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## Paper Armor, the Forgotten Defense

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A wide variety of materials have been used as armor throughout history. From the earliest use of animal skins to the advent of custom alloys and ceramic plating, man has striven to find ever better means of protecting himself from the weapons of his time. From both an historical and scientific basis many of these materials, particularly iron and steel plating, have been the subject of a great deal of study. Other materials, including leather and cloth have also been similarly if somewhat less thoroughly investigated. One armor material in particular however has remained largely forgotten: paper.

The fact that investigation into the use of paper as an armor material has lagged behind that of other materials is somewhat understandable: unlike armor made of metal, almost no artifacts of paper armor have survived to the present day. While this is in large part due to paper's biodegradable nature, the fact that paper armor saw little widespread use outside of Northeast Asia has contributed to its overall lack of familiarity as an armor material to many modern readers. Many parts of Asia have a well-established history of using paper for a wider number of uses compared to both Europe and North America, including the production of boxes, clothes, rope and even shoes and blankets<sup>1</sup>. Even within Asia however, the advent of paper as an armor material was an unusual choice based upon a rather simple premise: necessity.

### Origins

The history of paper as an armor material can be traced to the latter half of Tang dynasty China (circa 750-907 CE) where Shang Sui-ting purportedly made armor out of paper for civilian use during "times of great peril"<sup>2</sup>. The fact that it was used during times of distress to outfit civilian populations is revealing. The use of paper as an armor material at least during this first recorded instance was an emergency measure, and possibly seen as inferior to normal armor of the day, which typically consisted of iron or leather fashioned into overlapping plates in a scaled configuration<sup>3</sup>.

In fact under siege conditions paper would have had a number of advantages compared to more traditional armor materials. Paper could be cut, folded and sewn into individual scales by almost anyone, and would have required very few tools or skills. Civilians otherwise not contributing to the city defense could be mobilized and put

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<sup>1</sup> TEMPLE 2007: 93.

<sup>2</sup> LAUFER 1914: 292.

<sup>3</sup> DIEN 1981: 19.

them to work making armor and make it faster than specialized workers using traditional materials. The resulting product would not have lasted as long as metal armor but would allow the production of a large amount of armor in a very short amount of time.

Exact dates for when Shang Sui-ting lived have been lost, but imperial records help narrow down the range somewhat: an assay of different armor styles and materials in use during the reign of Emperor Yüan-tsung (713-755 CE) fails to mention paper as an armor material, but does mention several other less common armor materials including wood, silk and layered felt<sup>4</sup>. A later account of Governor Xi Shang (847-894 CE) from the city of He-Dong however specifically mention the presence of one thousand soldiers, all of whom were equipped with “pleated” paper armor yellow in color<sup>5</sup>. When taken together these two sources leave somewhat less than two centuries during which paper armor was invented and gained at least local acceptance for military service.

The exact form of this early armor is difficult to determine, as the term “pleated” is somewhat subject to interpretation: Laufer uses the similar term “folded,” and both terms almost certainly refer to a method of construction rather than a particular style of armor<sup>6</sup>. Of the major armor styles known at the time only two (scale and lamellar) can be readily applied to the terms “folded” or “pleated,” which potentially describes the means by which an individual scale or lamellae was made via the process of accordion-folding a larger strip of paper into a suitable thickness. There are of course also many ways to fold a small “plate” or lamella of paper which result in a stable unit which are not prone to unfolding like a simple accordion-fold<sup>7</sup>.

Given the circumstances under which paper armor was first used supports the argument that paper armor in its original form most likely consisted of individual accordion-folded scales sewn onto a backing, perhaps with each scale additionally sewn closed to help prevent the folds from opening. Additionally, scale construction is generally easier to make compared to lamellar construction as each scale only needed be pierced by two or three holes along the top edge, but suffers from slightly decreased freedom of movement<sup>8</sup>. While the Chinese generally favored lamellar construction, both styles were in continuous use throughout the region (although not necessarily utilizing paper) up through the late 1800's CE<sup>9</sup>. This supposition is further supported by a later reference from 1621 CE which includes an illustration of a coat of paper armor<sup>10</sup>. The accompanying text specifically mentions that scales should be laced to a thick quilted cotton backing clearly establishing but not necessarily limiting production to scale construction for at least some types of paper armor<sup>11</sup>. While the detail noting the yellow color of paper armor is interesting, it is of limited use as this could refer to the use of natural color-shift that can occur in some kinds of paper over time, or that the particular type of paper used had an inherently yellow hue, that

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<sup>4</sup> LAUFER 1914: 292.

