Art and Technology

Pamela Vandiver and Jim Druzik,
Guest Editors

Art has as many meanings as contexts in which it operates. It can mean surface decoration or the integral sum of parts and whole which a historian analyzes as structure using visual, musical, theatrical or other criteria. Art serves as decoration, but also serves to signal or sign a particular meaning. Art often confers an elite social status on its patrons or provides goods which support the power and prestige of a special group or person. Art is also used to describe the experience of viewers, usually as "aesthetic experience"; for instance, we experience art as beauty, as a shared emotional experience or empathetic understanding, or as interactive play or a process of performance by which we investigate or relate ideas, occurrences, or objects and give them meaning.

Technology, in contrast, is usually defined as "praxis" and involves doing things, as a craft practice involving materials selection and refinement, followed by making those materials into useful things, artifacts, or objects which serve useful functions for individuals, a social group, class, or culture. The products of technology can be useful as tools that enable a task to be accomplished, or as products which satisfy subsistence needs, or devices, or even practical ideas. When put to use, they enable travel, communication, transportation of goods, or control of energy. But technology has another meaning which is often thought to be less useful, namely technical marvels—things which amaze or surprise us. Some examples are the mechanical automatons of the 17th and 18th centuries, the latest computer game, a special way of hearing or seeing, or even the gas and light spewing magic machines described as being used in Greek temples to get peoples' attention. Another example is the technology described by the 11th century monk Theophilus, used to equip a church, from bells and censors, to glass windows and painted walls. In these examples, doing technology or learning to use technological marvels is a way of almost magically extending our own power and understanding beyond ourselves.

In this realm of making things which extend our power to sense, feel, or do things beyond our immediate selves, an area of overlap occurs between art and technology. Art serves to transform illusion into meaningful experience and is thus a very useful technology. Most often we confine our experience with "art" to museums or concert halls in an effort to relive the experience of someone in times past and compare our experience of an artifact or performance with theirs. This is usually a very safe experience in which what we experience has an official stamp of approval as recognized "culture." The articles in this issue of the *MRS Bulletin* are meant to expand the definitions we apply to art and technology and to show where the two disciplines overlap and become intertwined, even inextricably matted together.

Technology has long been a concern of art.

The means of making art provided through an understanding and use of modern technology are as much the provenience of modern art as the ancient craft secrets of master artisans. Otto Piene, director of the Center for Advanced Visual Study at the Massachusetts Institute of Technology, believes the interaction of art and technology are the proper concern of modern artists wishing to make statements about the 20th century using the media of the 20th century. Through the Center for Advanced Visual Study, Piene operates a competitive program for artists who participate in laboratories at MIT, and he has fostered interdisciplinary curriculum development where analysis of how and why things look or behave the way they do is intimately tied to how they were made and what aesthetic effect they can achieve. This point of view has a strong parallel with the paradigm of materials science and engineering in which interactions among structure, processing, properties, and performance are the focus of research.

Technology has often been required to produce objects with outstanding artistic qualities in the service of art, and often artisans have been at the cutting edge of technology. In one example documented by Martha Goodway, a metallurgist at the Conservation Analytical Laboratory of the Smithsonian Institution and head of the Historical Metallurgy Society, and the late Prof. William Savage, a physicist at the University of Illinois, wire for harpsichords was made using special compositions and heat treatments in advance of that developed for or required by industry. In a turnabout which is uncommon today, this high-strength wire was then adapted for scientific instrumentation, in this case by Coulomb in his famous pendulum. Underlying this article is a considerable amount of direct measurement of the properties of artifacts as well as a multiyear program of detective work which was required to reconstruct this double connection between art and science. A modern application of this study may be the production of modern harpsichord wire which has the same properties as the ancient wire and which can be strung on ancient instruments, yielding a high degree of acoustic integrity in the production of ancient music.

