light-Bluish-Gray	98100.dat	Brick 2 x 2 Round Sloped
2	Trans-Yellow	4073.dat	Plate 1 x 1 Round
2	Light-Bluish-Gray	3023.dat	Plate 1 x 2
2	Light-Bluish-Gray	3710.dat	Plate 1 x 4
2	Light-Bluish-Gray	3022.dat	Plate 2 x 2
4	Light-Bluish-Gray	2420.dat	Plate 2 x 2 Corner
4	Dark-Bluish-Gray	61409.dat	Slope Brick 18 2 x 1 x2/3 Grille
2	Light-Bluish-Gray	13548.dat	Slope Brick 45 2 x 2 Double Convex with Cant
4	Sand-Green	3070b.dat	Tile 1 x 1 with Groove

Bottom

Qty	Color	Part	Description
4	Light-Bluish-Gray	4070.dat	Brick 1 x 1 with Headlight
1	Light-Bluish-Gray	87087.dat	Brick 1 x 1 with Stud on 1 Side
1	Light-Bluish-Gray	3024.dat	Plate 1 x 1
2	Trans-Yellow	4073.dat	Plate 1 x 1 Round
2	Dark-Bluish-Gray	4073.dat	Plate 1 x 1 Round
1	Light-Bluish-Gray	3623.dat	Plate 1 x 3
2	Light-Bluish-Gray	3022.dat	Plate 2 x 2
2	Light-Bluish-Gray	2420.dat	Plate 2 x 2 Corner
4	Dark-Bluish-Gray	61409.dat	Slope Brick 18 2 x 1 x2/3 Grille



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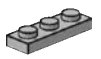

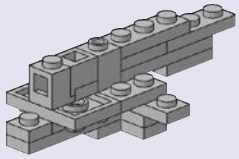

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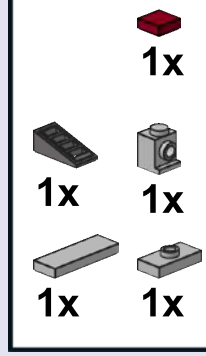

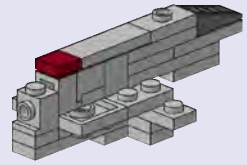

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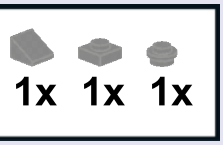

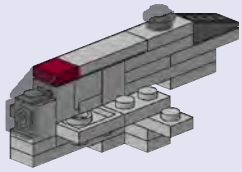

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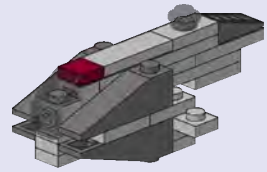

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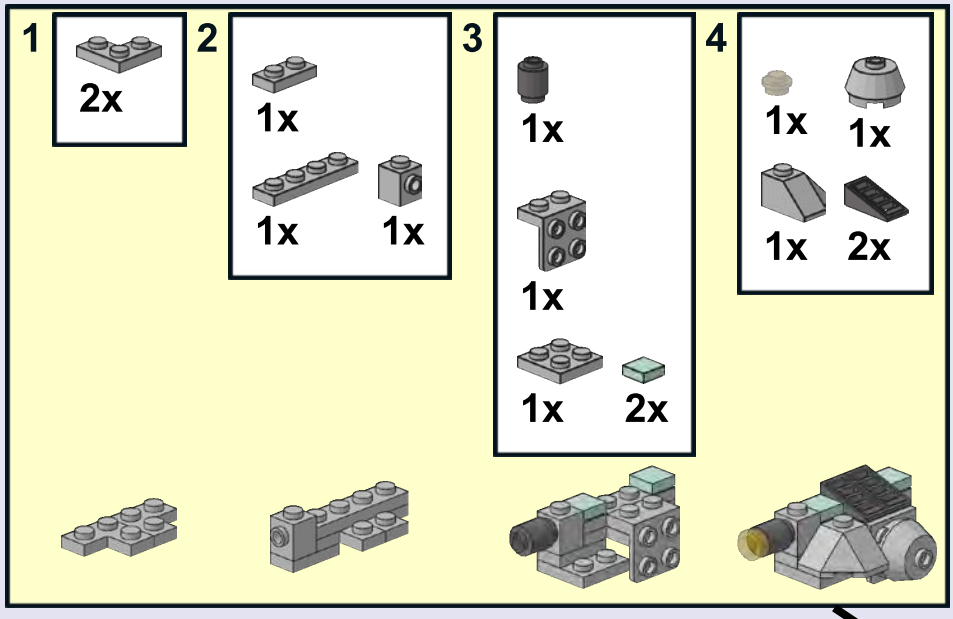

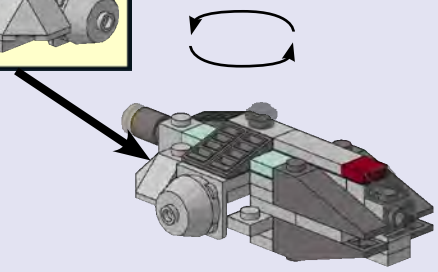

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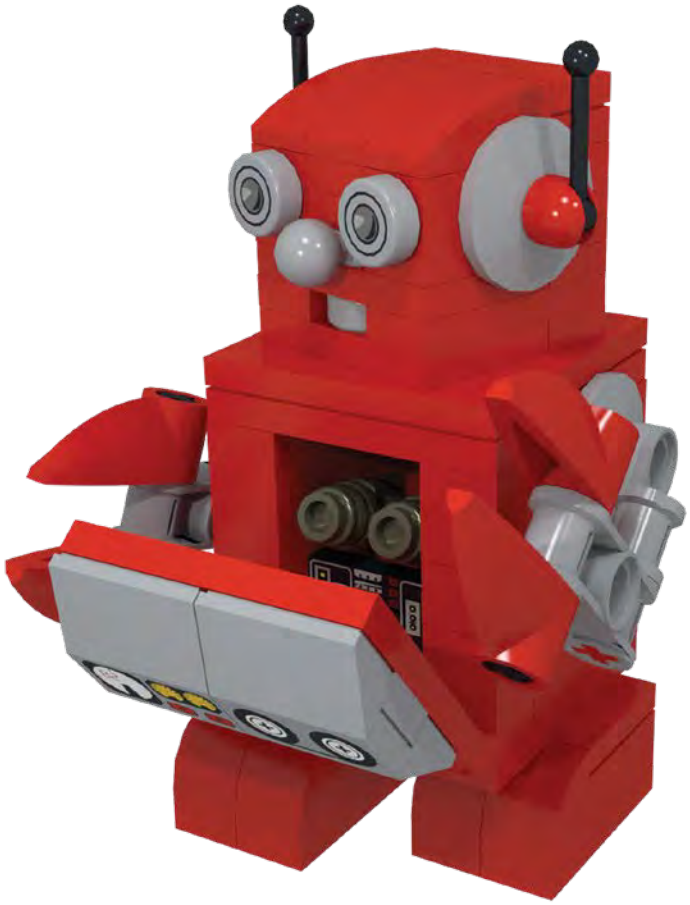


Tin Robot

Design and Instructions by Tommy Williamson

About this issue's model:

Since ancient times, humans have been captivated with the ideas of robots. Why we are so preoccupied with these labor-saving machines is a mystery, but just about everybody finds them fascinating. When I heard the theme of this issue was robots, I briefly considered all manner of MOCs inspired by pop culture. There's my favorite robot, R2-D2, there's the classics like Robby and the robot from *Lost in Space*, but then I thought about my childhood, before *Star Wars* came out, before I was watching re-runs of sci-fi classics—back when "robot" meant one of these guys, wound up and lumbering across the floor. So I give you a classic wind-up robot toy; enjoy!

Tommy Williamson is no stranger to *BrickJournal*, having been featured previously for his Jack Sparrow miniland scale figure. Since then, he has gone farther into building, making some remarkable *Star Trek* props and other models. He's now doing a column for *BrickJournal:* DIY Fan Art. Here, Tommy takes a little time out from his busy schedule at BrickNerd.com to make a model of his choosing for the magazine.

Parts List *(Parts can be ordered through Bricklink.com by searching by part number and color)*