<sup>5</sup> DEKKER 2009: 11; TEMPLE 2007: 93.

<sup>6</sup> LAUFER 1914: 292.

<sup>7</sup> HARBIN 1998: 8, 29, 49.

<sup>8</sup> ROBINSON 2002: 6.

<sup>9</sup> ROBINSON 2002: 144.

<sup>10</sup> DEKKER 2009: 11.

<sup>11</sup> YUANYI 1984: 4197-98.

the paper was specifically dyed yellow when made, or even that finished scales were coated or painted in some manner.

The effectiveness of paper as an armor material did not go unnoticed, as 110 suits of paper armor of unspecified style were seized when two pirate vessels were captured by Song Dynasty naval forces<sup>12</sup>. While modern readers may be tempted to focus upon the fact that paper armor would float as being particularly valuable for naval actions, different criteria appear to have been used by Song Dynasty military commanders: Needham relates that records specifically mention that “Heavy armor can only be used on board ships, since soldiers do not walk on muddy fields”<sup>13</sup>.

It should be noted that the military commanders might very well have had a different opinion of what made good shipboard armor compared to pirates. Chinese military ship and boat crews generally consisted of civilians that had been contracted or pressed into service. As such, they were not expected to fight and were not issued weapons or armor<sup>14</sup>. Pirates on the other hand were less likely to have separate non-combatant crew. With everyone on board responsible at least in part for both manning the ship and fighting, the issuance of armor light enough to climb, and handle rigging in to crew members would have made sense if paper armor was available. Over time the use of paper as an armor material gained in popularity in Ming Dynasty China, although it never supplanted the primacy of metal construction. Records indicate that garrisons in Shanxi province commissioned orders for thirty thousand suits of paper armor in the year 1040 CE<sup>15</sup>.

## Technological Evolution

The use of paper as an armor material also spread to a number of other countries, most notably Choson Dynasty Korea. Court records show that paper armor already existed in Korea by the year 1406 CE, which is described as “made by folding papers and tying them together with buckskin (thongs)”<sup>16</sup>. The specific reference of tying paper together rather than sewing them onto a backing also provides the first evidence specifically pointing to lamellar construction. Compared to scale armor, lamellar construction offers a greater freedom of movement to the wearer and takes little skill to create, but the process of lacing the lamellae into a jerkin or coat is somewhat time-consuming<sup>17</sup>. Additionally, paper lamellae would likely require the additional step of gluing the various layers of paper together.

Scale construction specifically for paper armor may also have spread to Korea, as a court record from 1454 CE calls for the replacement of deerskin armor with “leaf” armor made from paper<sup>18</sup>. While this implies a scale construction, other sources from Korea tend to imply either lamellar or quilted construction. As both lamellar and scale

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<sup>12</sup> NEEDHAM 1985: 114; TEMPLE 2007: 94.

<sup>13</sup> NEEDHAM 1985: 115.

<sup>14</sup> HASKEW et al. 2008: 218-219.

<sup>15</sup> LAUFER 1914: 292.

<sup>16</sup> Annals of the Choson Dynasty. 14 July 1406, first entry.

[http://sillok.history.go.kr/id/kca\\_10607014\\_001](http://sillok.history.go.kr/id/kca_10607014_001), accessed 4 January 2018.

<sup>17</sup> ROBINSON 2002: 7.

<sup>18</sup> Annals of the Choson Dynasty. 27 March 1454, second entry.

[http://sillok.history.go.kr/id/kfa\\_10203027\\_002](http://sillok.history.go.kr/id/kfa_10203027_002), accessed 24 December 2017.

construction methods do strongly resemble each other, making the use of scale construction somewhat unclear as both styles of styles were known and used in both countries<sup>19</sup>.

Records from roughly the same period of Korea include a materials list needed to make 120 suits of paper armor<sup>20</sup>. The list includes both new and recycled paper for the construction of lamellae, resin varnish, and lacquer for coating and/or laminating individual lamella and cotton for both “threading” and “tying.” An examination of this materials list reveals that a single suit of paper armor required 5.1 kilograms of paper, 5.38 liters of varnish, and 1.08 liters of lacquer. From this list it is possible to work backwards and arrive at an estimated lamella thickness.

