AT ATTEMPT TO MAKE A REPLICA 14TH CENTURY LINCOLN WARE JUG

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Summary

This is an account of how a modern potter attempted to replicate a 14th century green glazed jug (Fig. 1) using techniques as close as possible to the original. The making, glazing and firing techniques are described.

Introduction

This jug was chosen because it is a good 'typical' product, bearing most of the common characteristics of 14th century pottery. The research carried out relied heavily on the practical experience of making pottery.

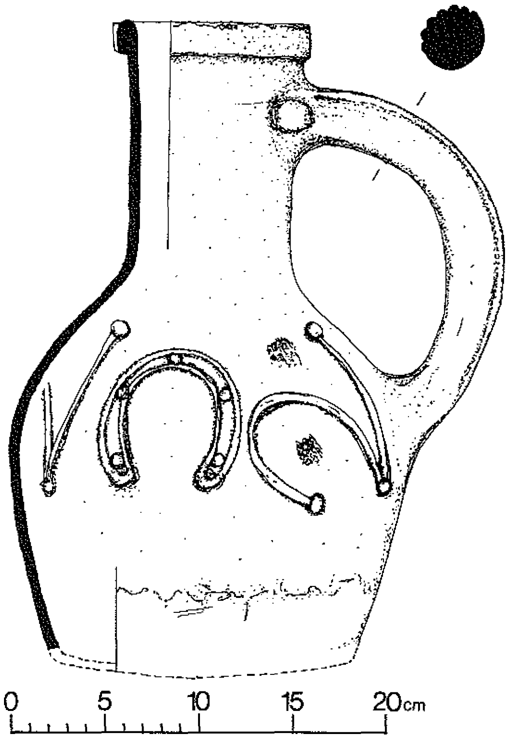

Fig. 1. A 14th century Lincoln ware jug

Clay Fabric

The clay fabric is fairly fine and fires in oxidation to a bright orange colour. Samples of clay dug in central Lincoln came out of the ground a yellowy tan colour and fired in an oxidising kiln to a similar orange colour. It is safe to assume, in any case, that the potters would have used locally dug clay. The clay has to go through a refining process before it can be used to make pots on a wheel. This process has been described by Brears, 1971, and McCarthy and Brooks, 1988.

Analysis of modern orange firing clays from pottery craft suppliers show a 'typical' orange clay to have a ratio of about 60% silica to 20% alumina with up to 10% iron oxide. The other 10% is made up largely of water and a few other oxides, including titanium and potassium.

Fillers

Whilst Lincoln ware has a fairly fine fabric, often pottery was made with clay where fillers have been present either naturally or added during some stage of the clay processing. These have included quartz sand, ground shell, rock fragments, grog (fired clay or pottery ground small) chaff, grass and dung (McCarthy and Brooks 1988). I have found sawdust a useful filler, especially if the pot is to be fired rapidly.

The Form

Most modern potters would probably confirm that the jug has been thrown with extreme competence to a standard which is hard to match. The jug has a confidence of form and wall thinness, demonstrating a total mastery of the throwing technique. To allow for shrinkage and water loss, the jug has to be made 10% bigger than its final desired size.

The archaeological and documentary evidence for the different types of potters' wheel have been considered by McCarthy and Brooks, 1988. Although several types of wheel can be used, the Lincoln jug must have been made on one where both hands were free for a long period of time so that considerable pressure could be exerted while the wheel head was turning at a steady speed.

To produce a pot of the correct form, the clay first has to be wedged to the correct consistency, which can be quite critical for a big object. The lump of clay is then placed on the wheel head and centred. This involves using two hands to coax the lump into a shape revolving absolutely uniformly, which can take considerable effort with a large lump of clay. A cylindrical shape is then usually produced by pushing out from the inside, or in from the outside. The pot, however, is not necessarily made in one throw, although the Lincoln jugs appear to have been. Alternatively, the base can be formed separately or at a later stage and then joined. If this is done skilfully it can be very difficult, or impossible, to detect, especially if a fillet of clay is added over the joint.

Some pots may have been made in sections - by throwing the first half (not necessarily the bottom half), leaving it to harden and then throwing on an extra section or sections to the required shape. This technique would appear to be more suited to the 'momentum' type wheel where it is difficult to sustain a steady speed for a long time. The difficulty here is that the shape has to be recentred exactly each time, otherwise the pot will be disjointed in profile. Modern potters can achieve this by using 'wheel-bats' - circular boards made of wood which can be taken on and off the wheel head and replaced exactly centrally back on to the wheel head. However, there seems to be no evidence of these from any of the medieval illustrations of potters' wheels.

