Papermaking: History & Technique

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Paper has played a major role in the dissemination of ideas for over 2000 years. This essay examines the history of paper's Journey throughout the world and its development is Europe. I will explore the ancient craft of papermaking and the techniques employed today.

Papers Journey from East to West

It is commonly understood that paper was introduced to the world by China, but because of China's long legacy of cultural and political upheaval, it has been difficult for historians and archeologists to report detailed investigations into the earliest papermaking techniques. Before paper, the Chinese used raw sticks of bamboo and wood for a writing surface and later used silk . The earliest paper fragments were found in Xian believed to date back to about 140-87 BC (Rudin, 15) . The earliest documented paper maker in China is Ts'ai Lun who reported his papermaking technique of combining hemp, bast and old fishing nets to the Emperor in 105 AD.

Papermaking did not make its way to Japan until the beginning of the 7th century. Korea, then part of China was in communication with Japan where the craft of papermaking was introduced by Buddhist monks. Though paper was first used for writing in China, it was Japan that produced the first prints. The first known prints were commissioned by Empress Shotoku in 770 AD . A smallpox epidemic plagued Japan in 735, In response Empress Shotoku authorized the printing of one million Buddhist prayers on paper, each prayer was enshrined in its own wooden pagoda and distributed to temples in the region. This achievement marked the advent of mass production.

Paper came to the Arab world through the silk routes in the middle of the 6th century and was imported from China. The silk routes were trading roads that helped to diffuse goods and ideas between China, Central Asia, India and the Middle East. Papyrus, imported from Egypt, was widely used as a writing tablet in the Arab world. Papyrus is a series of split reeds that have been laid across one another at right angles and then pounded with a mallet to let their natural juices and close contact bind them together. The craft of chinese papermaking was not known by the Arab world until 751 AD when a war was being fought by China and Turkestan. The Chinese lost a battle in Samarrkand and many of their troops were taken as prisoners, among

the captured were papermakers, who showed the Arabs their craft in the hopes of preserving their lives.

Continuing its Journey from east to west, paper emerged in North Africa during the 10th century AD. Until paper was introduced, papyrus was one of Egypt's largest export items. Papermaking was most prevalent in Egypt where linen (flax) was an abundant papermaking source. The Arabs introduced several new techniques, including the standardization of size and color as well as the advent of a wire mesh mould (Turner,14). Paper was introduced to Europe when Spain was conquered by the Moors in the 8th century. As the sphere of Christian influence expanded in Spain, Moorish paper production fell into the hands of European Christians. The first stamping mill was established in Xatvia, Spain in 1100. Stampers were water-powered wooden hammers that beat raw fiber into a pulp. The stamping mill exported the prefabricated pulp to be made into paper elsewhere. There are known paper documents from the 12th century AD that probably originated from Spanish mills. Paper made its way to Italy via Spain with the Crusaders. The first paper mill to be documented was established in Fabriano, Italy in 1268 AD and Cartiere Miliani Fabriano is still in operation today (Rudin, 24).

Making Paper

There are three main types of paper produced today, (1)man-made, (2)machine-made, and (3) mould-made paper. The process and techniques to make individual sheets of paper by hand are basically the same today as they were hundreds of years ago. First, the raw materials are softened and reduced to fiber. This happens by beating or macerating the fiber while suspended in water, beaten fibers are conditioned to intertwine and “felt” with one another creating a pulp. Pulp is made from a variety of plant based fiber. Raw unprocessed fibers such as flax and hemp for example, have a high level of cellulose content which makes them very desirable for papermaking. Most Japanese paper comes from the white inner bark of kozo, mitsumata and gampi plants. Recycled fiber are the traditional fiber material for western papermaking, though very little paper today is made of rags (recycled fiber also refers to paper made out of recycled raw fiber paper) . In the next stage, the soaked fiber are boiled in an alkaline solution to remove all of the non-cellulose material such as starches, fats, and tannins. The treated fiber (pulp) is then poured into a trough of water in an approximate ratio of 90% water 10% pulp. Moulds are used to form the pulp into sheets of paper. There are many different

types of moulds used for making paper, essentially in both eastern and western traditions, the mould is a rectangular frame covered with fine mesh. The inside edge of the frame establishes the size of the sheet of paper. A deckle edge is created where a thin layer of pulp seeps under the frame. Each individual sheet is then laid between a piece of felt. The felt absorbs the excess water when the paper is pressed. The paper is then laid out to dry. Different surface finishes are obtained depending on how the paper was pressed. There are three traditional finishes. Cold pressed paper as I mentioned, is pressed between damp felts, which gives the paper a moderately rough surface. Hot pressed paper is passed through steam rollers and retains a smooth finish. A rough surface is obtained by letting the paper dry in natural air.

Mould-made and machine-made are mechanized versions of the handmade technique. Mould-made paper achieves some of the same characteristics as handmade paper. The preparation of the pulp is similar to that of handmade paper up until the formation of the actual sheet. Instead of using a rectangular mould, the mould is in the form of a cylinder covered with a wire screen that revolves half submerged in a vat of pulp. The cylinder mould picks up the pulp in a continuous layer. The cylinder mould also creates a forced deckle on both sides of the cylinder. The paper then passes through a pressing and drying section which mechanically presses out the water and steam dries the paper before it is rolled into a continuous sheet of a paper. The paper is then divided by hand by either cutting or tearing each individual sheet.

