The Social Networks of Athenian Potters Project (SNAP): Networks, Tradition, and Innovation in Communities of Artists

1. Project Summary

The NEH Digital Humanities Advancement Level I Grant HAA 271803-20 awarded to the University of Arizona in 2020 (for an award period from September 2020 to August 2021), enabled the project co-directors Eleni Hasaki (University of Arizona) and Diane Harris Cline (George Washington University), to produce a network-based model for studying communities of potters in ancient Greece. The funded project, Social Networks of Athenian Potters (SNAP; snap.sbs.arizona.edu), employs Social Network Analysis (SNA) to map the ties among potters in Archaic and Classical Athens (600–400 BCE), a period when Athens becomes the intellectual and cultural center of Ancient Greece. The mastery of these artisans, both of the potters who formed the vessels and of the painters who painted them is unparalleled and defines the craft and art pinnacle of this period. The time frame of their activity (600-400 BCE) is also significant as Athenian potters dominated local and international markets by first advancing a centuries-old traditional decorative technique (so-called black figure) on their pots and later by inventing a new one (so-called red figure). We have already presented in conferences and online as well as published the preliminary results of the communities working on black figure (https://snap.sbs.arizona.edu/research). Similarly, for the NEH-funded phase we had an active agenda of conference presentations, general public talks, international collaborations, training of students, and a submitted article to *Journal of Historical Network Research*. We have laid the foundations for making our raw data available online to enable other researchers to run Social Network Analysis (https://snap.sbs.arizona.edu/data-and-image-gallery).

The project links the study of Athenian finewares (the *par excellence* specialty in Greek archaeology for most of the 20th century CE) with a relatively new data analytics method, the Social Network Analysis. The Athenian fine decorated ceramics been extensively studied mostly on the level of individual artist, or individual shapes and scholars have been able to provide detailed chronological tables with fine chronological resolution of 10-20 years.

In conference proceedings the scholars tried to integrate the painter of the show within his wider context. “The Amasis Painter and His World” (von Bothmer and Boegehold 1985) or “Euphonios and his Time” (Wehrgartner 1992), or most recently “The Berlin Painter and his World” (Padgett 2017) (*Figure 1*). In these publications the desire of contextualizing the production of a single maker is evident, paving the way for a more systematic way of studying individual makers within their broader craft communities.
In our project we have effectively shifted the focus to the producer’s communities as we try to see how they are connected. Ties, or links among these potters and painters, have long been established in scholarship based on stylistic relationships through the connoisseurship method that connect artists to each other through a variety of relational terminology, often with a social flare: a potter can have a pupil, a follower, an imitator, or a group of companions. With SNAP we harvest these ties –for the first time– from their foundational texts in two major databases and converted them into relational pairs using NodeXL software for Social Network Analysis and Visualization (https://www.smrfoundation.org/). In addition to artist-to-artist links, artists are also closely linked to preferred shapes. In the generated sociograms of the bimodal network, we have the opportunity to study how a potter’s position in the network enhances our understanding of the significant role of individuals within their social and technological networks. We are also well positioned to study their ties to influential shape sectors in the potters’ communities, and how these shape-centered communities maintain the traditional character of pottery production and regulate the flow of innovation during experimentation phases.

In this White Paper we will introduce our project, its development history, and some of its preliminary results. We will contextualize it within the broader field of Social Network Analysis in Greek and Roman archaeological research of prehistoric and historical times and provide some examples on how SNA and its ever-evolving software applications offer great opportunities to analyze data, even data originally presented in the older SNA applications. As our group under study is a community of practice, a community of craft practitioners, we will also outline how our project fits within other projects of craft practitioners to highlight issues of apprenticeship, cross-craft interaction, mobility, and trade.

2. SNAP Project Origins and Goals

The idea of rendering Beazley’s web of relationships as a network was first conceived by Eleni Hasaki in October 2016, when she presented her research at the The Maker’s Share in Ancient Greek Art, Classical Art Research Center at Oxford University (http://podcasts.ox.ac.uk/craft-apprenticeships-and-multi-craft-competencies-classical-antiquity). Hasaki, with the help of graduate student Nicole Mattwich from the School of Anthropology at the University of Arizona,
presented two sociograms, one on the apprenticeship networks of Greek sculptors and one on a subgroup of red figure Athenian Potters (Figure 2). Networks research was gaining great traction at the University of Arizona, with leading figures both at the School of Anthropology and in Sociology joining forces to implement SNA in large scale archaeological analysis both in the prehispanic SouthWest ceramics (Mills et al. 2013; Mills 2017) and in the Bronze Age Italy (Blake 2014) to examine trade patterns and formation of identity among others.

In early 2017, Hasaki joined forces with SNA pioneer and History professor, Diane Harris Cline, who had already successfully experimented with using ancient historical sources since 2010 to map the social network of the Hellenistic ruler, Alexander the Great (Cline 2012), and had already finished the network of the legendary philosopher Socrates (Cline 2019).