Alternatively, two or more pieces can be made separately and joined together or luted, after they have been thrown. Again, if this is done skilfully, this can be difficult to detect. Calipers or a ruler would probably have to be used with this technique. Also, when the pieces have been joined, it is possible to place the pot once again on the wheel and re-throw to some degree the entire pot, thereby changing the vessel's profile.

After the pot has been initially thrown, the excess clay can be removed by either 'knife-trimming' or 'turning'. However, it should not always be assumed that this was a separate process carried out at a later stage. It is perfectly possible to shave off excess clay at the base of the pot immediately after it has been thrown and before it has been removed from the wheel. The same is also true for 'knife-trimming'.

In practice, it is difficult to remove large newly thrown objects from the wheel head without deforming them; especially if the vessel has a large base area. The pot can either be lifted or slid off. I would assume that the thumbed marks around the base are added when the pot is harder, as it is too soft and sticky at this stage.

The rim of the Lincoln jug is a collar formed possibly by one of two techniques. A collar can be made from either a thickened rim, and the profile formed with the assistance of a throwing tool, or the rim is formed by folding over a section of clay. I have found this tricky to accomplish, as the clay has a tendency to split when stretched to its physical limits.

The Handle

A handle is usually added to the thrown form after it has been allowed to dry a little (e.g. overnight). The handle of the Lincoln jug is rounded in section with characteristic grooves running along its length. This type of handle seems to have been made in a number of potteries, especially in the East Midlands, Norfolk and Yorkshire areas. I am still undecided as to how these types of grooved handles were made, even after a number of practical attempts to make them.

I first tried modelling them with a round-ended tool which made a totally different type of mark. I then tried to extrude the handle through a die placed in an extrusion machine, but this was also unsuccessful and, in any case, no two handles are identical in section which would have been the case if the medieval handles were extruded.

Another failed attempt was to cut the handle from a solid block of clay with a shaped wire cutter. This too proved impractical.

A reasonable attempt could be achieved by a combination of rolling or pulling the handle from a coil and forming the grooves with a specially shaped wooden former, which is run along the length of the coil. Alternatively, the handle can be thrown on the wheel and the grooves again made with a former. This is, however, more tricky than it sounds.

On some highly decorated 14th century jugs (e.g. from Nottingham or Grimston) the potters have further elaborated this technique by twisting the handle to form the so-called 'twisted rope handle'. Again, this proved difficult as it is almost impossible to twist the clay handle without deforming the grooves. The handle is attached securely to the jug with fillets of clay smoothed over the joins and further decorated with enlarged thumb or finger impressions. The Lincoln jug has been pierced from the inside as an extra measure to secure the handle.

The jug is decorated with two horseshoe designs and a further three lines with 'C' curves ending in dots of clay. These designs are probably influenced by wrought iron work (Le Patourel 1986, 12) and are formed by applying sausages of clay. In addition, there are five flower-like designs formed from applied pellets of clay.

The Glaze

A glaze can be defined as being a 'glassy like substance fused onto the body of a fired ceramic' (Fraser 1976, 80).

Silica, one of the main constituents of glass, could not make a glaze alone because it has a very high melting point. To make a glaze, fluxes have to be added to lower the temperature at which fusion can take place. The main, or only, flux used in the medieval period was some form of lead compound.

A further component of a glaze can be a colouring agent, usually a metallic oxide, added either intentionally or unintentionally. However, this is not the only factor which can affect the final colour of the ceramic object as it can also be determined by the firing conditions and the colour of the clay.

Evidence from kiln sites indicates that medieval green glazed pottery was produced in a single firing. When there is no biscuit firing, problems arise finding a glaze which both adheres to the pot and shrinks with the body during drying and firing. This practical problem led, in some cases, to dramatic failures of my glaze tests where the entire glaze simply fell off before it even reached the kiln. The glaze had formed a sort of fragile 'shell' from which the pot had shrunk away. A more dramatic failure occurred during firing when the entire glaze coat came away from the pot in the kiln and melted all over the kiln furniture and other pottery.

There are a number of possible techniques of applying glazes to pottery. Some may have been applied dry or in a powder form. However, with this technique there must be some sort of adhesive as a dry powdery glaze will not stick to a leather hard pot and will simply fall away when handled. There is a literary reference to this glazing technique in De Coloribus et Arribus Romanorum, (translated in Evison *et al* 1974, 69) where, in order to facilitate the adherence of the powdered glaze onto the exterior surface of the pot, the author recommends the use of a wheat flour paste.