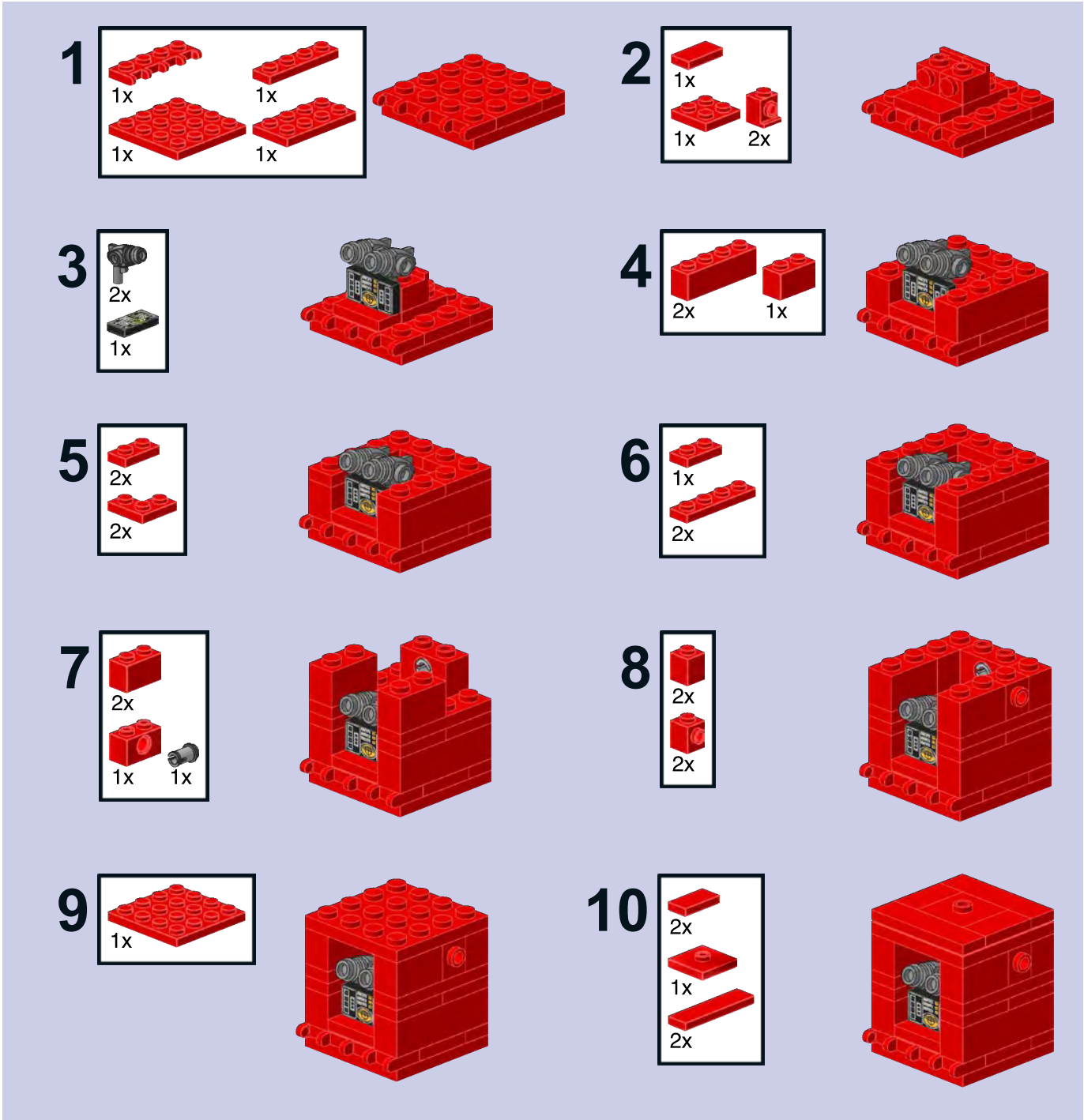
Qty	Part	Color	Description
2	3005.dat	Red	Brick 1 x 1
2	4070.dat	Red	Brick 1 x 1 with Headlight
6	87087.dat	Red	Brick 1 x 1 with Stud on 1 Side
3	3004.dat	Red	Brick 1 x 2
1	3622.dat	Red	Brick 1 x 3
2	3010.dat	Red	Brick 1 x 4
4	6091.dat	Red	Brick 2 x 1 x 1 & 1/3 with Curved Top
1	4213.dat	Red	Hinge Car Roof 4 x 4
2	4592.dat	Red	Hinge Control Stick Base
1	4315.dat	Red	Hinge Plate 1 x 4 with Car Roof Holder
4	3024.dat	Red	Plate 1 x 1
5	3023.dat	Red	Plate 1 x 2
2	3623.dat	Red	Plate 1 x 3
3	3710.dat	Red	Plate 1 x 4
5	3022.dat	Red	Plate 2 x 2
2	2420.dat	Red	Plate 2 x 2 Corner
3	87580.dat	Red	Plate 2 x 2 with Groove with 1 Center Stud
4	3021.dat	Red	Plate 2 x 3
1	3020.dat	Red	Plate 2 x 4
2	3031.dat	Red	Plate 4 x 4
3	11477.dat	Red	Slope Brick Curved 2 x 1
1	32062.dat	Red	Technic Axle 2 Notched
1	3700.dat	Red	Technic Brick 1 x 2 with Hole
4	41669.dat	Red	Technic Tooth 1 x 3 with Axlehole
3	3069b.dat	Red	Tile 1 x 2 with Groove
1	63864.dat	Red	Tile 1 x 3 with Groove
2	2431.dat	Red	Tile 1 x 4 with Groove
2	87993.dat	Metallic Dark Gray	Minifig Gun Laser Pistol
1	98375.dat	Metallic Dark Gray	Minifig Toy Winder Key
2	4593.dat	Black	Hinge Control Stick
2	4519.dat	Black	Technic Axle 3
1	3069bps6.dat	Black	Tile 1 x 2 with SW Jedi Starfighter Controls Pattern
4	4740.dat	Light Bluish Gray	Dish 2 x 2 Inverted
1	3614.dat	Light Bluish Gray	Plate 1 x 1 Round with Towball
1	3710.dat	Light Bluish Gray	Plate 1 x 4

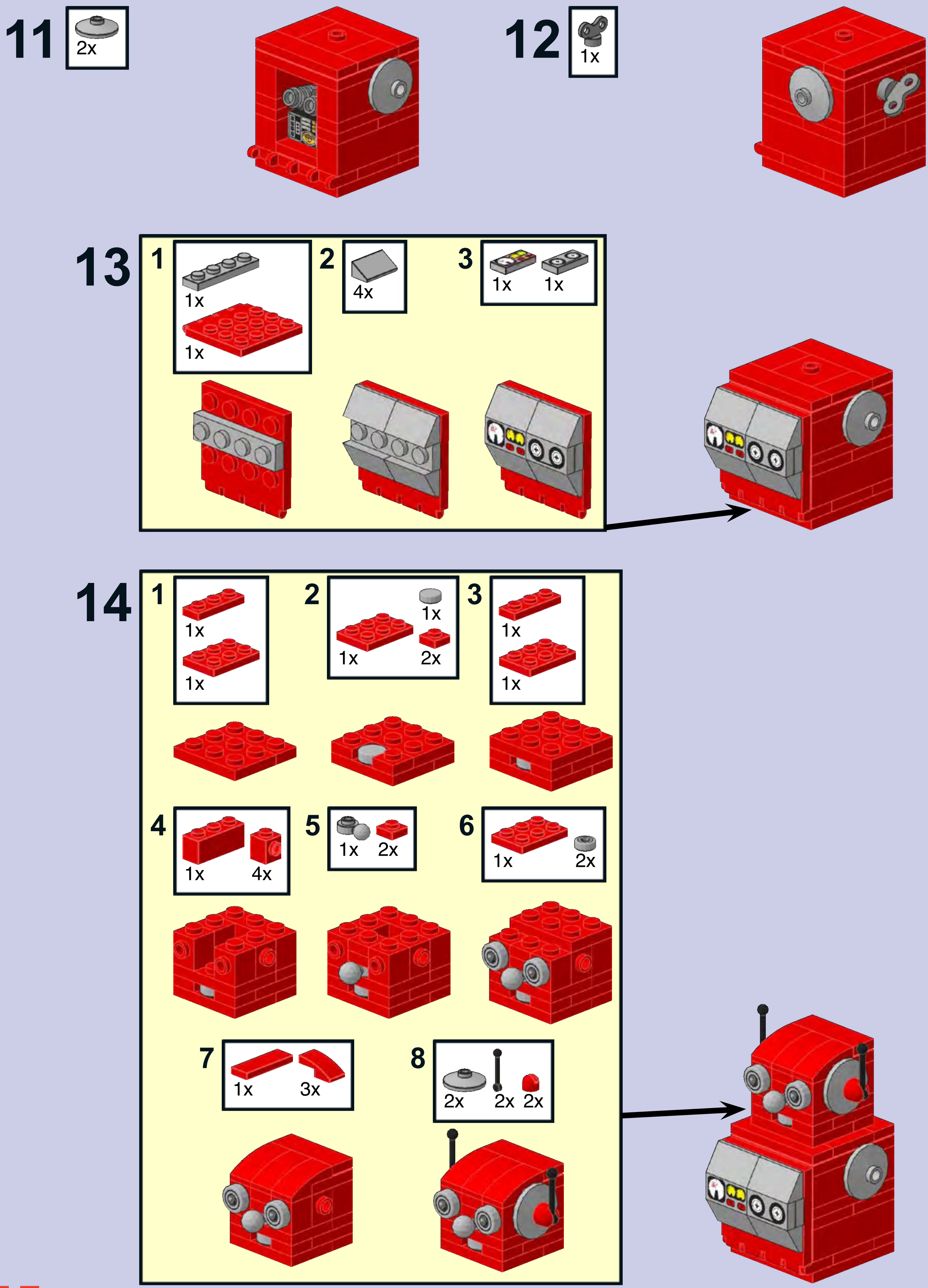
Parts List cont.

(Parts can be ordered through Bricklink.com by searching by part number and color)

Qty	Part	Color	Description
4	85984.dat	Light Bluish Gray	Slope Brick 31 1 x 2 x 0.667
1	32062.dat	Light Bluish Gray	Technic Axle 2 Notched
2	32126.dat	Light Bluish Gray	Technic Connector Toggle Joint Smooth
2	32184.dat	Light Bluish Gray	Technic Cross Block 1 x 3 (Axle/Pin/Axle)
1	4274.dat	Light Bluish Gray	Technic Pin 1/2
1	98138.dat	Light Bluish Gray	Tile 1 x 1 Round with Groove

Qty	Part	Color	Description
1	3069bpc3.dat	Light Bluish Gray	Tile 1 x 2 with Red "82" and Yellow and White Gauges Pattern
1	3069bp02.dat	Light Bluish Gray	Tile 1 x 2 with Tape Reels Pattern
2	98138p06.dat	Light Bluish Gray	Tile Round 1 x 1 with Headlight Pattern

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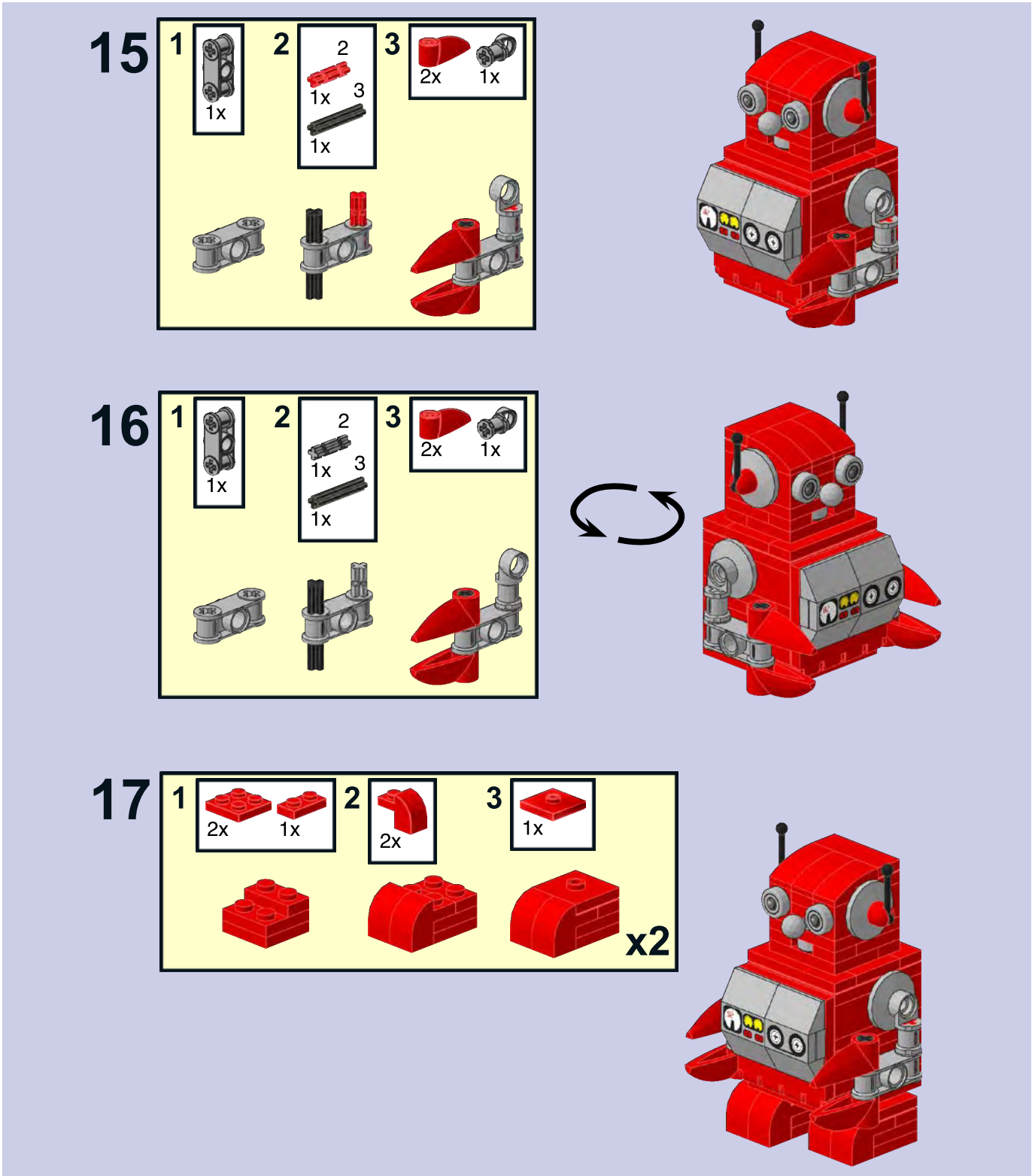


Building a Robot:

Article by Joe Meno

Sometimes, inspiration hits you from the most unusual of places. In this particular case, it was an event: Free Comic Book Day, a Saturday in early May that was established by publishers to promote comics and graphic novels. Over the past few years, what started as a way to get the word out on comics became events at comic stores, with entertainment and artist signings and displays. My club was asked to come and show our models, so I and another member set up some creations.