Key to any such efforts to identify lamellae thickness is the identification of the type of paper used – information not directly included in historical references. Careful examination of source material however provides four important clues: that the paper used was made of mulberry wood pulp, that it was used in book production in fifteenth century CE Korea, that recycled books were a major source of paper for armor production, and that the paper in question could be split into different thicknesses<sup>21</sup>.

Interviews with a craft design professors and artisans with a specialty in historical paper production in Korea identified a style of paper that fits all of the above criteria: *eumyangji*<sup>22</sup>. This particular paper is made of mulberry pulp, was used for book production throughout the Choson Dynasty, and if not calendered (a smoothing processes, accomplished either via heavy rollers or pounding), can be separated into separate thicknesses<sup>23</sup>. Direct measurement of samples indicates that *eumyangji* has a density of 48.5 grams per square meter, and (calendered) is 0.1 millimeters thick<sup>24</sup>. It should be noted that without artifacts to compare against the identification of *eumyangji* remains tentative, but for the time being date remains the most likely candidate for the construction of paper armor within Choson Dynasty Korea.

With figures for both density and thickness along with the knowledge that one suit of armor used 5.1 kilograms of paper an estimated lamella thickness can be derived. Militia recruits of the first half of the Choson Dynasty averaged between 164-166 centimeters in height<sup>25</sup>. As Korean lamellar, scale and coat of plates armor often came down to the knee, and had sleeves coming to the elbow, this amount of coverage would equate to lamellae of between 5-6 millimeters in thickness, significantly thicker (but still lighter) than metal lamellae artifacts<sup>26</sup>. This style of lamellar armor made of paper was later specifically chosen to greet Ming Dynasty

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<sup>19</sup> ROBINSON 2002: 10; HONG 2000: 123-124.

<sup>20</sup> MIN 2007: 343.

<sup>21</sup> YUM 2010: 8-9; ROCKHILL 1905: 25; HIEBERT 2000: 4; GRIFFIS 1904: 153; Annals of the Choson Dynasty. 27 December 1424, second entry. [http://sillok.history.go.kr/id/kda\\_10612027\\_002](http://sillok.history.go.kr/id/kda_10612027_002), accessed 30 December 2017; Annals of the Choson Dynasty. 26 October 1489, first entry. [http://sillok.history.go.kr/id/kia\\_12010026\\_001](http://sillok.history.go.kr/id/kia_12010026_001), accessed 15 December 2017.

<sup>22</sup> Personal interviews by the author with Ji-Eun Kim (17 July 2010) and Tae-Bok Kim (21 August 2010).

<sup>23</sup> RUDIN 1992: 3; SONG, MUNN 2004: 127.

<sup>24</sup> RANDALL 2010: 27.

<sup>25</sup> JUN et al. 2017: 109; PAK 2011: 192.

<sup>26</sup> BOOTS 1934: 31; DIEN 2000: 3; HONG 2000: 124; FAIRBANKS, FAIRBANKS 2005: 108, 110-115; Plastic Lamellar. Suit Builder. <http://www.plasticlamellar.com/suit-builder.html>, accessed 5 January 2018.

envoys in the year 1450 CE, where records state that paper armor was either multicolored or came in a variety of colors, including red, yellow, blue, white, and black, with the express purpose of presenting a display that would “seduce the enemy”<sup>27</sup>.

During the same year paper armor is first recorded in Choson Korea (1406 CE), a new form of paper armor was introduced by a courier, most likely from Ming China, where it was already in use<sup>28</sup>. This new style of paper armor was constructed not of scales or lamellae, but as a quilted vest<sup>29</sup>. Prior to assembly the paper was first soaked in salt water and allowed to dry prior to being finished with an inner and outer layer of either hemp or cotton cloth<sup>30</sup>. With no sleeves and coming only down to the waist this new style, at least in Choson Korea, was “sewed into a wad of ten to fifteen thicknesses;” significantly thinner than the author’s estimate of lamellae thickness based upon recorded materials lists<sup>31</sup>. This same style of armor constructed in China however was thicker and sometime prior to the nineteenth century evolved into a hybrid design using alternating layers of “calico and paper” approximately 30 layers thick<sup>32</sup>. It should be noted that construction details of this hybrid quilted paper/cloth armor could vary, as sources note that a famous bandit wore armor of double thickness, or sixty layers of alternating cloth and paper<sup>33</sup>.

