Visualizing Variation Within and Between Ceramic Types: A Clustering Approach

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INTRODUCTION

Ceramic analysts assign types to vessels based on observations of exhibited attributes. Types can materialize in a variety of finite ways (see figure 1), and various types have temporal associations as well as sociocultural meaning dependant on context. Types are assigned via outlines in the existing literature, within the framework of the analyst's experience. This procedure has analytic benefits but can be subjective and the assignment of a vessel to certain types may prove difficult (Emerson 1968: 34).

In order to explore the nature of the anatomical variability that Iroquoian pottery manifests, vessel assemblages from two Toronto-area 15th century ancestral Wendat archaeological sites - The Baker site (AkGu-15), an early 15th century settlement (Robertson 2006), and the Damiani site (AlGv-231) , a late 15th century village (ASI 2013, Pradzynski 2013) - were adapted into an agglomerative hierarchical cluster-based model. The resultant cluster dendrograms visualize relationships between individual ceramic vessels utilizing the attributes recorded during a typical descriptive typological approach.

This study examines the benefits of such an approach for examining ceramic assemblages, one of which is its independence from assigned types as an analytic unit. The variety and character of the assemblage is ascertained and presented strictly using observable attributes, and it is thought that this model is able to bring to the fore relationships of types and of sites that are not as readily apparent when using the descriptive approach.

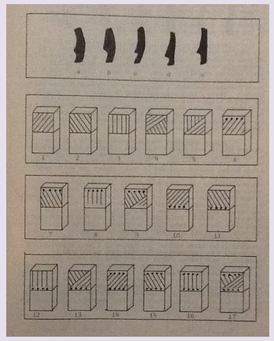


Figure 1 (adapted from Emerson 1968: 33)
The possible manifestations of Huron Incised collar, rim, and lip shape as well as design elements.

MATERIALS AND METHODS

This exploration employed 363 of the 374 vessel rims found at the Damiani site (removed from study were the castellation and collarless specimens) as well as 25 Huron Incised vessels from the Baker site.

Each vessel was analyzed based on 15 nominal variables and 3 continuous measurement variables (Robertson 2006, Pradzynski 2013). These variables were recorded in spreadsheet form and read into the software package R for manipulation. To prepare the data for clustering, the nominal variables in each assemblage were transformed into binary presence/absence characteristics, and the common logarithm of the continuous metric variables was taken to weight against excessive outliers and to scale them equally to the binary categories. The distance between each vessel in relation to its measured variables was calculated. An agglomerative hierarchical clustering technique was applied to this distance matrix in order to create a cluster dendrogram.

This clustering method was systematically applied to different combinations of the two assemblages to produce the following cluster dendrograms:

- Cluster 1: All 363 applicable vessels from the Damiani site
- Cluster 2: All vessels of the type "Huron Incised" from the Damiani site
- Cluster 3: All vessels "Huron Incised" from the Damiani and Baker sites

Rim Form	n	%	Collar Base Shape	n	%	Rim Orientation	n	%
Collared	322	89.2	Rounded	344	95.29	Outflaring	358	99.17
Incipient	23	6.37	N/A	16	4.43	Inslcoping	2	0.55
Collarless	16	4.43	Angular	1	0.28	Vertical	1	0.28
Total	361	100	Total	361	100	Total	361	100
Lip Form	**n**	**%**	**Angle of the Lip to Interior**	**n**	**%**			
Rounded	323	89.47	Obtuse	345	95.57			
Flat	34	9.42	Acute	16	4.43	**Collar Height (n=345)**		mm
Concave	4	1.11	Total	361	100	Mean		14.11
Total	361	100				Range		5.42–60.78
						Standard Deviation		7.41
Interior Profile	**n**	**%**	**Exterior Profile**	**n**	**%**			
Convex	292	80.89	Concave	250	69.25			
Concave	40	11.08	Convex	107	29.64	**Lip Width (n=361)**		mm
Straight	28	7.75	Straight	3	0.83	Mean		4.62
Concave-Convex	1	0.28	Convex/Concave	1	0.28	Range		2.21–15.81
Total	361	100	Total	361	100	Standard Deviation		1.82
Interior Motif	**n**	**%**	**Interior Technique**	**n**	**%**	**Basal Collar Width (n=345)**		mm
Plain	350	96.95	Plain	350	96.95	Mean		8.25
Oblique	11	3.05	Linear Stamp	10	2.77	Range		3.84–18.04
Total	361	100	Incised	1	0.28	Standard Deviation		2.11
			Total	361	100			

These cluster dendrogram combinations were chosen to represent the variety of typology clustering combinations to which a clustering approach can be applied.

Figure 2

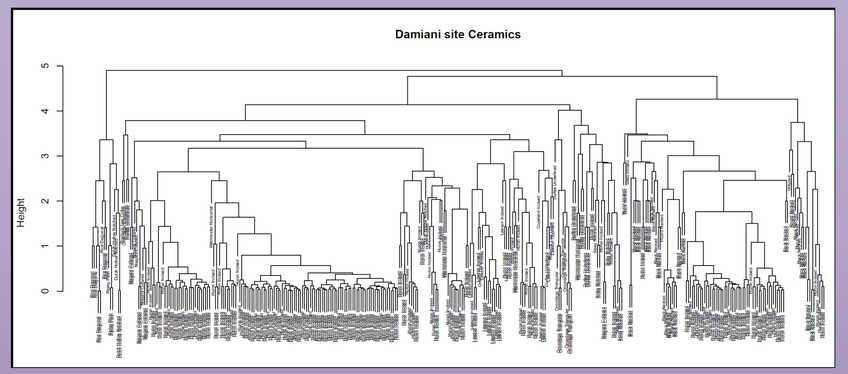
- Descriptive attributes-based analysis of the variability of vessel forms from the Damiani site (adapted from Pradzynski 2013).
- Twelve of the 18 attributes read by the cluster model.

