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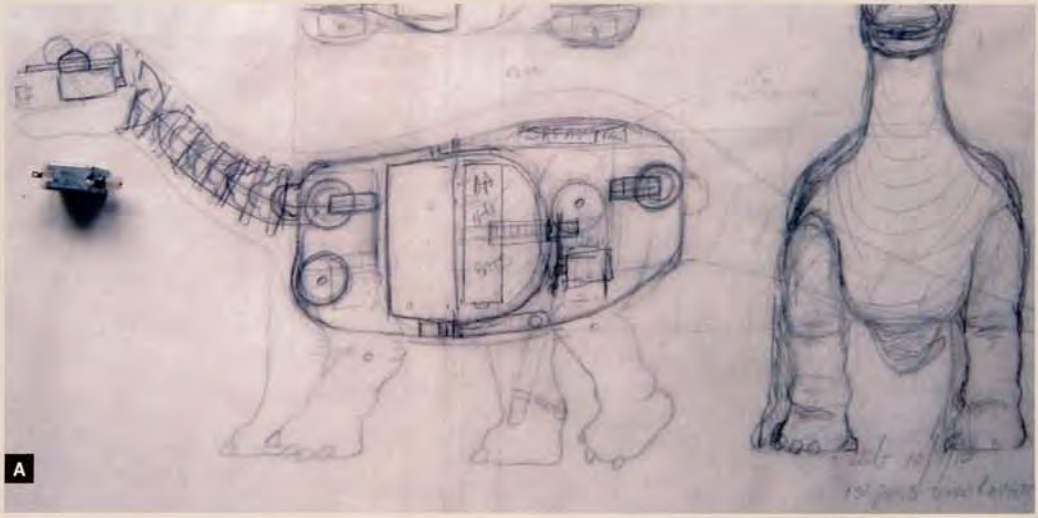
I, PLEO

How Caleb Chung went from street mime to toy-robot maven.

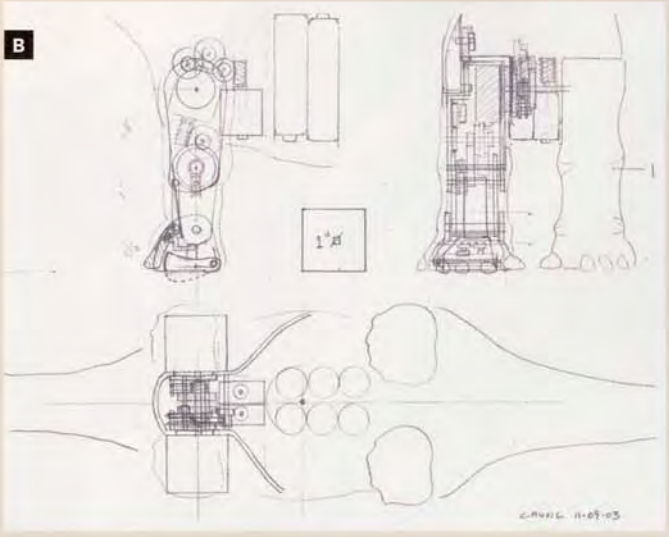
INTERVIEW & PHOTOGRAPHY BY ROBERT LUHN

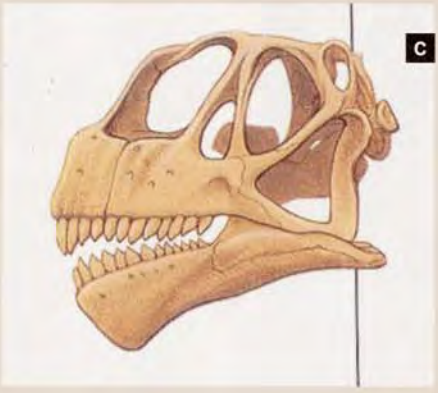
Can a machine have a soul? Can it think? Can it laugh and cry, bug you for a snack, tease you, or curl up on your couch and dream robotic dreams? Can you build such a machine? And can you sell it for $250?

