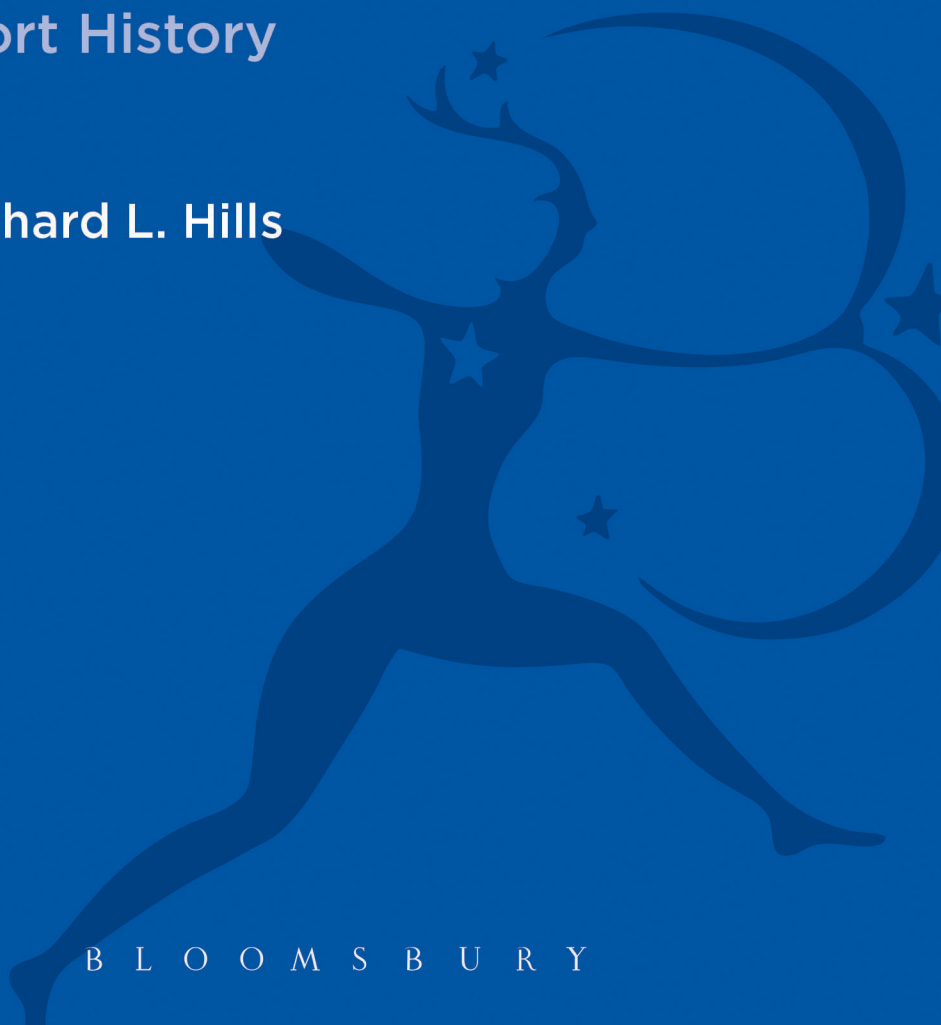


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A Short History

Dr. Richard L. Hills



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Papermaking in Britain 1488-1988

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A Short History



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FOREWORD

How easy it is to take familiar things for granted, and what other material is so pervasive in our everyday lives as paper and board in all its many forms – not only the books, magazines and writing papers, but in cars, on our walls and ceilings, in our kitchens and bathrooms, the filters, the tissues, or bank notes – the list is endless.

How easy to overlook the environmental benefits of this infinitely renewable, bio-degradable and recyclable material that in today's computer jargon is so 'user friendly'.

Outside the Industry it is often assumed, quite incorrectly, that because paper has been made in this country for hundreds of years, and in its simplest form can be easily made by hand, it is a process requiring a low level of technology.

The 500th anniversary of paper making in the UK presents an excellent opportunity to survey the development in paper technology over the years and chronicle the milestones in our history. Years that have seen the transition from handmade papers through the traumatic period of the introduction of machines, and the fears that must have been felt by the journeymen who could not possibly envisage the potential explosion in demand, through to the high technology computer controlled environment of today, when we see the Industry re-emerging once again strong, after large sectors were decimated during the 1970s.

Dr Richard Hills, an historian by training and inclination with a deep interest and knowledge of the Industry, has brought together in this book a wealth of information about its technical development over the period, and provides a valuable account of an Industry that contributes so much to our economy and everyday life.