With intermittent meetings in Spring 2018, Hasaki and Cline laid the foundations of the SNAP project, and presented their preliminary results at the XIXth International Conference on Classical Archaeology held in Bonn (now published as Hasaki and Cline 2020). Part of this work was carried out while Hasaki held a fellowship at the Center for Advanced Study in the Visual Arts at the National Gallery of Art, in Washington, D.C.

Hasaki and Cline launched SNAP during a collaborative fellowship at Harvard’s University’s Center for Hellenic Studies in Fall 2018. The results of this Harvard fellowship were published as Cline and Hasaki 2019; https://research-bulletin.chs.harvard.edu/2019/03/19/connected-world-of-potters/)

Cline and Hasaki built the relational database by extracting data dispersed in the fundamental studies of Sir John D. Beazley (at Oxford University, UK) who in the early 20th century identified over 1,000 artists in the Athenian potters’ quarters working in the black and red figure techniques by studying stylistic affinities in the painted scenes (Beazley 1956, 1963, 1971; Figure 3). In his five books totaling over 3,000 pages, Beazley tackled separately the potters working in the
traditional black figure technique from those working in the innovative red figure technique. The conventional names for both techniques refer to the final color that the painted figures acquire after firing. These stylistic ties have been foundational in the study of the Athenian ceramic industry.

Black figure technique (Figure 6a): it is believed to have developed originally at Corinth (ca. 730 BCE), perhaps due to its wider contacts as major port sea and connecting maritime and terrestrial nodes for east west trade. It was soon used in all major areas of ancient Greece, which although everyone uses the same techniques of making and firing a vessel, the iconographical syntax of each regional production was different.

Red figure technique (Figure 6d): it was invented in Athens (ca. 520 BCE), in a period of intense experimentation in several techniques. It was the one that prevailed while the others quickly faded away within a generation. It replaced completely the previous black figure technique except in the very specialized prize vessels (panathenaic amphoras) and also in some conservative lekythoi.

Our project had a large spectrum of targeted audiences. For almost any topic in the humanistic spectrum, the Athenian potters in particular have provided us with the best evidence to understand their societies and their continued relevance to our times. Educators in several humanistic disciplines from philosophy to politics, museum curators, fashion designers, and film directors have drawn on Athenian pottery to humanize both the past and the present. To this well-explored field of the Classical world, SNAP provides an innovative approach for its content, its method, and its digital focus. For the first time the stylistic ties of the Athenian potters, known for almost a century, are visualized in a synoptic, comprehensive way, allowing scholars to see both specific artists but also their wider contexts. We use SNA to search for the artists whose ideas were carried along pathways laterally inside a community through interaction. Our work expands upon the traditional paradigm which tends to focus on the cult of a genius artist who is single-handedly accredited with transmitting new shapes and imagery and highlights the more dynamic of a networked community of practice.
The goals for this NEH funded phase of our project were:
1) to code and analyze the social network data for the community of artisans in Archaic and Classical Athens working on the red figure technique, based on the prototype we had developed for the practitioners of the preceding technique, the Athenian black figure. For easier communication among the team members we scanned the books by Beazley, taught our research assistants how to establish the links, reviewed the coded data, and proceeded with the analysis.

2) to submit an open-access journal article on our preliminary findings: in December 2021 we have met this goal as well as we submitted a co-authored article entitled Cline, D.H. and E. Hasaki, under review, “Assortative Mixing in the Social Networks of Athenian Potters and the Search for Communities,” to the peer-reviewed, open access venue, Journal of Historical Network Research. This article is an expanded version of a peer-reviewed, co-authored paper, we presented at the International Historical Networks Conference in July 2021 (Cline, D. H. and E. Hasaki, “Diffusion of Innovation: The Social Networks of Ancient Athenian Potters,” Historical Networks Research Conference (http://hnr2021.historicalnetworkresearch.org/?page_id=314).

3) to release our data as open access on the project website and to create some teaching modules. We have created the foundation for the open access of our data, and we will release by December 1, 2022 the foundational edge-list (ties of the sociogram) on Athenian black figure vase painters and Athenian red figure vase painters on the project’s website (https://snap.sbs.arizona.edu/data-and-image-gallery). The public outreach of our project finds its fullest expression in this open data-sharing.

4) A secondary aspiration of our project was to conduct a workshop with faculty, students and members of the Classical Art Research Center (CARC) at Oxford but due to pandemic this has not been possible. We did maintain however close contact with the IT infrastructure head Greg Parker, whose data on chronology for some of these artists was critical in creating the time slices of the sociogram.

3. The SNAP Activities, Team, and Participants

The SNAP project proved to be ideal as a project for COVID-19 times. We all worked remotely, our data was already in books that could be scanned and shared online, and we used BOX to collaborate and consolidate resources throughout the project. We were also able to present the results virtually in conferences (with live Q and A sessions).