Since I had a few months notice, I took a look at who was going to be at the event, and found that a comic by the name of *Atomic Robo* was going to be represented. At the time, the comic was unfamiliar to me, but a picture of the title character caught my eye. Atomic Robo, as you may have guessed, is a robot. He's Nikola Tesla's last creation, and is a core member of Tesladyne, a group of Action Scientists who respond to paranormal and supernatural emergencies. He also looks really cool, which gave me reason enough to build him.

Starting Out

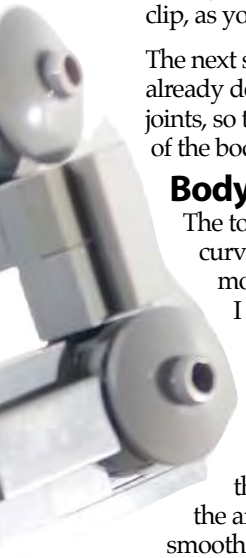
The first thing to do when building a model is to find as much reference as possible. For Atomic Robo, it was pretty easy to look him up online for initial reference and then buy a few books to complete my research. Atomic Robo's first book gave me more than enough reference to work with, thanks to a section that talked about the robot's design.

When I build a model that is held to a level of accuracy, I start at the most complex area and work out. In Atomic Robo's case, the part that had to prove to any viewer that he was unique was his head. While Robo's head is rather featureless, it still had a look, and I needed to capture it with LEGO elements.

I began by building his eyes. By making his eye gap one stud, his head width went immediately to three studs wide. This was important to figure out the scale of the final model. In comic book art, a hero is usually eight heads high and four to five heads wide, depending on how built the hero is. I used these proportions to roughly guide me in building Robo.

Since Robo's eyes are relatively big and round, his eye section is built sideways—this also allows his nose (such as it is) to be defined with a tile. After some exploring and trial and error, I managed to create a head that could attach to the neck with a clip, as you can see in the breakdown on the right.

The next section that I worked on was the torso and waist. I already determined that the legs would be attached by ball joints, so the waist was relatively easy to solve. Getting the rest of the body was a challenge.



Body Building

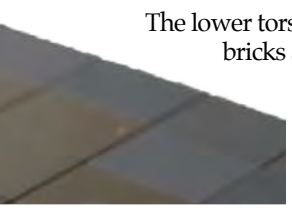
The torso posed some difficult challenges, as it was curved and had some details that needed to be on the model. I couldn't do a curved torso, but I learned that I could use the 1 x 1 cheese slopes to 'round' corners. However, to use them, I had to build sideways again, which meant that I had to have bricks with side studs placed. Shoulder joints were also added here, being 2 x 2 click hinge plates. The click hinge was strong enough to keep the arm in place, and the plate center tube became a pivot point to rotate the arm. Tiles were placed on the top of the shoulders to smooth the stud texture of the model and also to anchor the side bricks that hold the bricks that slope the sides.

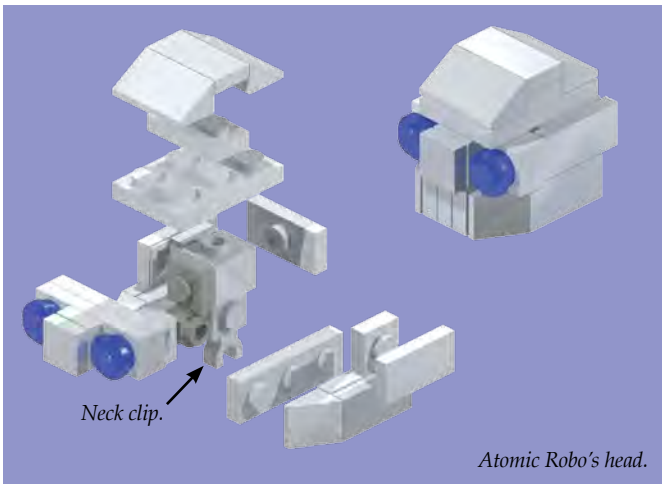
The front and back of the chest required some nonstandard building. The back was easy to do, using 1 x 4 bricks with side studs to place 2 x 4 tiles to make a smooth back. This also allowed the provision to add other items later, like a backpack—or more likely, a jet pack—to Robo's back.

To make the reactor housing in the middle of Robo's chest took the most thought out of the entire build, as a circular port had to be made in the center of the chest with a grilled vent in the middle. I knew the vent would be a grill tile and the reactor would be an inverted 2 x 2 dish, but these parts would have to be added sideways, and the round port had to be built.

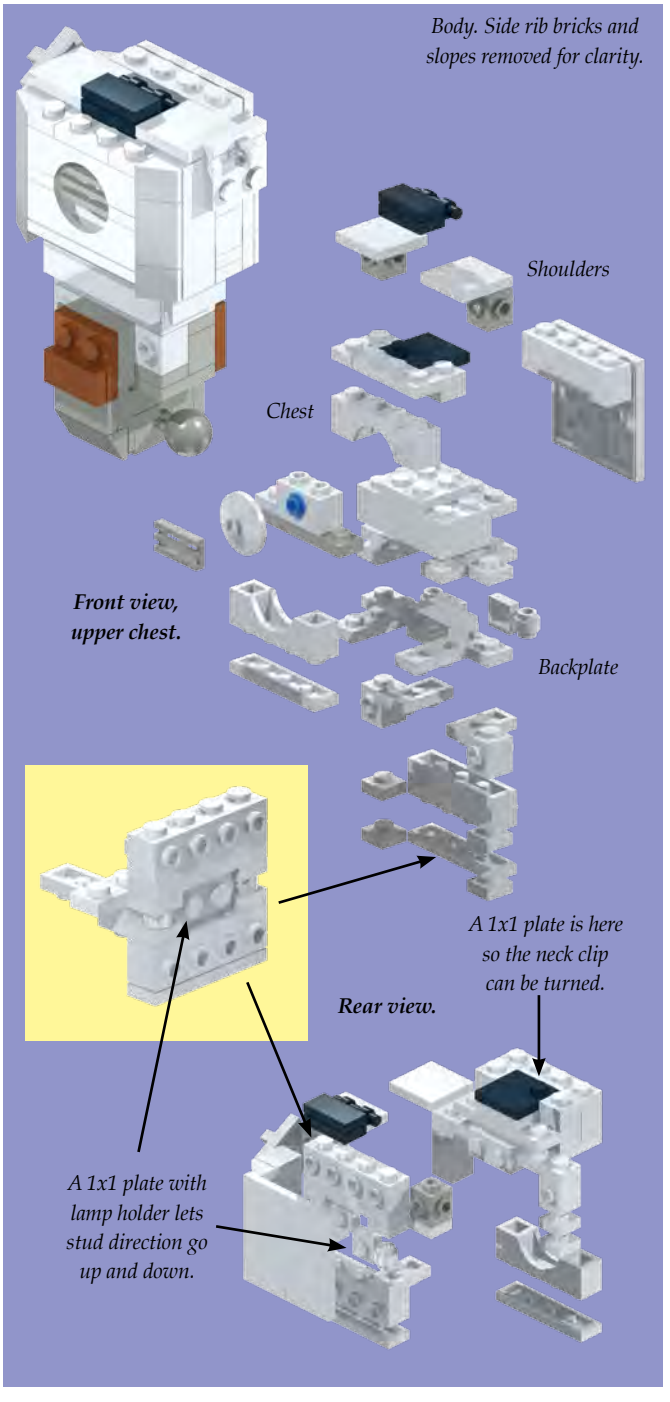
Some quick trial and error revealed that a circle-shaped port could be made with two 1 x 4 arch bricks. Using a plate as an insert, they could be attached at their bases. However, to do this would require a way to build a section of the chest upside-down. This was done using the 1 x 4 bricks with studs on the side and 1 x 1 plates with lamp holders (I call them O-rings). You can see on the inset on the right how the plates allow the stud direction to invert, so the 1 x 4 brick with side studs on the top is studs-up, and the 1 x 4 brick with side studs is actually *upside-down*. This also allowed the plates above the 1 x 1 plates to be studs-up and those below to be studs-down. The plate that was on the dividing line could be either up or down, and that was used to attach the bottom for the front chestplate arch. The inverted dish fit inside the port and the grill tile fits in the arch snugly, so it doesn't slip.

