

Archaeology and Craft: Experimental Archaeology and the Materials Science of Ancient Technologies

Brown University, Spring 2011

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School of Engineering

Wiki: <http://proteus.brown.edu/archandcraft11/13667>

Class Meetings: Wednesdays 3-5:20, Rhode Island Hall, Room 008.

Contact Info:

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Arch 'n Craft: Course Scope

How did people in the past make the things that archaeologists find today? How can archaeologists learn about processes of design, engineering, and technological change from ancient objects? These are among the most challenging questions facing archaeologists, who typically build interpretations by reverse engineering - working from fragmented material culture remains.

This class examines how ancient craft technologies were developed, learned, and performed cross-culturally. Students will approach production questions from the opposite direction through firsthand involvement with craft processes and materials analysis - from raw materials to finished objects. "Arch 'n Craft" is intensively hands-on and is centered on the problem-oriented production of two types of archaeological objects: ceramics and metal. As an applied archaeology class, each week involves a practicum; these will progress, over the course of the semester, from studying manufacturing traditions, examining raw materials, crafting and firing objects, to evaluating resulting material properties post-production. Practicums will draw heavily on tools, activities, and ideas from within and beyond the discipline, ranging from actual participation in blacksmithing and kiln design to learning about pyrotechnology, mechanical properties, and archaeometric techniques.

Course practicums will culminate in an attempt to replicate the production processes of either ancient pottery or wrought iron. Objects to be crafted will be based on, and later compared with examples that the class selects from the Haffenreffer Museum collections. Background information necessary for contextualizing the crafted materials is introduced in the weekly readings, which are drawn from archaeology, materials science (engineering), and museum studies. The results of the class research and accompanying experimental replications will be the basis for the final class project – an exhibit created in collaboration with the Haffenreffer Museum displayed at the Sciences Library.

Weekly in-class workshops with presentations and occasional field trips are included. Enrollment is limited to 15. No prerequisites.

OBJECTIVES

Upon successful completion of this course, students will

- Demonstrate a critical understanding of the research, interpretation and processes of experimental archaeology within the context of archaeological examples and principles of Materials Science
- Read and articulate studies relevant to course topics from a variety of disciplinary perspectives
- Strengthen independent and outside research practices and learn to apply these to course practicums
- Learn to work and communicate effectively during regular in-class group assignments
- Contribute to an archaeologically-informed replication of an ancient production technology
- Collaborate to produce an exhibit based on class experiments

CLASS MEETING STRUCTURE

Each week students will be assigned background readings and questions to guide the week's topic and accompanying in-class practicum. Students are expected to prepare required readings before each class. Classes will begin with an introduction to the week's topic, and will, on occasion, involve short oral presentations by students on selected case studies (to be assigned during the semester).

The second half of each class will usually involve a practicum, to be conducted in assigned groups. Each class involving a practicum will conclude with presentation and discussion of group results.

Note on Practicums: Before each class, questions will be circulated to guide background research necessary for in-class practicums, discussion, and design activities. Each practicum builds upon the prior weeks' work, therefore groups will remain the same for the duration of the semester. Students will be expected to conduct extra outside research necessary to prepare for the practicum – it is up to each group to decide how best to divide the labor. References will be provided on the wiki as starting points for practicum preparation. Students are also strongly encouraged to consult sources from other disciplines with which they are familiar.

ASSESSMENTS

The format of this class invites creativity and exploration, and therefore requires active participation by everyone. Students will collaborate regularly in small research groups. Results of these collaborations will then be presented and discussed with the class. Students' contributions in class and in-group activities will be evaluated three times during the semester in order to assess individual performance fairly.

Following each class meeting, students will post a short evaluation (blog) to the course wiki that identifies areas and reasons for successes, failures, and possible improvements in relation to the practicum. At the end of the semester, the class will work together to develop an exhibit about experimental archaeology based on the course exercises and informed by these blogs and data gathered.

- In-class participation, and practicum & exhibit preparation – 35%
- **3** practicum write-ups – 18% (6pts each)
~500-700 words each; submit under group or individual wiki section, depending on assignment
- **5** wiki posts – 10% (2pts each)
~200 words – to be written and submitted individually under individual student wiki links
- **3** individual assessments – 6% (2pts each)
~200 words – to be submitted individually to the TA, and addressing your contributions / role in group activities and group dynamics overall
- **1** oral presentation (on a case study) - 6%
~oral presentation and accompanying visuals, not to exceed 10 mins, on an experimental archaeology case study of your selection. Dates to be assigned in class.
- Participation in experimental replication(s) – 10%
- Final Report (group product – combining Weeks 9, 10, 12) – 10%
~2,000 – 3,000 words – one submission per group
- Exhibit design and presentation – 5%

ACADEMIC INTEGRITY

Brown's Academic Code is posted on the Dean of the College's webpage:

http://www.brown.edu/Administration/Dean_of_the_College/curriculum/academic_code.php. Please revisit the code's guidelines, as "misunderstanding the code is not an excuse for dishonest work."

