MEDIEVAL MINTING TECHNIQUES

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The role of the sciences in archaeology has, of late, become increasingly important and the method of the scientist—repeatable experiment leading to general hypothesis—is applied with great success to the unsolved problems of antiquity. This paper is concerned with some practical investigations into the possible techniques employed by medieval mint personnel in the production of what seems to us to be one of the basic, if inconvenient, essentials of civilized life—coined money.

FIG. 1.

Coins were, in fact, the first metal objects which were required in such large numbers that human ingenuity must constantly have been directed to finding easier ways of making them. This never-ending conflict between efficiency and tradition is nowadays graced by the title of 'Work-Study', but it is as old as the primeval flint artefact. The earliest coins are thought to have been made in Ionia about 650 B.C. and within a century or so their use was common to all the Greek-speaking peoples living round the Mediterranean. Steel, as opposed to wrought iron, was first produced in Egypt in any quantity about 800 B.C., and although knowledge of the way it was made must have reached Ionia from Anatolia (the source of ore and technique) at an even earlier date, it seems that bronze was the material from which the original coin dies were manufactured. There is in Sofia an iron die for a stater of Philip III of Macedon, but even by Roman times, to judge from surviving specimens, iron and steel were still not on an equal footing with bronze; it should be borne in mind, though, that the former are much more likely to corrode away completely and so be absent from excavated sites.

3 C. C. Vermeule, Ancient Dies and Coining Methods, Cyzicus die on p. 10, before 400 B.C.
4 C. C. Vermeule, op. cit., p. 12, die no. 6.
It might be supposed that the survival rate would increase as we come to the period under discussion, the centuries either side of A.D. 1000. Unfortunately there appear to be no extant dies from the Anglo-Saxon period and not until Plantagenet times is there any appreciable number on which to base our theories. It is, of course, not surprising that we have so few dies from antiquity, since the authorities would, in the normal course of events, have taken steps to ensure that they were destroyed (and the metal reused?) once their useful life was over. Such is the force of this argument that many scholars consider that all surviving specimens emanate from the workshops of forgers or other unofficial sources. This may well be true, but it is also probable that counterfeiters would have used the current official techniques and may often have been mint craftsmen doing 'part-time' work on their own account. The lack of dies may also point to another aspect of what we know to have been the very efficient civil administration of Saxon England—it tidied up better than its predecessors. Anyway, for the centuries before the Norman Conquest we must glean what information we can from the coins themselves.

Mr. Philip Grierson has commented on two facts of immediate importance; firstly, that in an annealed state, medium carbon steels can be 'worked' with astonishing ease and, secondly, that for medieval coins the design in general and the lettering in particular can be obtained by a very small number of different punches. Until the middle of the last century steels were produced by what is known as the cementation process. A piece of wrought iron, which contains less than about 0.05 per cent. carbon, is surrounded by carbonaceous material, such as charcoal, and placed in an airtight box. It is now maintained at a temperature of the order of 800° C. and the carbon will diffuse from the surrounding material into the surface layers of the wrought iron—the box being airtight neither the carbon nor the iron can combine with the oxygen from the air as they would normally do at this temperature. The percentage of carbon in the surface layer and the depth to which it penetrates depend upon the actual temperature and the time of 'soak'. The carbon would then usually be redistributed throughout the remaining material by hammering out flat, doubling over and similar 'working' of the metal, so that the average carbon content of the whole would be of the order of 0.4 per cent., giving a medium-carbon steel. This could then be subjected to the normal processes of quench-hardening and tempering.

In the case of die-making, however, it would, I think be advantageous not to carry out the final 'working'. This would leave the central core as relatively soft but fracture-resistant wrought iron while, after engraving or punching, the surface layers with their higher carbon content could be hardened; although thus more brittle, the surface would be backed up by the wrought-iron core. Even by using a very low-carbon steel a die could be made quite capable of satisfactory performance when used to strike coins of the nearly pure and relatively soft silver of the period under discussion. The punches themselves scarcely present more difficulty although they would be made from a steel of a higher carbon content.