Project Directors

Eleni Hasaki (PD): Professor of Anthropology and Classics, University of Arizona. Her expertise in on ceramic production and craft technologies of ancient Greece (https://anthropology.arizona.edu/user/eleni-hasaki). She uses archaeological, ethnoarchaeological and experimental archaeology approaches to her study of makers, skills, spaces, and their connectivity Hasaki was responsible for scanning the pertinent book volumes,
for data collection and coding. She introduced Sides, the graduate student assistant at the University of Arizona, to the SNAP project and the general field of Greek vase connoisseurship, trained and supervised her in the basic collection of links. Hasaki met regularly with Cline via Zoom meetings to discuss project goals and deliverables. She co-authored the conference paper presentation (Cline, D. H. and E. Hasaki. 2021. Diffusion of Innovation: The Social Networks of Ancient Athenian Potters, Historical Networks Research Conference, July) and was a co-author in submitted JHNR journal article “Assortative Mixing in the Social Networks of Athenian Potters and the Search for Communities.” Hasaki applied for additional funding at the School of Anthropology Faculty Research Award to support a 0.50 FTE Graduate Student Assistantship for Lauren Sides, a Ph.D. candidate in the Archaeology of the Mediterranean World. She introduced Sanchez-Genao from George Washington University to the Beazley Archive and the Oxford Data and co-supervised his contributions to the project with Cline. Hasaki led the effort for the final report and the White paper for the NEH reporting requirements.

Diane Harris Cline (PD): Associate Professor of History and Classics, The George Washington University (https://cnelc.columbian.gwu.edu/diane-harris-cline). Cline is a pioneer of Social Network Analysis for Greek History with her publications over 10 years. Cline met regularly with Eleni Hasaki via Zoom meetings to discuss project goals and deliverables. She carried out the Social Network Analysis on the data collected, generated a large number of visualizations from coded sociograms. She led the co-authored conference paper presentation (Cline, D. H. and E. Hasaki. 2021. Diffusion of Innovation: The Social Networks of Ancient Athenian Potters, Historical Networks Research Conference, July), and also led the resulting publication from that conference, the co-authored journal article for JHNR. “Assortative Mixing in the Social Networks of Athenian Potters and the Search for Communities.” She contributed to the NEH Final report and the White Paper. Cline was awarded a research student assistant from her participation as an Inaugural Faculty Fellow in the GW Humanities Center Year Long program on “Culture in Crisis“(https://humanitiescenter.columbian.gwu.edu/fellows/diane-cline/). Cline trained Sanchez-Genao in SNA through tutorials for NodeXL and co-supervised with Hasaki his contributions to the project.

Key Personnel

Gregory Parker (Data Analyst, Oxford), University of Oxford, UK. International participant. Parker provided invaluable data on the dates for over 1900 Athenian artistic “entities” both in black figure and red figure techniques and a total of 54,000 vases in the Beazley Archive Pottery Database.

Student Assistants

Lauren Sides: Ph.D. candidate in the concentrations of the Archaeology of the Mediterranean World, School of Anthropology, Tucson AZ. She worked remotely in Fall 2020, in helping with coding the data from Beazley’s Athenian Red-Figure Vase-Painters. His books had to be scanned, copied, and the final annotated pages with the links were scanned, for accessibility and for seamless collaboration among team members.
Joshua Sanchez-Gena: Undergraduate in Classics and Computer Science, The George Washington University, Washington DC, worked remotely under the direction of Diane Harris Cline and Eleni Hasaki helped in Spring 2021 in selecting the most populated age range from the “Oxford Data” a task that was critical in establishing the “time slices” of the sociogram. to secure a research internship in a major European collaborative project “Digitizing the Roman Imperial Road Network, by T. Brughmans (University of Aarhus, Denmark). Brughmans is one of the current European leaders in SNA (Brughmans 2013; Brughmans et al. 2016). https://archaeologicalnetworks.wordpress.com/2020/04/27/digitizing-the-roman-imperial-road-network/

The project was carried out according to the timeline proposed. The major issues we encountered were the broad time periods for several artists, which made our time slices a bit broader than desired. As the project continues we will focus on reducing the chronological span for each painter, so that the time-slice visualizations are more meaningful. We were pleased that students could be involved. The expertise gained in this project has been carried into the classroom by both project directors.

4. Project Outcomes

We completed the sociogram of the red figure vase painters of all the artistic relationships that Beazley had established between painters, between potters and painters and between makers and shapes. This was a time-consuming process, but we had standardized the extraction method for the first phase of the project. The project’s raw data of both the pre-NEH and the NEH funded phase will be uploaded on the project’s website (snap.sbs.arizona.edu) in 2022 (Figure 4). With several presentations of our project in diverse audiences, we have promoted the NEH, highlighted how this project enhanced both project directors’ academic profile, we were able to secure additional funding for hiring undergraduate and graduate assistants. Our project also serves as a model for a new generation of graduate students and recent Ph.D.s as they embark on applying SNA on other datasets from Classical Archaeology.

