Dawson & Kent (1984) *Bulletin of the Experimental Firing Group* No.2 pp.13-17

METHODS OF KILN RECONSTRUCTION

DAVID DAWSON AND OLLIE KENT

For the past three years we have been experimenting with various designs of simple up-draught kiln. It has occurred to us that there are a number of issues concerning the archaeological interpretation and reconstruction of post-medieval and earlier ceramic kilns that are in need of examination. Despite the sparse archaeological and documentary evidence available, there seems to be an accepted group of reconstructive models the validity of which is infrequently questioned. These models have their origins in a very limited number of sources: Rhodes' standard work (1968, 3-17) and Corder's summary of Roman kilns (1959) are often quoted. The majority of reconstructions are of updraught kilns, the inspiration for which ultimately derives from the series of votive tablets of the sixth century B.C. from Corinth (Noble, 1966, 199-200; Rhodes, 1968, 14-5). A minority, the more bizarre reconstructions, suspiciously seem to owe their origin to Oriental and later western European models. Suggestions of cross-draught kilns (i.e. kilns in which the hot gases are drawn more or less horizontally through the ware of the Roman period, such as those of the New Forrest or Hasseris, fall into this category (Sumner, 1927, pl.xvi; Lyne and Jefferies, 1979, 18). We wish to discuss three issues concerning the reconstruction of wood-fired updraught kilns; the firing characteristics of this type of kiln and their relationship to details of design of firebox and warechamber.

It has become apparent that this common type of kiln is inherently well-suited to reduction. In order for the temperature to increase, the fuel must be consumed at an ever-increasing rate. The rate of air consumption will increase proportionately as long as the flue/firemouth characteristics can accommodate further demand. At a particular point this will be exceeded, the ability of the kiln to increase its temperature will be severely impaired and continued stoking will produce reduction within the kiln. This state is characterized by a flaring flame from the flue at the top of the kiln as unburnt gases re-ignite on contact with the atmosphere. If after such a firing the kiln is left to cool with the firemouth and flue open, the ware will start to reoxidise. Such ware may exhibit a

dark reduced core where reoxidation has been incomplete. Although as Rhodes has pointed out, much research remains to be done to understand the processes changing clays during reoxidation, we have noted that some clays which fire red when oxidized will tend to a straw colour when reduced, and slipped or glazed areas may remain reduced except for the glaze or slip itself (Rhodes, 1975,270-1). It is important to remember that this cycle of reduction/reoxidation was employed in the production of Attic red figure wares (Noble, 1960,70-8).

Experimentation with various types of firebox has shown that the design has a bearing on the oxidation and reduction characteristics of the kiln. Although the height and diameter of the flue in the crown of the ware-chamber are the factors limiting the draw, it is the volume of the firebox which controls the maximum amount of fuel consumable at any one time, and the size of the firebox opening (firemouth) sets the maximum air-flow that can be drawn by the flue. A good draw with a restricted firebox will produce well-fired grey wares very easily but reoxidation must be prevented by efficient sealing at the end of firing or by firing down (Lyne, in press). The long narrow fireboxes of the Alice Holt kilns could be specially designed for reduced ware production (Lyne and Jefferies, 1979.17-9). To ensure full oxidation, modern gas kilns are fitted with variable-speed air blowers to keep pace with increase in demand for air. In a simple kiln, enlarging the firebox opening will supply more air but can draw in too much cold air and weaken the draw. Increasing the height of the kiln is the most efficient and practical way of increasing the supply of air as this creates a stronger draw.

In the Greek illustrations the firebox is shown as an open tunnel, sometimes with the potter prodding the fuel with a long poker. Its limitations are the difficulty of controlling air-flow, the tendency for the temperature to be held down by cold air drawn over the coals and a tendency to choke itself with coals because of their incomplete combustion. This arrangement can be modified in various ways, for instance by the addition of a grate. This is a structure supporting a fire which allows ash to drop down and improves efficiency of combustion by drawing air through the fuel

from below. It should not be confused, as occurs in Corder (1959) and other papers, with the openwork floor of the ware chamber. (The frequent misuse of terminology such as "grate" and "flue" can only serve to confuse. The term flue is used here in the sense of a passage to convey hot gases to and from the warechamber.) Such an adaptation cuts fuel consumption, shortens firing time and reduces ash raking to virtually nil. It must be admitted that archaeological evidence of ceramic or iron firebars is scant. Most of the ceramic firebars recorded from excavations are in fact supports for the ware-chamber as is shown by those found in situ. Nevertheless, the possibility remains that some may have functioned as part of a grate. If iron firebars had been used, it could be argued that one of the prime reasons for the scarcity of archaeological evidence for the form of fireboxes could be their systematic demolition to recover an important part of a potter's capital equipment.