Jeffery Bartlett
Director General
British Paper and Board Industry Federation

London

ACKNOWLEDGEMENTS

My first introduction to the paper industry was twenty years ago when I visited Nash Mills at St. Mary's Cray in Kent to see the exhibits of the National Paper Museum and decide whether we should accept them for the new Museum of Science and Technology in Manchester. The exhibits had been flooded by the river and were in quite a mess but I have never regretted recommending their acceptance because involvement with the paper industry has been one of the most interesting aspects of my life since then.

This book seeks to record a little about the technical achievements of the paper industry and particularly those inventions made here in Britain. I would like to thank all those who have helped with this aspect of my education during the intervening years and I apologise to any whose name is not included here because there have been so many people who have helped in so many ways and who have so kindly shown me around their mills, both in this country and overseas. I have been in a privileged position as President of the International Paper Historians to see many mills on the Continent and also to be helped by colleagues in that Association. I am most grateful to them, and to all those who have allowed me to take up their valuable time, for giving me a broad view of the industry which has been invaluable in the preparation of this book.

The fact that there is a book at all to help celebrate five hundred years of papermaking in Britain we owe to the British Paper and Board Industry Federation and George Mandl. Without their campaigning to obtain the initial backing, the project could not have started. The librarians at the patents section of the Central Library in Manchester and at the University of Manchester Institute of Science and Technology as well as the National Paper Museum Collection have given invaluable assistance. Offers to help with illustrations were received from the Bank of England, Bowaters U.K. Paper Co. Ltd., Comptroller of Her Majesty's Stationery Office, James Cropper, plc., C. Davidson & Sons, DRG Paper & Board, W. Green Son & Waite Ltd., Kimberley Clark Ltd., J. & J. Makin Ltd., Paper Industry Research Association, Purfleet Board Mills, Reed Paper & Board (UK) Ltd., St. Regis Paper Co. (UK) Ltd., Severn Lamb Ltd., Shotton Paper Co. Ltd., Thomas Tait & Sons and Wiggins Teape Ltd. Unfortunately space did not allow us to use all the pictures they offered.

I would like to thank those upon whom I inflicted the typescript for their gentle

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To all these people, and to the many others who have helped and given encouragement in so many ways I am most grateful and I hope that what follows will be worthy of their support in recording a little of the history of a great industry which still is vital to this country and contributes so much to our well-being today.

Richard L. Hills

I

THIS PAPER THYNNE

The Paper-Maker

'The water turns my mill wheel round,
Where rags to paper pulp are ground:
Their snowy leaves on felt I lay,
And squeeze the water well away,
And then I hang my sheets to dry:
All white, and shining like the sky.'

HANS SACKS, about 1550

Why should Henry VII have visited the first paper mill in Britain during May 1498, almost five hundred years ago? We have of course today the example of our royal family going to all sorts of places and industries, but we would hardly expect Henry VII, the founder of Tudor despotism, to be courting popularity among his subjects. Growing royal authority needed records. The laws of the realm had to be written down. Legal proceedings had to be documented. The king wanted to know the state of his finances, what was the taxable potential and what had been raised. Likewise an expanding commerce necessitated keeping accounts, bills of exchange to settle payments, as well as correspondence of all sorts. Some way of preserving all these laws, records and transactions had to be discovered which would not be too bulky and which could be handled easily so that reference could be made to the entries. Paper was one possible substance and perhaps Henry VII visited that infant manufactory because he hoped that it would enable his country to become self-sufficient in a commodity which was assuming greater and greater importance in the legislature and world of commerce.

If we go back to Henry VII's distant predecessor, William the Conqueror, we will discover that he had no alternative but to have his famous Domesday Book of 1086 written on parchment because at that time, no paper was available in England and it was barely known in the rest of Europe. Parchment was made from the skins of animals, in particular sheep. England was fortunate throughout the Middle Ages in having large flocks of sheep which brought prosperity in many ways. Their wool had been exported through the wool trade which had been overtaken and replaced by the cloth trade. At a period when many animals had to be slaughtered at the beginning of winter because there was insufficient fodder, skins for making parchment were probably more readily available than would be the case today.

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During the fifteenth century, the price of paper had fallen by something like 40 per cent while that of parchment had risen by possibly a similar amount. The quality of parchment had declined at the same time. This movement in favour of paper continued in the sixteenth century for while paper prices rose between 30 to 60 per cent during the first eighty years of that century, that of parchment rose a further 70 per cent.¹ So we find that increasingly paper was replacing parchment during the later part of the Middle Ages.