The SNAP project focuses on using connoisseurship-based ties to create a large-scale relational matrix using SNA methods. We are focusing on the fine decorated ceramics. In a special niche of the Athenian ceramics industry lie the decorated pots, especially those with figural scenes. Those pots allowed a closer connoisseurship analysis by Beazley (1956; 1963).

The proof of concept was developed by converting Beazley’s stable written text for black figure artists (an 850-page volume) into digital interactive format with a sociogram of 710 nodes and 863 ties. We preserved existing information, while expanding the possibilities of asking new questions, and of creating new reconfigurations of potters’ networks. While individual artists have since been studied with great results, SNAP was actually the first to visualize, calculate, and evaluate the totality of these associations and interconnections, moving beyond lists of painters and potters in linear form or databases which keep interrelationships hidden.
Through SNA metrics and visualizations, we identified the important artists in the network, who tend to be connected to more than one vase shape, acting as bridges and innovators. We also studied lesser-known artists for their contribution to the diffusion of new ideas because of their position in the network. The preliminary results were encouraging and through a sustained dissemination agenda in digital, conference, and print venues we witnessed the enthusiasm among our peers in related fields.
4a. Methodology

Beazley used a plethora of terms to capture the stylistic ties among the Athenian potters and painters. He never explained his rationale for his choice of terms or their true definition and that invited sharp criticism of his method. The results have not been challenged to this day. As a scholar who worked with what we now call “big data” himself in a time before computers, we hope Beazley would be interested in the quantitative and relational approaches we offer here. No published system of correlations has been published by Beazley and there is no diagram preserved in the Beazley Archive. As we have noticed, his books contain no photos, drawings, or diagrams.

Beazley may have imagined them as being next door, near, close to, or not far from, but in a social network, they all are tied, which is a reduction. The charts are not one-to-one renderings of Beazley’s community of artists in this sense (Figure 5).

Figure 5. List of relational terms used by Beazley. Left: a closest-to-farthest grouping of terms (terms listed in Robertson 1992). Right: A Venn diagram of select terms (Whitley 2018).

Generally, the first tie we recorded would be between a painter and the title of Beazley’s (modified) chapter where he appears. There are many qualitative variants for the way Beazley subdivided his chapters relative to the chapter title. When Beazley dedicates a separate section for an associate of a painter (e.g., Manner of the C Painter, Related to the C Painter) we recorded two additional ties, one for “Painter C” and “Manner of the C Painter”, and one for “Painter C and Related to the C Painter.” If Beazley did not assign a separate section, but mentioned in the text that Painter X recalls or is near Painter Y, for example when he says that the “Burgon Group” is near the “Painter of London B 76”, we recorded a tie between the two but without adding the qualitative terms near, related, akin, recalls, brother, next door or “pupil”, we recorded it as a tie between two nodes on the spreadsheet, without differentiation, although we saved these distinctions in our notes for later analysis.

We illustrate how our ties were constructed in the figure below (Figure 6). First one has to comb the text. Once a relationship is mentioned, Exekias and Manner of Exekias, we entered this link on the NodeXL (as vertices or nodes); the links are called edges, and the resulting list is called an edgelist. The NodeXL generates a basic relational diagram (sociogram), which the user can further manipulate through size, color, and shape of nodes.
When constructing the ties, we did not use differentiate the ties according to the term used. So all terms have the same edge in the sociogram. Beazley’s terminology probably crystal clear to him was nebulous and undefined to his readers. Despite its richness and sensitivity, it attracted harsh criticism after Beazley’s death. In the future it will be possible to further visualize these ties by different types of edges (Figure 7). We plan to upload the short exercise of the Exekias network on the project’s website as an introductory, small-scale, exercise to our program.
4b. The Network Metrics for ABV and ARV Sociograms

The sociogram for the Athenian black figure potters and painters has 866 edges and 703 nodes (Cline and Hasaki 2019; Hasaki and Cline 2020; Figure 8). There are 12 components and the largest one has 635 nodes (90% of the sociogram). In decreasing order, the attributed artists account for 47%, groups for 24% and Classes for 18%, while the named artists account for 11%.

The sociogram for the Athenian red figure potters and painters sociogram has 1588 edges and 1065 nodes. There are 13 components and the largest one included 823 nodes (ca. 77% of the entire sociogram (Figures 9-10). In decreasing order, the attributed artists account for 72%, the groups for 14%, the classes for 9%, and the named artists (through signatures) for 5% (Table 1).
Figure 8. The network of Athenian red figure potters and painters showing the various clusters. Sociogram by Diane Harris Cline (visualization) and Eleni Hasaki (coding) with data from Beazley 1963.

Figure 9. The network of Athenian red figure potters and painters. Sociogram by Eleni Hasaki (coding) and Diane Harris Cline (visualization) with data from Beazley 1963.