Records for the use of paper as body armor in Japan are far scarcer, but at least two examples of breastplates made from papier-mâché are documented<sup>34</sup>. It remains unknown if these were meant for actual use. The matter is further confused by the fact that *kendo*, or Japanese style fencing also utilizes breastplates. In the modern day better quality *kendo dō*, or breastplates, are made from steam-bent bamboo covered with lacquered deer hide, but entry level equipment uses pressed wood fiber – paper<sup>35</sup>. While the point at which paper came into use for *kendo dō* remains unknown its addition to the armor used as a part of Japanese fencing occurred sometime between 1765-1770 CE<sup>36</sup>. Sadly, it is not known if the above mentioned breastplates still exist, making existing materials lists and construction details all the more valuable.

Although less common, *jingasa* (literally camp, or military hat) were also at times made from paper during the Edo period (1603-1868)<sup>37</sup>. Worn most often by infantry, the *jingasa* was typically broad and slightly conical and while typically made of leather or iron, sometimes also utilized laminated paper<sup>38</sup>. While the *jingasa* had a broad brim unlike earlier helm styles, it lacked any form of neck protection<sup>39</sup>.

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<sup>27</sup> Annals of the Choson Dynasty. 15 January 1450, first entry.

[http://sillok.history.go.kr/id/kda\\_13201015\\_001](http://sillok.history.go.kr/id/kda_13201015_001), accessed 7 January 2018.

<sup>28</sup> LAUFER 1914: 292.

<sup>29</sup> MIN 2007: 342.

<sup>30</sup> MIN 2007: 343.

<sup>31</sup> GRIFFIS 1904: 153; BOOTS 1934: 31; MIN 2007: 343.

<sup>32</sup> DEKKER 2009: 12.

<sup>33</sup> DEKKER 2009: 12.

<sup>34</sup> EGERTON 1896: 167.

<sup>35</sup> TOKESHI 2003: 49; Kendo Guide. Kendo Equipment. [http://www.kendo-guide.com/kendo\\_equipment.html](http://www.kendo-guide.com/kendo_equipment.html), accessed 16 January 2018.

<sup>36</sup> SASAMORI, WARNER 1964: 54.

<sup>37</sup> MASAHARU 2000: 33.

<sup>38</sup> Arts of the Samurai. *Jingasa*. <http://www.artsofthesamurai.com/>, accessed 12 January 2018.

<sup>39</sup> HASKEW et al. 2008: 41.

The decision to create an all paper war hat or helm may have been linked to the earlier *kawari-kabuto* (strange helm) style that featured papier-mâché built up over a frame of wood or split bamboo to create elaborate helm decorations<sup>40</sup>. European helms also used papier-mâché decoratively in the form of lightweight helm finials, but never utilized paper as a primary armor material<sup>41</sup>.

Unlike body armor described earlier, at least one example of a *jingasa* made from paper has survived to the modern day<sup>42</sup>. The war hat in question was bequeathed to the Metropolitan Museum of Art in 1935 CE by Mr. George Stone, and most likely dates to the late 18<sup>th</sup> or early 19<sup>th</sup> century CE. While thickness is somewhat difficult to determine, the *jingasa* does not appear to be exceptionally thick, and is no more than five millimeters at the rim, which is usually rolled or trimmed such that it is thicker than the helm body<sup>43</sup>. This would make the body of the *jingasa* approximately three millimeters thick. While some paper *jingasa*, including the example at the Met, were quite richly made, most were rather simple, and would have been owned by, or provided to, common infantry soldiers<sup>44</sup>.

A source from 1703 also indicates that the use of paper as a form of armor was also used among several groups in Central Asia, including the Kyrgyz, which was used while mounted<sup>45</sup>. While no known artifacts remain, descriptions indicate that it was of quilted construction, similar to that used in Korea and that a similar style was further used in Mongolia during the 1600's, but also used by the Tubans and Altyrians among other central Asian tribes<sup>46</sup>. Unlike the style used by the Kyrgyz, Ming China and Choson Korea however the Mongolian construction purportedly differed in that it did not utilize inner and outer linings of cloth but instead may have been covered with plates perhaps in a scale construction<sup>47</sup>. Mikhailov speculates that this outer cloth lining was meant in part to disguise the armor to appear more innocuous, but as similar construction was both known and utilized in Ming Choson by the military this is uncertain.

