The Evolution of Paper

by Sandra Ker, Antiquarian Print Gallery, Unley, South Australia

In the Beginning….

Early writing and drawing was done on cave walls and so a natural progression was carving stone tablets i.e. the Rosetta Stone. Then "Paper", defined by Noah Webster as "a substance made in the form of thin sheets of leaves, straw, bark, rags, or other fibrous material." was beginning to evolve. In about 3000 BC Egypt was developing the papyrus "papers", and later supplied papyri to the ancient world from the Far East to the Roman Empire.

The date given for the invention of first material we call 'paper' was 105 AD in China. The Chinese kept a monopoly on its fabrication for 500 years. They traded their product westward, while keeping their technique a secret, until 751 AD when the major paper producing district of China fell into the hands of Mohammed, who saw the use of paper as a way to spread the Islamic faith. By the 12th century the first paper making mills had been set up by the Moors in Spain. Paper is accredited for the Chinese, and then the Arabic, spreading their superior knowledge and scientific discoveries that surpassed that of the West. The Catholic Church had outlawed reading and writing in what became known as "The Dark Ages". For 95% of Europeans to be caught with reading matter was often punishable by death. (www.librarypreservation.org). Europeans preferred the use of *Parchment*, or *vellum*, as paper was made by "*the infidels*". Parchment was made from goats or sheep skin and was the most common writing material during the Middle Ages. Vellum has considerable strength and durability and so survived the centuries. However, the preparation process was long and expensive and included the use of toxins like arsenic etc. The city of Chester in Britain has a building known as the "God's Providence Building" which is nestled among the 'Rows'. Apparently the residents who lived in and around this house survived the Plagues unscathed and so it appeared that they had God's good favour. Speaking to a local archeologist when I was there in 1987 it seems they discovered that the basement (where shops and the poor resided) had been a tannery for leather etc. and arsenic is the one thing that would have killed the rats on which the plagued-spreading fleas were transported. (Even though the poor tanners may not have succumbed to the plague I dare say the arsenic would have got them in the end.)

With the invention of the Johan Gutenberg's printing press in the mid fifteenth century, their was a requirement for a product that was cheaper and more malleable than animal skin. So it is that paper was required as a printing surface for Gutenberg's movable type and is responsible for the rapid spread of knowledge that followed. By the end of the 15th century paper was made in all the principal countries in Western Europe to supply the newly developed printing press. Vellum's reign was over. Now rag paper was the writing material of choice in Europe and it's dominance continued until the introduction of wood pulp paper during the Industrial Revolution as the demand on the printing presses increased due to the growth of a more affluent middle class.

Laid Paper

The First hand made paper were made from cotton and linen rag pulp that were washed, boiled and macerated to separate the fibres. (www.CBBAG.ca). Most paper consists of cellulose materials and pre-1800 also utilized hemp, mulberry and rice (particularly in Japan) fibres.

"Until 1883, over 75-90 % of paper was made with hemp products" (www.hfmgv.org), which were sourced from worn-out clothes, curtains, diapers, old hemp fishing lines and sails. The latter items were sold by ship owners to scrap dealers, or "Rag 'n Bone Men", who in turn sold them for recycling into paper. Rag paper was the epitome of the phrase 'waste not want not'. *Laid paper* was made by dipping a wooden mould and deckle into a fibre suspension slurry. The resulting paper had a "grid" pattern in the sheet, a result of the rag pulp resting against wires stretched across the timber frames. *Laid paper* is recognized by these wire impressions left in the paper sheet. However, Laid paper was hand made and the domain of the industrial revolution had a solution for this slow production that was high quality wove paper. The strength of rag paper is due to the long length of the fibres as opposed to short wood fibres that were to be used later. It

is believed that Rag paper containing hemp fibres and mulberry, is the highest quality and the longest lasting ever made, surviving up to five hundred years so far. (Jack Herer, 2002). However, even good quality rag paper can deteriorate due to external factors such as light, air pollution, mould, insects and heat.

