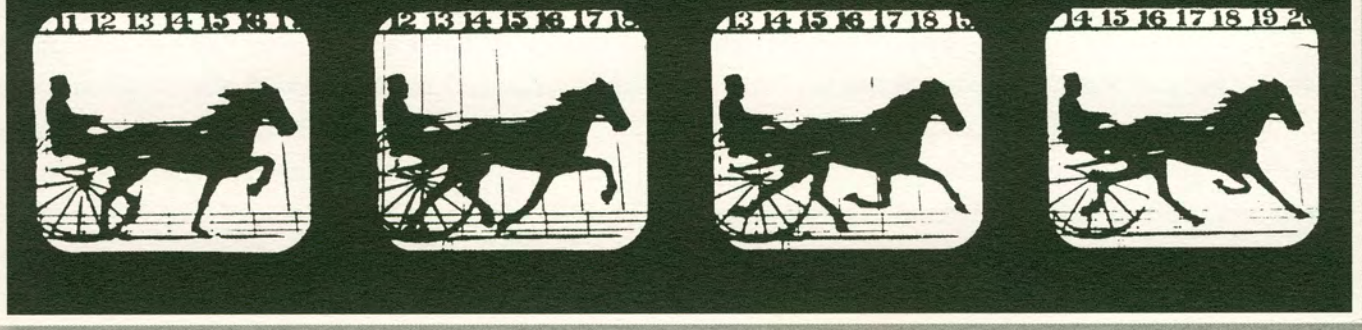
Leland Stanford Jr. on his pony Palo. Alto. May 1879

photographed. may 1879 by Eadweard Muybridge

A series of 8 phases of a stride by a pony while cantering. Photographed on wet collodion plate. E.M.



Illuminating the Possible

JOHN ETCHEMENDY

This historical overview is an excerpt from remarks by Stanford Provost John Etchemendy at an October 20, 2006, groundbreaking at SLAC for the Linac Coherent Light Source (LCLS). The LCLS, the first X-ray free-electron laser in the world, will produce ultrashort, ultrafast X-ray pulses a billion times brighter than any other source on earth. It is the fourth generation of instruments designed to produce synchrotron radiation for scientific research, a concept that SLAC pioneered in the 1970s. The LCLS is the largest science facility under construction by the U.S. Department of Energy.

Stanford takes great pride in the Stanford Linear Accelerator Center and in our long partnership in this enterprise with the Department of Energy. SLAC was hatched in a nearby Los Altos Hills living room by Stanford professors in electrical engineering, microwave, and high-energy physics laboratories. They further refined the idea—as physicists tend to do—at a beer garden just down the road. They called it "Project M"—M meaning *monster*. In retrospect, construction of SLAC was an accomplishment almost beyond imagination, given the overwhelming financial and engineering impediments it presented and the scientific leap of faith it required.

But if history has taught us anything, it is that our inventions become more than embodiments of our aspirations. They command our attention and stretch our capabilities in ways imagination alone cannot. At their best, they surprise us by taking us places we could never anticipate. SLAC has done that, and so too will the Linac Coherent Light Source (LCLS).

The interplay of science and the instruments of science cannot be disentangled. Ian Hacking, a historian of science and former teacher of mine, used to say that the history of science and the history of instruments were one and the same. Tom Hankins and Robert Silverstein put it well in their book, *Instruments and the Imagination*. They wrote:

> *"Instruments have a life of their own. They do not merely follow theory; often they determine theory, because instruments determine what is possible, and what is possible determines to a large extent what can be thought."*

The telescope, the microscope, the chronograph, the photograph: all gave rise to a blossoming of theoretical understanding not possible before their invention.

Eadweard Muybridge photographed Leland Stanford Jr. on his pony (top left) and a trotting horse and driver (bottom left) for his horse-in-motion studies at Governor Stanford's Palo Alto Stock Farm.

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Muybridge's cameras are set up for his pioneering experiments in instantaneous photography, which enabled him to capture images of subjects in motion.

Let me mention just one example bound up in Stanford's history. Instantaneous photography was developed in the nineteenth century to enable images to be captured without first immobilizing their subjects, a limitation of the photographic instruments of the day. Less than a mile from where we are standing, Eadweard Muybridge, one of the pioneers of the technique, famously refined the technology to capture a horse's gallop at Governor Stanford's behest. Muybridge went on to study many forms of human and animal locomotion, while others applied his techniques to investigate the dynamics and kinematics of all manner of objects. Like the telescope and the microscope, instantaneous photography bestowed on science a new set of eyes, revealing phenomena that were previously open only to speculation.

Over the years, six Nobel prizes have resulted from research conducted at SLAC. Five of these were in physics, enabled by the great instrument that gave the facility its name. The sixth, awarded earlier this month, honored Roger Kornberg's discovery of the mechanism of DNA transcription, a mechanism ultimately revealed through images captured at SSRL, the Synchrotron Radiation Lab—another amazing instrument built at SLAC. But Kornberg's discovery was the culmination of 20 years of painstaking work to develop techniques to immobilize the transcription process—immobilize it so it could be captured by SSRL's state-of-the-art X-ray beam.

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What instantaneous photography did for optical images, the LCLS will do for X-ray imaging, allowing us to see processes and phenomena that simply cannot be immobilized: to see, so to speak, the molecular counterparts of Governor Stanford's horse. The LCLS will yield fundamental discoveries in physics, chemistry, biology, and materials science; it will generate applications in medicine, nanotechnology, energy production, and dozens of other fields. We know that. But what is most exciting is that the LCLS will take us places no one can predict.