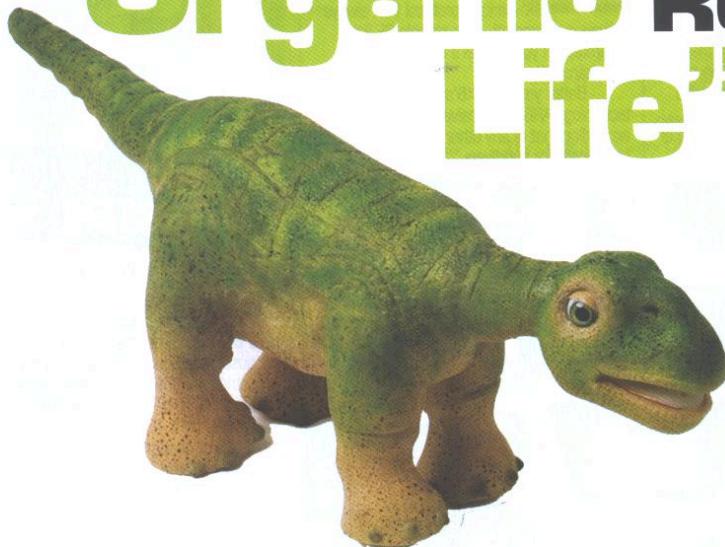


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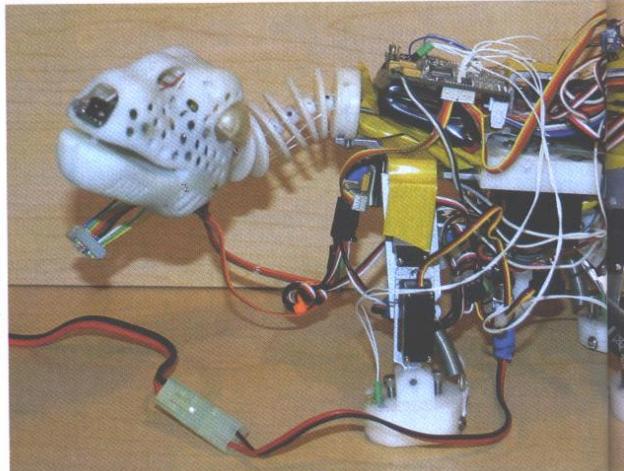
Inside the Ugobe Pleo “Organic Robot Life”



A new robot system patterned after nature thinks for itself

The buzz has already begun about Pleo's amazing ability to represent an organic life form. Pleo is UGOBE's first designer Life Form and is based on the Camarasaurus dinosaur. He is made up of an amazing array of sensors, motors (14!), and distributed computing with an ARM-7 processor commanding it all. This much-anticipated robot Life Form is targeted for limited release in time for the holidays.

Robot was fortunate to be able to chat with UGOBE's Bob Christopher (CEO and Co-Founder), Caleb Chung (Chief-Inventor and Co-Founder), and John Sosoka (CTO) about their company and Pleo.



ROBOT: What is UGOBE's vision?



CALEB CHUNG: There is nothing new with people wanting to make lifelike creatures. Making an organic, lifelike robot, I think, is just an execution of a commonly held cultural vision. We are going after artificial life, and we hope our products create an emotional response within people.

We want to combine science and art and do it so well that you forget about the science. Similar to what Pixar is able to do with its films. They take a very difficult thing to do—CGI—do it incredibly well, and then they make you completely forget about it so you only care about the characters. The technology becomes transparent. So instead of showcasing our robotic talents, we want to use our abilities to create emotional responses—like a pet.

ROBOT: Why start a new company?

CC: I've been working on animatronic toys and dinosaurs for many years. I did Furby back in 1998 with a couple partners and hoped the toy and entertainment industry would take off in the direction that Pleo will be going. The toy industry floundered on this idea, and I realized you can't do something like Pleo from inside the toy industry—they simply are not set up for this kind

of project.

Creating the organic motion and coordinated gestures of moving all 14 motors at different degrees of speed and staying balanced at the same time was a breakthrough we were able to achieve. We can program this sort of thing in very little time—hours. Pleo is able to stand on two of its feet, the front right and rear left, and stay balanced without any real-time feedback from accelerometers and the like. That is why we decided to tackle this complex project—because of our breakthrough engineering techniques. Bob helped create the business model to support the vision.



BOB CHRISTOPHER: The toy industry was not prepared to make the level of investment that the Pleo idea required. We have invested over \$1 million dollars in the development of Pleo.

ROBOT: Why a dinosaur?

CC: First, you can't have a dino like you can have a dog or cat. What's neat about the baby dino is that you can have a 1:1 scale. Biologists are telling us that Pleo is approxi-

mately correct for a two-week-old Camarasaurus. We actually obtained skeletal remains and measured them so that the geometry reflected in Pleo is as close as possible to the real thing. We took a little artistic license to make bigger feet and bigger eyes and a shorter neck. Second, from the character design, the Camarasaurus was a good choice. It has a longer neck and tail, which help to communicate expressions. It also has a bigger face and bigger head, so we could have expression through the eyes.

ROBOT: Tell us about the level of complexity within Pleo.