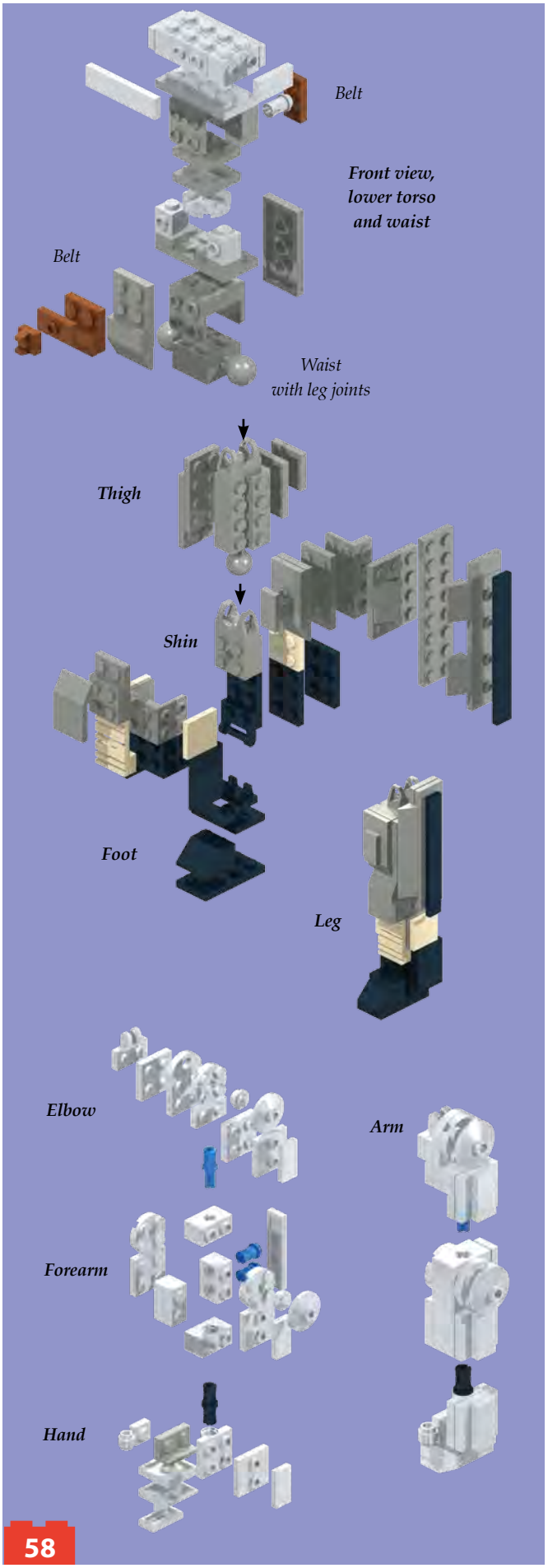
The lower torso was an easier build, as most of it is stacking of bricks and plates. There are brackets and bricks with side studs to begin building the pants and belt. The belt is brown plates that are covered with tiles to keep Atomic Robo's look smooth. The waist is





Atomic Robo's head.





a 2 x 2 brick with ball sockets and, because it's only joined by four studs at the top, is the weakest point of construction for the whole model. The weight of the model makes balance a small challenge if Robo is not standing straight.

Doing Legwork

Atomic Robo's legs are made up of three sections: the thigh, shin, and foot. The thigh and shin use ball joints, so they can go almost all directions and provide a lot of poseability. The ankle uses clips to keep the foot's orientation. There's only one axis of motion for the foot, so there are restrictions on posing. Most of these can be solved by attaching one of Robo's feet to a baseplate, which was what I wanted to do initially.

The thigh is made of a core of a brick with ball and a brick with socket. Plates are used to define the legs more, with brackets allowing sideways building. Further definition is made by adding tiles and cheese wedges to 'round' out the thigh. I also added a stripe on the pants to help define the form of Robo. The bottom black segment is a 1x2 tile that can be turned ninety degrees when his leg is bent.

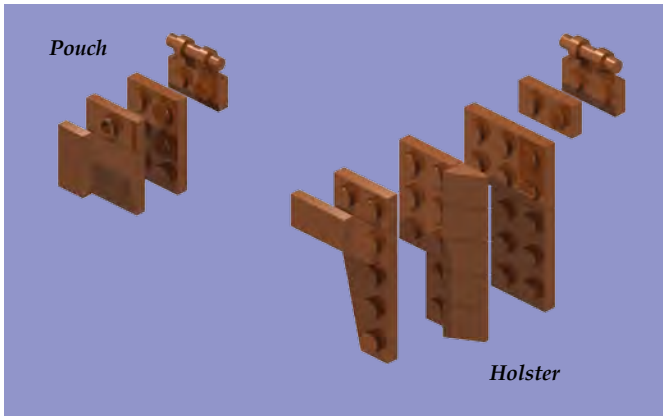
The shin has one ball joint brick and a 1x2 type 2 handle on the bottom for the ankle. Like the thigh, it uses plates to define its shape. It also has brackets for sideways building. There are more plates used here than the thigh. When bent ninety degrees, a large gap opens at the knee. To cover this I made a 'kneecap' that is simply a large bracket (1x2 that bends to a 2x2) that attaches under the knee 'slope' on the front with its 1x2 plate. The 2x2 plate has a tile on it that covers the gap. However, this means that the knee cannot return to a straight position until the cap is removed.

The foot is the simplest build of the leg, with only a plate, a 2x2 45-degree slope, 1x2 jumper plates (with one stud on top) and tiles with clips. The tile with clip has one of the strongest grips for a part, so it was natural to use two for the feet. The shin hides the clips with black tiles.

Making Arms

The arms are almost duplicates of each other, except for the hands, where the thumbs have to be switched. This makes it easy to build and repair the arms if needed.

The arm connects to the shoulder of Robo by click hinge. This sounds like a less-than-ideal solution, because the arm motion is limited by the hinge's divisions, but it's actually an advantage. Limiting the arm's movement with the click hinge means that the arm will never slip down. In fact, the click hinge strength is stronger than the stud that holds the shoulder click hinge plate, so the arm is prone to fall off while setting up. Once put in place, though, the arms will stay in place securely.



The arm, like the leg, has sections. There's the elbow (upper arm), forearm (lower arm) and hand. The elbow is a bunch of plates that have a Technic pin attachment point, which allows rotation of the forearm. The arm can be straight or bent, but changing its position requires taking apart the forearm.

The forearm is like the elbow in that it has holes for Technic pins. However, the hole for the elbow pin can be re-oriented by switching out the 1x2 brick on the forearm to 1x1 bricks. After that, you can rotate the Technic brick and move a 1x1 brick behind it and leave the other under the Technic brick. This will give Robo a bent elbow that can rotate, as seen here in the photo. You can see the other arm positioned just forward and straight.

The hand is a simplification of a real hand that I had to decide on, as there wasn't a way to make fingers in that scale that looked right. Also, the hand was too small to make anything that could really grip with hinges, so a shape that resembled a closed hand or fist was the solution I made. It took a couple of prototypes to build a hand I was happy with, as it was harder than it appeared to make a hand that looked accurate.

The final hands can rotate at the wrist and use a small bracket to build the knuckles and fingertips. The thumb is a 1 x 1 plate with lamp holder, which gives a hint of an opposable digit. Making both hands was a matter of duplicating and moving the thumb to opposite sides of the palm. The gun is actually built into the hand since it cannot grip. I didn't include the gun in diagrams because it's not a very stable part of the model at all, and I am planning to make another weapon.

Finishing Details

It took a couple of weeks to complete Atomic Robo, but there was one thing that made the model look incomplete. Originally, the belt was going to have no pouches. However, they had to be added.

With only a belt, there was a part gap that showed when Robo was posed with his legs even slightly open. This made Robo look strange, as this was the only area that looked unfinished. Something had to draw the eye away from this. After some experiments, I found that I could cover the gaps with pouches, which was a perfect solution to the problem.

With the pouches came a holster, which is what Atomic Robo has. All of these belt additions are clipped on by tiles with top clips on jumpers so they can be moved around as needed. As the legs are moved to a position, the pouches drape over the gaps.

So that's Atomic Robo. A few weeks, more than a few builds, and a fun challenge! I hope that you will take a look at this and make your own robot!

If you want to find out more about Atomic Robo, you can go to his website: http//www.atomic-robo.com !

Minifig Customization 101:

This is not the FLO You're Looking for!

by Jared K. Burks

You wanted Flo?

Through the course of this series we have covered how to customize or modify many different kinds of minifigures. These techniques can be applied to most any LEGO part. In this article we are going to use just a couple of droid minifigure parts and some non-droid parts to create something new. I challenge you to look outside the classical minifigure parts when creating custom figures. Get creative; don't limit yourself to only LEGO parts — look everywhere for inspiration.

So let's create a FLO minifigure — no, not *that* Flo (left). Let's look at FLO, also known as WA-7 from *Star Wars*. FLO is a unicycled service droid in Dex's Diner on Coruscant. According to the *Star Wars* wiki, FLO had a built-in transmitter, keeping her in contact with the kitchen and a paired set of repulsor stabilizers that allowed her to maintain balance as she moved around her customers. Apparently FLO disliked low tippers and was often seen flirting with the dishwasher unit.

FLO was featured in several scenes of *Star Wars: Episode II Attack of the Clones* when Obi-wan drops in to visit Dex. She also made an appearance in the *LEGO Star Wars* Video Game, where Dex's Diner featured as the hub for the game. It is the video game version of FLO that I will use as inspiration for the figure. As in most of the games, the designers take license to create figures using parts that either do not exist or combine elements to create new ones. Well, we can do that too.

Inspirational images for WA-7 droid.

CAUTION: *This article will feature cutting and gluing elements together. Always use safe practices when cutting any LEGO part. When possible use sandpaper instead. When not possible always cut away from yourself. If you are a younger reader, please get your parents' help before attempting to cut any part.*

Parts List (Wheel Up):

Part 3464c01 Wheel Center Small with Stub Axles (Pulley Wheel), with Black Tire 14mm D. x 4mm Smooth Small Single (3464 / 3139)

Part 2607 Magnet Holder 2 x 3

Part 3938 Hinge Brick 1 x 2 OR Part 2415 Plate, Modified 2 x 2 Thin with Plane Single Wheel Holder

Part 3794 Plate, Modified 1 x 2 with 1 Stud (Jumper)

Part 2555 Tile, Modified 1 x 1 with Clip

Part 30375 Torso Mechanical, Battle Droid

2x Part 30377 Arm Mechanical, Battle Droid

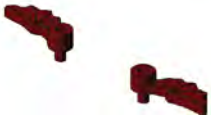
Part 4150 Tile, Round 2 x 2

Part 3749 Technic, Axle Pin without Friction Ridges Lengthwise

Part 32474 Technic Ball Joint

Part 6019 Plate, Modified 1 x 1 with Clip Horizontal

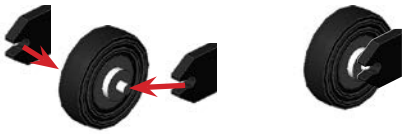
Part 4485 Minifig, Headgear Cap—Long Flat Bill



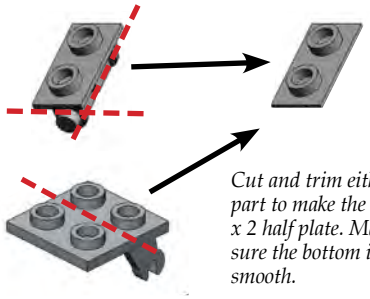
Part 87685 and 87686 Minifig, Plume Wheel Complete Left and Right, Dragon

A razor saw.

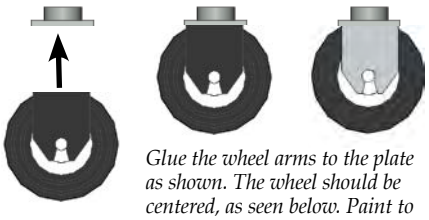
Cut or sand the body of the magnet holder off, leaving the arms to use.



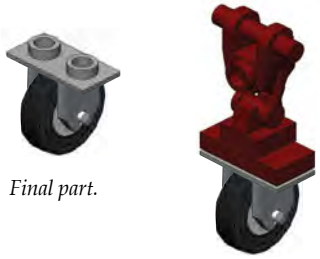
Clip the arms to the wheel and position so the edges are on the same side.



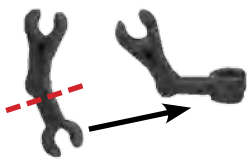
Cut and trim either part to make the 1 x 2 half plate. Make sure the bottom is smooth.



