DIFFUSION OR IMPEDANCE - OBSTACLES TO INNOVATION IN MEDIEVAL CERAMICS

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Summary

This paper puts forward general ideas about innovation and its diffusion, and the points of view of an industrial psychologist and a prehistorian are examined and set in context by reference to the economic historian Braudel. The general theory is demonstrated by its application to two case studies - tin-glazed ware and stoneware - and leads to a model for technological innovation in medieval and early post-medieval ceramics.

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1. Introduction

This paper was written for the Medieval Pottery Research Group's Conference 'Pottery Technology in the Middle Ages' (25-29 March 1985). My terms of reference were to look at this theme in the setting of social and economic factors, and to ask why pottery technologies, styles and forms changed as they did and when they did. I cannot claim to have answered these questions, but I hope to show that they are worth asking, and can stimulate fruitful study.

The paper has three parts - a general consideration of the theory of innovation and diffusion, followed by two case studies, and finally, a very tentative general model for the development of medieval ceramics, more as a stimulus to critical work than as a lasting structure.

2. Innovation and diffusion

Innovation is not just change, nor is it simply invention. Renfrew (1984, 391) defines it in an archaeological context as 'the widespread adoption of a new process or form', and points out the difference, and the often long time-lag, between invention and adoption. Kingston (1977, 20), in a more general study of innovation, stresses the unique role of the innovator as both a thinker and doer, and as a force for change. Quoting Schumpeter, that 'successful innovation ... is a feat not of intellect, but of will', he points out that mere knowledge of the necessary techniques is not enough: there must also be an emotional commitment to put them into effect (1977, 50). If we look at the sort of changes that occur in ceramic production (Fig. 1) we see that innovation as defined here refers to levels 4 and 2 - technological and functional change - Renfrew's 'processes and forms'. This paper will concentrate on technological change.

Diffusion is 'not a mode of explanation but a subject for explanation' (Davis 1983, 57). As a spatial process - the spread of the general use of a new process or form (Renfrew 1984, 393-7) - it has a theoretical background, based on the work

1.	stylistic change	- new shape within existing 'form' - new motif within existing tradition (e.g. change from biconical to barrel-shaped jug)
2.	functional change	- new form to meet new practical need (e.g. dripping pan, chafing dish, moneybox)
3.	technical change	- new techniques within existing tradition (e.g. changes in method of attaching handles)
4.	technological change	- new technology involving several aspects of production simultaneously (e.g. wheel-throwing, glazing, slip decoration, tin-glazing, stoneware, porcelain)
5.	social changes	- new ways of organising production (e.g. domestic production, part-time craftsmen, full-time craftsmen, industrial craftsmen)

Fig. 1. different types of change in pottery production

of Hägerstrand (1953). In this theory, the spread of a process follows much the same pattern as that of an epidemic - one of 'infection through contact'. As Renfrew (1984, 393-4) points out, this approach is based on two implicit assumptions - (i) change is exogenous, i.e. it is 'caught' from outside; (ii) widespread adoption follows rapidly in a regular manner after exposure to 'infection'. It has had its successes in archaeology, for example the work of Ammerman and Cavalli-Sforza (1979) on the spread of agriculture in Europe, where the predicted 'wave-front' epidemic-like model works quite well, and in a less formal way, the spread of an architectural feature (a gable shape) across England (Jope 1972). It may often be suitable for the spread of stylistic change (see Davis 1983, for background and references), but less appropriate for more radical changes. One such is the inception of metallurgy in Europe (Renfrew 1984, 411-15): our case studies will suggest that ceramic technology may be another. Another useful idea is that of stimulus diffusion: this occurs when contact imparts the general knowledge of a process without the precise details, which are re-invented (ibid., 391). Renfrew (ibid., 397) suggests a more general model of the diffusion process (Fig. 2) in which discontinuities or sudden changes are to be expected under certain circumstances. He models such situations by Catastrophe Theory (ibid., 397-403), which may show change in a clearer light, but does not tackle the question 'why?' It does, however, lead on to the idea that if diffusion is a driving force for spreading ideas and processes, and if they do not spread according to the 'infection' model, something must be holding them up. This something is here called impedance and it is the conflict between these two forces that we shall examine in our case studies.

