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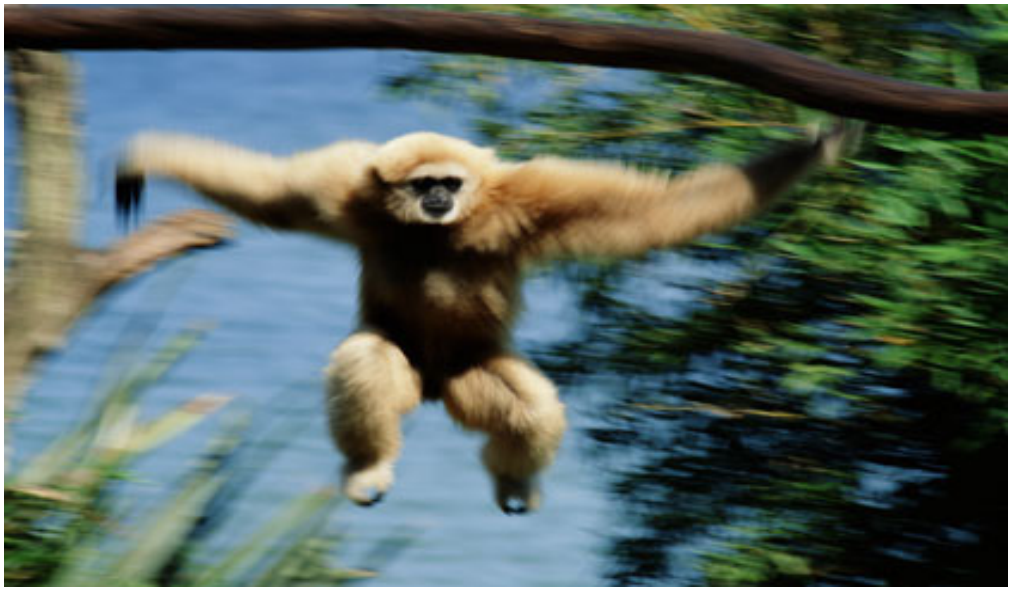
A Tireless Stroll, in Theory

What do a rolling wheel, a walking toy, and a swinging ape have in common? In the absence of friction and collisions that make them lose steam, all three can cruise along without using up one whit of energy, according to new research. The findings suggest that animals move in way that minimizes the work their muscles do.



Swinger. Using ideal movements, this ape would run out of trees before it ran out of energy.
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Once in motion, objects tend to stay in motion, according to Newton's law of inertia. So without air resistance and other energy losses from friction, a wheel rolling along a flat surface will keep on trucking forever. Biomechanists Andy Ruina and Mario Gomes of Cornell University in Ithaca, New York, wondered if a walking or swinging robot--as long as it had no friction in its joints or air resistance--could achieve the same feat.

To find out, the researchers developed a mathematical simulation of a robot with two legs attached to its body by hinges and springs. They then eliminated collisions that dissipate energy, for example, by making the robot take infinitely soft steps as it walked along a flat surface. Under these conditions, the robot strolled along indefinitely. Its pendulumlike motion kept it going: Energy shuttled back and forth between the rocking of its body and the shuffling of its legs, the researchers report in a paper under review at *Physical Review E*.

A similar model using a hypothetical swinging ape produced more lifelike motion. Lacking any springs, the ape could gracefully swing along monkey bars in either a walklike motion, where one hand was always holding fast, or in an analogue to running, where the ape takes flight in between handholds. In either case, eliminating friction and collisions allowed the postulated primate to coast indefinitely, the researchers report in the December issue of the *Journal of Theoretical Biology*.

The solutions these models use to eliminate energy losses in collisions are "profound and quite beautiful," says biomechanist John Bertram of the University of Calgary, Canada. The work shows that using energy is not