Paper was important as a wrapping substance as well as a writing surface. Coarse grades of paper and, in particular brown paper, were used as a wrapping material from a very early time but, such is the nature of this use that we have few details of it because most has been thrown away. Our history of papermaking derives principally from white paper because laws, contracts, accounts, etc. have been written on it and preserved in archives. Both from its uses and from the way it has been filed, such paper can be identified and dated with fair accuracy. Generally we find that a country had been importing paper for a considerable period before starting to make paper. England was no exception for, while our white paper industry was not firmly established until the end of the seventeenth century, the oldest surviving piece of paper found in the Public Record Office dates from about 1220. Yet it is not until after 1500 in Tudor times that paper is to be found with any frequency among the records there.²

In France, a mention of the *Pielle* mill at Troyes in 1338 must be considered as confirming the oldest manufactory of paper in that country,³ although a date of 1326 has been claimed for *Ambert*.⁴ Yet paper had been used in France for at least one hundred years before that. Some paper must have been imported through *Marseilles* from *Syria* during the thirteenth century because the *Charter of 1237* and the *Register of 1249* in the archives at *Bouches-du-Rhone* are evidence of this.⁵ In *Italy*, a society for manufacturing paper had been formed near *Genoa* in 1255 but there could have been a paper industry in southern *Italy* before that. In 1220, *Frederick II* had forbidden the use of paper for public records in the councils and courts of *Naples*, *Sorrento* and *Amalfi*, while in 1145 the King of *Sicily* had ordered that deeds written on paper must be transcribed onto parchment because it was feared that paper would not last. The oldest document on paper in the *Italian peninsular* appears to be one of 1109 in the archives of *Palermo* in *Sicily*.

It was the *Moors* who introduced papermaking into *Italy* but they had brought it into *Europe* even earlier through *Spain*. The traditional date is 1151, by which time there was a flourishing industry at *Xativa* in *Valencia*. However, the first paper mill may have been started here as early as 1056 and another one at *Toledo* in 1086.⁶ From this we can see that *William the Conqueror* had no alternative but to use parchment for the *Domesday Book*, the more so because the other material commonly used as a substance for writing in the ancient world, *papyrus*, had disappeared by the tenth century. The reason for this is unknown. It may have been that the *papyrus* reed had died out in the river *Nile* because it had to be re-introduced

This Paper Thynne

recently to enable modern production to start once more. It may have been that papyrus could not compete with paper being made first in Damascus where it had started in about 794 and a little later in Egypt itself. The traditionally assumed date for the introduction of papermaking to the West is 751 when allegedly the Arabs captured some Chinese papermakers at the battle of Talos near Samarkand and so learnt the art. Yet in 648 the Buddhist monk, Hiuen Tsang had encountered a place about three miles south of the town Taras in Turkish territory populated by some three hundred Chinese families among whom there may have been papermakers.

The art of papermaking had taken a long time to spread beyond the Chinese borders, for the original centre was the Hunan province in the South East of that country. Tradition has it that in 105, T'sai Lun first presented a sheet of paper to the Emperor as a substitute writing surface instead of the silk or other cloth which had been used up to that time. At this point, we must ask 'what is true paper?' The usual definition is that it is a matted material made from cellulose fibres from herbs or trees which have been macerated or beaten to fibrillate them. Then they have to be dispersed in water until they are suspended evenly so that, when the water is drained off, a sheet of paper is left. It is of course possible to make a felted mat of fibres which can look like paper, but one of the hallmarks of true paper must be the beating which breaks down the fibre walls and enables the vital hydrogen bonding to form between the fibres. It is this hydrogen bonding which gives paper most of its cohesion and tearing strength.

Recent research in China using analysis with electron microscopes has shown that what was thought to be some of the oldest paper in the world has never received any beating.⁷ In the Baqiao brick factory of the Shanxi province there was discovered a tomb dating from the West Han dynasty (140–87 BC) with, among other objects, three bronze mirrors. Under these mirrors was cloth and what appeared to be paper. Not only is the dating doubtful but the electron microscope has shown that this paper was probably only wadding or even sweepings off the floor. The average fibre length is far too short to have been achieved by any mechanisms available then or much later. Similar investigations into other early papers which have been dated to the pre-Christian era have shown that some of them too are a type of wadding and not true beaten paper. However, those papers made after the time of T'sai Lun do show the effects of beating in their fibre structure to develop hydrogen bonding and compactness of the sheet and are therefore considered to be true paper. Perhaps the legend of T'sai Lun may be the truth after all and perhaps paper was originally developed as a material for writing.