The majority of machines making paper today are based on the design of the of the Fourdrinier machine. The first Fourdrinier was built in 1803 at the Frogmore Mill in Hertfordshire, England and is still in use today. On a classic Fourdrinier, a highly diluted pulp is discharged onto a plastic mould which shakes sideways to create an even distribution of linking fiber. Then, the wet fiber are smoothed by a ‘dandy’ roll and transferred to wet presses that give the surface of the paper a particular texture. Next the wet fiber or web is dried with felts at increasing temperatures and then passed on to cooling cylinders. The paper is than smoothed to achieve a uniform finish. Lastly, the paper is rolled automatically and the cut into various sizes (Turner, 18). Machine-made paper is advantageous for its cost and availability but does not retain stability and aesthetic qualities of mould-made and handmade paper. Newsprint, is an example of machine made paper indispensable in the printmaking studio.

European Developments

In the 12th century AD, European paper was made out of rotted linen, and flax rags rather than raw vegetable material as it was in the east. Most early European paper was linen, made from castoff clothing shredded into rags. Thick and hard papers were found to be best for printing, made from rags that were not as rotted, while thin paper was considered best for writing. Fabriano introduced sizing to the papermaking process, by treating the paper in a gelatin, sharp quill pens could be used without scratching the surface of the paper and letting ink bleed (Turner, 14). Sizing is still used today and makes paper moisture resistant. Fabriano is also responsible for introducing the art of the watermark. Watermarks are created by sewing a formed wire into the mesh of the paper mould, creating a slightly thinner layer that reveals the shape of the watermark when held up to the light. Watermarks were used to identify the paper maker and were first in the forms of circles, crosses and stars and other religious symbols relevant in the 13th century AD. Watermarks are used to identified the quality of the paper; plainer paper is often left without a watermark. Watermarks are helpful to historians in identifying the age and authenticity of a piece of art. The watermark is a European tradition and usually not seen in Eastern made papers.

Papermaking was slow to spread across Europe. Italian paper known for its high quality had a monopoly on the European market. Italian monasteries often took on the task of making paper to be sold at market. The first German papermill belonged to Ulman Stromer in Nuremberg- a converted flour mill that began making paper in 1390 (Hunter, 231). In 1390 Stromer wrote the first manuscript relating to papermaking technique in Europe. The art of papermaking greatly improved in Germany, Experts believe that the quality of German paper used to create Gutenberg's 42-line Bible has never been surpassed (Rudin, 25). Papermaking was considered a trade secret and the first distributed papermaking manuals were not published until the 18th century AD. Papermakers were introduced to the craft as apprentices, but because of the inadequate heat and damp and dim atmosphere of the vat-houses and the intense physical endurance required to mass produce handmade paper, many workers could not make a career out of the craft (Hunter, 245). Handmade paper in the western tradition requires the work of a papermaking triumvirate, First the Vatman scoops the pulp from the vat and forms a piece of paper on the mould, next the Coucher transfers the wet sheet of pulp to a damp felt to be pressed and and give the paper a particular surface. Finally, the Layer removes the wet sheets from the felts and stacks them for further pressing and drawing, the layer is also responsible for removing

defective sheets.

Cotton rags were introduced as a papermaking material in the 17th century AD. New cotton paper surfaces emerged with the advent of etching, engraving and mezzotint printing techniques. In 1720, the French Nationalist, René' Reaumur observed wasps gnawing on wood fence posts and making their nests out of paper-like material. He hypothesized that humans could do the same: turn wood into paper (Hunter, 314). His theory led to other experiments in papermaking materials other than the traditional European cotton, linen and hemp rags. Paper made of woodpulp was first developed in England in the mid-nineteenth century AD, but was refined in the United States where the original inventors secured a patent (Hunter,389-390). Mechanical woodpulp is produced from coniferous trees that still contain lignin, which rejects water and bonding and can contribute to the degradation of paper. Woodpulp is currently the most common fiber for machine-made paper but is almost never used for handmade and mould-made paper. Most western handmade and mould-made papers made today are from cotton, flax, hemp, sisal and jute fiber. Between 1868 and 1912 AD, what is called the Meji period, a variety of machines and woodpulps were introduced to Japan from Europe, though the new techniques and materials proved to be detrimental to the longevity and the beauty of Japanese paper (Barrett,21). Handmaking Japanese paper is still the preferred method today.

Printmaking Paper

Paper has the ability to enhance the character and aesthetic qualities of a printed image. Understanding specific paper qualities is essential to producing quality prints. Paper is susceptible to moisture absorption and can affect the outcome of a print. If the paper is in a moist atmosphere, wavy edges can result. Paper should hang or lay flat in the printing room itself so it can adapt to the temperature and humidity in which it will be printed (Turner, 168).

Wove paper is commonly used for printmaking. Wove paper refers to the mesh covering on the mould. Wove sheets have additional wire woven into the mould which produces an even distribution of pulp and a fine character in the paper (Turner, 28). The wove mould was developed in 1755 when John Baskerville created movable type with fine serifs and required a paper that showed the steep contrast between thin and thick lines . Previously, all European paper was formed on laid moulds, which are wires laid across a frame with widely spaced wires running perpendicular. The lines of the mesh are visible in the finished sheet .

Woodblocks and relief prints with fine detail require a paper with a fine surface. Smooth, thin Japanese papers are ideal for woodblocks because the produce clean, sharp images. Paper used for intaglio techniques are sturdy papers that can withstand the dampening and stretching process required to force the paper into the depressed areas of the metal plate while picking up the fine details of an image (Turner,170).

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