Also recorded and modeled: Lip Motif, Lip Technology, Collar Motif, Collar Technology, Neck Motif, and Neck Technology.

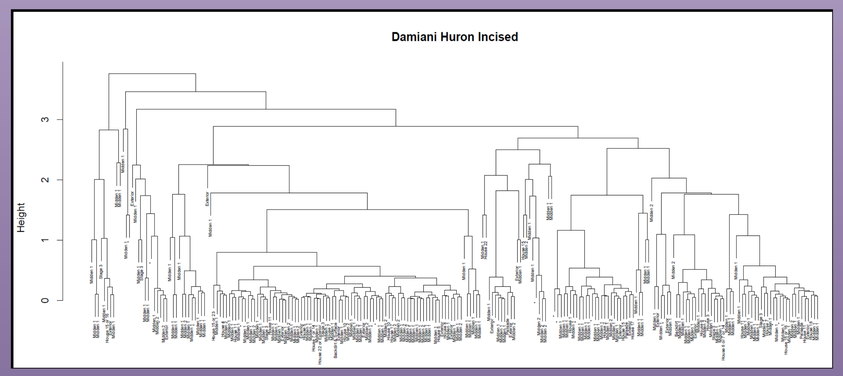
RESULTS

Clustering based on basic analytic attributes appears to produce distinct groups of related ceramic types, with a few anomalies and curious patterns worth discussing.

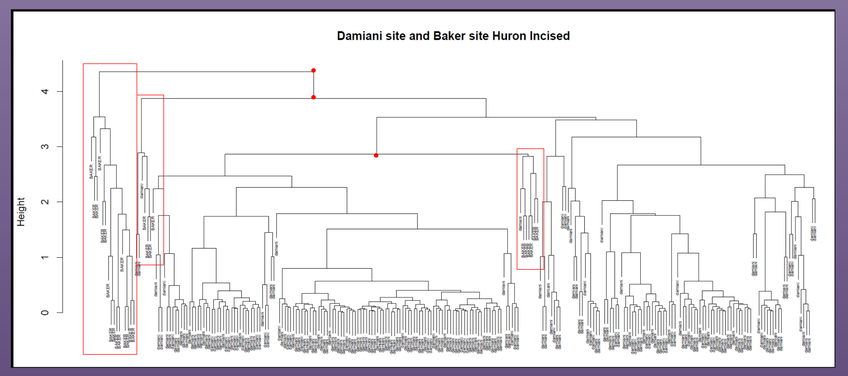
- Cluster 1: Ceramic vessels from the Damiani site appear to cluster close to related types. The odd outlier, an apparent variation from the expected form, occasionally joins another form. Relationships between related types are visible here as well. Types such as Rice Diagonal and Dutch Hollow Notched are least like all other types; their forms leave a unique, striking signature. The types Black Necked and Pound Necked often cluster together (on the right of the dendrogram), a pattern predicted by Emerson (1968: 34).
- Cluster 2: The Damiani site's most prevalent type manifests in a variety of ways, with large clusters of very similar (height≈0, <0.5) vessels evidencing a remarkable continuity of form. Provenience labels show that this form does not cluster spatially.
- Cluster 3: 16 of 25 Baker site Huron Incised vessels are less like the Damiani Huron Incised assemblage (height≈4.5) than other types of ceramics within the Damiani site assemblage are to each other (Huron Incised and many Black Necked, height≈3.25). This again highlights the Damiani site's uniquely continuous Huron Incised form.



Cluster 1: Damiani site vessels labeled by type.



Cluster 2: All Huron Incised vessels from the Damiani site, labeled by provenience.



Cluster 3: Huron Incised vessels from the Baker site **(AlGv-231)** were clustered along with the collection from the Damiani site.

Huron Incised vessels from the Damiani site (AlGv-231).
Left: reconstructed vessel with pointed castellation; Right: six Huron Incised vessel rims.

DISCUSSION

A cluster-based approach to ceramic analysis engages the descriptive attributes-based method as seen in figure 2 by mapping the design elements as they manifest upon each vessel in relation to other vessels. Attributes rather than types are used as the foundation for comparative analysis, though still within the typological framework. This exploration shows that the model can be applied not only to whole vessel assemblages, but to sub-sections of an assemblage and to elements of multiple assemblages at once.

This study does not advocate abandonment of typological analysis, but instead seeks to transcend its reductionist limitations. The present examination of the Huron Incised type does precisely this. The blending of form within the Huron Incised vessel assemblage and between this vessel type and others is clearly visible in relation to both the overall assemblage as well as vessels found at the nearby Baker site. The Huron Incised vessels from the Baker site do not show the same uniformity as do the majority of the Damiani site specimens. Indeed, unlike at Damiani, Huron Incised type was not the primary vessel form, instead being dominated by Black Necked vessels. When information such as this is paired with archaeological context, the archaeologist is left to muse upon meaning.

With larger amounts of ceramic data, more developed models of typologies can be created, and it is possible that typological signatures of vessels at the archaeological site level can be seen. It is argued that the most beneficial way to organize a ceramics analysis is by recording and using both typological and attributes data - for present exploration and future work as well (Birch & Williamson 2013: 129). This clustering method is one such model which can map the character and distribution of traditional types in a uniquely visual way.

The agglomerative hierarchical clustering technique for ceramics attributes presented here appears to be a valid and useful analytical tool for visualizing the nature and characteristics of ceramics vessels both within types and between them.

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