Proposed 'Nanomechanical' Computer is Both Old-School and Cutting-Edge

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A group of engineers have proposed a novel approach to computing: computers made of billionth-of-a-meter-sized mechanical elements. Their idea combines the modern field of nanoscience with the mechanical engineering principles used to design the earliest computers.

In a recent paper in the *New Journal of Physics*, the researchers, from the University of Wisconsin-Madison (UWM), describe how such a nanomechanical computer could be designed, built, and put to use.

Their work is a contemporary take on one of the very first computer designs: the "difference engine," a 15-ton, eight-foot-high mechanical calculator designed by English mathematician and engineer Charles Babbage beginning in 1822. Corresponding UWM scientist Robert Blick said that he was also inspired by the design of a small hand-cranked mechanical calculator invented and sold in the 1950s, the Curta.

The computer they envision could never be as fast as traditional semiconductor-based computers, where individual transistors can operate at 100 gigahertz (GHz). However, Blick told *PhysOrg.com*, "We designed the circuits in this nanomechanical computer with the idea in mind that, at the nanoscale, mechanical motion is quite fast – 100 megahertz to a few gigahertz. This should make them competitive with existing micro-processors, which are used in a variety of mundane applications."

Among these applications are appliances, electronic toys, and

automobiles, all which contain basic computers in order to function but don't require ultra-fast processors.

The design's basic unit is the “nanomechanical single-electron transistor,” or NEMSET, a tiny circuit component that combines a typical silicon transistor with a nanoscale mechanical switch – a tiny moving part. A full circuit composed of multiple NEMSETs could be created, the researchers say, using one step of photolithography and one step of etching, methods commonly used to create silicon-based circuits.

The nanomechanical computer has three main advantages compared to semiconductor-based computers. It is more resilient to electric shock, its circuits can operate at significantly higher temperatures (several hundred degrees Celsius), and it is much more energy efficient, dissipating a fraction of the energy of traditional computers.

Additionally, the computer's memory structure may have an edge over standard memory. A nanomechanical form of memory may not need to be restricted to the “1” and “0” states that a typical computer uses to store a single bit (the most basic unit of information; these values correspond to a memory cell that is either charged or uncharged). A nanomechanical system could have several stable states, allowing for more efficient data storage.

Citation: Robert H Blick, Hua Qin, Hyun-Seok Kim and Robert Marsland, “A nanomechanical computer—exploring new avenues of computing” *New Journal of Physics* 9 (2007) 241.