Grates were certainly in use in other contexts such as water-heating, metallurgy and alchemy, but any transference of this technology to ceramics before the post-medieval period has not been possible to demonstrate (Goldsmith and Wyndham Hulme, 1942). Piccolpasso is the most detailed commentator and he clearly illustrates several kilns and furnaces, all without grates, although his fritting furnace is remarkably similar to apparatus sketched by Leonardo da Vinci sixty years earlier, which does have a grate (Goldsmith and Wyndham Hulme, 1942; Lightbown and Caiger-Smith, 1980). It is quite possible that the grate was not widely adopted by the potter until coal became commonly used as a fuel. It is not our intention to prove the use of the grate by Roman and Medieval potters, but to demonstrate that its use is a possibility.

It is now accepted that many kilns had temporary roof structures which were demolished after each firing. (As both the Greek votive tablets and Piccolpasso show kilns with doors into the ware-chamber, it is not improbable that kilns with permanent roofs were in use in this country.) There would seem to be two principal variants of updraught kiln involved. The first is a tall narrow structure with a flat temporary roof of loose potsherds, as recorded at Verwood (Algar et al.,1979) and Ewenny (Lewis,1982,15) and in Middle Kingdom Egypt (Hodges,1971,58) and in modern Crete (Rhodes,1968, 11-12). The second has lower side walls surmounted by a large tem-

porary or permanent dome with one or more flues at the apex, as recorded at Corinth (Noble,1966), Ewenny (Lewis,1982,50), and in modern Egypt (Leach, 1976, pl.75). Both are similar in height to obtain the good draught essential to get a kiln to temperature whether the firing is reducing or oxidizing. A flat top on a shallow kiln is obviously contrary to this. Indeed if Cardew's ratio of 1:10 for volume of firebox to volume of warechamber is taken into account (admittedly he is referring to a downdraught kiln, but the point is valid), such a kiln would be so wide in relation to its height that the parts farthest away from the firebox would remain unfired, even supposing the draw was sufficient to persuade flame into the kiln at all (Cardew, 1969, 185). Whereas low flat kilns may fire successfully on a small scale, one should consider the problems of firing full-scale examples. It is significant that in both variants the roof, if temporary, is built after loading and before firing; Bryant's suggestion (1971) that the roof can be added during firing may be practicable but is unnecessary. In conclusion, it might be more fruitful to consider these two common designs in the interpretation of kilns excavated in this country.

There may in fact have been a number of distinct types of kiln, some of which were geared to particular products. It is, for instance, unlikely that Samian wares could have been made in any of the kilns so far discussed. We have attempted to show a number of ways in which the reconstructive models might be adjusted. There are other issues which cannot be discussed here but we hope that a more critical approach to the problems will benefit the study of the ceramic process as a whole.

REFERENCES

Algar, D., Light, A., and Trahane, P. 1979. *The Verwood and District Potteries*. Ringwood.

Bryant, G. 1971. *Experimental Romano-British kiln firings at Barton-on-Humber, Lincolnshire*. Workers' Educational Association, Barton-on-Humber Branch, Occasional Paper No. 1.

Cardew, M. 1969. *Pioneer Pottery*. London: Longman.

Corder, P. 1959. The structure of Romano-British pottery kilns. *Archaeological Journal* 114, 10-27.

Goldsmith, J.N. and Wyndham Hulme, E. 1942. The history of the grated hearth, the chimney and the air-furnace. *Transactions of the Newcomen Society 23*, 1-12.

Hodges, H. 1971. *Technology in the Ancient World*. Penguin Books.

Leach, B. 1976. *A Potter's Book*. London: Faber and Faber.

Lewis, J.M. 1982. *The Ewenny Potteries*. Cardiff: National Museum of Wales.

Lightbown, R.W. and Caiger-Smith, A. 1980. *The Three Books of the Potter's Art, by Cipriano Piccolpasso*. London: Scolar Press.

Lyne, M. In press. The Alice Holt Kilns. In A.J. Woods (Ed.) *Ceramic Technology; Ethnography and Experiment*.

Lyne, M. and Jefferies, R.S. 1979. The Alice Holt/Farnham Roman Pottery Industry. *Council for British Archaeology Research Report 30*.

Noble, J.V. 1966. *The Techniques of Painted Attic Pottery*. London: Faber and Faber.

Rhodes, D. 1968. *Kilns*. London: Pitman.

Rhodes, D. 1973. *Clay and Glazes for the Potter*. London: Pitman.

Sumner, H. 1927. *Excavations in New Forest Pottery Sites*. London: Chiswick Press.