In western Europe the demand for paper was increased by Johann Gutenberg's improvements to printing around 1446 at Mainz in Germany. Up to this time, the letters on each page to be printed had to be carved out of a solid block of wood. Gutenberg cast each letter individually so that, when the printing of that page was completed, the type could be dismantled and used again. By 1452–6 he was able to print a Vulgate Bible. In 1475, William Caxton returned to England determined

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to establish his own printing press. Caxton had been apprenticed to the Mercers' Company in 1438 to one Robert Large.⁸ In 1463, he was appointed Governor of the Company of Merchant Adventurers and spent many years in the Low Countries involved in its affairs there. It was while he was on the Continent that he learnt the art of printing. Members of the Mercers' Company held control over the Merchant Adventurers whose constitution at this period was extraordinarily fluid. While the Merchant Adventurers negotiated as a body with the authorities on matters of commercial policy, chartered ships, arranged convoys to the marts and times of sailing, its members traded individually and remained closely connected with the craft to which they happened to be members. The Governor of the Merchant Adventurers, virtually always a London Mercer, moved constantly from England to the Netherlands and back, and held court at the Mercers' Hall in London. While the Mercers' chief trade was in fine cloth, they dealt in many other commodities, such as sugar and spices, wood, wine, oil, tar, in fact in almost anything that offered a profit. In their records, we find one Robert Tate, possibly John Tate's son, importing one hundred bundles of brown paper in 1497.⁹

Caxton established his printing press at Westminster Abbey where he might have been able to avoid some of the restrictions imposed by the guilds in the City of London. The more probable reason was that Caxton saw a better market for the books he wished to print among the courtiers and noblemen attached to the royal household than among the merchants of the City. What is certain is that by the end of 1476, he had settled all the formalities of finding premises in Westminster and had printed an 'indulgence' which has the date 13 December 1476 added by hand on the only surviving copy. He produced thirty books in the first three years and continued to operate his press until his death in 1491. Then his business was taken over by Wynken de Worde who later moved to Fleet Street in the City of London and became a member of the Stationers' Guild. By 1403, the Stationers had formed their own trade guild. This was incorporated in 1557 as the Stationers' Company and given control of all printing in England.

Gutenberg printed his Bible partly on parchment and partly on paper. It has been estimated that each parchment copy, consisting of more than 641 leaves, needed the skins of more than 300 sheep. In the event, he printed only thirty copies on parchment and 180 copies on paper. By the time of Caxton, an edition of a printed book might run to a thousand copies and so it was evident that paper was the only possible material if the printing industry were to expand. Possibly John Tate had expected a quicker growth in publishing than in fact occurred for it was to be some years before another press was established in England and the first book printed in Edinburgh dates from 1508. However, there was a continuous demand for paper of high quality throughout these years for printing as well as for writing. The first paper that was used in England came from Italy and France from the early fourteenth century until the end of the sixteenth century.¹⁰ The region around Troyes in France formed an important source of supply to the Netherlands and through them to the

This Paper Thynne

English market.¹¹ Caxton procured his paper from the Low Countries and in it has been found watermarks of a bull's head and a unicorn.¹²

Although people were not to realise it at the time, the accession of Henry VII in 1485 ushered in a time of political stability after the turmoil caused by the Wars of the Roses, allowing trade inside the country to begin to prosper again without fear of disruption. This was essential for papermaking because paper in Europe was made from rags which had first to be collected, then sorted into types of fibre and colour, before being taken to the papermill and such activities needed a peaceful state in the land. At this period, hemp ropes and linen cloth were the principle sources of fibres for papermaking and, to make white paper, only white fibres could be used because there were no bleaches to remove dyes or discolourations. Old sails of ships were one source of supply. Another was the worn-out garments from people. Papermills were therefore established close to large towns where it was easier to collect rags being thrown away by the inhabitants.

Nothing is known about John Tate's reasons for launching out into the paper industry. It may be significant that he also was a member of the Mercers' Company. His father was John Tate, another Mercer, who was Mayor of London in 1473 and died in 1478 or early 1479. It is difficult to identify positively either of these John Tates and the position is further confused because they had a relative, Sir John Tate, who was Mayor in 1496 and died in 1514. He had a son John as well.¹³ Our John Tate also had worked for the Merchant Adventurers on the Continent and so was well placed to be involved in trade and commerce. On his return from the Low Countries, he may well have thought that he saw a profitable opening for selling paper to the fledgling printing industry.

Precisely when John Tate began to build his papermill is unknown. J.B. Powell gave a date of 1476¹⁴ and claimed to have found Tate's watermark in one of the Paston letters dated 1485, but no evidence has been found to confirm either of these dates.¹⁵ A rare, and perhaps unique combination consisting of Caxton's printer's device overlying Tate's watermark was found by W.A. Churchill.¹⁶ This would suggest a date prior to 1491 but Wynken de Worde continued to use Caxton's marks so this evidence is not conclusive.