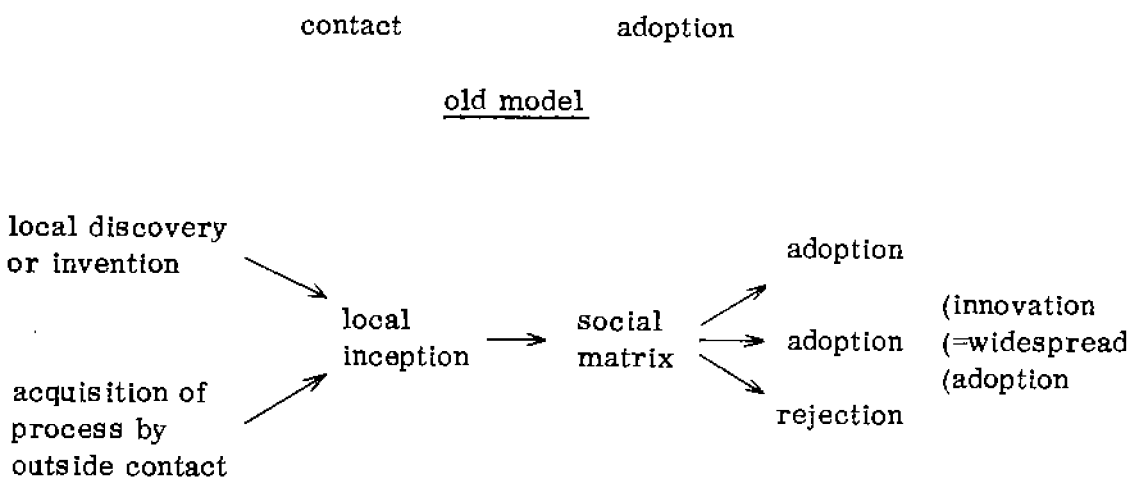

Fig. 2. models of innovation

The most obvious form of impedance is simply the dislike of strange ideas (Kingston 1977, 72). But far more is involved - apparently trivial changes (e.g. decorative motifs) may diffuse rapidly, presumably because impedance is low, while some technical aspects (e.g. methods of handle attachment) may scarcely diffuse at all. The most interesting case is the delay in the spread of ideas or processes which, a priori, one might expect to diffuse rapidly, like the subjects of our two main case-studies, tin-glazing and stoneware production. Here the impedance must occur in Renfrew's 'social matrix' (Fig. 2), which for our period might be better called the 'social/economic matrix'.

3. The social/economic matrix

We need to look at why people make pots at all, before looking at why they change, or do not change, their technology. We also need to look at why people buy pots, because in our period most of the pottery was made to be bought, i.e. it was influenced by demand (Blake 1980, 4-8). Perhaps the most comprehensive attempt to look at modes of pottery production is Peacock's (1982) (Fig. 3). One should not accept this uncritically, but stages 2-5 (and possibly 7) do provide a potentially useful model, although one may prefer something simpler, e.g. domestic production - part-time craftsmen - full-time craftsmen - industrial production. An important point is the contrast between the income-support role of stage 2 (ibid., 23) and the more vigorous economic climate of stage 3, in which quantity, quality and price take on increased importance (ibid., 31).

1. household production

2. household industry — a secondary, part-time but 'professional' activity. Little investment in equipment. Probably no proper wheel or kiln.

3. individual workshop — similar to 2, but primary source of income. May still be part-time, but more equipment used. Possible employment of assistants.

4. nucleated workshop — as 3, but grouped together. Any other income is subsidiary. Production of a standardised range of high-quality products. Co-operation. Use of middle-men in marketing.

5. manufactory — a group working in a single place or building. Division of labour. Use of machinery, powered by wind or water. Twelve or more workers (arbitrary level set to distinguish it from 4).