Beazley had set out originally to develop his connoisseurship-based system on vessels which did not carry signatures, therefore red figure technique was ideal to him. Although there are more signatures in the black figure, he was more conservative defining too many individual styles, and often he grouped artists to groups and classes for the form.

Table 1. Network Metrics for the black figure and red figure potters and painters.

<table>
<thead>
<tr>
<th></th>
<th>EDGES</th>
<th>NODES</th>
<th>COMPN</th>
<th>Top</th>
<th>Named</th>
<th>Attributed</th>
<th>Group</th>
<th>Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black figure Technique</td>
<td>866</td>
<td>703</td>
<td>12</td>
<td>635</td>
<td>79 (11%)</td>
<td>326 (47%)</td>
<td>169 (24%)</td>
<td>127 (18%)</td>
</tr>
<tr>
<td>Red figure Technique</td>
<td>1588</td>
<td>1065</td>
<td>13</td>
<td>823</td>
<td>51 (5%)</td>
<td>765 (72%)</td>
<td>149 (14%)</td>
<td>100 (9%)</td>
</tr>
</tbody>
</table>

4c. Time Slices of Producers’ Activity

Central to all these efforts is to study a painter/potter as a product of their time, a temporal consideration. The dates of activity for ancient artists are notoriously difficult as there are no biographies with birth and death dates. The stylistic links between artists and their co-existence in closely-dated assemblages put in place some general chronological boundaries, but they are
usually in spans of 50 years. An admirable attempt of positioning the painters is seen in the graph by Sapirstein where he has tried to reduce the activity date to 10-20 year segments, based on the dates of published vases (*Figure 11*).

![Figure 10. Graph showing the main activity period for the more prolific Athenian potters and vase painters and their shape specialization (Sapirstein 2013).](image)

Gregory Parker from the Beazley Archive Pottery Database harvested all the dates for the black figure and red figure artists (*Figure 12*).

![Figure 11. Time Slices of Athenian red figure potters and painters. Sociogram by Diane Harris Cline (visualization) and Eleni Hasaki (coding) with data from Beazley 1963. Dates provided by Greg Parker, Beazley Archive Pottery Database (BAPD).](image)
A total of 54,000 vases had listed dates in the Beazley Archive Pottery Database as of February 2021. For the majority of artists a specific quarter or half century was prominent, but for several others, the dates covered a larger spectrum. In these cases we chose the one with the largest number of pots assigned. Moving forward we will have to refine the dates to enable an in-depth analysis of time-sliced networks of contemporary artists.

5. Project Evaluation and Impact

In this section we highlight three areas in our discipline where we believe our project has made significant impact: a) the panoramic visualizations of complex datasets such an industrial quarters, b) the importance of specialized clusters within a larger craft community, c) mobility networks of producers and products.

5a. Panoramic Views of Athenian Potters’ Quarters

The first ever views of all the ties is indeed eye-catching as there has been no prior snapshot of the entire system. It is of course important to keep in mind that these sociograms cover at least two or as many as four generations of artists, as they are not all contemporary.

In earlier times there was not an easy way to visualize relationships. We have already commented on a wire diagram by Osborne (2004), a telling example of how complicated it is to show connections (Cline and Hasaki 2019; Hasaki and Cline 2020; Figure 13). In the second example, we show how Beazley listed the collaborations in the red figure Penthesilea workshop where we have instances of artists collaborating in decorating the exterior, highly-curved, sides of a cup (sides A and B) and the interior, rather flat central circular space of the cup, the so-called tondo. NodeXL can render these ties more effectively and with additional visual enrichment one can even insert the specific cups they worked on (Figure 14).

![Figure 12: The collaboration chart of red figure potters and painters. Left: Wire diagram from Osborne 2004. Right: Sociogram by Diane Harris Cline and Eleni Hasaki.](image-url)
This method we also used to highlight specific groups in the large network, such as the network of “Pioneers (Beazley 1963: 13-36) which included influential artists such as Epiktetos, Oltos, Euphronios, and even Andokides Painter who has been credited with the introduction of red figure technique in Athens (Figure 15).

During the NEH funded phase, we also coded and visualized the highly-dense chart of lekythos producers studied in detail by Oakley (1997). In the networked format the second the shape specialization becomes more pronounced and links the producer with his collaborators and the shape specialization, instead of studying the artists as separated from their products (Figure 16).
We believe that our complex visualization with the large data of the Athenian potters’ quarter will also inspire others to revisit some earlier attempts of SNA. In the example below we provide one of the pioneer examples of official delegates from a Greek city-state (theoroi) visiting major Greek sanctuaries for religious festivals (Rutherford 2007; Figure 17).