Tate's watermark has been found in a reissue during 1494 of the Latin text of the Papal Bull of Pope Innocent VIII, to which Pope Alexander VI also agreed, expressing pleasure in the marriage of Henry Tudor and Elizabeth of York (though cousins of some degree) and in recognition of Henry as the rightful occupant of the English throne. Of the six copies extant, it is the one at Lambeth Palace which has been claimed to be the oldest piece of English paper for it shows John Tate's watermark. The other copies at St. John's College, Cambridge, Ripon Cathedral and Eton College also show Tate's watermark. This Bull was printed again as a Supplementary Proclamation in 1498.

It is reasonable to assume that paper bearing his watermark was actually made at Tate's mill near Hertford and that therefore this mill was in operation by

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at least 1494. While it seems that Caxton himself actually learnt how to print, John Tate would never have been able to acquire the skills of the papermaker at the vat without a long apprenticeship. He would have needed to employ skilled men, first to design and build his mill and then to run it. Such people could have been found only abroad. He needed a site where he could drive the papermaking machinery by waterpower and where there would be clean water for the actual manufacture of the paper. He would have had to arrange to lease that. After equipping the mill, he had to organise a supply of rags which may have been difficult because competitors would have been purchasing them to send abroad and people in England may not have been accustomed to save them. Then he had to hire people with the knowledge of how to make the pulp as well as the actual paper. Finally he must have had somebody who was capable of making and keeping in repair the moulds on which the paper was made. All these people must have been foreigners. Around 1800, it was estimated that at least three months would elapse between arrival of the rags at the mill and their despatch as finished paper. Therefore John Tate must have been working for quite a long time, possibly years, in order to plan, build and equip his mill before production actually started. The date of the start of Tate's schemes must have been considerably earlier than 1494, the date of the first paper from his mill of which we have any knowledge. Once the mill was running, other people had to be trained in the skills of papermaking if it were to function over a long period because this was a trade which depended upon experience to produce a good quality product.

Whatever the actual date of the foundation of Tate's mill, it must have been well established by 1495 when Tate must have been thrilled to receive the order for paper for a book, the *De Proprietatibus Rerum* by Bartholemaeus Anglicus, which had been translated by Caxton and was printed by Wynken de Worde in 1495–96. It is through a verse printed in the colophon of this book that we are able to identify Tate's paper, for it is stated:–

'And also of your charyte call to remembraunce
The soule of William Caxton, first prynter of this boke
In laten tonge at Coleyn hymself to auauunce
That every well disposyd man may theron loke
And John Tate the yonger, Joye mote he broke
Whiche late hathe in England doo make this paper thynne
That now in our Englysth this boke is prynted inne'.¹⁷

It was a thick volume of 478 leaves. Each leaf was folded in half so one book consumed nearly half a ream of 480 sheets of paper. It has been suggested that possibly 500 copies were printed. This paper is quite reasonable in quality, except that not all of it is equally thin, and would stand comparison with many other papers of its date. However, there are some bits of grit within the pulp, possibly coming from the water used in the vat or sand blowing into the stuff while the vatman was actually plunging his moulds into it.¹⁸ The paper is also a trifle rusty and the sizing is a little soft.

This Paper Thynne

It is in this paper that we can identify the first of Tate's watermarks which has been variously described as an eight-pointed star or spokes of a wheel within a double circle. The outer diameter of the outside circle is $1\frac{5}{16}$ in. (33 mm.) and the inner diameter of the inner is $1\frac{1}{8}$ in. (28 mm.). The distance across the points of the star is only $1\frac{3}{16}$ in. (21 mm.) so they do not touch the surrounding circle on these early watermarks.¹⁹ It is not known why Tate chose this watermark, but there is no reason to suppose that the design was personal to him. A motif of eight points or petals within a double circle, bearing a considerable resemblance to this watermark, was sometimes carved in Tudor wooden panelling; an example can be seen in the Tudor guest house at Topsham, Devon, which dates from the fifteenth century. The design may have been quite common at that time.²⁰

The sheets of paper were formed by the vatman dipping his mould into a vat full of water with the paper fibres suspended in it. The mould was a sort of sieve, with a cover supported by a wooden framework. The vatman formed his sheets by first putting on top of the mould a deckle, a removable frame round the edge of the mould, which acted like the sides of a tray to keep the pulp on the mould. These were dipped into the vat to scoop up the pulp. The water drained through, leaving the sheet of paper on the surface. The paper in the Bartholemaeus was made on moulds constructed in two different ways. In both cases, the watermark was sewn only onto the middle of one half of the mould. In one type of construction, all the wooden ribs supporting the surface of cover were equally spaced at roughly $1\frac{3}{8}$ in. (35 mm.) intervals apart except for the pair either side of the watermark which were at a distance of about 2 in. (50 mm.). The ribs formed shadow zones or darker areas in the paper which show up either side of the chain lines, those wires binding together all the laid wires which made up the cover itself. The laid lines were spaced at 24 per inch or 10 per 10 mm. In the first type of mould, the watermark was held in place by another chain line which was not quite central. There is no shadow zone here, so there can be no rib underneath it.