Technology has long been a concern of art. Ingrid Alexander, a chemist and art historian, shows how the visual effect of painted images differed during the Renaissance in northern and southern Europe. These differences depended on variations in choices of raw materials as pigments and media and in the style of applications of those materials. Such choices are best documented in the analyses of the artifacts themselves, but are also reflected, although frequently distorted, in the writings of artisans, patrons, and other influential, interested parties.

Art can serve as a means to understand the history of technology. In one example, study of art objects was used to isolate instances of technology transfer as well as instances of technological innovation. Using trace element analysis of both ancient artifacts found in archaeological excavations and geological sources of raw materials, Jacquelin Olin and Emlen Myers of the Conservation Analytical Laboratory of the Smithsonian Institution were able to establish sources for the production of majolica ceramics, a type of ceramic traded between the Old and New Worlds during the 16th and 17th centuries. Heretofore, these ceramics had been considered to have a common origin because of stylistic

similarities. By sourcing these as two separate ceramic traditions, one Spanish, the other Mexican, they were able to pursue a study locating where particular technological innovations occurred and in which direction they were transferred.

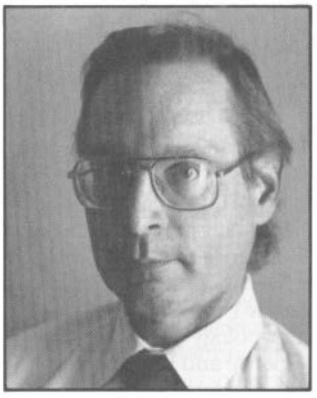
Art and technology can also complement one another, for instance, in a study of the longevity of textiles. Mary Becker, a doctoral candidate in a special program in Conservation Science offered by the Department of Materials Science at the Johns Hopkins University, and Noreen Tuross, a biogeochemist with the Conservation Analytical Laboratory have used modern technology to study the degradation mechanism in ancient silk. The textiles in question are the collection of presidential wives' inaugural gowns in the National Museum of American History, but this study has ramifications for the preservation of more ancient silk textiles.

Clues to the social implications of the production of art are also enriched by a re-discovery of the technology. In the case of the sculpted plaster head from Jericho studied by W. David Kingery (University of Arizona Materials Laboratory), Pamela B. Vandiver (Smithsonian) and Tamar Noy (Jerusalem Museum), the examiner of an ancient artifact has only the residual structure to probe and must reconstruct the processing of selected raw materials, the nature of those materials, as well as the properties and performance of the completed object. For such an investigation, the intensive study of one representative object, and replications of that artifact or the critical steps in its processing, may be as significant as a survey of a large population of artifacts necessary to sourcing. Many of the modern probes of materials science require intensive sample preparation and an extensive period of observation even though the actual sample size required for the analysis may be smaller than can be seen with the naked eye. Interpretation of such analyses involves an interdisciplinary team capable of integrating information from geological, archaeological, museum, and laboratory contexts; able to differentiate original from weathered structure and composition; and willing to hypothesize a chain of inferences tightly bound to the empirical data, sometimes known as "middle-range" inference. The social character of this artistic technology is demonstrated by the considerable amount of resources, in terms of organization of production, skill, labor, raw materials and fuel, which were required to produce lime plaster sculptures, probably as objects of ancestor worship.

Another instance of the interaction of art and technology is the dating of art objects. Using recently developed techniques for the preparation of microsamples combined with linear mass accelerator technology, Dusan Stulik of the Getty Conservation Institute and Douglas G. Donahoe of the University of Arizona have applied carbon-14 dating almost nondestructively to many types of art objects, giving the hope that many objects incorporated into museum collections without proper context may be limited to a range of date by objective physical means.