SCHEDULE

Background. Ancient Technologies and Reverse Engineering

Week 1 (Jan 26). Introduction to Experimental Archaeology

Practicum 1

Required Readings (to be completed before Week 1):

Mathieu, J. 2002. Introduction to Experimental Archaeology: Replicating Past Objects, Behaviors, and Processes, p. 1-13. In *Experimental Archaeology...* BAR International Series 1035.

Costin, C. 2000. The Use of Ethnoarchaeology for the Archaeological Study of Ceramic Production. *Journal of Archaeological Method and Theory*, 7(4).

Ascher, R. 1961 Analogy in Archaeological Interpretation, *Southwestern Journal of Anthropology*, 17(4): 317-25.

Reynolds, P. 1999 The Nature of Experiment in Archaeology. In *Experiment Design: Archaeological Studies in Honor of John Coles*, A. Harding (ed), 156-162.

Supplemental Readings (optional):

"Arts and Crafts", Ch. 5 in J. Coles, 1979, *Experimental Archaeology*, p. 159-208.

Part 1. Metal Production: Smelting and Smithing

Week 2 (Feb 2). The Metal Production Process and Introducing Reverse Engineering (Archaeometry)

Guest Lecture: Kevin Smith, Haffenreffer Museum of Anthropology

Practicum 2

Required Readings (to be completed before Week 2):

Gordon, R. and Killick, D. 1993 Adaptation of Technology to Culture and Environment: Bloomery Iron Smelting in America and Africa, *Technology and Culture*, 34(2): 243-270.

Tite, M.S. 1999. Pottery Production, Distribution, and Consumption – The Contribution of the Physical Sciences. *Journal of Archaeological Method and Theory*, 6(3).

Hodges, H. 1988. Iron and Steel, Ch. 5 in *Artifacts: An Introduction to Early Materials and Technology*, p.80-90

Bouzakis, K. et al. 2010. An Investigation of Ceramic Forming Method Using Reverse Engineering Techniques: The Case of Oinochoai from Dion, Macedonia, Greece. *Journal of Archaeological Method and Theory* (online first access).

Brandon, R. 2004. Re-enactments of Smelting: How to describe and transcribe? Ch. 4 in *An Ethnoarchaeological Study of Iron-Smelting Practices among the Pangwa and Fipa in Tanzania*.

Making Iron The Old-Fashioned Way Is A Tricky Business, *Science Daily*, Oct. 14, 2005:
<http://www.sciencedaily.com/releases/2005/10/051011073801.htm>

Supplemental Readings (optional):

Velde, B. and I. Druc, 1999. Some Current Analysis Methods, Ch. 9 in *Archaeological Ceramic Materials*, 259-294.

Week 3 (Feb 9). Raw Materials and Fuel: Physical Properties, Location, Extraction, and Preparation

Ore and examples of reconstructed smelting operations

Practicum 3

Required Readings:

Gordon, R. 1996. Ore, Fuel, and Other Natural Resources, Ch. 2 in *American Iron, 1607-1900*, p. 27-55.

Senn, M. et al. 2009. Tools to qualify experiments with bloomery furnaces, *Archaeometry*, 52(1)

Rapp, G. 2002. Chapter 7 in *Archaeomineralogy*.

Craddock, P. et al. 2007 On the Edge of success: the scientific examination of the products of the Early Mines Research Group smelting experiments. In, *Metals and Mines: Studies in Archaeometallurgy*, S. La Niece and D. Hook (eds), 37-45.

White, Paul J. 2010 Heads, Tails, and Decisions In-Between: The Archaeology of Mining Wastes:
<http://www.adoptamine.org/aboutaml/other-reasons/243/archaeology-of-mining-waste/>

Supplemental Readings (optional):

Robert H. Richards and Charles E. Locke, *Textbook of Ore Dressing*, 3rd ed. (New York: McGraw-Hill, 1940), 355-60

Ottaway, B.S. 2001. Innovation, Production, and Specialization in Early Prehistoric Copper Metallurgy. *European Journal of Archaeology*, 4(1): 87-112.