With the assistance of a pair of small files, a grinding wheel, and a gas-ring, I made the set of punches and graving tool, shown in Fig. 2, in rather less than an hour. With these I prepared the two dies shown in Fig. 3. The surfaces of these had been turned flat, but the actual marking out, punching, and engraving took me, with next to no previous practice, 25 minutes for the obverse die and 15 minutes for the reverse. In order to add,
as Gilbert said, 'verisimilitude to an otherwise bald and unconvincing narrative', I tried to imitate the designs of one of Edward the Confessor's coins—the 'Facing Bust' type, Brooke 9. It can be judged from Fig. 1 how successful was my attempt. The obverse die was usually the lower one in practice. This was because it was more difficult to engrave and it would be the one to be protected from the worst effects of the shock waves by the intervening layer of soft silver.

The die axes on later Anglo-Saxon coins are, with few exceptions, at 0°, 90°, 180°, or 270°. The reason for the alignment must lie with the special technique of minting employed. The most obvious way of achieving it is by having the shanks of both upper and lower dies of square section as are those shown in Fig. 3. A small box of thinner sheet metal may then be attached to the upper die so that it projects slightly beyond the die's working face and thus positions and aligns the two dies when they are brought together prior to striking. If, as seems possible, the upper die was held in tongs during striking (to minimize the loss of craftsmen's fingers) an alternative method suggests itself. This is to have each arm of the tongs ending in two sides of a square with the actual die perhaps fixed to one of them.

The standards of measurement at any time before the last century were extremely vague. In the time of Edward III an inch was three barleycorns laid end to end. We might suppose that in the matter of the weight of precious metals some more strict control was exercised. For gold no doubt it was. The Trial of the Pyx and its hypothetical predecessors, however, imply that only the average weight of silver coins was, within fairly wide limits, considered important. Inspection of any particular series of late Anglo-Saxon coins shows that the diameter is more or less constant and hence the weight will vary directly as the thickness. With the limited possibilities of measurement indicated above, how was the correct thickness attained? I suggest that a mass of silver of a known and adjusted weight was beaten out flat until it occupied a certain, probably circular,
area. Provided the area is not too large, it is not difficult to ensure that the thickness is sufficiently uniform over the whole area, whose magnitude for any particular required thickness could simply be found by trial and error.

In Fig. 4 I show two Confessor coins of the type I tried to imitate. They are die duplicates and the diameter of both is 1/32 inch less than what was, perhaps, a nominal dimension of \( \frac{3}{4} \) inch (1063 was a bad year for barley corns!). Working on a basis of 21 grains to a penny, I tried beating out a lump of silver to the area to give the correct thickness for a coin diameter of \( \frac{3}{4} \) inch. From this sheet I cut, by a method described later, three blanks \( \frac{1}{4} \) inch diameter whose weights were 21·5, 20·7, and 19·4 gr. These are well within the variation found in coins of the time, thus showing that my method of obtaining the right thickness is feasible.
Such illustrations as we have, that are concerned with contemporary coining techniques, imply the use of a pair of shears.\footnote{P. Grierson, op. cit., p. 491, illustration. The workman appears to be cutting round blanks.} A little time spent with a modern pair on a piece of silver sheet convinced me that the very regular circumference of late Anglo-Saxon coins could not satisfactorily be produced by using shears. I think that they were used for cutting roughly square blanks out of the sheet of prepared thickness. These blanks were somewhat in excess of the final flan diameter in their dimensions.

My original thoughts on the problem were that the flan was next cut from the sheet by means of a sort of circular ‘pastry-cutter’ (Fig. 5). This had been mentioned to me by Mr. Dolley as also the idea of Mr. B. H. I. H. Stewart. I now believe that some such sort of tool was, indeed, used, but not at this stage.

We have, then, the dies which can be aligned more or less directly above one another, and a blank of the correct thickness but otherwise oversize. The latter fact means that much less care need be taken in putting the flan on the lower die, since its position can vary quite a lot and still receive the full impressions of both dies. Mr. Grierson says\footnote{P. Grierson, op. cit., p. 490.} that the actual striking could be done by a man in a standing or sitting position holding the die in one hand and hitting with the other. I found that, using a 2½-lb. hammer and only one blow, a reasonable impression of the face of each die could be obtained on the blank. For greater speed of production it might be that one man held the die while another wielded the hammer, but this is not absolutely necessary.