Many prominent scientists have talked about discovery as an aesthetic experience. Cyril Smith has written at length about the sensual experience of working with materials and finding out how they behave. Philip Morrison has discussed the interaction of play and imitation with real-world materials in hands-on situations as the basis of learning to manipulate symbols. Norbert Wiener thanked the automated door for opening his way to the workplace each day. In a similar way of learning by the example of doing, I hope this *MRS Bulletin* will raise many issues of the meaning and context of making things, whether we define those things as art or technology, or both. I also hope this *Bulletin* will help each of us to envision what we do as materials scientists as a complex interplay of art with technology, idea with material and craft, observation with analysis and manipulation—activities which have long histories replete with cultural meaning and strewn with objects of material culture from which we can learn and with which we can teach our children. In the concluding words of Vladimir Nabokov to his introduction to Pushkin's Eugene Onegin (Princeton University Press, 1990: 8), "In art as in science there is no delight without the detail, and it is on the details that I have tried to fix the reader's attention. Let me repeat that unless these are thoroughly understood and remembered, all "general ideas" (so easily acquired, so profitably resold) must necessarily remain but worn passports allowing their bearers short cuts from one area of ignorance to another." □

Pamela B. Vandiver



James R. Druzik

Pamela B. Vandiver, Guest Editor of this issue of the *MRS Bulletin,* is a senior research scientist in ceramics at the Conservation Analytical Laboratory of the Smithsonian Institution. She was a lecturer in the Department of Materials Science and Engineering at the Massachusetts Institute of Technology, where she earned SM and PhD degrees. There Vandiver also taught an experimental undergraduate subject that evolved over 13 years, combining hands-on traditional glassmaking, ceramic forming, metal casting, raising, and welding with instrumental analysis of ancient objects and student replicates as a way of introducing students to materials science. Vandiver, who holds degrees in humanities, art, materials science, and archaeology, co-organized three MRS symposia titled "Materials Issues in Art and Archaeology." Author of over 150 papers, she collaborated with W. David Kingery in 1986 to write a book, *Ceramic Masterpieces.*

James R. Druzik, Guest Editor of this issue of the *MRS Bulletin,* is a conservation scientist at the Getty Conservation Institute, Marina del Ray, California, where he is responsible for coordination, monitoring, and much of the experimental design development of the Institute's network of sponsored contract research. This research falls into the distinct areas of environmental engineering, stabilization of historic architecture, and archaeological sites, materials science of art and architec-

ture, and new technologies. Druzik is currently working on a symposium titled "Materials Issues in Art and Archaeology III" for the 1992 MRS Spring Meeting in San Francisco. He has a BS degree in chemistry.

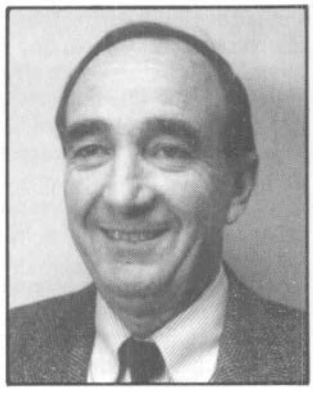
Ingrid Alexander is a research art historian with the Conservation Analytical Laboratory of the Smithsonian Institution. She received her PhD in art history from the Université Catholique de Louvain in Belgium. Her research interests focus on the application of scientific methods to the history of art. These methods include both chemical and physical analyses such as microscopy and neutron-induced autoradiography. Alexander's current work focuses on the historical and technical studies of painting materials and techniques in American and European paintings.

Mary A. Becker is one of the first doctoral candidates in a special program in conservation science in the Department of Materials Science and Engineering at Johns Hopkins University. She received her BS in chemical engineering from the University of Rochester and her MS in textiles from North Carolina State University. Her current research interests are in characterizing the deterioration of natural products found in the museum environment.

Douglas J. Donahue, professor of physics at the University of Arizona in Tucson, has research interests in low-energy nuclear physics, atomic physics, medical physics, and accelerator mass spectrometry. For the past 10 years, he has been co-director of the AMS facility at the University of Arizona, where he has applied the techniques of nuclear physics to the precision measurement of radiocarbon in very small samples. Donahue and colleagues have used the technique of radiocarbon dating with accelerators to study such diverse problems as the arrival time of human beings in North America, the age of air trapped in polar ice cores, the radiocarbon content of lunar rocks, and the age of the material of the Shroud of Turin.