6. factory

7. estate production — a Roman phenomenon, but should not be ignored in medieval and post-medieval periods, e.g. monastic tileries.

8. military/official production

Fig. 3. modes of ceramic production (after Peacock 1982)

4. Factors affecting willingness to innovate or accept innovation

To link innovations with their social context, we need to look at factors which might influence a producer's decision to make an innovative change, and a consumer's decision to purchase the product of that innovation. We must bear in mind Blake's point (1980, 5) that pottery is an 'elastic consumption' commodity, because it is intrinsically inessential and its functions can be performed by vessels made in other materials. He states two premises which must be fulfilled before the link which we are seeking can be made: (i) pottery must have been widely used, without excessive use of wood or metal, (ii) in order to create the diversity and to register change, there must have been a desire to live like the better-off, and acquire similar

'pro' factors	'con' factors
functional superiority	lack of raw materials
attractive appearance	inability to reproduce new technology
'fashion'/symbolic benefit	lack of markets
durability	lack of capital for investment (fixed and working capital)
lower cost of manufacture, including speed of manufacture	unwillingness to take risks
need to compete with other sources	unwillingness to change
possibility of increasing production	

Fig. 4. factors influencing decision whether to innovate

possessions (ibid., 6). These premises appear to be fulfilled within our area and period of study.

The factors themselves can be divided into two groups - 'immediate' factors, the sort of 'pros and cons' one might list in trying to come to a decision (Fig. 4), and 'background' factors, which set the scene for a decision but are less consciously grasped.

Some guidance to the relative importance of the immediate factors may be obtained from the general theory, and more from the case studies. Kingston (1977, 50), while making the obvious point that innovation is based on knowledge, stresses the importance of individuals in embodying knowledge. 'People' knowledge is worth far more than 'paper' knowledge (ibid., 70). He also points out the need for capital to sustain the innovative phase (ibid., 82) until adoption of the product is widespread (cf. Renfrew's 'local inception' leading to adoption: Fig. 2).

For background factors, one might consider overall economic trends - are we dealing with an expanding or contracting economy? - the economic position of a production area vis-a-vis the wider area with which it has economic and social contact, the question of administrative encouragement or discouragement (taxes, monopolies, etc. Kingston, (ibid., 80) sees the granting of monopolies as an important condition favouring innovation). To focus our ideas, we shall look at the pottery of the London area within the context of the western European 'world-economy' (Braudel 1984, 96ff.). We will take as 'given' the initial innovation in the wider area, whether as a result of local invention or technological transfer from another world-economy (e.g. Islam), and simply look at the rate and nature of subsequent diffusion.

1200/1250		1150/1200
	upswing	
1350		1350
	downswing	
1510		1480
	upswing	
1650		1630/40
	downswing	
1730/40		1730
	upswing	
1817		?
	downswing	
1896		?
	upswing	
1974		?

Fig. 5. long-term economic cycles,
after Braudel (left) and modified for London area (right)

For the economic history of this area in the late medieval and early post-medieval periods I shall rely heavily on the work of Braudel (1981; 1982; 1984), from which one can distil three background factors relating to the European 'world-economy': (i) a series of long-term secular cycles of economic activity (Fig. 5), upon which are superimposed cycles of shorter duration (Braudel 1984, 77-8); (ii) the idea that the upward trends favour all economies, while downward trends favour only the 'core' economies (see below); and (iii) the observation that real wages fall on the economic upswing and rise on the downswing (ibid., 87; Brown and Hopkins 1955).

To help explain the different economic paths of different counties and regions, Braudel (1984, 96ff.) introduces the notion of 'core' and 'peripheral' regions within a world-economy. The economic lead is provided by a 'core-region', which so to speak 'sets the pace' and is least affected by economic downturns. At different times different regions take on this role. Surrounding it are concentric zones of progressively less leading regions, surrounded by a periphery which is relatively backward, marginalised and exploited.