The final stage is now reached. This is the use of the ‘pastry-cutter’ to separate the correct-diameter coin from its oversize blank. The cutter is lined up as nearly as may be on the circumference of the design of one of the struck faces (usually the obverse) of
the flan, which is resting on a piece of hard wood, and the cutter is struck with a 2 1/2-lb. hammer. Again I found that one blow is sufficient for the purpose of punching out. The small central hole in the cutter permits the insertion of a rod or stick to free the coin. Perhaps two or three coins were cut out before being extruded and the greater force required if the coins were jammed would account for the slightly buckled appearance of some otherwise unworn coins—they would certainly not have emerged buckled from between the dies.

I have now to justify this sequence of operations. As far as the engraving of the dies is concerned I am following the theories of Mr. Grierson in the number of punches required and I hope that the illustrations of my resultant imitation penny shows it to be not too unlike the original. The lead impression of the Alfred die in the British Museum shows that, in his time, at any rate, dies were square in cross-section. I have no corroborative evidence for the idea of beating out the lump of silver of a given weight to cover a given area, but I cannot think of a more simple way of getting the necessary thickness. There are, to my knowledge, no pre-Conquest English coins surviving with circular designs on square flans. That there are not is merely another example of the great efficiency of the Anglo-Saxon mints, because we do have them from the much more primitive contemporary Scandinavian ones. Taking as examples lots 479, 480, and 481 from the Lockett sale no. v, the actual weights of these rectangular flans multiplied by the ratio of the area of the circular designs to that of total flan area give in each case an approximate weight for the hypothetical round coin of 33 gr.—high, but not, I think impossibly so for these crude productions which were generally over-weight. Judging by these and other square-flan coins from the same catalogue, they were all left at this incomplete stage because part of the circular design was off the blank, or they were in some other way mis-struck, rendering them useless for the application of the final cutting-out operation. They should have been melted down again but remain to point out the contrast between some long-forgotten Swede's lackadaisical attitude to his responsibilities and the efficiency of his twentieth-century countrymen.

Reference to Fig. 6, enlargements of part of the two die-identical coins already mentioned, together with views on the edge of the coins at the same places, is necessary to follow the remainder of my argument. On the ‘off-centre’ coin there appears to be a circumferential line joining the middles of the letters, which are partially off the flan; this line is not present on the other, centrally struck coin and so, presumably, was not on the die, either. If the cutting-out operation had come first, then the lettering would have produced bumps or burrs on the edge of the coin, instead of which the burr is seen to be present on the surface which had been in contact with the die. This I think proves that the coins were struck first on the oversize flans and cut out afterwards to exact dimensions. The fact that on one of the genuine coins the reverse die is off centre indicates that there was some considerable play in the box or whatever it was that was used to align the dies.

When I read this paper, the use of the ‘pastry-cutter’ was the part of my argument which a good many of my audience boggled at accepting. However, as I stated earlier, I found that even after a good many trials with shears on silver or softer lead sheet, I could produce nothing so nearly circular as most Anglo-Saxon coins appear to be. In addition, this process took me much longer than the single blow ‘pastry-cutter’ did.

1 R. H. M. Dolley and D. M. Metcalf, Anglo-Saxon Coins, p. 158.
My cutter is, no doubt, at once more truly circular and more sharp than those I postulate for my moneyer's mate, who would probably have had to make his by hand rather than, as I did, on a lathe. This, I think, accounts for the slightly turned-up edge on the obverse and more pronouncedly turned-down edge on the reverse of true coins. The turned down reverse edge only is present on the coin I cut out.

The two genuine coins illustrated appear, in fact, to have been separated from the square flan by the same cutter. A good many small marks on the edge correspond and such slight discrepancies as there are may be attributed to the cutter having been re sharpened in between being used for the two coins. I have observed similar agreement on die-identical coins of Steyning Mint of the Confessor's reign.

Many later coins do not exhibit the 'pastry-cutter' sheared-off edge. Edwardian pennies and groats, for example, have a much more rounded edge appearance and must have been produced quite differently. The blanks for these may have been obtained by pouring the molten silver through a metal sieve with holes of the appropriate size, the drops thus produced falling directly into water where they solidified as odd shapes but of fairly uniform weight. They were then ready for use between the dies without further adjustment than that of beating flat on a plane surface. Tylecote\(^1\) discounts the possibility of pouring direct into water without the sieve, a commonly advanced hypothesis, on the grounds that only small size (4 gr.) coins could be produced this way.