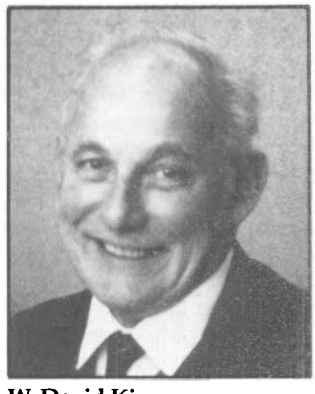
Ingrid Alexander

Mary A. Becker



Douglas J. Donahue

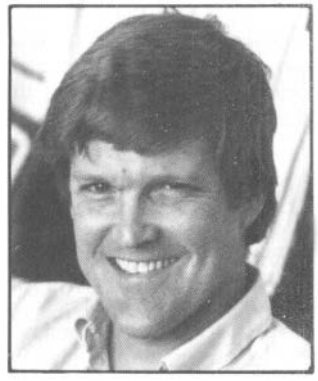
Martha Goodway



W. David Kingery

Martha Goodway received her undergraduate training at the Massachusetts Institute of Technology in metallurgy, and studied history in the Graduate School of Arts and Sciences at Harvard University. She has been with the Conservation Analytical Laboratory of the Smithsonian Institution since 1970. She was elected Fellow of ASM International in 1988 and is president of the Historical Metallurgy Society. She is author with J. Scott Odell of *The Metallurgy of 17th- and 18th-Century Music Wire.*

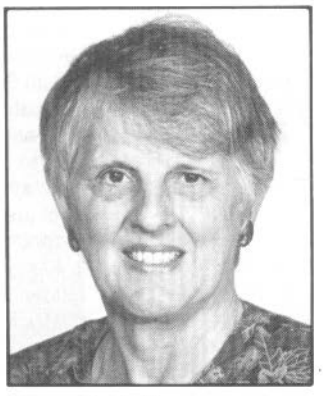
W. David Kingery, recipient of an ScD degree from the Massachusetts Institute of Technology and an honorary PhD from the Tokyo Institute of Technology, is a professor in the Departments of Anthropology and Materials Science and Engineering at the University of Arizona. He has written extensively on ceramic science and technology and most recently on its applications to archaeology, art, and history. His next book *Learning from Things,* is jointly edited with Steve Lubar of the National Museum of American History and Technology. He is a Distinguished Life Member of the American Ceramic Society, a member of the National Academy of Engineering and MRS Materials Education Council, and a Fellow of the American Academy of Arts and Sciences. Kingery has been a Regents' Fellow at the Smithsonian Institution and has initiated a University-Smithsonian consortium on graduate research in materials.



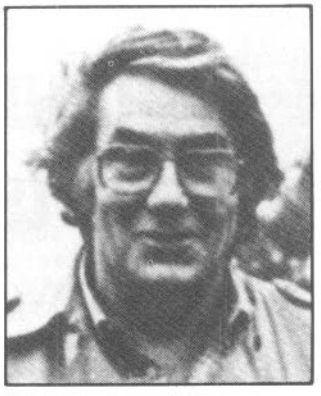
Emlen Myers

Emlen Myers studied anthropology at the University of Michigan and at the State University of New York at Binghamton. He received his PhD from Binghamton in 1984 for an archaeological and ethnographic study of Moroccan pottery. His principal interests lie in the study of state formation and complex societies of the historical period, principally through methods of ceramic analysis. Since coming to the Smithsonian in 1984 he has conducted compositional studies (principally by neutron activation analysis) of ceramic production and distribution based on Islamic and Christian pottery from Morocco, Portugal, Spain, and the southeastern United States and Caribbean. His current laboratory work focuses on ceramics excavated from

