C S Smith and the Prehistory of the Solid State

Heather Lechtman

Heather Lechtman's research interests lie in understanding the dynamics of systems of technology developed in prehistoric and non-industrial societies using the combined methods of archaeology and materials analysis. Archaeological artifacts are examined in the materials laboratory using the most up-to-date equipment and procedures to characterize the ancient materials and techniques used in their production.

Throughout his career, Cyril Smith maintained a deep and penetrating interest in the history of his own profession. By the time he joined the MIT faculty as Institute Professor in 1961 he had already edited and published four of six primary sources on early materials technologies, including metallurgy, for which he is well known: (with M T Gnudi) 1942. *The Pirotechnia of Vannoccio Biringuccio*; (with A G Sisco) 1949. *Bergwerk und Probierbuchlein*; (with A G Sisco) 1951. *Lazarus Ercker's Treatise on Ores and Assaying*; (with A G Sisco) 1956. *Réaumur's Memoirs on Iron and Steel.*

The final two, *On Divers Arts: The Treatise of Theophilus* (with J G Hawthorne) and the *Mappae Clavicula, A Little Key to the World of Medieval Techniques* (with J G Hawthorne) came out in 1963 and 1974, respectively.

As a materials scientist, Smith was interested in and excited by all materials, ancient and modern. As a metallurgist and especially as an historian of materials technologies who had pored over the well and lesser known written sources on the subject, he often acknowledged that "people rarely write about technology." People learn technical skills by watching others, by practice, by engaging in the activities themselves. They rarely write about them.

By 1961 Smith had virtually exhausted exploring the known primary sources about early metallurgy, which took him back only to the Middle Ages. His focus had been on the development of European metallurgical technologies during a short span of history, because he was constrained by the availability of primary data, written sources. But in his 1960 letter to President Jay Stratton at MIT, in discussing the interests he hoped to pursue at the Institute, Smith defined a new trajectory: "... I

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want to work at the interface between history, metallurgy, and archaeology ..." (9 August 1960). Adding archaeology meant addressing prehistory, the metallurgical technologies practiced by societies before the invention of writing or in the early historical periods for which archaeology, not writing, provides the primary data. Smith knew that the prehistory of metallurgy lay in the objects themselves and that early metallurgical technologies could be identified by the metallographic examination of artifacts.

Cyril Smith was not the only metallurgist who understood the power of metallography as an analytical tool for reconstructing early technologies. In 1915 the metallographer C H Mathewson published "A Metallographic Description of Some Ancient Peruvian Bronzes from Machu Picchu" in the *American Journal of Science*. Smith often referred to Mathewson's excellent early work. But Cyril Smith undertook the task of informing archaeologists and art historians about the potential utility and contribution of metallographic analysis to the issues that concerned scholars in these fields. His 1967 article, "The Interpretation of Microstructures of Metallic Artifacts" is a classic in explaining and illustrating the ways in which metals retain in their microstructures the history of their fabrication. "Metallurgical Footnotes to the History of Art" (1972) is another important publication in this vein.

Cyril Smith's engagement with archaeological artifacts of metal began early in his career as a metallurgist. Between 1935 and 1937 Wendell C Bennett, the eminent archaeologist of the Andean societies of South America, sent Smith a group of copper and copper alloy artifacts Bennett had recently excavated in the Virú valley, Peru. At the time, Bennett had an appointment at the American Museum of Natural History in New York City, and Smith had an appointment at the American Brass Company, in Waterbury, Connecticut. Many years later the museum deaccessioned this collection of artifacts, and it remains curated in Smith's Laboratory for Research on Archaeological Materials at MIT.

Metallography as a Harbinger of Solid-State Physics

The rapid advances of solid state physics in the 1950s would not have been possible had there not existed a rather well-developed body of knowledge relating properties to the level of structure visible under the optical microscope. This realistic concern with structure was the metallurgists' particular contribution to science.

C S Smith

In 1949 Smith published an "Examination of a Sample of Metallic Zinc from Ancient Athens" with Marie Farnsworth and J L Rodda. This was followed in 1957 by "A Metallographic Examination of Some Japanese Sword Blades", based on research Smith carried out at the Institute for the Study of Metals at the University of Chicago. While in Chicago, Cyril Smith also began an important metallographic study of artifacts made from native copper that were lent to him by the Chicago Natural History Museum. The artifacts were primarily worked, and often annealed, spearheads, axes, and knives manufactured by craftspeople of the so-called Old Copper Culture who inhabited the Lake Superior Basin of North America from the third to the first millennium BCE. The examination of this corpus was completed and published jointly in 1968 by David Schroeder, one of Smith's graduate students at MIT, and Katharine Ruhl, Smith's laboratory associate.

In 1960, guided by a now primary focus of his interests, Cyril Smith agreed to join the MIT faculty with a joint appointment in the Department of Humanities and in the Department of Metallurgy (now the Department of Materials Science and Engineering). Because of a shortage of space, however, he was unable to set up a small metallographic laboratory in the Metallurgy Department until 1964. Katharine Ruhl joined him as his laboratory associate, and they worked together until Katharine left Cambridge for Cleveland in 1967. Katharine Ruhl describes the quality of her experience and the vitality of the laboratory during those initial years.

A parade of eager archaeologists offered artifacts for our study. Only later did I appreciate who some of them were and how unique the objects we sampled.

(K Ruhl, personal communication, May 2006).