A more attractive method involves the use of a 'draw-plate'.\(^2\) This contains circular holes through which thick rods of silver are pulled reducing their diameter to some specific dimension. From this rod are then cut exact lengths by means of a chisel. These lengths are then finally beaten out flat into the requisite thin flans. Not having a 'draw-plate' I drilled a \(1/2\)-inch diameter hole in a steel block and poured molten silver into this, thus effectively obtaining a \(1/2\)-inch diameter rod. On this I scratched marks at equal

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intervals with dividers and cut off lengths with a chisel. The first three weighed 18·4, 18·9, and 19·9 gr. This method then appears satisfactory for producing penny blanks particularly since only one intermediate annealing was necessary when beating the flan out to the necessary diameter. On the other hand, I tried the method with 1-inch diameter rod and the first three lengths (which I tried to make equal) weighed 61·0, 68·4, and 77·3 gr.—in fact the deformation of the bar during cutting with the chisel rendered the method very inaccurate and unsuitable for groat blanks. For these I tried yet another method, based on the idea of the Ancient British clay moulds. I drilled flat-bottomed holes in a piece of cast iron so that each hole was the same depth. This could have been produced in a clay mould by a hemispherical projection from a flat surface so that the depth of each impression was the same. After little practice I found that I could pour very accurately into ten such depressions within the limits of 56 gr. to 64 gr. for eight out of ten. These ‘buttons’ again, I found, could be beaten out flat with only one intermediate annealing. The fact that on medieval groats the flans were so frequently of insufficient size for the dies merely shows that the workmen skimped their task of beating out the flans before striking. Newman\(^1\) states that ‘de Turnemire . . . introduced in 1280 the casting of square-sectioned bars from which transverse slices of the thickness of the intended coins were cut. These pieces were forged into the round, pickled in vegetable juices, and then hammered between an upper die and lower die’. It is just as easy to cast circular as square section rods and it would be quite impossible to cut, by chisel, blanks of the thickness of medieval groats from square section bar and then hold them on edge, to forge them round and maintain the original thickness. In fact many coins of the period show slight radial edge cracks consonant with the blank having been hammered out flat with insufficient intermediate annealing.

I shall now consider the relevance of these theories to some other aspects of Anglo-Saxon numismatics. Messrs. Dolley and Metcalf have ably demonstrated\(^2\) that commencing in the reign of Edgar the coin types were altered initially at six- and subsequently at three-year intervals, all current coin being called in and restruck. These drastic change-overs might be thought to have entailed bursts of almost frenetic activity both by engravers and moneyers. Using the methods outlined above it can be seen that one engraver could produce about four dies per hour or thirty-two in an eight-hour day. Thus, in an emergency, each of 150 moneyers could be given his initial issue of one pair of dies by one man working steadily for ten days. The actual speed of striking is more problematical. A team of three (blank placer and remover, die holder, hammerman) could probably turn out a coin every five seconds. The other operations seem to me more likely to impose a limit on the production rate.

The number of coins which could be made from one die is again difficult to estimate. I am currently engaged on some experiments into the probable life of ancient Greek bronze dies. I have found that each coin requires two blows of a 2½-lb. hammer to force the metal into the very much greater intaglio of the die. So far I have been using only one obverse die and have made 9,000 coins without the die showing any really big flaw. Making allowance for the fact that the flans of medieval coins are much thinner but that the steel used was somewhat stronger than the Greeks’ bronze, I should suppose that 10,000 coins per die would be a not unreasonable minimum.

There can be very few contributions to the study today of Anglo-Saxon numismatics

\(^1\) W. A. C. Newman, British Coinage, R. Inst. of Chemistry.
in which Mr. R. H. M. Dolley has not played some part. I should like gratefully to acknowledge here the fact that he encouraged me to commence this investigation and has shown practical interest at all stages of it. I have also to thank Dr. J. R. I. Hepburn, Principal of Kingston College of Technology, and Mr. K. J. Tolley, Head of the Engineering Department there, for permission to carry out experiments in the college laboratories. Messrs. J. and C. W. Baker have kindly assisted me in the preparation of the specimens and the photographs.