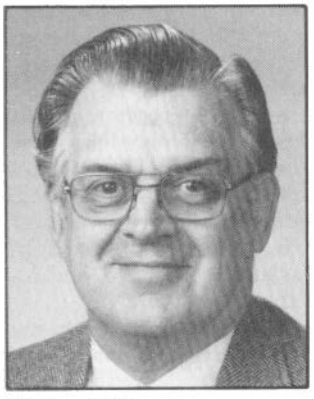
Tamar Noy



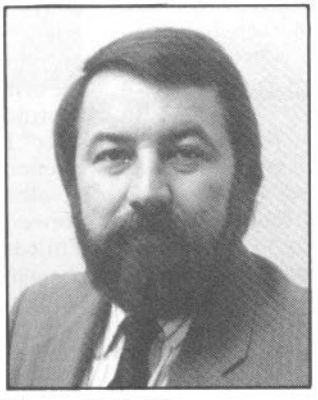
Jacqueline Olin



Otto Piene



William R. Savage



Dusan C. Stulik

Noreen Tuross

Columbus' 1493 settlement of La Isabela in the Dominican Republic.

Tamar Noy, curator of prehistoric periods at the Israel Museum in Jerusalem, has published extensively on the archaeology, iconography, and culture of the ancient Near East. Noy co-curated the traveling exhibition of archaeological finds titled "Treasures of the Holy Land," displayed at the Metropolitan Museum of Art in New York in 1986. She has participated in excavations at Nahal Oren, dating from the Epipaleolithic through the Pre-Pottery Neolithic B; Holon, a Lower Paleolithic site; and most recently the Gilgal sites in the lower Jordan Valley with Natufian and Pre-Pottery Neolithic A phases. Noy holds a PhD from the Hebrew University, Jerusalem.

Jacqueline Olin is the assistant director for archaeometry at the Smithsonian Institution's Conservation Analytical Laboratory, whose Archaeometry Section has collaborative research programs with archaeologists on a national and international level. Studies there involve the production and exchange and technological development of a range of materials with emphasis on ceramics and obsidian. Her own research has centered on using neutron activation analysis to research the distribution of 16th century Spanish majolica ceramics in the New World. She developed the collaboration between the Smithsonian Institution and NIST for neutron-activated autoradiography and is participating in a study of paintings by 19th century American artists.

Otto Piene, sky artist and author, co-founded Group Zero in Düsseldorf (1957-1966). He has been a visiting professor at the University of Pennsylvania and the Massachusetts Institute of Technology. He has been a professor of visual design for environmental art at MIT and director of the MIT Center for Advanced Visual Studies since 1974. Piene's work, which includes numerous exhibitions, installations, performances, celebrations, and large-scale sky events, is represented in about 200 museums and public collections. He has published books, essays, and manifestos on art, art and technology, and sky art since 1958.

William R. Savage, now deceased, was a professor in the Physics and Astronomy Department of the University of Iowa from 1963 to 1988. He established a solid-state physics laboratory and prepared and studied materials related to high-T_c superconductors. Savage became interested in musical acoustics after volunteering to teach an acoustics course to music and speech pathology students, engaging in research on harpsichords and other instruments and developing a program on acoustics. He served as chair of the technical committee on musical acoustics of the Acoustical Society of America from 1976 to 1979.

Dusan C. Stulik is deputy director of the Scientific Program at the Getty Conservation Institute. He graduated from Charles University (Prague) with BS and MS degrees in chemistry, and subsequently earned his PhD in physics from the Czechoslovak Academy of Sciences. Stulik's current research is in the application of scientific methods in art research and art conservation.

Noreen Tuross is a research biochemist at the Smithsonian Institution's Conservation Analytical Laboratory. After receiving her PhD from Brown University in 1985, she was a postdoctoral fellow at the Bone Research Branch of the National Institutes of Health. She is interested in the degradation of biomolecules in the museum environment and in the fossil record. □