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<sup>40</sup> SINCLAIRE 2004: 32.

<sup>41</sup> BREIDING The Decorations of Arms and Armor.

[https://www.metmuseum.org/toah/hd/decaa/hd\\_decaa.htm](https://www.metmuseum.org/toah/hd/decaa/hd_decaa.htm), accessed 8 January 2018.

<sup>42</sup> The Met Collections. War Hat (Jingasa) with Storage Bag.

[http://www.metmuseum.org/Works\\_of\\_Art/collection\\_database/arms\\_and\\_armor/a\\_jingasa\\_war\\_hat\\_b\\_storage\\_bag/objectview.aspx?OID=40002305&collID=4&dd1=4](http://www.metmuseum.org/Works_of_Art/collection_database/arms_and_armor/a_jingasa_war_hat_b_storage_bag/objectview.aspx?OID=40002305&collID=4&dd1=4), accessed 6 January 2018.

<sup>43</sup> CLAIRE H. Hat (Jingasa). <https://www.flickr.com/photos/unforth/2556740598/in/photolist-4TVXUs>, accessed 9 January 2018.

<sup>44</sup> HASKEW et al. 2008: 41.

<sup>45</sup> НАГОРНЫЙ et al. 2016: 562.

<sup>46</sup> MIN 2007: 342; СОЕНОВА, ОЙНОШЕВА 2005: 108, 385.

<sup>47</sup> БОБРОВ, ХУДЯКОВ 2008: 38.



Fig. 1. Interior damage, Papier Mache Shield, Ahmedabad India ca. 1867, Victoria and Albert Museum.



Fig. 2. Papier Mache Shield, lacquered and gilt, Ahmedabad India, 19<sup>th</sup> century, Victoria and Albert Museum.



Fig. 3. Papier Mache Shield, Karauli India, 19<sup>th</sup> century (front), Victoria and Albert Museum.



Fig. 4. Same shield as shown above (back). Note double handles and cushioning for hand, Victoria and Albert Museum.



Fig. 5. Papier Mache Shield, Bikaner India, Undated (likely 19<sup>th</sup> century), Front, Victoria and Albert Museum.



Fig. 6. Papier Mache Shield, Bikaner India, Undated (likely 19<sup>th</sup> century), Back. Note double handles and fabric hand cushion, Victoria and Albert Museum.



Fig. 7. Same shield as above (front). Foliage motif in done lacquer, Victoria and Albert Museum.



Fig. 8. Same shield as above (front), close up of decorative pattern, Victoria and Albert Museum.

Testing by the author indicates that while an unsealed, quilted pad of paper can indeed be protective, it would be far more durable against both abrasion and the elements when covered by a layer of cloth<sup>48</sup>. While an initial date of transmission to Central Asia remains uncertain, trade of paper to the region predates the 1703 source by nearly two millennia<sup>49</sup>. Given the transmission of quilted armor construction to from Ming China to Choson Korea, if not independently developed by Central Asian nomadic tribes the spread of quilted paper armor spread westward most likely occurred sometime between 1400 and 1650 C.E.

Finally, several paper artifacts have also survived in India and Iran in the form of *dahl*, or double-handled, single-grip shields<sup>50</sup>. Originally part of Lord Egerton of Tatton's catalogue of Indian military artifacts, the published descriptions outline shield diameter, color and styling but lack information on item weight, thickness, and type of paper used<sup>51</sup>. Egerton goes on to mention that such shields were in common use during the 19<sup>th</sup> century CE in both the Punjab and the Presidency of Bombay regions<sup>52</sup>. The shields apparently remained on permanent loan at the South Kensington Museum, and are part of the Victoria and Albert family of museums in London<sup>53</sup>. Modern measurements made by the curators at the Victoria and Albert museum lend credence that the shields are the same as those described in the Egerton catalogue, and vary from between 43~52cm in diameter, 4~6cm thick (not including boss height) and between 3~7mm in thickness at the rim. A sixth shield, also at the Victoria and Albert museum (Museum No. IM.226-1922) is alternatively described as being made of paper or hide making a precise determination of construction impossible at this time<sup>54</sup>. Only one of the paper shields (Museum No. 798-1869) is on display. It is also currently the only known paper shield to which photographs are available<sup>55</sup>. While paper shields were produced domestically in several locations within India, either local production was either unable to keep up with demand or lower prices were available elsewhere, as the Dutch East India Company ordered lacquered shields made in Japan to be shipped to India starting in the year 1656 CE<sup>56</sup>.