In the second type of mould, the watermark is again placed between two ribs which are further apart than most of the others at $1\frac{7}{8}$ in. (48 mm.). In this case, the chain line supporting the watermark runs down the middle of this space. Spacing the ribs further apart at the watermark is a feature of early Italian moulds and has led to the suggestion that Tate's moulds were made perhaps by a mouldmaker from Genoa.²¹ There is an additional feature in this second type of mould for the spacing of the ribs at one side of the watermark is not $1\frac{3}{8}$ in. (35 mm.) as in the rest of the mould but only $1\frac{1}{16}$ in. (27 mm.). So this mould must have been constructed differently from the other one and probably made a slightly smaller sheet of paper. We know the size of this mould because an example has been found in a draft court roll of Watton Woodhall Manor, written in 1500. Woodhall Manor was about four miles up-stream from Sele Mill near Hertford and both that and Sele Manor were held by the Boteler Family from the fourteenth to the eighteenth centuries. The size of this sheet is $17\frac{3}{4}$ in. (453 mm.) by $12\frac{3}{4}$ in. (325 mm.).²² A comparison of

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both sets of these watermarks show sufficient differences to indicate that the paper was made at the vat with pairs of moulds, and not single moulds, which were dipped in the manner to be described later.

In 1498, Tate received a further order for paper from Wynken de Worde on which he printed three more books with the star and circle motif as the watermark and the same features in the moulds. These were *The Golden Legend* by Jacobus de Voragine with 449 leaves, *The Canterbury Tales* by Geoffrey Chaucer with 157 leaves and a much shorter work, Lydgate's *Assembly of the Gods* with 16 leaves. It is thought that only about 250 copies of these may have been printed. The character of the paper used in the Chaucer is well sized but possibly of slightly inferior quality to that produced earlier for occasionally there are lumps or small knots in the pulp and the watermark is less distinct. It has been estimated that, even allowing for trial prints and wastage, these four books would have consumed around 800 reams of paper. A paper mill, if it were to stay in business, would have to sell more than that so that Tate, after a promising start would have needed to broaden his markets.

1498 was the year when Henry VII visited the mill. At that time, Hertford Castle was a royal residence. Henry VII arrived there on 23 May and we find in the Privy Purse expenses two days later an entry of 16 s. 8 d. 'for a rewarde yven at the paper Mylne'.²³ In the following year, there was a somewhat similar entry, 'Geven a rewarde to Tate of the Mylne, 6 s. 8 d.'²⁴ That the paper mill was in or near Hertford is confirmed by a poem of William Vallans, printed in 1590 and called *A Tale of two Swannes*, which describes the River Lee and its tributaries. In the notes appended to the poem, there is the following,

In the times of Henry VIII [correctly VII] there was a paper mill at Hertford and belonged to John Tate, whose father was Mayor of London.²⁵

An ingenious reason for the second payment by Henry VII has been put forward. Wynken de Worde continued to use Tate's paper after 1500. Tate's star watermark has been traced in two more books, *Thordynary of crysten men*, published in 1506, in which a number of sheets have been used and on a single sheet in *The Justyces of peas*, published in 1510. Other watermarks appear in these books, some of which are found on the Continent, but there is one not used there, a Tudor Rose. From the way the sheets of paper are intermingled with Tate's known star, and from the quality of the paper being similar, it is almost certain that the paper was all produced at the same mill. This assumption is further strengthened by the fact that a few sheets with the Tudor Rose have been found in copies of *The Golden Legend*. The book was published originally in January 1498, and these odd sheets may represent reprinted pages to cancel an error. So it has been suggested that, after the first visit of the King in 1498, Tate's Italian workman fashioned new wire profiles emblazoned with the royal Tudor Rose and that some of the paper made with this watermark was presented later to the King himself.²⁶