**Figure 15. Sociogram showing the collaborations in Achilles Painter’s network. Sociogram by Eleni Hasaki and Diane Harris Cline. Data from Oakley 1997.**

**Figure 16. Theoric Hypernetwork. Left: Rutherford 2007: Fig. 10. Right: Sociogram by Eleni Hasaki of the same data rendered in NodeXL.**

### 5b. The Shape Sectors in the Ceramic Industry

Although Beazley and the connoisseurship method have been criticized for placing too much emphasis on the individual artists, Beazley had actually organized his books according to the shapes they decorated. The skills for a potter and painter producing an 18 cm tall drinking cup (kylix) with intense curvature are distinct from those for producing a 30 cm lekythos with
cylindrical body and almost no curvature, or a Panathenaic prize amphora with a height of 60-80 cm (Figure 18).

Figure 17. Representative Greek Vase shapes and their sizes (https://dwgmodels.com/917-greek-vase-shapes.html).

By mapping Beazley’s linear arrangement of shapes and artists, we realized the importance of shapes and how shape specialization could be a fruitful avenue to study innovation and tradition even beyond SNA (Figure 19).

Figure 18. Athenian black figure potters and painters, highlighting the lekythoi sectors. Sociogram by Eleni Hasaki (coding) and Diane Harris Cline and Eleni Hasaki (visualization) with data from Beazley 1956.
In both the black figure and red figure potters’ communities, the shapes of the vases are often the foundation for clusters inside the network as a whole. Because we have more than one type of vertex (humans and vases), the vase shapes can create affiliation-networks, as artists tend to specialize in shapes, and those actors who are contemporary perhaps know of each other. Shapes were ways that artists affiliated -- artists specialized in larger or smaller vessels, which required different drawing skills, and the shapes had curvature, and artists got comfortable in painting on lower or higher curved surfaces. The shapes often have the highest degree or “connectivity.”

Ordinarily in bipartite networks it is standard practice to study them by projecting them down onto one-mode. That requires us to assume the artists who work on a specific vase-shapes are affiliates and belong together. This is not the case: the shape can continue to be produced for many generations, but the artists live and die, so we have made the choice not to compress them.

In our study case we seek to understand the high scores in the SNA metrics of the lekythos sectors both in the black and red figure sociograms. The lekythoi were destined for the public spaces of cemeteries, for inclusion in the graves, or placed on the funerary markers. As the staple offering for the regular tomb visits by all social strata, the lekythoi workshops had a steady market. With a guaranteed clientele, with a choice of high or low visibility and with half their surface undecorated, the lekythoi workshops could function as experimentation labs both for apprentice painters and for innovative ones, who broke new ground in decorative techniques, both short-lived ones, such as coral-red, white ground, and the one which prevailed, the red figure technique.

5c. Mobility Network of Export-Oriented Producers

Beazley constructed his communities of specialists by studying exported Athenian vases, uncovered mostly in Italian tombs, and then formed the core the major European and US museum collections (Figure 20). Their undisturbed funerary context ensured a better rate of preservation, and facilitated the connoisseurship study of larger pieces instead of small fragments in domestic or other contexts. With the exception of a large number of lekythoi, very little of his material comes from contexts in Athens itself. In other words, Beazley’s data represent the major artists involved in the export trade.

A major painter in Athens who did not make lekythoi and did not export would not have made the cut. It seems however, that due to the specialized and labor investment in this niche industry, export sales were as important in their business model as the local sales, perhaps even more. If one tries to map which artists from Beazley’s system are represented in a local highly visited context as the Athenian Agora this is what it would look like (Figure 21).
Figure 19. The geographical distribution of all Athenian vases in the Beazley Archive Pottery Database (Beazley Archive Pottery Database).

If Beazley had substantial deposits of complete vessels excavated in Athens available to him in the beginning of the 20th century CE, a different network of locally-prominent artists might have emerged.

Figure 20. A selection of the black figure potters and painters found in the Athenian Agora (Cline and Hasaki 2019). The small number represented in the heart of Athens underscores that our network does not necessarily reflect the reality of the painters locally (in Athens) but their power in the export trade networks. Sociogram by Eleni Hasaki (coding) and Diane Harris Cline (visualization) with data from Beazley 1963 and Moore and Philippides 1986.
Mobility and connectivity have been at the core of Social Network Analysis since its early applications in Bronze Age Aegean and in recent studies of shipwrecks capturing networks of trade routes. In one of the earliest SNA application on a Greek craft community, that of marble sculptors in Hellenistic Aegean, Larson similarly highlighted patterns of mobility and interaction (Figure 22). Larson harvested the data from 493 inscriptions representing at least 244 sculptors, active in the Aegean including Attica for about three centuries between 323 BCE and 1 BCE. The major difference between our work and hers is that in our case only the products of the potters moved, where in the case of sculptural commissions, the makers themselves moved as well to the commissioning and final display site.