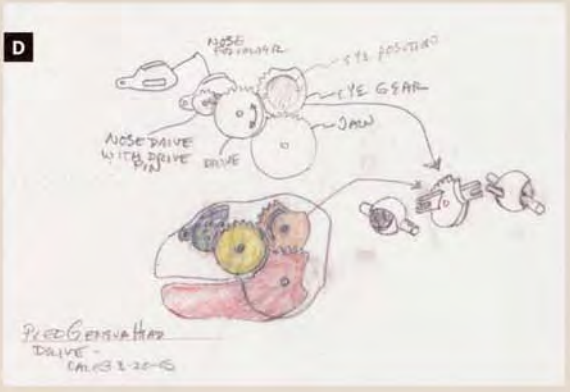
It's alive! Puppet master and puppet — or rather, Caleb Chung and his autonomous robot companion, Pleo.



A. Pleo is the size of a week-old baby camarasaurus, a dinosaur from the late Jurassic period. **B.** A camarasaurus' naturally stocky legs are perfect for containing motors and gears. **C.** Chung and his colleagues studied camarasaurus fossils to create an accurate model for Pleo. **D.** The head contains an IR communication device, an object detector, a light sensor, a mouth object sensor, and a motor to control jaw, nose, and mouth movement.







Those are just some of the challenges facing Caleb Chung and his cohorts at Ugobe, Inc. ("*You! Go and be!*" Get it?) Chung doesn't need the tsuris or the money. As one of the developers of the Furby, which has sold an estimated 40 million units since 1998, Chung never has to work again. But there's something gnawing at Chung, something beyond conquering the toy world again or making enough money to buy his own country.

"Humans have a fundamental need to nurture — it makes you a better person," says Chung. "And one of the roles of digital life forms is to bring out the best in people."

The embodiment of Chung's passion? An unassuming baby dinosaur — the size of a cocker spaniel — called Pleo. Inside this camouflage-green camarasaurus is a ton of technology: 14 servo joints; 38 touch, sound, and light sensors; a half-dozen digital signal processors; a gaggle of electric motors; a camera installed in its nose; an infrared transmitter for communicating with other Pleos; a flash-card slot; and a real-time operating system that oversees Pleo's lifelike movements and its personality.

Outside, Pleo is sheer experience, performance art combined with emotional sleight of hand — just what you'd expect from Chung, a former mime. Pleo ambles along in amazingly lifelike fashion, smiles and shrugs, frowns when he's unhappy, and yowls for "food." According to Chung, Pleo is not only autonomous, but evolves over time based on your interactions with him. Unlike his robotic brethren, Pleo isn't a battle bot; he's a love bot, designed to be your pal and to summon your latent (or overactive) nurturing instincts.

But something more primal drives Chung: the desire not only to manipulate life, but to create it from scratch. To create a robotic companion that thinks and, maybe, even feels. Call it the Geppetto Syndrome.

It's Alive! (Kind Of)

To meet the puppet and the puppet master, I fly up to Chung's lab in Boise, Idaho. As I stride out of the spacious new terminal and behold the stunning mountains in the distance, a worn, white Lexus pulls up to the curb. Out jump Chung and John Sosoka (chief technology officer and key artificial intelligence guru), both clad in Hawaiian shirts and flip-flops — standard high-tech attire in Boise. After a jovial exchange of handshakes and jokes, we're off — and so are Chung and Sosoka, chatting animatedly about the joys of Boise, the nature of robotic emotions, synthetic versus organic life, and more. A fancy lunch follows, and then we're off to the lab.

Alas, there are no bubbling beakers, giant sparking electric generators, or even a tiny tar pit for Pleo to play in. The "lab" is a nondescript box in a faceless office park, manned by a handful of engineers and designers. I meet the staff and poke around, examining Pleos in various stages of undress. One Pleo has returned from a demo in China in tatters, apparently chewed by a jealous panda. Another is stripped down to its motor/gear/wire skivvies, as three engineers fiddle with a locomotion problem. I snap pictures of Caleb in silly poses with Pleo and talk with one of the engineers about the joys of QA testing Pleo's tail.

Later, at a local cafe, I chew the robotic fat with Chung and Sosoka and finally meet a more-or-less working Pleo face-to-face. To say I'm skeptical is an understatement. The company's website and literature make some mighty big claims: "[Pleo is the] genesis of a whole new era in robotics. If you can imagine it, Ugobe can create it," "Pleo is the first truly autonomous Life Form capable of emotions that allow personal engagement," and "Pleo ... can feel joy and sorrow, anger and annoyance ... even dream." The Pleo I meet runs a six-minute script that showcases his range of motions and emotions, but it's hardly autonomous.