Wove Paper

In the mid 18th Century, Elder Whatman is credited with devising what we now call *Wove paper*. However, it took about another half a century to develop the technology to produce a high quality rag paper that could be made in large quantities at economical prices. The first papermaking machine was invented in France in the late 1700's by Nicholas Louis Robert and later developed by Henry Fourdrinier in the early 1800's. Instead of using crossing wires, wove paper was made in a mould covered by a very fine woven mesh of thousands of brass wires. This made a much smoother paper sheet. In addition a roller was added to further smooth the surface of the paper sheet. Early wove paper was still made from cotton fibers, and was of high quality. However wove paper was not as strong as the hand made Laid paper because the fibres were more uniform and laid in the same direction.

Wood –Pulp Paper

The next step in the evolution of paper was the use of hard and softwoods from the vast forests being unlocked by expanding empires. As the demand for books grew so did demand for paper to print them on, and the supply of good quality rags began to dry up. The Industrial Revolution had created a fibre shortage. During the 1840's wood pulp was used experimentally in Germany for papermaking and the industrialists discovered that it could be mass-produced by using wood conifers. It is from this time we can date the rapid aging of books and documents due to the high acid content, or lignin, which resides in this new paper product. Book pages, and especially newspapers, become brittle and disintegrate, after many years, on the shelves in private and public libraries creating an ongoing battle to rehabilitate these items using chemicals to neutralize the acid and bond the cellulose fibres together. So paper became much cheaper, but it was poorer in quality and had a shorter longevity due to its instability when compared to the lignin-free status of the "rag" paper. Industrial papermaking machines are responsible for the huge quantities of cheap, fragile paper not just because wood pulp was high acid but also was produced in a continuous roll. This meant the shorter wood fibres align in one direction as opposed to the hand made *Laid paper* whose longer fibres suspended in liquid randomly intertwined adding to the papers strength.

The term "Inherent Vice" is used for materials that 'degrade at an exceptionally rapid rate due to chemical composition. Wood pulp degrades due to the presence of lignin which forms acidic compounds as it degrades' (www.hmgv.org).

The New Paper Generation

With the modern knowledge identifying "lignin" as the culprit causing paper deterioration paper makers have now refined the use of wood pulp papers by chemically changing it into *high alpha cellulose* which neutralizes the potentially damaging substances and removes lignin (7-9 PH). Alpha Cellulose *"is plant (usually wood) pulp that has been purified, removing lignin and other potential damaging substances, leaving almost pure cellulose which is pH neutral*" Some producers of paper products are marketing a 'conservation' mat board that is made up of high alpha cellulose with the key qualities of the surface papers being made up of light-fast pigments and the board utilizing the *Micochamber technology.* Now, Microchamber technology denotes the presence of *zeolites* that act as '*tiny molecular traps capturing airborne pollutants and turn them into an inert substance.*' (www.lenzarts.com) Kaye Evans, an educator in the framing industry for 14 years, believes it is important for mat board products that surround artwork to be inert so as not to interact and change the conditions of the artwork. "*They must be neutral*". She also notes of the new microchamber technology that it "*actively attacks and neutralizes airborne pollutants and acids that can damage artwork.*" This new product has yet to have the test of time on it's side but she notes that "*in the future it could be as important to picture framers as the polio vaccine was to health care".*

Conclusion

Therefore, in closing, I would like to point out that, although my experience with aged paper leads me to favour the *"test of time*" cotton product when it comes to archival and conservation framing techniques, I can not close my mind to the potential use and benefits of technological advances. After all, in a medical sense it has lead to a greater quality and longevity of human life in the 20th century. When customers enter The Antiquarian Print Gallery they see a visual record of history that has them pondering how wonderful a perceived simpler life would have been. My historical knowledge goes beyond the poetry of the visual and I can break the spell by extolling the virtues of advances in Dentistry, Childbirth, Penicillin, Transport & Body Odour Control to name a few, all of which have been addressed by a more accessible knowledge, facilitated in the late 20th century by the internet (like the Printing press of 1450), and industrial progress.

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