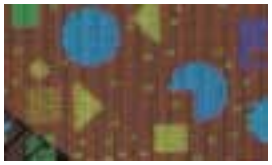
About the Photographs

The National Science Foundation is profoundly grateful to photographer and NSF grantee Felice Frankel for her contribution to *America's Investment in the Future*. Her photographs are compelling visual metaphors for the scientific and technological advances celebrated in this book. While they are not literal representations of the research described, Frankel's images enable the Foundation to communicate the dramatic impact of the basic research it advances.

Frankel is an artist-in-residence and research scientist at the Massachusetts Institute of Technology. Her first NSF grant was awarded in 1997 for "Envisioning Science," a project in which she works with students and researchers to raise the standards in scientific imaging and visual expression of data. She is writing a handbook for scientists on how to communicate their research through accurate and compelling images. MIT Press will publish *Envisioning Science* in 2001. Frankel and colleagues from MIT and around the country are also establishing an initiative to promote new collaborations among researchers, imaging experts, and science writers. The initiative will begin with the Image and Meaning: Envisioning and Communicating Science and Technology conference from June 13-16, 2001 (http://web.mit.edu/i-m/). The conference is partially funded by NSF in partnership with various corporations.

Frankel has been a Guggenheim fellow and a Loeb Scholar at Harvard University, and has received grants from the National Endowment for the Arts, the Camille and Henry Dreyfus Foundation, and the Graham Foundation. In 1997, Frankel co-authored *On the Surface of Things: Images of the Extraordinary in Science* with George Whitesides, National Medal of Science winner and Mallinckrodt Professor of Chemistry at Harvard University. Frankel, who began her career as a landscape photographer, also wrote the award-winning *Modern Landscape Architecture: Redefining the Garden*.



Internet

This extreme close-up of a computer monitor screen symbolizes the transforming power of the Internet, which NSF was instrumental in building. The interlocking pixels suggest the complex network of processors, packets, switches, and wires that make up the global network of networks.

Advanced Materials

Miniaturized wireless communication devices, nonlinear optical crystals, artificial skin, and thin metals are just some of the discoveries made possible by NSF's longstanding support of materials research. The freestanding origami-like microstructures in this photograph were formed by printing a pattern of thin metal on glass capillaries.

From the laboratory of Rebecca Jackman, Scott Brittain, and George Whitesides, Department of Chemistry and Chemical Biology, Harvard University.

Education

NSF-funded education projects and information technologies capture the imagination of students and spark their interest in science, mathematics, engineering, and technology. This scanning electron micrograph of a CD-ROM, taken at MIT's Microsystems Technology Laboratories, reveals the dots and empty spaces (the 1s and 0s) of the disk's binary code. The result: everything from the music of Mozart to the adventures of The Magic School Bus®.

Micrograph taken with the help of postdoctoral fellow Albert Folch, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology.

Manufacturing

A microrotor, the blades of which are depicted here, is just one example of MEMS, or microelectromechanical systems—machines built at diameters less than a human hair. Part of a microscale revolution in instrumentation design, MEMS has become a multibillion-dollar industry thanks in large part to early, basic research funded by NSF.

Research from the laboratory of Martin Schmidt, Stephen Senturia, and Chunang-Chia Lin, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology.

Arabidopsis

Through the eye of the photographer, even the mustard weed, *Arabidopsis thaliana*, becomes a work of art. With support from NSF, plant biologists the world over are cooperating in research to create a genetic map of *Arabidopsis* and thereby unlock the mysteries of all flowering plants.

From the laboratory of Gerald Fink, Whitehead Institute, Massachusetts Institute of Technology.

Decision Sciences

A femtosecond is one quadrillionth of a second. In this photo, femtosecond laser pulses have created micron-sized holes in quartz. NSF-funded mathematicians have systematically studied the complex decision-making pathways that lead to winning strategies—femtoseconds of thought captured in elegant, timeless theorems.

From the laboratory of Eric Mazur and Eli Glezer, Harvard University.

Visualization

Computer visualization techniques pioneered by NSF-funded researchers reveal otherwise hidden details of complex events—the evolution of a storm, the beating of a heart. For this image, Frankel photographed a printed version of the ferrofluid pictured on the cover. The pattern serves as another visualization of the ferrofluid's gryphon-like nature.

Science on the Edge

Scientists and engineers endure harsh conditions at the Earth's icy Poles to find abundant answers to many questions, from global climate change to the cosmic origins of life. Residing in relative comfort, Frankel shot this image of ice crystals condensing and growing on her windowpane in winter.

Environment

What better symbol is there of the environment's enduring, yet fragile, nature than the butterfly? Nightly, the tropical morpho butterfly folds its wings to display camouflaging browns and grays. But sunlight striking the morpho's wings at just the right angle reflects a brilliant, mate-attracting blue, as captured here by Frankel. The environment in all its mysterious beauty remains a vital focus of NSF-sponsored research.

Astronomy

The human race has long yearned to explore and understand worlds beyond our own. This close-up of a telescope lens, so suggestive of a planet's curving horizon, celebrates the many avenues of astronomical research, including the support of observatories worldwide, made possible with support from NSF.

Lens courtesy of Philip and Phylis Morrison, Massachusetts Institute of Technology.

Disasters & Hazard Mitigation

This photograph shows cracking of a silicon chip that was previously deposited by a plasma-enhanced chemical vapor. By understanding the conditions that cause such cracking, researchers gain new insight into silicon microfabrication processes required to create high-powered micromachines. Just as this laboratory "disaster" leads to a greater understanding of matter and manufacturing, so NSF-funded research helps us better understand and mitigate the effects of natural disasters.

Research from the laboratory of Martin Schmidt and Arturo Ayon, Massachusetts Institute of Technology.