It is also known that potters making tin glaze pottery added sugar or gum arabic to their glazes to help make them adhere to the pottery. Perhaps medieval potters knew of this technique too, but it is impossible to tell from fired pieces as any organic contents of a glaze burn away during the firing process.

The other possible techniques of applying a glaze to a pot include dipping, pouring and painting. It is often extremely difficult to tell which technique has been used. In practice, I found it almost impossible to achieve a uniform coating by painting it on as the paint brush tended to re-absorb much of the glaze, giving a patchy appearance.

The Glaze Materials

Lead

Lead can begin action as a flux at temperatures as low as 500°C and boils or vaporises at temperatures above 1150°C. The normal firing temperature for lead glazes is in the region between 900°C and 1100°C. A number of different forms of lead compounds can be utilised for glazes. These include:

Read lead	$Pb_3 O_4$
Lead Carbonate	$Pb CO_3$
White Lead	$2Pb CO_3 pb(OH)_2$
Galena (lead sulphide)	PbS
Litharge	PbO

Other forms of lead compounds (having similar characteristics to the above) are also available. One of the problems with analysis of fired lead glazes is that all these different compounds tend to revert to plumbous oxide (PbO) at temperatues over 700°C. Lead oxide itself melts at 886°C.

Lead is highly toxic, especially in its powdered form and stringent safety regulations were introduced in the 20th century to combat lead poisioning of pottery workers. Consequently, it is now compulsory for modern factories to use fritted lead only. This process involves combining silica with the lead oxide thus rendering it insoluable in human gastric juices.

The following three are examples of lead frits:

Lead monosilicate	$PbO SiO_2$
Lead bisilicate	$PbO 2SiO_2$
Lead sesquisilicate	$PbO 1.5 SiO_2$

Lead compounds can be made in several ways, but the most common methods involve treating the lead in metallic form with acids or heat (McCarthy and Brooks 1988).

Fritting can be carried out in a crucible by heating the materials until the contents are thoroughly molten, cooling (usually by plunging into a bath of cold water so as to break up any solid lumps) and grinding. Lead frits are still made today in a similar fashion but on a much larger scale with the use of specially constructed fritting kilns.

Copper

By the 13th century many potters were deliberately adding copper to their lead glazes to produce a bright green glaze. A number of different forms of copper are readily available:

Pure copper	Cu
Copper alloy e.g.	Brass
Copper oxide	CuO
Copper carbonate	Cu CO_2

Any of these added to a lead glaze will produce a green glaze in an oxidised kiln. Copper is a reasonably strong colouring agent and the addition of over 5% to a blaze recipe will usually produce a black, metallic, opaque glaze due to the precipitation of copper out of solution.

Copper oxide can be made by heating scrap copper in a crucible until it oxidises, then cooling it and grinding it with a mortar and pestle. At least one pottery in the post-medieval period is known to have used cuprous fillings in the form of 'pin dust' - a by-product of the brass pin industry (Brears 1971, 128).

Iron Oxide

Some form of iron oxide is usually present in medieval glazes, whether added deliberately or not is difficult to say. The iron can show as a brown speckle or streak or sometimes its presence is very subdued and can subtley soften the hue of a green glaze. The iron oxide can be present in the glaze naturally or formed from the effects of heat on the iron present in the clay.

Silica

As has been mentioned, this is an essential component of the glaze. Silica is an integral part of clay and of most glazes. It occurs naturally in many forms and can be added to glazes as ground quartz, flint or sand. It also occurs in combination with other oxides (silicates).

Some notes on the firing

The final appearance of the glaze is inevitably influenced by firing technique. Conditions which can influence the appearance include the rate of temperature change, the reaching of an optimum temperature and the atmosphere within the kiln.

There must have been considerable variation in the thermal performance of medieval updraught kilns. The medieval potter needed immense skill and experience to avoid the many potential calamities that can occur during firing. These can be caused by too high or too low a temperature and, also, by sudden temperature change, causing thermal shock.

In a wood fired kiln, the kiln atmosphere can change intermittently as new wood is added to the firebox. In the initial stages, the new wood gives off smoke and carbon monoxide. As it burns down, oxygen enters the kiln and the reducing atmosphere is replaced by an oxidised one. These alternating atmospheres within the kiln have a crucial effect on the pottery.

Kiln reduction has a varying effect on pottery at different temperatures. In general, reduction causes the clay body to darken and has a detrimental effect on lead glazes. Heavy reduction results in lead glazes blistering violently whilst mild reduction causes them to blacken and lose their glossiness. I have found that if the reduction is too heavy before the glaze starts to melt, there is a tendency for the dark reduced clay to be trapped underneath the glaze.