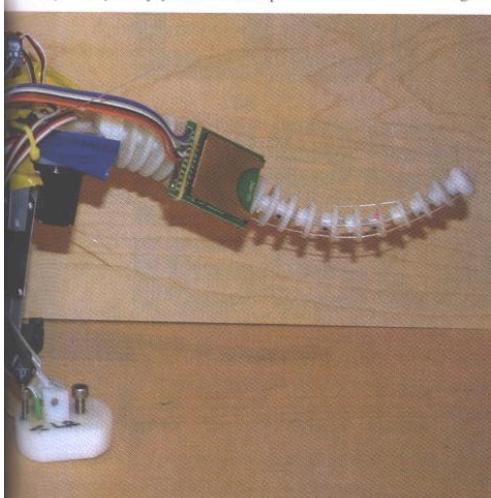


PHOTO ABOVE: MACK FRAGA, UGOBE, INC.



JOHN SOSOKA: One of the ways to get Pleo to be lifelike is to give it the ability to have a lot of information about its environment. By having multiple sensors, Pleo can find out a lot about what's going on. Some of them are sensors that you would not normally expect. For example, there are clutches in the leg so that when the user starts torquing on the leg, the internals don't break. But we designed it so that Pleo knows when the leg is moving by an outside force, so he can cry out in pain and then maybe walk with a limp for a while with that leg. That is the sort of thing that starts to blur the distinction between a robot and the real creature.

We also worked pretty hard on the capacitive touch sensors under Pleo's skin, because the idea of pushing a switch really breaks the illusion of dealing with a real creature. You don't have to actually touch the sensors; you just get near them. It's almost like Pleo has little hairs on his skin. It has been a challenging design problem because of the environment that the sensor is in, but the payoff has been great.

CC: Of course we could have used micro-servo motors to accomplish the motion of Pleo, but we aren't able to use expensive motors. So we had to engineer it with a high-speed motor with high gearing and no backlash for control purposes and have it all fit within the muscle envelope of Pleo. The internals of Pleo look like a cell phone because of the electronic and mechanical components' interaction in such a small space.

ROBOT: What goes into making a robot more lifelike?

CC: What we didn't want was something where you squeeze its hand and it counts to

UGOBE PLEO ROBOT

ten. Humans are very good at seeing patterns, and these patterns have to be based on rules. The rules are what fascinate people when they look at an organism. We've had to study a lot of psychology to understand animal behavior—we probably have more books on animal behavior than on robotics.

It really is kind of surreal—you find yourself on the same path as nature. For example, nature has lactic acid to cause our muscles to slow down when they are getting overworked and inefficient. Similarly, when running all the motors in Pleo, the batteries wear out quickly. We had to write “lactic acid” code to limit the current draw and have Pleo change behaviors and take a rest when the motors are being inefficient due to current draw. The effect is what we expected; Pleo looks more natural and conserves power.

ROBOT: What range of behaviors and limits does Pleo have?

CC: It is hard to characterize Pleo's range of behaviors because we don't program exactly what he does. We just give him choices.

JS: The issue we had was that he has so many ways to express himself with all those degrees of freedom and sensors that it was too rich of an environment. We had to take a different approach from the usual simple state machine software, because that approach did not capture enough detail, and it wasn't flexible enough. So what we did was go after a lot of ethology research. How do animals really handle the complexity of their environment? We built a virtual brain—a whole system that decides how Pleo will react in various situations.

Eventually, we got to the point where we don't know what Pleo will do next because he learns. If Caleb and I went to your house to see your Pleo, we couldn't predict a lot of the things he would do, even though we know everything we put in him. Pleo has



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the ability to change and figure things out on his own.

ROBOT: How would you describe Pleo's ability to learn?

JS: We want the creature to adapt to its environment—more like a life-form. If you play with him a certain way, we want him to adapt to that. So if you play rough with Pleo, he will get used to that and start thinking it's fun.

CC: Pleo will reset thresholds and adjust his idea of what he thinks is normal. Let's say you get Pleo and you take him home to your shag carpet. When Pleo walks, the carpet will drag on his feet. So his force feedback sensors will realize that he is spending too much energy to walk around. Pleo will try different things to reduce the energy spent. Eventually, he will have the idea to step higher. Your Pleo compared to my Pleo will walk with a higher step.

ROBOT: Tell us about the Software Development Kit (SDK).

CC: The dashboard of our personality engine, our development software, looks like something out of NASA. There are many widgets, sliders and controls for tweaking every aspect of Pleo's personality, and that's just for creating the base-

line product. The users will be able to do tweaking at a simpler level. They will be able to take the SD card from Pleo and go online to adjust his age, hunger, fatigue and basic personality traits.

BC: It is anticipated that there will be a couple levels of software development kits. Consumers will be able to download and customize Pleo later this year or early next year. We want to give the user the ability to change Pleo's personality, animations and tricks. We also want to allow developers and hobbyists to take the SDK and motion system and behavior system and choreograph advanced features and animations for new AI functionality.

CC: We didn't include a camera (or voice recognition) in Pleo because of the price point for the product. Pleo is probably a good hack for a CMU camera, and we want people to develop these sorts of things.

ROBOT: Any final words about your work?

CC: The only way you can create life is to give it choice. Life is very complex, and it has to evolve, otherwise it is a robot. The only way to get complex systems to work is to let them chose for themselves. ☺

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