Figure 21. Network of sculptors linked by places 323-226 BCE based on epigraphic data. (Larson 2013)

Larson even produced time slice for providing a micro-scale of the historical and economic circumstances that fostered or hindered mobility in the Aegean during distinct phases of the Hellenistic era (321-33 BCE). Larson had to code the ties herself. For studies of migration of artists in more recent times, scholars are aided by online resources, which can be coded much faster. Keiser and his collaborators (Keiser et al. 2018) relied on the APIS data in Österrichisches Biographisches Lexikon 1815-1950 and with additional manual annotation they constructed a network of artists and the places of birth, death, education, travel, work, and exhibitions. Vienna is the central node in the person-place network (Figure 23). They integrated mobility/patterns of migration into the concept of “cosmobilities” a comprehensive term including “local rootedness, transcultural orientations and global entanglements with insights on mobility” in order to overcome “one single master narrative.”
6. Project Continuation and Long-Term Impact

SNAP project is well-positioned to have a long-term impact can provide a blueprint on how to code text-formatted stylistic relationships and map entire craft communities, whose connectivity lies hidden in linear textual form. In our case, it also highlighted how much gravitational force the learning networks around shapes exert on the network.

For this last section of the White paper, we will focus on how the SNAP fits within network analysis in Classical Studies, and more broadly within the study of ceramics in the Ancient Mediterranean. Given its central position, it has the potential to open up new ways of detecting and highlighting patterns in large datasets.

The SNAP project represents the first big data example of the SNA in Classical Archaeology, especially on ceramics. Most previous ones had focused on textual sources to reconstruct extensive networks of philosophers (Socrates), politicians (Perikles), and imperial leaders (Alexander the Great) (Cline 2012; Cline 2019; Cline 2020). The references to actual names in

Figure 22. Migration/mobility patterns of European artists based on biographical data (Keiser et al. 2018).
these textual sources bring these social networks alive (*Figure 24*). They capture both the small world effect in a Classical city-state like Athens, but also the globalization flare of the vast Hellenistic empire constructed by Alexander the Great.

*Figure 23. The Social Network of Athenian philosopher Socrates (Cline 2019).*

Ceramics with their frequent changes in form and in decorative techniques make them ideal proxies for establishing chronologies to date the contexts in which they are found. It is even better when the ceramics themselves carry epigraphical data, like stamps, that help pinpoint their date even more. With these layers of formal diversity, prosopography, or regional affiliation, they are also ideal candidates for network analysis.

Archaeological networks especially those focused on ceramics also constructed their ties on textual evidence, mostly but not exclusively, on business ownership stamps on Roman bricks (Graham 2006; 2014). Below you see the original network in Graham’s seminal study of brick industry in the Tiber Valley (2006), the first large-scale application of SNA on archaeological materials. In 2014 with advanced software, Graham reran the ties he had established for his earlier study through GEPHI using directionality and other metrics and produced the sociogram below (*Figure 25*).
In recent years, archaeologists used a type of ceramic transport amphoras with strong chronological and geographical index power to reconstruct how integrated some regions were in specific maritime trade routes. Leidwanger was able to trace diachronically how cargoes were more mixed in earlier times with more connectivity, while in the Late Antique, one has a more fragmented pattern of interaction (Figure 26).

Our project augments significantly the applicability of SNA to communities of artists across eras and cultures. It stands on the intersection of SNA and ceramics and SNA and communities of makers. The SNAP project can provide comparative material for long-term SNA studies such as the archaeological one on Southwestern Ceramics (a multi-year project at the University of Arizona, now entering its second phase as CyberSW; https://cybersw.org) or the ethnographic projects centered in traditional potters’ communities in India and Kenya. The ethnographically-based SNA provides an interesting comparison on how potters themselves identified who was a major influencer within their communities, vs. our archaeological methods which try to reconstruct who is in the broker’s role (Figure 26).
Figure 26. Left: Networks of Southwest Ceramics (Mills 2013); Right: Manzo et al. 2018. Kinship ties among Muslim potters in Rajasthan (194 nodes; 2703 links) (Manzo et al. 2018).

5d. SNAP and Digital Communities of Artists

A growing community of classical scholars are working on digital humanities projects which will enable data mining like we have never had before. The SNAP project was inspired and built upon the seminal research by Beazley in the pre-computer era of the early to mid 20th century CE. It maintains its strong partnership with the home of the Beazley Archive Pottery Database at the Oxford University (Classical Art Research Center). The most impactful website for Athenian decorated pottery is the Beazley Archive Pottery Database, at Oxford University (770,000 database searches annually; 6 million page views, with 160,000 unique users in 2020). This invaluable resource offers access to images of these vases, links to major publications such as the CVA, and even plot the geographical distribution of a painter’s set of attributed vases, a total of 17 different fields of searching (Figure 27). We are working closely with them (Gregory Parker, collaborator in this project) and endeavor to help them make the “relational turn”, where we move from the study of the prominent individuals to communities and relationships through networks or ecologies, which is just beginning in classical studies, and we are a leading part of this shift.

Another Greek-ceramics centered digital humanities project, KERAMEIKOS (NEH DHAG recipient; kerameikos.org, is an important initiative based on metadata and focuses on linking several museum databases of Greek pots using a common script to facilitate searches among different collections. According to the project website, it is “dedicated to defining the intellectual concepts of pottery following the tenets of linked open data and the formulation of an ontology for representing and sharing ceramic data across disparate data systems. Access to a comprehensive data set has been a chronic hindrance to studying the workshops of the Athenian Kerameikos and this will be catalytic for many projects.