Starting with Europe's emergence from a period of 'direct agricultural consumption' (i.e. self-sufficiency) to the stage of 'indirect agricultural consumption' created by the marketing of surplus rural production, about 1150 (ibid., 94), Braudel sees the development of a zone running from northern Italy to the Low

	north 'pole'	south 'pole'
13th - 15th century	Bruges	Venice, Genoa, Pisa
late 14th century - c. 1500		Venice
c. 1500 - 1570	Antwerp	
c. 1560 - 1630		Genoa
c. 1630 - 1750	Amsterdam	
c. 1750 - 1920	London	
c. 1920+		New York

Fig. 6. economic 'core' zones and 'lead' cities (after Braudel)

Countries as the 'axis' of the European economy. The 'lead' within this core seems to swing in bipolar fashion. One pole is provided by the north Italian cities - Venice, Milan, Genoa, Florence - and the other first by Bruges and the area of the Hanse, and later by Antwerp and Amsterdam (Fig. 6). He sees the 14th-17th centuries as the period of the great economic cities, living by trade, with London taking the lead in the 18th century, not as a free-standing city-state but as the embodiment of the integrated English economy. We can link his work with Kingston's by noting the latter's point (1977, 61) that new techniques are adopted more rapidly in expanding economies, for example through a greater willingness to create new productive capacity.

5. Case Studies

We shall look at two examples which are reasonably well evidenced in both the archaeological and historical record: tin-glazed ware and stoneware. We shall add some evidence from trailed slipware, salt-glazed whiteware and industrial whitewares, and try to draw out some general principles which might help us to understand the so-called 'Saxo-Norman' wares (in particular Stamford ware) and the 'high medieval' wares of our area (e.g. London, Mill Green).

Tin-glazed ware

We see the arrival of this technology in the European world-economy both in north Italy, with the production of archaic maiolica in many Tuscan towns from the end of the 13th century (Blake 1981, 101), and by the re-conquest of Spain effecting

the transfer of advanced Islamic technology, in the form of lustrewares, into the European economy. Hurst (1977) has charted the main centres of production, from Catalayud in the 12th century, Andalusia in the 13th - early 15th century to Valencia in the 15th century. The Italian archaic maiolica seems to be little differentiated from the local slipwares, but in about 1400 the first blue decorated 'renaissance' maiolica was made in north Tuscany, in imitation of the Spanish lustrewares traded by Ligurian merchants (Blake 1981, 101). More recently, these two production areas have been linked by the discovery of the production of the tin-glazed pottery at Avignon from the late 13th century (Norton 1984). Production was on a large scale - in Montelupo in the 15th century, for example, it was on an 'almost industrial' scale with division of labour and control by those with greater capital (Blake 1981, 101).

The next major production centre is at the other end of the axis - Antwerp and the towns of the Netherlands in the mid 16th century (Korf 1981, 30), although we have the enigmatic 'South Holland altar vases' of late 15th century - early 16th century date (e.g. Platt & Coleman-Smith 1975, nos. 1156-8). Braudel (1984, 153) notes an expansion of industry in Antwerp in the 1560s following difficulties in the commercial/financial sectors. If we discount the problematic 'Malling' or 'Sandwich' jugs (Noël Hume 1977, 2), production in England seems to start c. 1570 at Norwich and Aldgate (Edwards 1974, 31 and 78), associated with the names of Andries and Janssen (or Johnson), both ex-Antwerp.

Both ventures seem to fail, and take-off occurs in Southwark c. 1610 with Christian Wilhelm at Pickleherring and Bradshaw & Cressey at Montague Close (ibid., 39, 49, 120). It may be significant that the successful innovators were all merchants, and had involvement with City business interests.