Glue the wheel arms to the plate as shown. The wheel should be centered, as seen below. Paint to match.

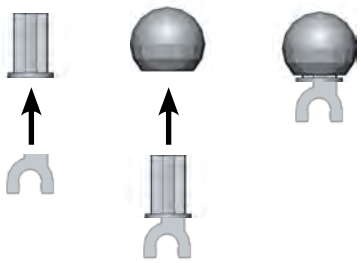


Final part.



Cut and glue the arm as shown. The hand will attach to the tile.

Cut the Technic pin and plate as shown above and glue as seen below. You can then slip the pin in the Technic ball.



Just as the parts are listed, let's start from the ground up and build this figure. In order to do this we need to start by cutting off the arms from the magnet holder (2607). These arms are most easily removed using a razor saw, or if you prefer a bit more elbow grease, sandpaper. If using the razor saw, simply saw off the arms; if using the sandpaper, sand away all the material above the arms.

Using the wheel, attach the arms to the stub axles. This will allow the arms to be in the correct placement relative to the wheel and hold them while they are superglued to the bottom of part 3938 or 2415. If using 2415 you will have to cut off 1x2 of the plate for use; if using 3938 you will need to cut the hinge region off the bottom of the plate. This plate is being used as it is thinner and perfectly flat to allow a good connection with the two wheel holding arms. Once the bottom of the hinge is flat, glue the arms and wheel in the center of the 1x2. Simply look at the reference images to get the placement. The foundation of the droid has now been created.

Attach the 1x2 Jumper (3794) to the modified plate/droid foundation. To that attach the modified tile with clip (6019). Following up, attach the mechanical battle droid torso (30375). The arms can now be attached; however one must be modified to properly hold the tray table.

The arm modification is very easy; simply cut the droid arm (30377) with a razor blade at the elbow joint and rotate the hand and change the attachment angle of the elbow joint (modified 30377). This can be glued back together with superglue. The modified arm can now be attached to the 2x2 round tile (4150) that is being used as the serving tray.

Now FLO's neck needs to be created to allow the (32474) Technic Ball Joint to serve as FLO's head. In order to do this we need to cut off the clip from the modified plate with clip (6019). The clip is easily removed with a razor blade. Next cut the Technic axle pin (3749) with the same razor blade to remove the pin, leaving the axle and round plate that separates the pin from the axle. Superglue the clip to the cut axle and attach the clip to the Battle droid torso and the Technic Ball joint to the axle. Again refer to the reference image.

Finally we have come to the head of the figure and the most difficult modification, the creation of FLO's hat. To create this part I used a rotary tool, a Dremel tool, and started with a LEGO classic Long Flat Billed cap (4485). I removed the bill and the stud acceptor from the cap. Then I slowly cut away from the rest of the cap until I got the shape I wanted for the piece. This is the most difficult to perform because the part must be held in your hand while using the rotary tool. Please wear a protective glove (Kevlar) when performing these tasks and try using sanding bits for material removal as they are friendlier to your fingers. Once the skull cap hat is created, I then cut the wings off of the round portions of 4502w. I did this at an angle so they would attach to the modified cap; just remember to cut each wing at the correct angle as they will be mirror images of each other. I then glued them in place and painted them to match LEGO Dark Red as these parts are not available in the Dark Red color.

Now that all is created we have to put the final touches on the figure. The hat has to be attached to the ball joint head and then detailing for the eyes and mouth

Cut the hat brim and sides as shown, and cut the wings at their bases. Glue the wings to the hat as seen on the photos here.

need to be added. A simple decal was created to do the later and printed on waterslide decal film and applied. The hat attachment could be added with superglue or through the use of double-sided tape. Because the interior of the hat isn't perfectly round, glue is difficult, which is why I mention the double sided tape. The tape fills the void under the hat nicely.

Now that you have FLO created, you need to build her a workspace. I looked to the game for inspiration. Also, as you have FLO, and LEGO has given us Pong Krell, Dex should be easy to create, and I will leave him to you.

Special Note: FLO cannot stand on her single wheel on her own; we were not able to build a minifigure-scaled paired set of repulsor stabilizers. Therefore, I commonly wedge her tire between two studs to get her to stand. After a while the tire conforms to this shape and can be easily clicked in and out of studs.

Another look at the layout.

Face decal graphic.

For the bulk of this figure we modified non-traditional minifigure parts to create the unicycle and head portion of this droid. Create and expand your ideas beyond the minifigure parts, bring the brick back home to play with and ***in*** the figures.

You can go to Jared's webpage by going to http://www.fineclonier.com/ *or scanning this QR code!*

Come back next issue for more Minifigure Customization!

MINDSTORMS 101: The Perils of Dead-Reckoning!

Article and art by Damien Kee

In the last installment of our MINDSTORMS articles we used a gripper attachment to pick up objects. This time, we look at one of the challenges in robotics competitions: how to move your robot accurately.

It is common for many teams when competing in Robotics competitions to rely heavily on dead-reckoning. But sometimes, this is not the best option.

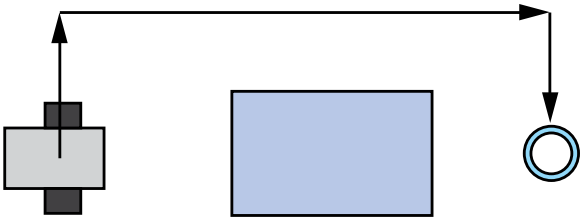
What is Dead-Reckoning?

Dead-reckoning is the process of driving your robot around without the aid of external sensors. The theory goes, if you know where you start, and you know exactly how far you are telling your motors to travel, then you can calculate *exactly* where you'll end up after a move.

Well that sounds great in theory. Suppose I've got the following challenge. Navigate the robot around the obstacle and stop at the ring.

Providing I line up my robot perfectly straight, this could be a possible solution:

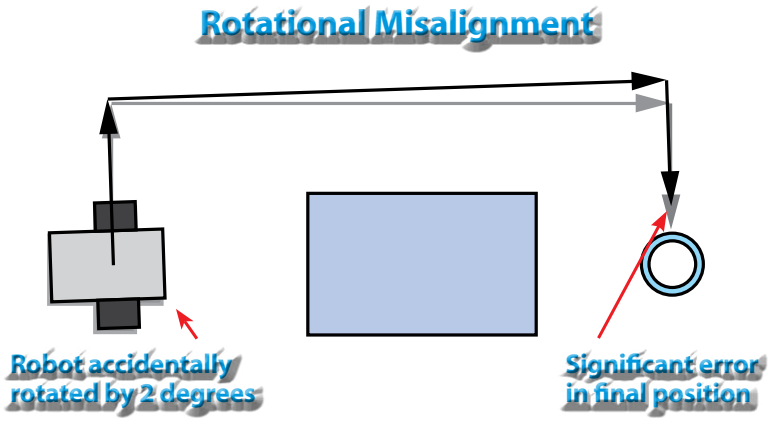
1. Turn 90 degrees left
2. Drive Forward
3. Turn 90 degrees right
4. Drive forward
5. Turn 90 degrees right
6. Drive forward



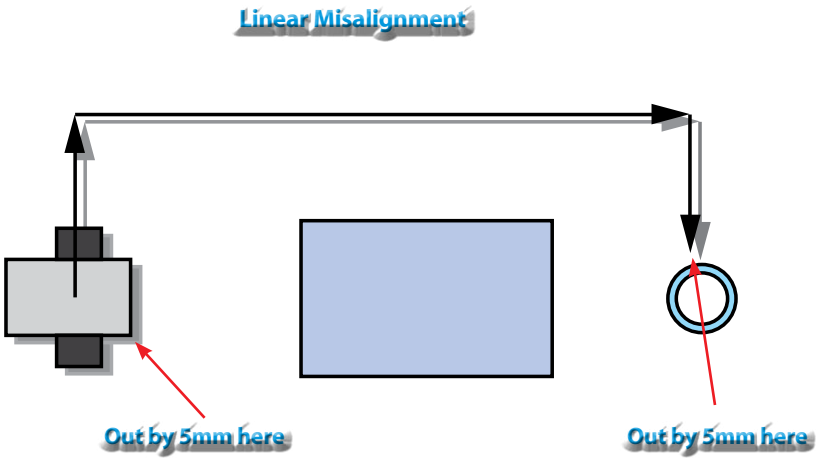
In the robot's mind, what it is effectively doing is closing its eyes, driving blindly while following its instructions, then at the end it opens it eyes and hopes that it is in the right place. In reality there are often things that can go wrong.

Misalignment

Looking back at the above example, let's suppose that in the rush of the competition countdown clock, I don't line up my robot as well as I wanted. When placing, I put it down 2 degrees counter-clockwise from what I had intended. Two degrees isn't very much at all, and to the human eye is probably not even noticeable, but because the robot doesn't realize this misalignment, it will just continue on its predetermined path. However, it can lead to significant errors in where the robot will finish. This is called Rotational Misalignment.



A similar problem, Linear Misalignment is where a robot is placed straight, but perhaps just a few millimeters away from its ideal starting position. The end error isn't as bad, but can still have an effect of your robots position.



Other Factors

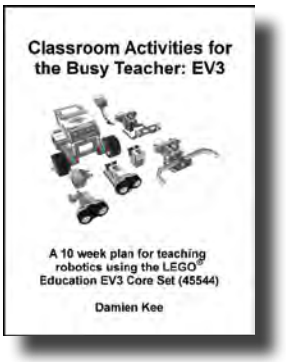
There are a few other factors that can impact your robot's final position if it is just using dead-reckoning.

- Friction of the surface: Even though you may have told your robot to spin the wheels so that it travels exactly 500mm, in reality a surface that has more friction will result in the robot not travelling as far as you expected.
- Weight of the robot: Just like the friction of the game surface, the weight of the robot will impact how far it travels.
- Obstacles along the way: If your robot accidentally clips the obstacle along its path, that will upset which way the robot is heading.
- Hubs moving within the tires: Even though you may think of the wheels as being a single piece, in fact the hubs can move slightly inside the tires as they drive along.

You can see that after a few runs, the hub does not line up exactly with the tire.

While each of these factors are small by themselves, when many movements are combined, all the little errors are added up to result in quite a large error.

Dr Damien Kee has been working with robotics in education for over 10 years, teaching thousands of Students and hundreds of Teachers from all over the world. He is the author of the popular "Classroom Activities for the Busy Teacher" series of robotics teacher resource books.

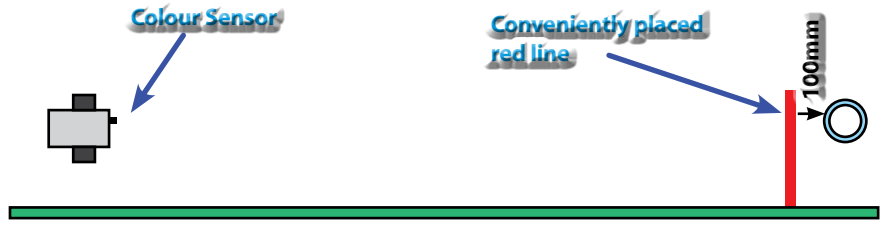


You can find more information at www.damienkee.com or contact him directly at damien@damienkee.com. Or you can scan the QR code below!