Still, for a construction of rubber, gear trains, CPUs, and wire, Pleo is pretty engaging, with a sly smile on his face that's pure Chung. Chung puts Pleo through his paces, the baby dino showing fear (complete with trembling), happiness (wagging tail, dancing, little yippy sounds), groaning for food, playing dead (like a kid, dramatically falling over with a clunk), sneezing, and more. Pleo's motions aren't perfect, but that's the idea.

Illustrations courtesy of Ugobe

"Pleo's movement has 'noise,'" says Chung. "That's what makes it organic. And because he moves naturally, his movement becomes invisible — and that's when you become interested in what Pleo can do, what he's thinking."

Thinking Pleo

The question is, what can Pleo do or think about? At this point, it's a little theoretical because Pleo is still a prototype. But according to Chung and Sosoka, Pleo will be autonomous first and foremost — which means no remote control.

"When you leave for work in the morning, your dog doesn't sit by the door all day. He explores; he does stuff. Pleo will be doing something when you're gone because he's alive", says Sosoka, without a trace of irony.

Pleo will also remember and adjust his behavior accordingly; in other words, he will learn. If you twist Pleo's leg, he'll know you're abusing him. He'll cry out and limp, and you won't be able to play with him for a while. He'll store that grudge, cataloging the event and assigning it a value. The next time you try to play with him, he may snap at you. Conversely, the more you reassure and nurture Pleo, the quicker his naturally sunny nature will reappear.

As you'd expect, Pleo is programmed with strategies for solving certain problems, such as finding food. But ultimately, says Chung, you can't program every possibility. "You have to let him choose. Pleo keeps a record of what works and what doesn't — filtering experience the way all living things do."

Like his Furby forebears, Pleo will be able to communicate with his kin, although Pleos will do more than swap colds. "When two or more Pleos get together, there'll be some kind of meeting ritual and they'll pick the 'alpha' — and that Pleo will transmit behaviors and tricks and moods to the others," says Chung. But that's just a start.

You can plug Pleo into your PC via USB, run a little program, and adjust Pleo's personality by moving sliders or writing scripts akin to JavaScript or Logo. Want to really hack Pleo? In the future, there may be a C/C+-style developer's kit that lets you mod the dino to the max. Whatever personality you create, you'll be able to back it up and share it with others.

"Pleo is not a closed product. At every step we ask, 'How can other people play with Pleo, modify it, personalize it?'" says Sosoka. Eventually, users will upload new personalities and tricks to Ugobe's site that others can use. "Pleo is ultimately a platform, and creating new Pleo personalities is like making a movie." Pleo, in short, is as much art form as life form.

Making Pleo

Building that art form, however, involved some real-world tradeoffs. For example, why build a robotic baby dinosaur? Why not a popular computer-game character?

It was a sound business decision, says Sosoka. "Dinosaurs are great, they're already a brand, and you don't have to pay royalties on them." More important, says Chung, is that you'd never be afraid of a baby dinosaur like Pleo — he's small enough to sit on your desk. And a baby anything is easier to animate. Adult creatures have sublime, complex movements; babies falter and stumble, and they have a smaller emotional palette. One plus even a baby camarasaurus offers: big, blocky legs, perfect for holding motors and gears.

And these motors and gears have been notable headaches. "Exotic magnets that go all the way around a motor are really powerful, really efficient, and really expensive," says Sosoka. The solution? Write a sophisticated control program that makes cheaper, less accurate motors work better. Slap a 12-cent 6502 processor on the motor, says Sosoka, and you've got a smart servo that knows force feedback, self-clutching, and self-calibration. "We do a lot of localized intelligence, just like your body," he adds. Off-the-shelf gearboxes were noisy, so the company turned to an "unrelated" industry for custom units.

Ugobe won't disclose much about its real-time "Life OS" that oversees Pleo's movements and cognition. Basically, Pleo is built around a simple, one-layer neural net; something happens and the event is weighted and remembered. Over time, the connection strength between a stimulus

A. Pleo is a proportionately correct baby camarasaurus robot. B. An exoskeleton provides support. C. Motors, gears, and linkages provide realistic movement. D. Sight, sound, and touch sensors are hidden under the hide.

(like turning Pleo upside down) and a response (Pleo laughing or crying) changes. "It's almost like muscle memory," says Sosoka. It doesn't dictate how Pleo will react every time an event occurs, but Pleo's past experience will influence his future choices.