Looking at our list of 'pros and cons' (Fig. 4) we can see that the main 'pros' appear to be in the areas of 'fashion' and the possibility of increased production - tin-glazed ware is no more functional or durable than lead-glazed earthenware, and presumably is more expensive. I suggest that its main advantage is its suitability as a 'status' possession, which arises from the possibility of rapid changes in design without the need for technical or technological change. This is, in fact, just what we observe, with a major style change every 30/40 years (Orton forthcoming) and constant variation within each style, making it very suitable for keeping one jump ahead in the status stakes. Indeed, it is tempting to define status as the ability to sustain and display variation and differentiation, and see this period as an early example of consumerist manipulation of domestic symbols. The 'con' factors appear to be overcome by willingness to invest in ceramic production at this time, and by the arrival of the 'new blood' with the appropriate knowledge. Note how the knowledge is embodied in people - tin-glazed ware was known in London and elsewhere in the country from the late 13th century and throughout the 14th-16th centuries (Platt and Coleman-Smith 1975, nos. 1274-7, 1299-1302, 1348-9; Allan 1984, 20; Vince pers. comm.). The question of raw materials is interesting, since three English clays were blended to produce the correct body and two of them were also exported to the Netherlands (Edwards 1974, 19). I would rate the factor of capital highly: it may be the difference between the failures of the 16th century immigrants and the successes of the 17th century businessmen.

Turning to the background factor, we see that production of tin-glazed ware correlates well with Braudel's cycles and 'core' activities. It becomes established in north Italy in an 'upswing' (Fig. 5), expands locally but does not spread during the following 'downswing', finally makes the jump to the Netherlands in the next 'upswing', just reaching across the North Sea to London before the next downswing sets in. In economic terms it is behaving as a 'status' good and seems to be a good indicator of overall economic conditions (Blake 1980, 4). In social terms, it seems to correlate with social changes in potting - larger enterprises, division of labour, and a switch from 'craft' to 'industrial' organisation.

Stoneware

The story of stoneware is less straightforward. An excellent account of the emergence of stoneware in the Rhineland c. 1300 is given by Stephan (1983). There appears to be some spread into northern France in the 14th century (Barton 1977), and a massive increase in production and exports towards the end of the 15th century (Allan 1983, 43), which provokes a 'Catastrophe' (in the theoretical sense) in the pottery industry of the London area c. 1480. Despite this, the first serious attempt to produce stoneware in this area appears to be Rous and Cullen's abortive attempt at Woolwich in 1626 (Edwards 1974, 16; Pryor and Blockley 1977, Phase Two: despite the clay pipe evidence I believe their stoneware to be of this date). The first success appears to be Dwight's at Fulham around 1670 (Edwards 1974, 16) - a stubborn man determined to solve the problem. After this, there is a rapid spread of production to Lambeth, Staffordshire, Nottingham and elsewhere.

Looking at the pros and cons (Fig. 4) we see that stoneware is extremely functional and durable, but less suitable for the sort of symbolic manipulation we see with tin-glazed ware. In particular, it is limited in the range of colour it can carry, although this must be partly offset by its scope for plastic decoration. It is more expensive than earthenware.

The lack of raw materials is often advanced as a reason for England's failure to develop a stoneware industry for some 200 years after the first large-scale imports, but both Rous/Cullen and Dwight appear to have used local clays (Weatherill and Edwards 1971, 164; there is in the Surrey Record Office an 18th century agreement for the supply of clay from Cheam to a Lambeth stoneware pottery). The other technological obstacle, a kiln firing at higher temperatures than the earthenware kilns, should not have been insuperable in the 16th century. A more important obstacle may have been an unwillingness to invest in the new techniques: unlike those of tin-glazed ware, imports of stoneware were very widely established, and their very quantity and success may have acted as a deterrent to 'taking them on'. It is worth noting that by the time of Dwight's success, imports of stoneware had already fallen from 15% of all London's pottery in 1630 to next to nothing (Vince 1981, 76). The stoneware bottle (bellarmine) had been largely replaced by English green glass bottles after c. 1660, and much of Dwight's early production consisted of mugs - a form not common in imported stoneware of the 17th century. Perhaps it only felt safe to 'kick' the Rhenish stoneware industry when it was already 'down'.