What to do?

Dead-reckoning can be useful, if it is used sparingly and only over short distances. To improve on dead-reckoning, you'll need to add in sensors. I'll look at a few basic ways to combine the Colour Sensor with dead-reckoning to get a far more reliable robot.

Challenge 1: Drive your robot up to the ring.



In this challenge, the ring is quite a large distance away. We already know that friction of the surface, weight of the robot and tire slippage will affect how the robot performs, so while we could measure the exact distance and calculate from the tire circumference, there is a very good chance we'll be off by a small amount. What is handy to know is that the ring is 100mm away from a very conveniently placed red line.

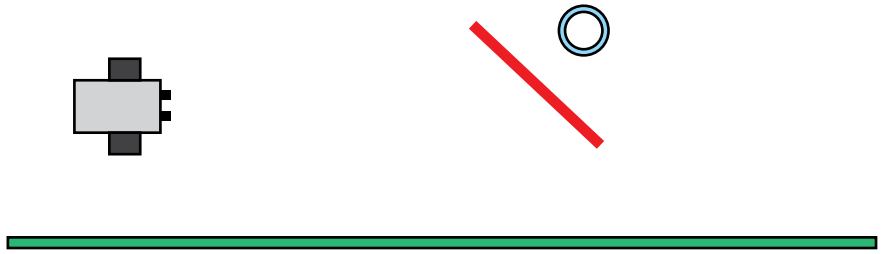
Here is how we'll approach this problem.

While we're not sure we could be very accurate driving up to the red line using just our Motor commands, we can be sure that we could use the Colour sensor to know *exactly* when we get there. Once we know we're at the red line, we could use dead-reckoning to just do the last 100mm.

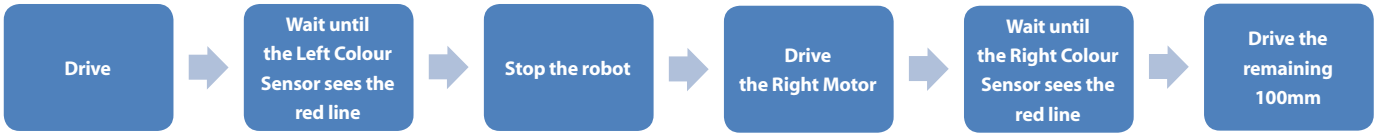
This is how it would look in the EV3-G language.

Challenge 2: Lining up.

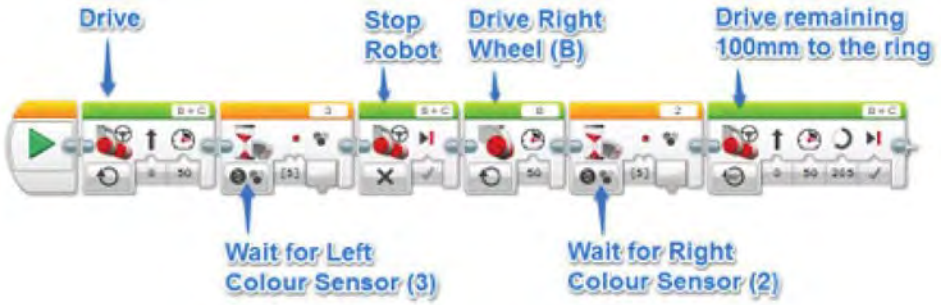
Challenge 1 works well if you know you are travelling in a straight line to your object, without any turns. What would happen if the challenge looked like this?



We can't just turn and head to the ring; otherwise we're at the mercy of Rotational Misalignment. A better course of action would be to head directly to the red line, and then use the red line to orient ourselves towards the ring. Our new plan would probably now be along the lines of this:



This is what it would look like in the EV3-G programming language.



What Next?

This is just the start. Can you think of other ways you can use sensors to get close to your targets, and then use dead-reckoning to do just the last little bit?

Educational Robotics

The rise in role of STEM (Science, Technology, Engineering and Match) as an important part of students' education has seen a greater uptake of robotics in the classroom. I've being using robots in an educational setting for over 10 years and the LEGO MINDSTORMS system is one of the best I've ever used. The modular nature of the LEGO bricks allows kids to quickly explore new ideas and concepts. While I'm a huge fan of some of the great LEGO robot creators (Lee Magpili, Steven Hassenplug, Brian Davis, Michael Brandl, Laurens Valk, Daniele Benedetelli just to name a few), the creations they come up with are often not practical to do in a classroom. Classroom time is often very limited and given the crowded nature of the curriculum these days, you can't just set aside time to do some 'fun' things; instead everything needs to be justified as a contributing activity to the wider curriculum.

RCX design.

NXT design.

EV3 design.

Instead, my robot designs swap the 'wow' factor for simplicity. Each classroom robot that I've designed, from the RCX to the NXT and most recently the EV3, uses a bare minimum of parts and takes on average 10 minutes or less to put together. Each was designed so that you only need a single Education version of the kit so there was no need to order weird or exotic parts. This quick build time allows us to shift into programming far quicker as students are not spending considerable extra time trying to come up with their own elaborate robot designs. Once students have had a good introduction with the programming, the simple nature of the robots, along with the multiple connections, allows customization and attachments to be added with ease. You can download full building instructions for all my classroom robots at *www.damienkee.com*

LEGO IDEAS 101: Finding Your Audience

Article by Glen Wadleigh

LEGO Ideas (https://ideas.lego.com/) is a website that lets you submit your own set designs to LEGO, and if they garner enough public support (10,000 votes), LEGO will review and consider producing them. But there are two huge misconceptions about promoting LEGO Ideas projects. The first misconception is that you don't need to promote your Ideas project. Putting your project in front of potential supporters is essential to getting a LEGO review.

For those that realize that promotion is required, most unfortunately make the mistake of promoting their project only in the LEGO fan community (FOLs).

You certainly should not ignore FOLs, but excepting a few extreme cases, the average FOL is not going to be your strongest supporter. Why? Well, FOLs love LEGO, and what they can do with it. But, we each have favorite themes and subjects and, regardless of how much one loves LEGO, we are not going to support a project just because it is LEGO.

Additionally, even if you find FOLs who like your project's subject, we are highly inoculated to whatever you have to show us. We eat, sleep, and breathe LEGO. Many will reject your project because they A) Have seen it done better, B) Can do it themselves, or C) "Know" LEGO won't make it for any number of perceived or actual reasons, and the list goes on...

On top of all that, many FOLs are surprised to find out how small the active FOL community is. In North America, for example, there are only 3500 LUG members. Even the most popular articles on Brickset.com rarely get more than 10,000 views.

So, in promoting your project to FOLs, you are targeting a relatively small community, and only a subset of a subset of this community is likely to support your content.

Where do you go for support then?

It is quite simple. Although not everyone is a FOL, nearly everyone likes LEGO. So find the people who love the subject of the project and they will like your LEGO version of it, hopefully enough to support it.

Consider the communities that might be interested in your project, then figure out the best way to contact them. Google is incredibly helpful for this.

For instance, if you were to seek out supporters for the Classic Douglas DC-3 (https://ideas.lego.com/projects/17534) you might try to present your project to:

- Fans of the Douglas DC-3 (pretty obvious)
- Fans of the C-47 Skytrain, Dakota, Lisunov Li-2, and Lisunov Li-2 , and the other variations of the DC-3
- "AvGeek" or "Aviation Geek" sites (I am led to believe that is the equivalent of FOL in the aviation fan community)
- Boeing Aircraft (Boeing owns Douglas)
- Pilots
- Airplane photo "clubs"
- Airplane museums
- Airshows
- Airplane podcasts
- Airlines (especially those that use the DC-3)
- Social media personalities who like airplanes or are, in fact, pilots
- World War II buffs
- Pulp Adventure fans (Including Indiana Jones)
- Aircraft Model enthusiasts

You will want to investigate every avenue, but you tend to get a bigger bang for your buck if you focus on the groups with a wide reach and a heavy focus on your specific subject.

You will need to be creative, persistent, and thorough. You will get many rejections along the way, but you will also find people who are absolutely stunned by the fact that you have taken something that they are passionate about and materialized it in LEGO.

Some IDEAS on Robots

Article by Glen Wadleigh

Robots have been a constant presence in LEGO. I remember playing with the little guys that came in the space sets for hours on end. The inclusion of licensed robots like the droids from *Star Wars* and actual working robots from the development of MINDSTORMS have only stoked the interconnection between bricks and 'bots over the years.

It is no surprise then that LEGO Ideas also has its abundance of robots. In fact, with Hayabusa and Curiosity reaching production and Angus MacLane's WALL•E in review, robots are also one of its most successful subjects.

What follows are a collection of some of the more interesting LEGO Ideas projects based on robots.

Transforming Nintendo Game Boy and Accessories by Baron Julius von Brunk

https://ideas.lego.com/projects/14089

This Project is a triple whammy right in the nostalgia for AFOLS in their thirties. This brick marvel appears to be a very accurate Nintendo Gameboy with Tetris and Pokemon cartridges, but this MOC is really a combination of "robots in disguise." Obviously inspired by the classic Transformer Soundwave and his cassette minions, this portable gaming system turns into a robot with a battery-themed shoulder cannon and two raptor-like companions.

Editor's Note: This project was archived December 17, 2014 by the LEGO Group after its decision to not pursue this license. However, you can download instructions to make your own model at the site below:

http://www.instructables.com/id/Domaster-Tetrawing-Game-Boy-Tetris-game-tran/

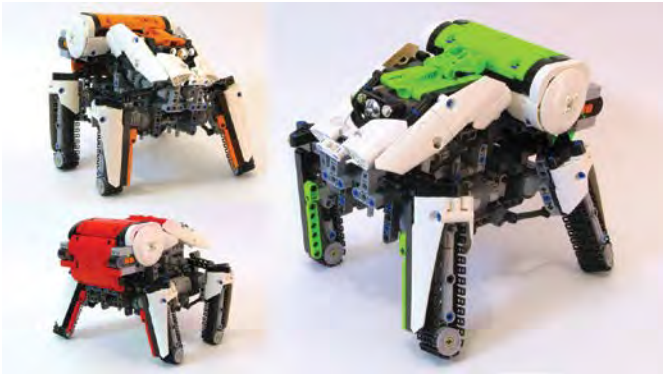
ModBots: Modular Brick-Built Robots by Alex Kelley

https://ideas.lego.com/projects/68592

Mixel meets machine with this LEGO idea.

The concept for this set is to create a set designed to assemble three highly articulated robots. The twist is that every joint is designed to be fully interchangeable. I like this idea because it showcases a lot of the higher end robot/mecha design techniques you see in the AFOL community, but puts in an accessible format. The set would be like a primer for people finding their way into more advanced LEGO Robot designs.

I can confirm that this technique is quite popular in my household as my son applies it to mixels, swapping out the different limbs and heads until he gets the overall look he likes best.



