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News and Views
Material witness: Miniature motors
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The physicist Richard Feynman did not get much wrong. But when in 1959 he offered $1,000 to anyone who could make an electric motor no bigger than 1/64th of an inch on any side, he figured his money would be safe for some time. He was chagrined to find his challenge met only months later by Bill McLellan, a mechanical engineer and alumnus of the California Institute of Technology.

It wasn't the money that Feynman regretted; rather, he'd hoped that his prize would stimulate the development of new miniaturization technologies. He hadn't anticipated that anyone could make the microscopic motor by hand, using existing methods and tools.

Now that I've seen McLellan's motor (one of the several he made), I'm not surprised at Feynman's confidence. It is about the size of a grain of sand, and the feat of dexterity involved in making the components and assembling them into a working device is staggering — all the more so given that McLellan's assembly tools consisted of a pair of tweezers, a fine paintbrush and a toothpick.

But there was something even more astonishing about my recent trip to see the motor, on display in the corridor of the Caltech physics department. The motor sits under a microscope behind a glass panel, surrounded by yellowed, hand-typed labels describing how it was constructed. There is a push-button to start the motor up, but Caltech students burnt it out long ago.

As I marvelled at the sight, a spry man with a white crew-cut walked by and, noticing my interest, introduced himself: "I'm Bill McLellan, the guy who made it."

He was happy to share his reminiscences of Feynman's reaction. Already wearied by a string of false claims, Feynman seemed to be thinking "Here comes another one" as he watched McLellan carry in his large wooden box. But his expression altered when McLellan opened the box and took out a microscope. No one had brought one of those before.

McLellan was not an electronic engineer, but as a one-time radio ham he figured that he knew enough about electronics to put a motor together. And he knew some tricks of the trade for scaling down components, such as the technique of rolling a fine metal wire between glass plates to reduce its gauge. To drill holes in his minuscule components he used watchmakers' tools.

It was as well that McLellan made several of his motors, because a device smaller than an ant has a precarious existence. The BBC borrowed one to show to its viewers, but they never saw it: as the technicians in London lowered a microscope towards it, they misjudged the distance and squashed the motor like a bug.

There is a curious parallel here with the way it was thought that a new photolithography technology would be needed to reach the present scales of electronic miniaturization — yet the existing methods continue right on, supplying 90-nm and even 65-nm systems. Do we, like Feynman, always underestimate what our current technologies can achieve?