Due this week : Turn in (on wiki) write-up for Week 2 practicum, as an individual product.

Week 4 (Feb 16). Pyrotechnology: Furnaces, Firing Processes, and Physical Properties

Practicum 4

Required Readings:

Rehder, J. 1996 Use of Preheated Air in Primitive Furnaces: Comments on Views of Avery and Schmidt, by J. E. Rehder; and The Use of Preheated Air in Ancient and Recent African Iron Smelting Furnaces: A Reply to Rehder, by Donald H. Avery and Peter R. Schmidt, In *The Culture and Technology of African*

Ironworking (Schmidt)

Avery, D. and P. Schmidt 1996 Preheating: Practice or Illusion? In *The Culture and Technology of African Ironworking*, P. Schmidt (ed), 267-276.

Timberlake, S. The use of experimental archaeology/archaeometallurgy for the understanding and reconstruction of Early Bronze Age mining and smelting technologies. In, *Metals and Mines: Studies in Archaeometallurgy*, S. La Niece and D. Hook (eds), 27-36.

Tabor, G.R., et al. 2005. Computational simulation of air flows through a Sri Lankan wind-driven furnace. *Journal of Archaeological Science*, 32: 753-766.

Brandon, R. 2004. The Pangwa practice of iron smelting (includes sections on building a furnace, processing ore, etc.), Ch. 5 in *An Ethnoarchaeological Study of Iron-Smelting Practices among the Pangwa and Fipa in Tanzania*.

Due this week : Post (on wiki) entry about Week 3 practicum.

Week 5 (Feb 23). Form and Function: Crafting Objects and Materials Science Considerations

Practicum 5

Required Readings:

Gordon, R.B. 1997 Processes Deduced from Ironmaking Wastes and Artifacts, *Journal of Archaeological Science*, 24(1), Pages 9-18.

Coustures et al. 2003. The use of trace element analysis of entrapped slag inclusions to establish ore – bar iron links: Examples from two Gallo-Roman iron-making sites in France. *Archaeometry*, 45(4): 599-613.

Humphris et al. 2009. Variability in single smelting episodes – a pilot study using iron slag from Uganda, *Journal of Archaeological Science* 36.

Supplementary Readings (optional):

Revisit readings in Brandon (2004)

Callister, William. 2008 Metals Chapters, In *Fundamentals of Materials Science and Engineering*.

Due this week : Turn in (on wiki) write-up about Week 4 practicum as a group product (1 submission per group).

Week 6 (Mar 2). Experiencing or Experimenting with Iron Production?

Either: Field Trip to Saugus Ironworks or creation of a mini-bloomery

Due this week : Post (on wiki) entry about Week 5 practicum.

AND

Individual assessment # 1 – Turn in to TA.

Part 2. Ceramic Production

Week 7 (Mar 7). *Raw Materials and Fuel: Physical Properties, Location, Extraction, and Preparation*

Practicum 6

Required Readings: (ore processing, geochemistry, etc.)

Hodges, H. Pottery, 1988. Chapter 1 in *Artifacts: An introduction to early materials and technology*, p. 19-41.

Velde, B. and I.C. Druc 1999. *Archaeological Ceramic Materials: Origin and Utilization*. Springer-Verlag Berlin Heidelberg (Chapters 2, 3, 4).

Rapp, G. 2002 Ceramic Raw Materials. Chapter 8 in *Archaeomineralogy*.

Neff, H. (ed) Part IV: Good, Fast, Cheap; Pick Any Two: Characterization of Ceramic Materials (chapters 18 and 20), in *Ceramics in Archaeology: Readings from American Antiquity, 1936-2002*.

Borregaard, T. 2005 "Experimental kiln firings: why bother?." Bulletin of the Northern California Experimental Firing Group 3, 23-32

Supplementary Readings (optional):

Arnold, Dean, et al. 1991 Compositional Analysis and "Sources" of Pottery: An Ethnoarchaeological Approach. *American Anthropologist*, 93(1): 70-90.

Neff, H. (ed) Part IV: Good, Fast, Cheap; Pick Any Two: Characterization of Ceramic Materials (chapters 25-27), in *Ceramics in Archaeology: Readings from American Antiquity, 1936-2002*.

Revisit: Tite 1999 from Week 2

Due this week : Turn in (on wiki) write-up about Week 6 practicum (product, individual or group, TBD).