ARAK-N3 by Mahj

https://ideas.lego.com/projects/17553

The ARAK-N3 is one of the few projects on Ideas that implements power functions, and is therefore one of the only actual robots on Ideas. It is even more unique, however, for its rocky history with the Ideas system.

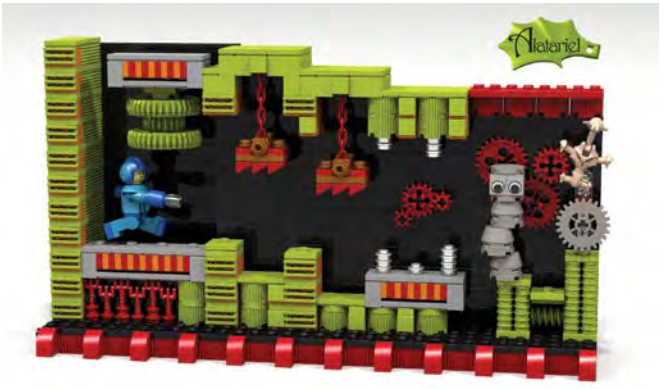
Mahj originally posted a project based on the Tachikoma from the animated series *Ghost in the Shell* (GITS). The build was a marvel of accurate modelling, cuteness, and advanced technical functionality. The proposal finally started to catch fire and was quickly moving to 10k.

At that point, LEGO caught on to the fact that GITS showcases material well outside of its comfort zone. This was still the early days for LEGO Cuusoo (a forerunner to Ideas; "Cuusoo" means 'imagination' or sometimes 'wish' in Japanese), so they decided to try to work with Mahj and the Cuusoo community on a compromise. They allowed Mahj to change his project to the ARAK-N3, a build that carries forward the technical functions of the original Tachikoma design while shedding the appeal and burden of the GIST connection. The project was allowed to continue with the thousands of supporters it had garnered as "Tachikoma."

This experiment failed, however. Both the GIST and the Cuusoo communities rebelled against this compromise and the ARAK-N3 was forced to "reboot" and start over at zero support.

Sadly the ARAK-N3, though being a technical marvel *and* adorable in its own right, has never had the media fanfare of its predecessor.

I highly suggest you check out the videos of this little guy in action, and then go support the project!



Mega Man by Ellen Kooijman

https://ideas.lego.com/projects/16218

One of the few Robot Ideas projects that uses the minifig for the robot. This set is an attempt to recreate one of the all time classic video game characters "Rockman" from the Mega Man series of games.

This project has changed a lot as Cuusoo developed. It originally showcased several levels and adversaries (still accessible via Ellen's flickr account). The project is now focused on creating the castle of Dr.Wily, Rockman's nemesis, with an integrated embedded scene from one of the game's many environments.

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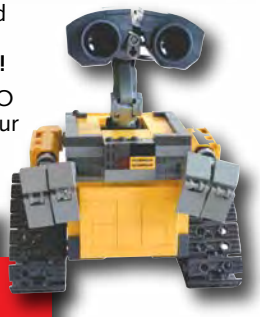

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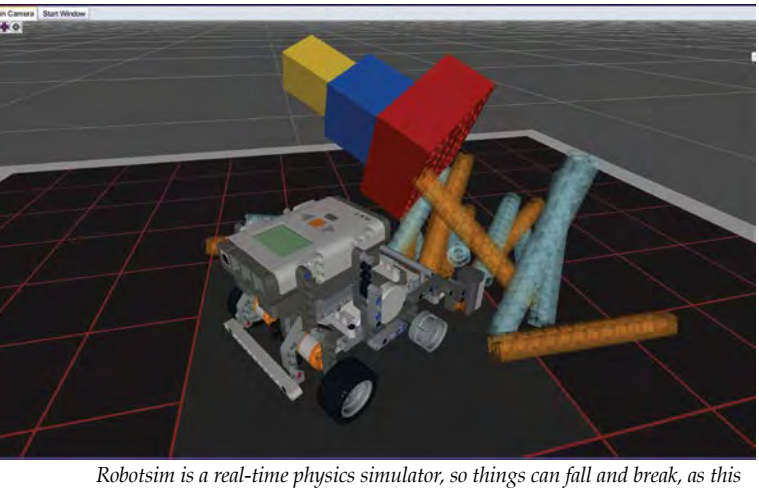
Robotsim running an NXT robot on a FIRST® *LEGO® League game field.*

Cogmation: Simulating LEGO Robots

Article by Joe Meno
Screengrabs provided by Cogmation



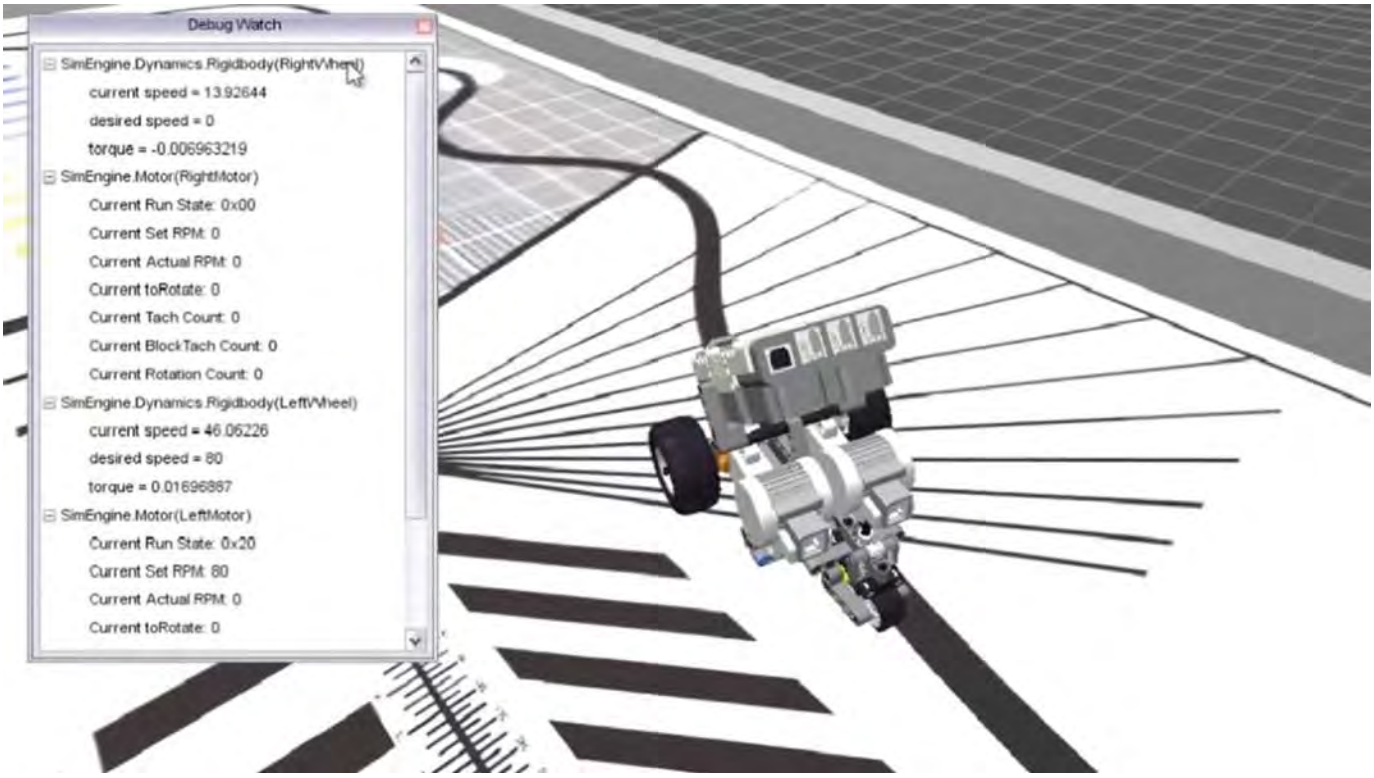
Robotsim is a real-time physics simulator, so things can fall and break, as this screen shows.

One of the challenges of starting a LEGO robotics team or program is the robot itself, Starting at $380 USD, the MINDSTORMS sets are at a price point that for many are a challenge to raise. What if there was a way to build a LEGO robot that was less expensive and easy to learn? Simulation company Cogmation may have found just such a way with Robotsim.

Cogmation is a company that sprang from a group of University of Manitoba students that specialized in robotics. From there, they branched into simulation software. Initially working on industrial robotic simulators, Cogmation got involved with FIRST through a mentor and began thinking about simulators for education. Why not build a LEGO MINDSTORMS simulator? As a result, their newest simulator, named Robotsim, will be able to build and run MINDSTORMS robots not only for FIRST, but for other users!

Users of the simulator will be able to use LEGO programs in all phases of constructing their robot. Building the robot can be done using LEGO Digital Designer, a free program that is available for both Macintosh and Windows systems. This program has been around for a few years and is used by LEGO fans to build models and robots. Robots created from LEGO Digital Designer are then imported into Robotsim and can be programmed using MINDSTORMS software.

When the robot is imported into Robotsim, it is placed into a simulation environment that can be made into any place desired. Robots start in a generic room, but can be placed on a FIRST LEGO League game table (with models), or a custom sumo platform, or even on a lunar environment with accurate gravity! Once programmed, the robots perform in the environment as they would in real life, with accurate physics. Challenges can be created and evaluated in the program as users build and learn to solve them.



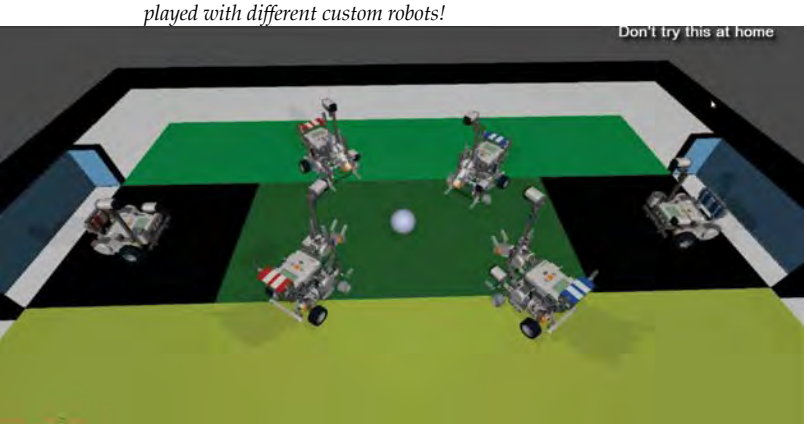
Robotsim can not only show a robot running a program, it can show its sensor and performance information.

