shoemaker Goosebumps Products Inc. has sued supplier Bell Chem Corp., accusing it of delivering the wrong chemical for an insole gel, caus-
roduce an unwanted sound effect. "They were whoopie cushions for the feet," Goosebumps spokesman Bryan Thomas said. — *Associated Press*

ROBOT LEARNS WITH EACH STEP

## Energy-efficient design mimics strolling human

By Paul Recer
ASSOCIATED PRESS

WASHINGTON — The difference between man and machine is shrinking. Scientists have developed a robot that "learns" to walk like a toddler, improving its step and balance with every stride.

The walking robot looks more like a moving Erector set than a human being, but the machine has the unmistakable gait of a person strolling along. The robot uses its curved feet and motorized ankles to spring its legs forward, its arms swinging at every step to help with balance.

Researchers on Thursday showed off the learning, walking robot, along with two less-advanced models, at the national meeting of the American Association for the Advancement of Science. A report on the research appears this week in the journal Science.

The machines use what the researchers called a "passive-dynamic design" that closely mimics the way humans walk. Earlier robots required powerful machines to stroll, with each leg, knee and ankle requiring motorized assistance. The effort requires a lot of energy.
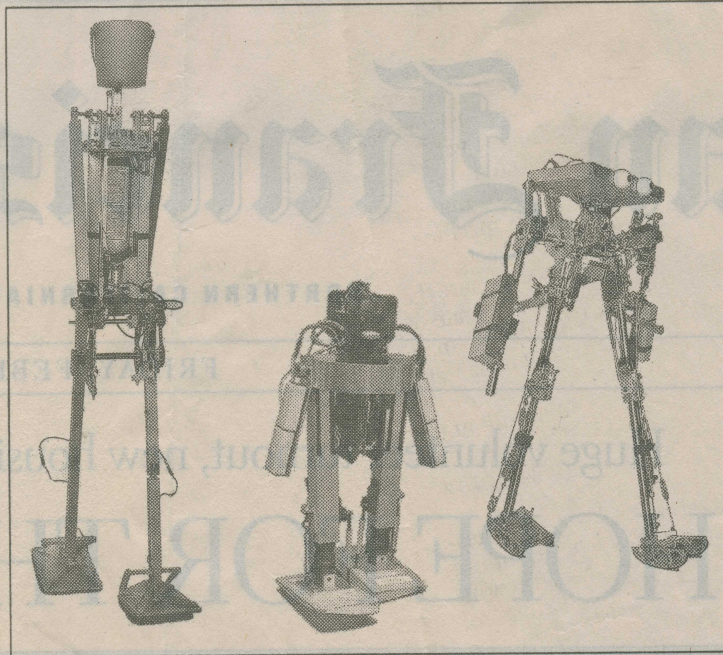
STEVEN H. COLLINS / *Science via Associated Press*

Researcher presented three robots at the Washington meeting: MIT (center) is a learning, walking robot; Delta (left), and Cornell (right) are two less-advanced walking models.

The passive dynamic design uses gravity, along with muscle-like springs and motors. The energy required is a fraction of that needed by other walking robots, said Andy Ruina, a Cornell University researcher.

Ruina said the walking robots move like humans, falling and catching themselves as they move forward. This essentially is the same movement people use, a motion toddlers must master to walk.

"We let the machines take care of a lot of the motion," he said. In contrast, most walking robots, such as Asimo, developed by the Honda Motor Co., require a motor to power every motion.

A robot designed by Russ Tedrake of Massachusetts Institute of Technology is equipped with sensors that help the machine learn to walk in a way similar to humans' gait. Appropriately, the machine is called "Toddler."

The robot's sensors measure the machine's motion, tilt and rate of movement and then direct small motors to adjust and compensate for changes.

"It can learn to walk in 20 minutes," Tedrake said. "Once it learns to walk, then it adapts its gait to new terrain."

He said the sensors take measurements at the rate of 200 times a second and constantly send new instructions to the motors that control the tilt and motion. The sensors also direct actuators that control the tension on springs in the robot ankles. This helps the machine push forward with each stride.

"Every time it takes a step, it changes the parameters a little bit, based on its experience," Tedrake said. "It will walk on any surface and adjust the way it walks."

In effect, the robot changes its stride just as humans do when moving from sand to grass to pavement.

He said the machine even has learned to walk on a treadmill, making adjustments as the surface tilts or speeds up. The robot can start on its own and even walk backward.

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