The other key factor in Pleo's reactions? Emotions. (Well, what passes for emotions in a $250 robot.) The factors that really control Pleo are his drives — hunger, bonding, fatigue — and the goals associated with them. If Pleo's hungry, the goal is food, and the preprogrammed strategy Pleo picks to meet this goal is based on which one worked best in the past. It's kind of like fuzzy logic: rules combined with sophisticated probability with a little sloppiness allowed. In an unusual situation, emotions — colored by Pleo's success or failure, someone hitting or petting him, etc. — act as a secondary control system. It's why Pleo should have many different reactions to a given stimulus over time.

From Mime to Machine

Pleo's ultimate stimulus, of course, is Caleb Chung. Chung has pushed, prodded, and pulled Pleo into existence with a scary singlemindedness. "He's a character — a mad scientist," says Ivy Ross, a former Mattel executive who worked with him on the Miracle Moves Baby doll. "He has a vision and relentless drive to bring something alive."

Gary Schwartz, longtime friend and Chung's mime partner, says simply, "He's the irrepressible kid, the incarnation of Tom Hanks in *Big*, pure inspiration, pure yin, but with the emotional savvy of a 50-year-old."

How did Chung get from street mime to toy-robot maven? At first glance, Chung's resume looks like a hodgepodge of careers. He went from performing mime (as part of the Schwartz & Chung comedy team in the 70s and early 80s), to voicing live-action TV cartoon characters (he was QT the Orangutan in *Dumbo's Circus*).

By chance, he applied for and got a job devising cutting-edge toys for Mattel's R&D group. Later, his knack for creating props led to work designing mechanical effects for such films as *Total Recall*. Since the late 90s, he's consulted with various toy companies, helped develop Furby, and ultimately, decided to tackle Pleo.

Illustrations courtesy of Ugobe (A, B, C). Illustration courtesy of Mack Fraga Studios (D)

"Pleo's movement has 'noise.' That's what makes it organic."

In his years as a performer, Chung became a master of props and mechanics. "We got a gig on the *Queen Mary* in Long Beach to entertain the tourists," says Schwartz. "They couldn't afford animatronics, so they hired mimes." It was here that the duo created their first notable bit, "Caleb 9000." Chung did a spot-on robot routine while Schwartz, offstage, supplied his voice. At the end of the bit, Caleb 9000 says, "Absolutely nothing can go wrong ... wrong ... wrong" and then blows up, courtesy of a remotely triggered explosive pack Chung designed.

So what's the connection between mime and robotics? "Caleb is a superb actor," says Schwartz. "It's a key skill that game and robotics animators need to learn. As a mime, you're also super-aware of your body, of motivated movement, the physical cues to emotion." Chung's ability to tell a story via movement, to play a cartoon character, to suspend disbelief, and to think like a kid is uniquely suited to dreaming up innovative toys or convincing you that an animatronic dinosaur is emotionally aware.

Not surprisingly, the inspiration for all of Chung's work is his fervent belief in, yes, magic. "The first books my mother read to us were Tolkien's," he says. "Fantasy and magic were an integral part of my upbringing. They've become an integral part of my product design. I want to transmit that wonder."

Not just via robots, mind you, but via random acts of surrealism. Take Chung's interest in, um, fairies. On an island near his house, Chung collects sticks and makes little fairy furniture that he leaves all over the island — a little chair, a tiny broom, maybe a bassinet with a walnut "baby" inside. With a diamond-bit drill, he even carves pseudo-hieroglyphics onto stones. "If you actually found one, you'd never think someone put it there, because it's too frickin' obsessive. But I want to change how people view the world."

A Tale of Two Furbys

After visiting Chung and meeting the lovable Pleo, it's easy to take a sip of Ugobe's Kool-Aid. Chung is intelligent, charismatic, and clearly dedicated to making Pleo a breakthrough. The question is, can he deliver? Ugobe expects to release Pleo in March 2007, but the units I saw — only seven months before release — didn't seem very close to prime time. Still, robotic innovation hardly runs like clockwork, so ship dates are always fluid.

But the dispute over Furby — the robotic toy that made Chung's reputation and fortune — casts a shadow over Chung's current efforts. Chung, who was responsible for the design of Furby's mechanics, tells one story about how Furby came to be.

David Hampton, the co-inventor responsible for the programming and electronics, tells a rather different one, which is mostly corroborated by several former executives from Tiger Electronics, the company that licensed Furby. (Tiger was bought by Hasbro the day after Furby's debut at the 1998 International Toy Fair in New York.) The engineer brought in to "save" the project contributes still another angle.