Comparison with Braudel's cycles and 'core' areas is interesting (Figs. 5, 6). Production is established in the 'core' zone, but not at one of the 'poles', around the peak of the 13th century upswing, remains stable in the following downswing, and expands in volume but not in geographical location in the 15th/16th century upswing. Its production in the London area in the later 17th century appears to 'buck the trend', but may be due to the persistence of an individual. It seems to behave more like a 'functional' product than does the 'status'-orientated tin-blazed ware. Its very durability may have in a perverse way diminished its status by making it a less suitable vehicle for displaying changing fashions.

The 18th century

It is worth filling in the picture by looking briefly at the 18th century. The start of the next upswing c. 1730 is marked by the first English innovation - salt-glazed white ware, which has all the advantages of stoneware plus a white appearance, but is difficult to decorate and does not seem to shake the position of the tin-glazed ware. This upswing sees London, backed by an integrated national market, move to the economic fore (Fig. 6). Soon after, we see a major technological innovation (again English) in creamware and the industrial white wares, which have the advantages of both stoneware (durability) and tin-glazed ware (capacity for variability of decoration), and which quickly replace both salt-glazed white ware and tin-glazed ware.

Slipwares

Finally, to round off the survey we move down in status to the slipwares. These reach London in the 13th century upswing (Fig. 6) but disappear in the following downturn. In more 'core' areas, e.g. north Italy and Holland, they continue through the downturn. Plain slipwares (i.e. not trailed and rarely incised) reappear in our area towards the end of the 15th century ('Guys' ware, Dawson 1979, 44) and remain throughout the following upswing without any increases in sophistication, although decorated slipwares are evolving rapidly in Holland at this time (Hurst et al. 1975, 49). The arrival of trailed slipware in our area ('Metropolitan' slipware) coincides with the start of the next downswing, and may mark a step back from the dizzy pinnacle of tin-glazed ware just reached by the local industry. Certainly, it is accompanied by a reduction in decoration on tin-glazed ware, especially in the range of colours used (Noël Hume 1977, 25-6).

6. Conclusion

This survey seems to reinforce Blake's scheme of a hierarchy of potting technologies (Blake 1980, 6) shown here (Fig. 7) with some additions, and also his views on the value of pottery as an economic indicator.

We can combine this hierarchy with Braudel's schemes of economic cycles and zones, into a model for the innovation and diffusion of medieval and post-medieval ceramic technologies (Fig. 8). It would be interesting to expand this model in both space and time. From the ceramic evidence we might cautiously postulate