Further corroboration for the use of paper for shields can also be found as a general description of shields and shield materials rather than a listing of artifacts. Chodyński describes "shields from Persia and the Moghul (Empire)" as being between 35 and 60cm in diameter, and made of *bulat* (steel containing trace amounts of cementite), leather and papier-mâché from the seventeenth to nineteenth centuries CE<sup>57</sup>. While "Moghul" can essentially stand in for "India," the inclusion of Persia

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<sup>48</sup> СОЕНОБА, ОЙНОШЕБА 2005: 108; RANDALL 2010: 72-73.

<sup>49</sup> HARMATTA 1994: 226; HUANG 1948: plates 23-25.

<sup>50</sup> EGERTON 1896: 111, 112, 139 and 167.

<sup>51</sup> EGERTON 1896: 111, 112, 139.

<sup>52</sup> EGERTON 1896: 68.

<sup>53</sup> V&A Collections. Search Values "papier, shield".

<http://collections.vam.ac.uk/search/?limit=15&narrow=1&q=shield%2C+papier&commit=Search&collection%5B%5D=THES48598&offset=0&slug=0>, accessed 14 January 2018.

<sup>54</sup> V&A Collections. IM.226.122. <http://collections.vam.ac.uk/item/O40317/shield-unknown/>, accessed 14 January 2018.

<sup>55</sup> V&A Collections. 798-1869. <http://collections.vam.ac.uk/item/O482061/shield-unknown/>, accessed 14 January 2018.

<sup>56</sup> ELGOOD 2004: 262.

<sup>57</sup> CHODYŃSKI 2000: 70.

indicates that that the use of paper laminate shields expanded westward to include at least part of what is now present day Iran. Chodyński's work also provides rough dates which can potentially be applied to the shield's described in Egerton's work and correlate with the shipment dates of Japanese shield orders detailed by Elgood<sup>58</sup>.

### Effectiveness

Ironically while several sources describe the effectiveness of body armor made of paper, no known records remain describing the effectiveness of paper for those styles where artifacts still exist (*jingasa*, a *chanfron* and *dhal*). With regard to body armor, both lamellar and scale armor were described as being proof against puncture from “even heavy arrows”<sup>59</sup>. The effectiveness of paper armor of quilted dates to the 19<sup>th</sup> century CE, and is described as being able to “resist a musket ball but not a rifle bullet”<sup>60</sup>. Another reference shows that while effective, quilted armor made of paper was not impregnable defense as a suit of paper armor was pierced by spear when several individuals stormed a prison and freed the prisoners inside<sup>61</sup>. This effectiveness could however be improved if additional layers were used, as the previously described double thick armor made of 60 alternating layers of cloth and paper purportedly made the wearer “practically invulnerable”<sup>62</sup>.

Physical testing during the modern day has been limited, but revealing<sup>63</sup>. The author performed physical testing against a number of samples of different materials of both laminate and non-laminate (folded) construction<sup>64</sup>. Each sample was 5 millimeters thick, and testing covered 40# white copy paper, 40# kraft paper, *eumyangji*, and traditional Korean hemp paper. Test results showed that folded samples were damaged but not penetrated by draw cuts<sup>65</sup>. Laminate samples were impervious to draw cuts, and cracked against chopping cuts but would have protected the wearer. Neither laminate nor folded samples of any of the tested materials presented an effective defense against spear thrusts or arrows with pyramidal points designed to penetrate armor. As sample thickness did not take into account overlap which typically occurs with both lamellar and scale armor however, further testing desirable<sup>66</sup>. Overall, paper armor would have provided useful, but likely disposable outer layer of armor that would benefit from the addition of a padded gambeson as an under layer, sentiments echoed by Mao Yüan-I in 1629 CE<sup>67</sup>.