What most everyone (including Chung) agrees on is that 1) the mechanics for the Furby prototype that was going to be demo'd at the Toy Fair didn't work; 2) mechanical engineer Richard Maddocks' last-minute assistance helped get Furby working in time; and 3) after the Toy Fair, Chung was bumped off the project.

The rest of the story has multiple versions as to who did what, when, and why. On one hand, it's clear that Chung bit off more than he could chew. While he was instrumental in developing the Furby concept and designing the mechanics, execution was another thing. Chung couldn't use off-the-shelf parts; the tiny pulleys, gears,

Photography by Robert Luhn; Furby drawing by Kelly Heaton

A

B

C

E

A. *The Anatomy of the Furby* by artist Kelly Heaton, who once made an interactive Furby wall. **B.** A Ugobe engineer troubleshoots a locomotion problem with Pleo. **C.** Caleb Chung's lab is an unassuming box in a small office park outside of Boise. **D.** A Pleo tail-testing unit. **E.** Pleo in a classic pose.

D

cams, and other parts had to be custom made to very fine tolerances. If a part didn't work, Chung modified it until it did — but that introduced friction that could stall Furby's motor. "[Chung's] design was brilliant and sound in principle," says Richard Maddocks, now a senior principal designer at Hasbro. "But there was a huge amount of stuff packed into a very small form factor. No one had ever done this before. I didn't redesign Furby — I just helped it run reliably."

First, Maddocks put in a bigger motor to overcome the friction. Then, he created new parts to replace Chung's oft-modified (and worn) parts. After some final tweaking, he got Furby working reliably enough to debut at the Toy Fair.

Chung also readily admits he was lousy at overseeing his time and that of the engineers and machinists he hired. (At the same time, he sings David Hampton's praises: "He's a virtuoso in digital design and programming — a great talent who, until Furby, never got the credit he deserved.")

Tiger, too, can be faulted for slashing Chung's prototyping budget (from $60,000 to $40,000) and not keeping a closer eye on the progress of Chung's work, which, after all, involved making something that no one had ever made before. "We were undermanaged," says Chung. "God knows, I needed a manager."

What did Chung learn from the Furby?

"I thought I could run the process and manage a group, but I made some bone-headed decisions," says Chung. "I never made that mistake again. At Ugobe, I invent, I come up with ideas — but I let someone else manage and do the tooling and engineering."

Apparently the lesson stuck. Chung's next project, creating the Miracle Moves Baby for Mattel, won high fives all the way around. Ivy Ross, the senior VP in charge at the time, lauds Chung's dedication and ability to execute.

"Caleb really understood the emotional connection [the doll] needed to have with kids. We didn't have this kind of expertise in house. Caleb showed up and collected a whole group of experts who made it happen," he says.

The Soul of a New Machine?

The Great Furby Debate may never be settled. As the old saying goes, "Success has many fathers." The acid test for Chung will come when Pleo hits the market. Will it work as advertised? Will buyers embrace Pleo as their robotic pal, or dismiss it as a novelty? Chung's reputation and his worldview are riding on the results. But Chung is simultaneously bullish and realistic.

"I think we have something magical," says Chung. "When I showed off Pleo at the Demo 2006 show [see makezine.com/go/pleo], I realized this moment in time would be remembered in the history of man-made life-forms. They'll say, 'These people didn't have all the tools, and there were all these restraints, but they tried to do this for real.' Still, I don't have to prove something to the world. Pleo is going to be what it's going to be."

But if Pleo lives up to half its promise (and a fourth of its hype), it will raise a host of intriguing and troubling issues. Is Pleo an autonomous life-form? Is he sentient? Can he feel?

"All that matters is what the user perceives," says Chung. "Once you create organic movement and add just enough emotive cues, people will suspend disbelief — they'll fill in the rest and fall in love with Pleo." Besides, he adds, he's not even sure it is suspension. "I think Pleo really does these things."

But if Pleo or his successors develop even a tincture of self-awareness, don't Chung and company have a huge obligation to these new creatures and their human owners?

"Of course we do — especially for a creature that plays to the human heart," says Chung. "An invention like Pleo can fundamentally change society. That's why we want to be first, to set a responsible tone. These machines are extensions of us, how we think and feel. As much as we're going to get monsters and creatures we don't want around, we'll also get beauty and magic from artists who really know how to create," he says. "Great art tackles the great issues of our time. That's why we're digging here — we're digging in the right place."