Week 8 (Mar 16). *Form and Function: Crafting Ceramic Vessels I – Techniques and Materials Science Considerations*

Practicum 7

Required Readings:

Sinopoli, C. 1991. Defining Ceramics, Ch. 2 in *Approaches to Archaeological Ceramics*.

Velde, B. and I.C. Druc 1999 *Archaeological Ceramic Materials: Origin and Utilization*. Springer-Verlag Berlin Heidelberg (Chapter 6).

Pierce, Christopher 2005 Reverse Engineering the Ceramic Cooking Pot: Cost and Performance Properties of Plain and Textured Vessels. *Journal of Archaeological Method and Theory*, 12:117-157.

Schiffer, M. 1994 New Perspectives on Experimental Archaeology: Surface Treatments and Thermal Response of the Clay Cooking Pot, *American Antiquity*, 59(2): 197-217.

Schiffer, M and J. Skibo 1987. Theory and Experiment in the Study of Technological Change. *Current Anthropology*, 28(5): 595-622.

Klemptner, L. and P. Johnson 1986. Technology and the primitive potter: Mississippian pottery development seen through the eyes of a ceramic engineer, In *Ceramics and civilization, vol 2*. (D. Kingery, ed), p. 251-271.

Skibo, J. et al. 1989. Organic-tempered pottery: an experimental study. *American Antiquity*, 54: 122-146.

Supplementary Readings (optional):

J.W. Arthur 2002 Pottery Use-Alteration as an Indicator of Socioeconomic Status: An Ethnoarchaeological Study of the Gamo in Ethiopia. *Journal of Archaeological Method and Theory* 9(4): 331-355.

Due this week : Post (on wiki) entry about Week 7 practicum.

Week 9 (Mar 23) Pyrotechnology: Firing Processes, and Physical Properties

Practicum 9

Required Readings:

Dawson, David, & Kent, Oliver 1985 "Kiln superstructures – the Bickley experiments", in Bulletin of the Experimental Firing Group 3, 70-79.

Dawson, David, & Kent, Oliver 1984 "Methods of kiln reconstruction", in Bulletin of the Experimental Firing Group 2, 13-17.

Smith, A. L. 2001. Bonfire II: The Return of Pottery Firing Temperatures, *Journal of Archaeological Science*, 28: 991-1003.

Shoval, S. 1994. The firing temperature of a Persian-period pottery kiln at Tel Michal, Israel, estimated from the composition of its pottery, *Journal of Thermal Analysis*, 42(1994): 175-185.

Velde, B. and I. Druc, 1999. Ch. 5.4 + 5.5 p. 96-1137 and Ch. 6.7, p. 169-175.

Gosselain, Oliver P. 1992 Bonfire of the Enquiries. Pottery Firing Temperatures in Archaeology: What For? *Journal of Archaeological Science* 19(3): 243-259.

Bronitsky, G. and R. Hamer 1986 Experiments in Ceramic Technology: The Effects of Various Tempering Materials on Impact and Thermal-Shock Resistance. *American Antiquity*, 51:89-101.

Supplementary Readings (optional):

Rice 1987 (Chapters 11, 12)

Callister, William. 2008 Ceramics Chapters, In *Fundamentals of Materials Science and Engineering*.

Due this week : Post (on wiki) entry about Week 8 practicum.

AND

Individual assessment #2 , turn in to TA.

SPRING BREAK!!!

Part 3. Experiments in Action

Week 10 (Apr 6). *Experiment Preparation*

Practicum 10

Required Readings:

Sinopoli, Carla M. 1991. Chapters 2, 3, and 4, In *Approaches to Archaeological Ceramics*. Plenum Press, New York.

Week 11 (Apr 13). *Form and Function: Crafting Ceramic Vessels 2 – Techniques and Materials Science Considerations*

Practicum 11 – Making ceramics

Due this week : Post (on wiki) entry about Week 10 practicum.

Week 12 (Apr 20). *Experimental Firing and Evaluation*

Practicum 12 - Experimental firing. Evaluation of Technological Process

Week 13 (Apr 27). *Wrap-up and Exhibit Preparation*

Required Readings:

Wylie, Alison 1985 The Reaction Against Analogy. In *Advances in Archaeological Method and Theory*, vol. 8, M. Schiffer (ed), 63-111.

Due this week : Turn in (on wiki) report, addressing practicums from Weeks 9, 10, and 12 – as a group product.

Week 14 (May 4). *Exhibit Presentation*

Due this week : Fully-mounted exhibit

AND

Individual assessment #3 – turn in to TA.