Science

Discovery Channel on-line guide

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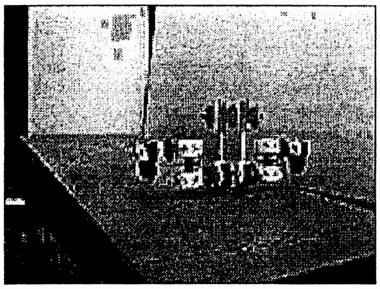
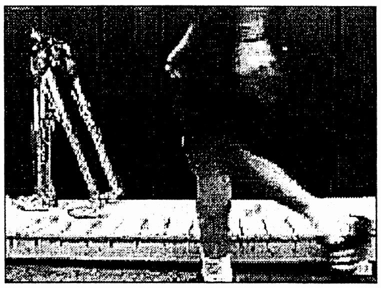
These two-legged Tinkertoys are going downhill fast April 9, 1998



Mike Coleman's tinkertoy creation is going places...Click the image and see.

Researchers at Cornell University may be playing with Tinkertoys, but they're not fooling around. They've created a little gravity driven robot that can't do much except walk. It can't even stand still without falling down. But this toddling Tinkertoy may hold significance for the development of prosthetics for people who are gait-impaired, as well as new systems for advance walking robots.

The robot is made of plastic Tinkertoy parts and a couple of other tack-ons. It has no electronics, no motors and no gyroscope-like stabilizers. But it walks down a mild sloping surface, well, not exactly like a runway model, but well enough to provide mechanical engineers with insights into human locomotion. "We believe this is the first two-legged, statically unstable 3D passive-dynamic walker that can walk stably down a slope with no control systems whatsoever," says its developer, Cornell mechanical engineering lecturer Mike Coleman. But what does all that mean?

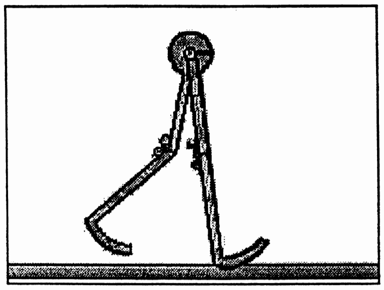


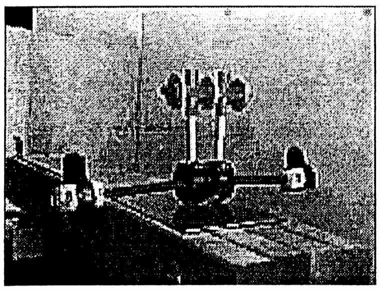
This robot has knees. Click the image and see it do the catwalk.

A passive walker refers to a walking device that has no feedback control systems, nothing to tell it when it is losing its balance or moving too fast. A walker that is described as dynamic but statically unstable is one which is stable when it is moving dynamically through space, but isn't when it's *still*. A good example of that would be a rolling coin, or even a bicycle, which stands up when it is in motion, but falls down as soon as it stops. An example of a system that's statically stable might be a chair or a bridge.

It all may seem complicated, but

It all may seem complicated, but the goal of the work at Cornell's Human Power Lab, where the robot was designed, is simplicity. They quote Einstein on their web site: "Make the model as simple as possible, but no simpler." The study of human design is a little explored region of mechanical engineering, according to Andy Ruina, one of the lab's founders. Clearly, though, it has important ramifications in the development of not only robotics, but devices to help disabled humans as well. The engineers at the lab take something of a backward approach to mechanical design, trying to decode the human body, a system which has already been designed.





Another version of the bipedal tinkertoy walker. Click the image to see it go.

Their approach de-emphasizes the role of the brain, the nervous system and the muscles in the act of walking. There are several reasons for this. For one thing, the complex feedback loops that the brain and spinal cord use in walking are poorly understood. To simulate them would invariably involve making presumptions about human neurology that can't be confirmed. Perhaps more importantly, research has shown that some very basic human motions, including gait, actually use little in the way of complicated feedback loops. Walking doesn't seem to use muscles that much. Legs swing in just the right way to minimize energy use.

Human Power Lab researchers like to compare the work they are doing on gait synthesis to the pioneering days of airplane design. Their Tinkertoy walkers are like the early motorless gliders, uncontrolled models and paper plane-like devices that were the forerunners of modern aircraft. They believe their simple, no-frills walking systems will underscore basic gait fundamentals that can later benefit from the addition of motors, feedback mechanisms and other sophisticated controls. But for now, they're happy when their toys wobble, but don't fall down.

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