This Paper Thynne

The moulds on which this other paper was made were different from the earlier ones, with the ribs at the watermark only $1\frac{5}{8}$ apart (42 mm.). Once again, the locating chain line for the watermark was not central. There may have been two different pairs of moulds as the measurements vary sufficiently for the differences not to be caused by the coucher moving the mould when laying off the sheet or the unequal drying of the paper. The laid lines too on one mould seem closer together at 27 per inch (12 per 10 mm.) instead of 24. A third set of moulds may have been used with another simpler smaller variation of the Tudor Rose with an even finer cover. On this paper, while the watermark is distinct, the chain and laid lines are less so than in the other papers. The rib spacing is $1\frac{3}{8}$ in. (35 mm.) apart but at the watermark only $1\frac{1}{16}$ in. (40 mm.). This time the watermark is in the middle between the ribs but there seems to be no supporting chain line. It has been suggested that, in *Thordynary of crysten men*, we can find a further example of Tate's watermarks, either a hand or a hand with a star above it. If so, the moulds on which this paper was made were different again.

The watermarks with Tate's known star and circle in the *Thordynary of crysten men* appear to have been made on moulds similar to the second type in the earlier books with the unequally spaced rib. However, the single sheet of Tate's paper in *The Justyces of peas* is quite different. The circle round the star is smaller at about $1\frac{3}{16}$ in. (30 mm.) outside diameter and the points of the star touch the inner circle. The laid lines are finer at about 35 per inch (15 to 10 mm.) but the chain lines remain thick and show clearly. The paper has quite a different feel about it. Unfortunately the evidence for yet another variation of Tate's star watermark was probably destroyed when the archives of Canterbury Cathedral were blitzed during the Second World War. In 1897, Michael Beazeley traced a star inside a circle with outside diameter 40 mm. vertically and 35 mm. across, or larger than any of the others, with the chain lines spaced differently. Beazeley gave the sheet size as $13\frac{3}{4}$ in. by 19 in. (350 x 482 mm.) and the date 1512.²⁷ This and the sheet in the Woodhall Manor draft are two examples of Tate's paper used for writing which points to a more widespread employment than has been considered hitherto. The variety of watermarks and moulds suggest that Tate continued to make paper for some years but for how long cannot be ascertained.

The reason for Tate's choice of Hertford probably lay in the River Lee (or Lea), because he needed transport of the raw materials, the rags, and the finished article, the paper, as well as power to work the papermaking machinery. The River Lee and its tributaries supplied both. In 1424, an Act had been passed empowering the Chancellor to issue commissions for the purpose of 'cleaning, scouring and amending the River Ley' and another Act the following year appointed commissioners.²⁸ There was a further Act in 1430 'To scour and amend the River Lea'. Through the work carried out under these Acts, the navigation commenced just below the Town Mills in the centre of Hertford.²⁹ Therefore

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Tate had, for that time, good transport within easy reach of an important town and harbour, the City of London.

The River Lee itself and its tributaries were sites for many watermills. One tributary, the Beane, passes round the north of Hertford before joining the Lee just below the town. The road out of Hertford to the north follows the Beane through the manor of Ceal or Sele in which the Domesday survey records a watermill.³⁰ This site is within half a mile of the head of the navigation. This mill was noted in 1700 as the first in which the fine flour called Hertfordshire White was ground, and, today, the Sele Roller Flour Mills still are producing flour. Waterpower probably ceased to be used in about 1891 when the mill was rebuilt after a fire.

The deeds of 1867 conveying the Sele Mill to the forebears of the present owners, G. Garratt & Son, mention:

Also so much of a parcel of meadowland formerly containing by admeasurement one acre two roods and twenty three perches near or adjoining to the said last described hereditaments and being part of a certain mead lately occupied with the said mill formerly called paper mill mead but now or late called Flowers Mead bounded on one side thereof by the stream or River there running from the said Mill Tail and on the other side thereof by a stream or ditch carrying off the waste water from the said mill.³¹

A beautifully coloured plan of the mill included with this Conveyance unfortunately does not cover this meadow but it is shown as Plot 102, Flowers Mead, in the Tythe Map of 1838, drawn by W. Wilds.³² It is the principal water meadow between the Sele Mill and the town of Hertford itself. One end forms the boundary of the mill buildings while the tailrace from the mill waterwheel runs along one edge. On the upstream side of the mill, a weir has been constructed to pen up the flow of water and create a fall to operate the waterwheel. In the 1838 Tythe Map, all this land on either side of the river is shown to belong to the ‘Trustees of the late Miss Dimsdale’.³³ The riparian owners had power to control the flow of water in the river or stream adjoining their banks and the block of land owned by Miss Dimsdale’s Trustees gave them the water rights to Sele Mill, with Paper Mill Mead forming a vital part of those rights. It is interesting to note that, in the fifteenth century, Sele Mill would have been far enough away from Hertford for the noise of the paper pulping stampers or hammers not to have caused a nuisance in the town.