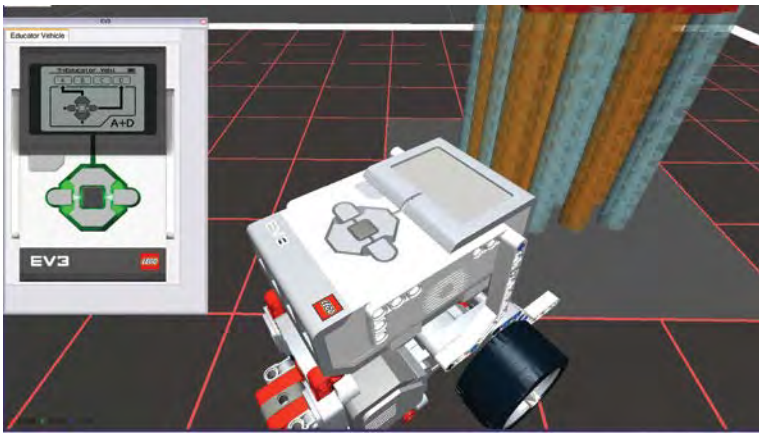
Both MINDSTORMS EV3 and NXT will work with Robotsim, so their programming languages will be usable as well. For these robots, users can access the programmable brick by clicking the buttons on a virtual version of their brick. Users can select and run programs as if using the actual NXT or EV3 brick, which will make this invaluable for FLL teams testing their robots.

Robotsim also comes with other advantages. There are no space limitations to the robots, as they are in a computer, not in the classroom. Parts are not lost or broken, and most importantly, every user has a chance to use a robot. Teachers and coaches can train all of their group with the software and in the case of sumo robots, run them together on the same machine using game controllers!

Robotsim will be available on Windows and Macintosh platforms. Single and multiple user licenses are available. If you want to know more about Robotsim, you can go to www.cogmation.com.

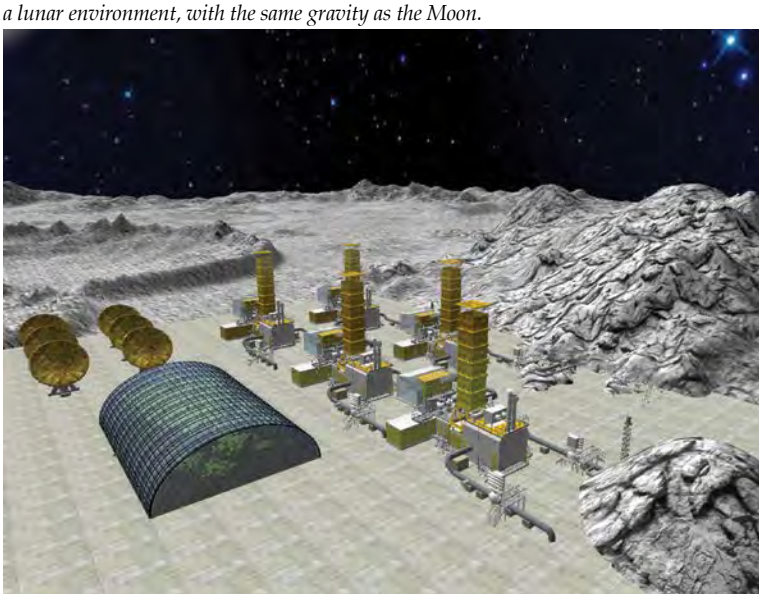
More than one robot can run on the simulator, so games like soccer can be played with different custom robots!





The simulator lets users directly interact with the programming brick. Pushing a button on the EV3 brick above can be done with a mouse click.

Environments for simulation don't have to be limited to Earth locations. Here's a lunar environment, with the same gravity as the Moon.



To the Batcave!

LEGO Batman 3: Beyond Gotham

Beyond Expectations!

Review by Joshua Kranenberg
Art provided by Warner Brothers

As a full-time college student who also works a full-time job, I do not have as much time as I used to for playing video games. Luckily, ever since I started playing *LEGO Batman 3: Beyond Gotham*, I really haven't felt like playing anything else. Moreover, as a self-proclaimed Batman fanboy, I had been looking forward to this game ever since I beat *LEGO Batman 2: DC Superheroes*. When I beat *LB2*, I felt slightly disappointed; the story was great, but the open world and flight mechanics left much to be desired. Luckily, Traveler's Tales has fixed these issues and provided a glitch-free playing experience. I was able to play through the whole story mode without ever having to restart a level or my console — something that cannot be said for previous LEGO games which have often been plagued with horrible bugs and glitches. On the new generation of consoles (Xbox One and PS4) *LEGO Batman 3* is an amazingly beautiful game, surpassing what most would expect from a LEGO game. The game still looks good on Xbox 360, PlayStation 3 and Wii U, but seems to be missing that extra layer of polish and shine, with less detail and LEGO elements on screen. There also is no difference in gameplay on any of the consoles.

LEGO Batman 3 has more than 150 playable characters with well-known characters like Superman, Wonder Woman, The Flash, etc. and lesser known characters such as Booster Gold, Bronze Tiger, and Lobo (aka the main man) and many more. Due to the large number of characters, I really enjoyed playing as all the different big figs such as Killer Croc, who Robin points out looks bigger than last time. Other big figs include Solomon Grundy, Martian Manhunter, and even Cyborg and Lex Luthor. Furthermore I loved playing as all the Lanterns: Blue, Green, Sapphire (Purple), Indigo, Orange, Red, and Sinestro (Yellow) and felt that TT Games did a great job capturing the individual characteristics of each Lantern Corp while injecting that sense of humor we have come to expect from LEGO games. A great example of the game's brand of humor is how when flying as Wonder Woman, the original Wonder Woman theme song begins to play.

When *LEGO Batman 3: Beyond Gotham* was first announced I expected for it to have an open-world Gotham City, much like the open world of *LEGO Marvel*. However this is not the case; instead the game has many smaller open areas. These areas include the Hall of Justice, Hall of Doom, The Watchtower, Batcave, and all the Lantern worlds (Zamaron, Odyn, Qward, Ysmault, Nok, Okaara and Oa). To my great surprise, these open areas are super fun and filled with tons and tons of DC goodness. The Lantern worlds feels like playing a totally different game, like a Mario Galaxy game but LEGO Travelers' Tales style. The Lantern worlds, which can be accessed via the moonbase, are larger than expected, and each world is full of characters and golden bricks to collect. On almost every lantern world the one and only Green Loontren (Duck

Dodgers) is waiting to give you a tour of the planet. However, on the Green Lantern homeworld of Oa there is no Loontren tour. Instead you can drive any unlocked vehicle. There is nothing better than an evening drive in the 1960s Batmobile taking in the scenery on Oa!

The only thing I did not like about *LEGO Batman 3* was the story. The overall theme of the story is that friends can overcome anything and you should not bury your emotions. After playing for a few minutes, a cut scene plays in which a mind-controlled Batman is about to hurt Robin. Robin begins telling Batman how they are friends, which snaps Batman out of the trance. Also on the first level of the game, as Robin is being chased by Killer Croc, Batman tells Robin that his emotions are a weakness, only to realize that he was wrong later on in the game. The whole story felt very un-Batman and very disappointing compared to the amazing original story from last year's *LEGO Marvel Superheroes*. Another problem is that Brainiac did not seem like himself: he seemed dumber and weaker then he should have been. There was only one part of the main story I liked: when some of the heroes and villains are hit with the different Lantern lights and begin to heavily express the light's emotions. A great example of this is how Flash, hit by the orange (greed) Lantern light begins to try and take things saying "it's mine, all mine". Sadly, even this almost redeeming aspect of the story is slightly ruined when Cyborg is struck by Sinestro's yellow (fear) Lantern light and begins to fear everything. In the comics, for the Sinestro Corps fear is not felt, but is a power drawn from the fear of others. This oversight on the part of TT Games is just one of many which not only leaves the story feeling un-Batman, but un-DC.

However, I did love the 1960s Batman bonus level. Upon completion of the main story, this level is unlocked; the level lets you play as the Adam West version of Batman, in all his campy goodness!

The Justice League plays a part in this game...

...as does Doomsday!

Even though the story is a disappointment, the rest of the game is great. I enjoyed playing as tons of the best DC characters. Moreover, this game has one of the best, most amazing and unique open world set-ups I have ever played. After playing the whole game I can honestly say that *LEGO Batman 3: Beyond Gotham* is worth the $60 asking price and is a great game that every DC and/or LEGO fan of all ages can enjoy.

Thanks for reading the review! Here are some Codes for unlocking characters and extras in *Lego Batman 3: Beyond Gotham*. These codes can be used from the pause menu of the game or in the Batcave.

Code	**Character**
9WYGLP	Joker
QDQ3YL	Superboy
TRQTPS	Red Hood
J6ANCT	Kevin Smith
FQ4ESE	Frankenstein
YC3KZZ	Beast Boy
4LS32K	Batgirl
V3GTHB	Aquaman
B5ABP	Lobo

Code	**Extras**
5MZ73E	Studs x2
EWTPKA	Fight Captions

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LEGO ARTISTRY with builder/photographer **CHRIS McVEIGH**; mosaic builders **BRIAN KORTE, DAVE WARE** and **DAVE SHADDIX;** and sculptors **SEAN KENNEY** (about his nature models) and **ED DIMENT** (about a full-size bus stop built with LEGO bricks)! Plus Minifigure Customization by **JARED K. BURKS**, step-by-step "You Can Build It" instructions by **CHRISTOPHER DECK**, **MINDSTORMS** building, and more!

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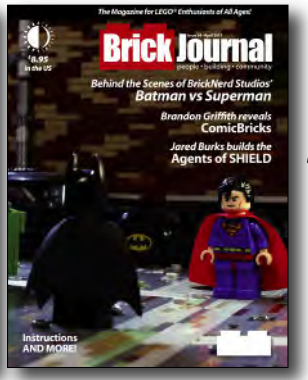

BRICKJOURNAL #34

TOMMY WILLIAMSON on the making of his YouTube sensation **BATMAN VS SUPERMAN, BRANDON GRIFFITH'S COMICBRICKS PROJECT** recreates iconic comic book covers out of LEGO, **JARED BURKS** and his custom **Agents of SHIELD** minifigs, step-by-step "You Can Build It" instructions by **CHRISTOPHER DECK**, BrickNerd DIY Fan Art, **MINDSTORMS** robotics lessons by **DAMIEN KEE**, and more!

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Community Ads

Last Word

Hope you had as much fun reading this issue as I did making it—I learned a lot and got to talk to some old friends and make new ones. I also learned a bit here and there about building and programming a LEGO robot.

Next issue is going to be fun—we get a look at some comics-inspired LEGO work...including a video that went online in early December about Batman and Superman. It's not what you would expect. And neither is next issue!

See you then!

'Nuff said.

Something's not quite right here.

GEO needs some training.

We interrupt your regularly scheduled AFOLs comic to bring you something a little different!

Earlier this year, I was asked by my friend, John Kovalic, to write and draw some guest fill-in strips for his on-line DORK TOWER comic. I was quite honored to be asked! For those of you who haven't seen DORK TOWER, it's a comic that is about nerds and nerd culture, but mostly focuses on gaming. Seeing that a) I'm not really a big gamer myself, b) my nerd thing *is* LEGO and c) DORK TOWER is a big influence on my own AFOLs comic, it seemed natural to make my guest strips about the DORK TOWER characters discovering the LEGO way to game, BRIKWARS!

And so we bring you, for the first time ever in print, the strips I did!

Read more DORK TOWER on-line at www.dorktower.com!

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