Smith was eclectic in his choice of artifacts to study, and that choice was somewhat a function of the requirements of the archaeologists who sought his help. Frank Hole sent copper artifacts from Chagha Sefit, SW Iran; George Bass sent an ingot

fragment from the Cape Gelidonya shipwreck off the Mediterranean coast of Turkey; the Freer Gallery of Art at the Smithsonian Institution in Washington D.C. sent fragments of a Chinese bronze sword from the Warring States period; Wilhelm Solheim II sent samples of early artifacts from Thailand. Over the years the lab processed material from many parts of the world and from many prehistoric and historic periods. In addition to the works already mentioned, some of Smith's most influential publications that issued from the lab during the early years include: "Metallographic Study of Early Artifacts Made from Native Copper" (1968); "The Techniques of the Luristan Smith" (1971); "Bronze Technology in the East: A Metallurgical Study of Early Thai Bronzes, with Some Speculations on the Cultural Transmission of Technology" (1973).

In the museum exhibit From Art to Science: Seventy-two Objects Illustrating the Nature of Discovery, and in the accompanying catalog (1980), Smith expressed the breadth of his knowledge of materials and his excitement in the variety of ways people used the properties of materials, especially in objects with a strong aesthetic moment. He dedicated the exhibit to his wife, Alice Kimball Smith, on her seventy-second birthday, thus the number of items he chose to display. One abiding interest continued to stimulate him during his laboratory years at MIT, however – the Japanese sword and its metallic accoutrements. Not only does the Japanese blade figure prominently in his book *A History of Metallography* (1960), but he and his undergraduate student, Elaine Savage, published a fundamental study on "The Techniques of the Japanese *Tsuba* Maker" (Savage and Smith 1979) in which they describe their metallographic examination of a variety of *tsuba* (sword guards), the experiments they carried out in casting alloys of *shakudo* and *shibuichi*, and the microstructures of the castings. We include in this brief tribute to Cyril Smith a photograph of him sitting at his desk, admiring a sword in his own collection.

In 1967 Heather Lechtman joined Cyril Smith in the Laboratory for Research on Archaeological Materials. Lechtman's

Cyril Stanley Smith examining a sword.

experience was in physics and anthropology, and she had just returned from a two-year fellowship to the Research Laboratory of the British Museum, London where she studied metallography and the conservation of archaeological artifacts of metal. Lechtman brought a different outlook to the laboratory, one that emphasized the anthropology of technology rather than its history. Her work focused almost exclusively on documenting and interpreting the development of metallurgy among the prehistoric societies that inhabited the Andean zone of South America. Lechtman and Smith worked side by side in the lab, each on her and his own research, learning from one another, with a deep and mutual, prevailing respect for the other's philosophy and premises. On one point they were steadfast – that in that small laboratory they were documenting the prehistory of the solid state.

In the mid-1970s MIT asked a visiting committee comprised of scholars from other US institutions to visit and evaluate the work of the Laboratory for Research on Archaeological Materials. The committee was unanimous in its enthusiasm for the goals and accomplishments of the lab. At the same time, committee members felt strongly that the impact of the laboratory's research within the scholarly community needed to be accelerated. They suggested that MIT share its intellectual and physical resources in the field of archaeological materials with other, nearby institutions in order to broaden the range of materials examined and to increase the number of investigators in the new field.

Smith and Lechtman convened colleagues from eight neighboring institutions in the greater Boston area and, together, this group of faculty proposed the establishment of a Center for

Materials Research in Archaeology and Ethnology (CMRAE). CMRAE was founded in 1977 with a grant from the US government's National Endowment for the Humanities. It is organized as a consortium of the founding institutions[1] and continues to be directed and administered by MIT. The Center offers year-long, graduate level subjects in the analysis of a range of archaeological materials to students from the consortium institutions. These subjects are designed and taught by faculty from the CMRAE universities, often in teams of two or three, whose specialties lie in materials that include metal, ceramics, stone, bone, floral remains, and others. CMRAE also offers an undergraduate subject, Archaeological Science, to students from its member universities. At MIT, students enroll for CMRAE subjects in the Department of Materials Science and Engineering.

Boston University, Brandeis University, Harvard University, University of Massachusetts, MIT, Museum of Fine Arts of Boston, Tufts University, Wellesley College.

In 1984, Dorothy Hosler joined the Laboratory for Research on Archaeological Materials and CMRAE. Hosler's background is in Mesoamerican archaeology with a specialty in the development of metallurgical technologies in Mexico. Her book *The Sounds and Colors of Power: The Sacred Metallurgical Technology of Ancient West Mexico* (1994) is a groundbreaking study in its demonstration of the cultural roots to the form and expression of a society's technology. It provided precisely the kind of meshing of archaeology and metallurgy that Cyril Smith had fostered in his laboratory's research and from the chairs he held at MIT in the humanities and in metallurgy.

Hosler and Lechtman are faculty members in the Department of Materials Science and Engineering. They and their departmental colleagues, Samuel Allen and Linn Hobbs, have established two degree-granting academic programs for the department: a bachelor of science degree in Archaeology and Materials and a doctor of philosophy degree in Archaeological Materials. MIT's Department of Materials Science and Engineering is the only materials department in the US to offer degrees in archaeological materials. Its two degree programs are unique among universities in the United States.

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Cyril Smith, with his breadth of vision, his generosity, his exuberance when confronted with what people have accomplished in their interactions with the physical world of materials, laid the foundation upon which we, at MIT, have built.

Suggested Reading

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