The tradition of this meadow being called Paper Mill Mead and therefore to this being the site of Tate’s mill can be traced back to two Stuart documents. The earliest surviving delimitation of the boundary of Hertford belongs to 1621 when it was set out as follows:

From a post at the west end of the town in the road to Hertingfordbury at the end of Castlemead to the corner of Sealeford; then it meets the highway from Hertford to Watton, thence to a post near Papermill gate, and to the

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northside of the river to Cowbridge, along the northside to the Lea at the east end of Hartham.³⁴

Then Charles I, in the third year of his reign (1627), granted to the mayor, burgesses and commonalty of Hertford, and their successors, the soil and fishing in the waters called Benwick or Bengrade, which extended from the east end of Paper Mill Mead to a place called Goods Pool.³⁵ Therefore this evidence places the mill firmly to the north-west of Hertford, and not at the site of the old waterworks where L. Turnor in his map of 1830 shows 'Paper Mill Ditch'.³⁶

The layout of the watercourses shown on the nineteenth century maps probably evolved after Tate's occupancy to derive the maximum power from the site. However, a visit there confirmed that the River Beane still has a reasonable flow of water. The fall at this point is insufficient for installing an overshot wheel so an undershot one must have been used. There would have been more than adequate water resources to power the mill if the type of machinery that survives today in old mills in Spain, Italy and France had been installed. The water in the river is normally clear and, coming off the chalk hills to the north, would have been suitable for papermaking.³⁷ Sele mill was situated quite a long way down the stream and, in times of flood, the water may have become polluted. So the site chosen by Tate would seem to have had suitable water for papermaking, adequate provision for power, good transport facilities near by, and been close to London from where its raw material, rags, would have come and where the paper would have been sold.

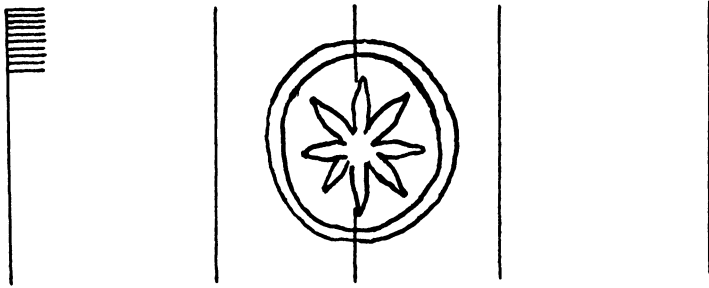
When production ceased at the mill is uncertain. Wynken de Worde's publication of a book with Tate's paper as late as 1510 suggests that some paper was made in the early years of that century. On the other hand, Wynken de Worde may have been finishing stocks that he had purchased earlier or even residual stocks from the mill sold on Tate's death. John Tate died in 1507 and was buried at St. Dunstan's-in-the-East, London.³⁸ In his will, he left to one Thomas Bolls 'as moche whit paper or other paper as shal extende to the somme of xxvi s. viii d.... oute of my paper myll at Hartford'.³⁹ It is interesting to note that Tate was involved with paper other than white. Either he had been importing some cheaper qualities and was using his mill as a warehouse, or he may have been manufacturing other types, presumably to keep up production because he could not sell enough white paper.

In his will, Tate directed his executors to dispose of the paper mill 'with all the goods, woods, pastures, medes, with all the commodities concerning said myll to the most advantage'. Finally, in leaving to his eldest son, Robert, all the lands in Hertfordshire and Essex, the paper mill was excluded, 'My paper myll with the appurtenances to be always excepted and to be sold'.⁴⁰ It is evident from this will that Tate died a wealthy man for he left money to various charities as well as his estates to his family. Why Tate failed, we shall probably never know. It may have been foreign competition, for no doubt Dutch suppliers soon found that they could reduce their prices as happens today.

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Once a Bookseller made mee when I asked him why we had not white and browne paper made within the Realm as well as they had made beyonde the Sea; then he aunswered mee that there was paper made a while within the realm: at the last the man perceived that made it that he could not aforde his paper as good cheape as it came from beyond the sea, and so, he was forced to lay down the making of paper; and no blame in the man, for men will geve never the more for his paper because it was made here.⁴¹

It may have been difficulty in obtaining rags as was suggested soon afterwards, 'Foreigners bought up our broken linnen cloth and ragges' and sold them to us in the form of paper 'both whit and browne'.⁴² Possibly demand at that time was insufficient to sustain the mill. Whatever the reason, no one else tried to start a paper mill at Hertford again.



Tate's early watermark on the mould with ribs spaced equally



Stevenson's reconstruction of the Tudor roses

1. Reconstructions of John Tate's watermarks.