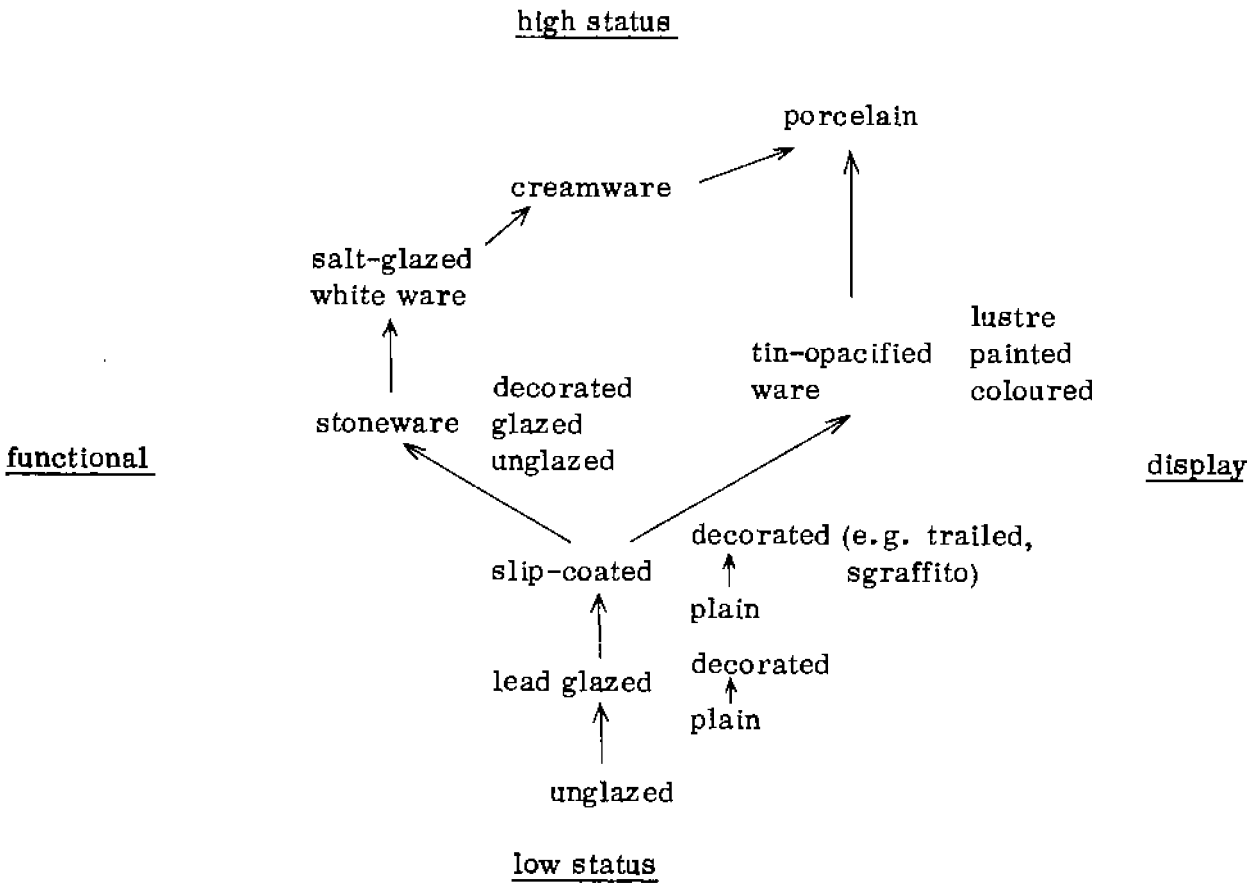

Fig. 7. hierarchy of potting technologies (after Blake)

an 'upswing' in the late 9th and 10th centuries, (marked e.g. by Stamford ware in the east and Late Saxon shelly ware in the Thames area), followed by a 'downswing' in the 11th and early 12th centuries with in this area a reversion to hand-made pottery.

Kilmurry's theory (pers. comm.) of Danes bringing the new technology from north France could be seen as an example of 'local inception', and the question asked, why and how did it 'stick', and outlast the potters brought reluctantly from their homeland? And how does the rest of England (outside the south-east) fit into this model? Does it, for example, support Braudel's idea of an early integration of the national market as a factor in the economic rise of London in the 18th century? Whatever the answers, I hope this model will provide a useful framework for the investigation of changes in ceramic technology. I have tried to show that there is nothing automatic about the innovation or diffusion of new technologies, but that economic conditions, and particularly the availability of capital for investment, play an important part. But we must avoid economic determinism - there is clearly a

1. Within a world-economy, innovation takes place in a 'core' area, from which the new technology spreads out through successive zones.

2. This spread is better modelled as a series of jumps (Catastrophe Theory) than as a gradual diffusion ('infection' model).

3. Innovation and diffusion take place on the upswing of economic cycles. This effect may be transmitted through a greater willingness to invest in productive capacity during an upswing.

4. In a downswing, 'core' areas retain their 'highest' technology. Other areas may lose their 'highest' technology, or re-introduce 'lower' ones alongside it.

5. The range of different technologies within an area tends to widen in an upswing and narrow in a downswing, possibly through the 'homogenising' effect of rising real wages at the bottom of the social scale.

Fig. 8. suggested model for diffusion of technological innovation in medieval ceramics

role for the personal attributes of will, emotional commitment and sheer pig-headedness on the part of the innovator, and greed, vanity and boredom with existing forms on the part of the consumer. We should not overlook the interaction of the pottery industry with other trades, such as wine or cloth, and general fashionable trends (particularly well reflected in dress, eating and drinking habits) which will have influenced the consumer.

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