Fourteenth century pottery from Lincoln usually has a grey core and orange surfaces where there is no glaze. This indicates either an initial reduced firing followed by a slight period of oxidisation, or a very fast initial firing, leaving insufficient time for the natural carbon present in the clay to burn out.

Glaze Tests

The glaze recipes given below were part of an experiment into the nature of lead glazes. In particular, I was searching for one which was not only a pleasant green colour, but had the ability to adhere to an unfired pot without crawling or running in the firing.

The weights are of the substances in a dry powder form. The ingredients are then mixed with sufficient water to form a paste, sieved and then applied to the unfired test pot. The tests were usually fired in an oxidising kiln to about 1000^{o}C.

I initially started with a variety of different forms of lead, but eventually decided that a form of fritted lead was the most practical, and least toxic, to use.

	Ingredients	Comments
1.	10 Red clay body 10 White lead (lead carbonate)	Not very effective. More like a dark red/brown slip with pieces of grog in. Fusing slightly on the shoulder of the pot to a yellow/brown.
2.	10 Red clay body 10 Galena (lead sulphide)	Very similar to test no. 1 only less fusion.
3.	10 Red clay body 10 Lead oxide (ligharge)	Has the appearance of a dark brown slip going shiny in patches. Glaze tests 1-3 have probably insufficient lead to make a suitable glaze. Also the pieces of grog in the clay body are not melting, causing rough bits to be left in the glaze.
4.	10 Red clay body 30 Galena	Patchy - formed a yellowish/ochre glaze in parts. The rest has the appearance of a dark red/brown slip.
5.	10 Red clay body 50 Galena	Dark, gritty, opaque, similar to no. 4.
6.	10 Clay body 30 Lead carbonate	Very similar to glaze test no. 4. No apparent difference between the various forms of lead used at this stage.

7.	30 Lead oxide 10 Clay body 10 Flint	This glaze would not fit an unfired pot but produced a highly crazed transparent yellow glaze on a biscuit fired one.
8.	30 lead carbonate 10 Clay body	Dark green, very dull and matt with visible brush strokes. Not fused well. Unsatisfactory base glaze.
9.	30 Lead carbonate 10 China clay 1 Flint 8 Red iron oxide	The type of clay is changed and extra silica is added in the form of flint. Although this test was accidentally overfired to about 1080°C, the glaze crawled drastically and formed a patchy lustrous dark yellow treacle.
10.	35 Lead bisilicate 10 Red clay body 1 Flint	This produced a transparent yellow coherent glaze.
11.	35 Lead bisilicate 10 Red clay body 1 Flint 1 Copper oxide	A dark brown glaze with a slight green tinge.
12.	35 Lead bisilicate 10 Red clay body 1 Flint 4 Copper oxide	An opaque black, shiny glaze caused by too much iron.
13.	35 Lead bisilicate 7 Ball clay 7 Red clay 1 Flint	A satin beige glaze.
14.	35 Lead bisilicate 7 China clay 7 Ball Clay 1 Flint	A very poor fit. Flaking away from the pot body. Opaque white possibly due to too much clay.
15.	35 Lead bisilicate 7 Buff clay body	Good transparent slightly yellow glaze. The flint does not appear necessary.
16.	35 Lead bisilicate 7 Buff clay body 1 Copper oxide	Good green.
17.	35 Lead bisilicate 7 Buff clay body 1 Copper carbonate	Good green.

18. 35 Lead bisilicate
7 Buff clay body
1 Copper oxide
1 Zinc oxide

A matt and dull non-medieval looking green glaze.

It can be seen from these tests that a successful attempt to produce a good copy of a medieval copper green glaze can be obtained by adding about 2% copper oxide or copper carbonate to a satisfactory base glaze (No. 15).

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REFERENCES

Brears, P.C.P., 1971. The English Country Pottery

Evison, V., Hodges and Hurst, J.G., (eds), 1974. Medieval Pottery from Excavations: studies presented to Gerald Clough Dunning

Fraser, H., 1973. Glazes for the Craft Potter

Le Patourel, H.E.J., 1986. 'Potters and Pots', Medieval Ceramics 10, 3-16

McCarthy, M.. and Brooks, C.M., 1988. Medieval Pottery in Britain AD 900-1600 (Leicester University Press)

Rhodes, D., 1973. Clay and Glazes for the Potter (revised edition)