The major challenge of employing network analysis in Classical Archaeology is that the information needs to be coded in SNA terms (building the edgelist), whereas colleagues dealing
with artists of more recent times have a lot of information already coded and standardized, so one can more easily harvest the data.

Figure 27. Beazley Archive Pottery Database (https://www.beazley.ox.ac.uk/carc/pottery).

SNAP is poised to enrich already established digital projects in art-history and to expand the digital footprint of the Classical world. In the art-historical digital universe, we highlight Cranach Digital Archive for the voluminous production of 15th century German painter Lucas Cranach. Sandrart is an internet research platform on the history of art and culture in the 17th century. Since 2007, this project has amassed an impressive database of artists, their works, linked themes, but is still without a mechanism to connect collaborating artists to each other. To all these extremely useful endeavors, a network approach can contribute a significant layer.

A great example of SNA application is Liu’s analysis of Dutch painters (Figure 28). She worked with metadata, and was able to highlight what networks of artists produced a specific iconographical themes. Through contemporaray and later documentary evidence and with all data already in digitized online resources (such as RKD and Ecartico) she was able to identify how iconographical themes were shared among specific painters in the mid-seventeenth century CE.
7. Conclusions

The NEH DHAG-funded project *Social Networks of Athenian Potters* successfully connected the potters’ communities in Archaic and Classical Athens working in a specialized niche of ceramic industry the figural wares and mastering two different visual syntaxes, the black and red figure techniques. The makers of these pots constitute a special community of practice both in antiquity and in modern scholarship: we have the largest number of artisan’s names and depictions of their craft known from any craft within a concentrated time period of 200 years (Hasaki 2021; Figure 29). We have a couple of hundred signatures surviving on their products, and we have a substantial number of collaboration signatures surviving on the pots themselves.

The products of this specialized community were highly regarded in Mediterranean markets so we have a unique case where we can see the impact (however skewed by data and chance of recovery) of these producers in their globalized context. For no other group of craftspeople have scholars created such an intricate web of relationships. Although Beazley’s lack of explicitly describing his connoisseurship methodology and the focus on the individual have been strongly criticized in the 1990s, the web accuracy has remained intact, and it provides a fascinating world of ties for a complex network analysis.

This chronological precision (unattainable for most other scientific methods) and the wide export spectrum of Athenian ceramics makes them extremely valuable for field archaeologists throughout the Mediterranean when they excavated contexts when Athenian ceramics appear. On the other hand, SNA visualizations can shed new light in several datasets of Greek and Roman archaeology which are already collected in indices or linearly-arranged datasets.
The SNAP project provides an innovative approach to study potters’ communities and more broadly communities of practice. It belongs to an ever-increasing trend in studies of Mediterranean archaeology and history to employ Social Network Research to study spheres of influence among prominent figures in the society through ancient texts and connectivity, trade routes, and identity through archaeological artifacts. The SNA tide has been slow but steady in the scholarly communities of Classical Mediterranean. The earliest applications were in mid 2000s brick stamps in Italy (archaeological artifacts carrying stamps with owners of brick workshops; Graham 2006). In 2010s, the Aegean Bronze Age scholars adopted SNA to visualize the connectivity and trade routes in the Aegean, especially the Cycladic islands and Crete (Knappett 2011). In 2013 the first study of the religious networks of the Roman empire were studied (Collar 2013) and focusing on Italy itself, the configuration of pre-Roman trade networks was undertaken (Blake 2014).

Contextualizing SNAP within this small group of studies also help researchers highlights the limitations from using different types of evidence used to construct the relational pairs, or building the pairs from scratch, rather than using already coded information in online databases.
As the first SNA-based project for potters’ communities in the Greek world, it can serve as a model for studying other potters’ communities within and beyond the Mediterranean world.

As a result, SNAP can provide an alternative model of studying creative communities and fills an important gap in digital humanities. We anticipate that our work on the data set of Athenian vase-painters will contribute to promoting the digital humanities and relational analysis in the field of Athenian, and more broadly Greek and Roman, pottery industries; ideal candidates for SNA are the Corinthian pottery industry, the South Italian potters, and the industrial scale workshops of Roman sigillata in France and Italy. Beyond ceramics, our project can further serve as a comparative model for evaluating different types of datasets on a cross-craft level (such as the social networks of Greek sculptors based on their signatures) and on a cross-cultural level (such as the networks of Renaissance artists as recorded in Vasari’s biographies, or legal documents). Building a critical mass of social networks of communities of practice across crafts and cultures will bring to fore any ancient or modern bias in (self) identifying within these groups.

For any questions on the SNAP project and for discussing the SNAP project at NEH workshops or with prospective applicants, please contact: Eleni Hasaki, hasakie@email.arizona.edu
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