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<sup>58</sup> Further study of Russian, Japanese, and Indian source material is recommended, as is an examination the Dutch East India Trading Company archives.

<sup>59</sup> DEKKER 2009: 11.

<sup>60</sup> GRIFFIS 1904: 153.

<sup>61</sup> Annals of the Chosun Dynasty. 6 June 1869, first entry. [http://sillok.history.go.kr/id/kza\\_10606006\\_001](http://sillok.history.go.kr/id/kza_10606006_001), accessed 16 January 2018.

<sup>62</sup> DEKKER 2009: 12.

<sup>63</sup> Mythbusters Discovery Communications. MythBusters 2011 Episode List.

<http://www.discovery.com/tv-shows/mythbusters/2011-episodes/>, accessed 14 January 2018.

While the episode brought to topic to a wider audience, the testing itself contained a number of significant flaws.

<sup>64</sup> RANDALL 2010: 43.

<sup>65</sup> RANDALL 2010: 87.

<sup>66</sup> RANDALL 2010: 88-89; BUGARSKI 2005: 165.

<sup>67</sup> TEMPLE 2007: 94.

Opinions at the command level on the relative merits and drawback of paper armor in both Korea and China were somewhat mixed. The first such record begins inauspiciously with criticisms: naval commanders complained that paper armor was susceptible to rot, not colorfast, was difficult to make, and was generally “useless”<sup>68</sup>. Certainly if not properly sealed (and possibly re-sealed with some regularity) paper armor would be subject to mold and/or rot. The possibility also exists that the paper scales themselves remained intact and that the lacing was subject to rot, a problem that was noted in several styles of contemporary Japanese armor<sup>69</sup>. The use of paper armor under the damp, humid conditions typically seen in naval service would have provided ample opportunity for rot to set in. Small scale testing done by the author found that on the scales themselves the inside edges of the lamellae holes are subject to the greatest amount of wear. It is also the most time consuming portion to ensure adequate coverage with either varnish or lacquer. As such, the inside of the lacing holes would have been both the easiest and most likely place for rot to start.

Chinese commanders may have held similar opinions, for when ten thousand Korean troops wearing “paper armor and wicker breastplates” assembled as part of Liu T'ung's forces in 1618 CE, they were criticized as being “ill equipped”<sup>70</sup>. This opinion was never proven, as T'ung was tricked into splitting from the main bulk of his troops and killed in an ambush. The Korean force never engaged the enemy and returned home<sup>71</sup>.

In contrast after the Imjin War, King Injo (1623-1649 CE) oversaw a general strengthening of military power in Korea. As a part of his efforts, he decreed that the military increase production of paper and fabric armor<sup>72</sup>. The same decree goes on to state that both fabric and paper armor provided an effective defense against arrows<sup>73</sup>. Less than a month later, court records mention paper armor again, extolling its virtues over metal armor including its light weight and ease of production<sup>74</sup>. Also noted was the usefulness of paper armor in cold weather, as it was able to provide insulation as well as physical protection<sup>75</sup>. A year later a shortage in military supplies was noted, resulting in the requisition of 400 suits of paper armor<sup>76</sup>. Along similar lines, Central Asian sources report that paper armor of quilted construction “could not be pierced by arrows”<sup>77</sup>.

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<sup>68</sup> Annals of the Choson Dynasty. 14 July 1406, first entry.  
[http://sillok.history.go.kr/id/kca\\_10607014\\_001](http://sillok.history.go.kr/id/kca_10607014_001), accessed 4 January 2018.

<sup>69</sup> SINCLAIRE 2004: 30.

<sup>70</sup> GOODRICH, FANG 1976: 967-968.

<sup>71</sup> GOODRICH, FANG 1976: 968.

<sup>72</sup> Annals of the Choson Dynasty. 12 May 1627, second entry.

[http://sillok.history.go.kr/id/kpa\\_10505012\\_002](http://sillok.history.go.kr/id/kpa_10505012_002), accessed 10 January 2018.

<sup>73</sup> Annals of the Choson Dynasty. 12 May 1627, second entry.

[http://sillok.history.go.kr/id/kpa\\_10505012\\_002](http://sillok.history.go.kr/id/kpa_10505012_002), accessed 10 January 2018.

<sup>74</sup> Annals of the Choson Dynasty. 10 June 1627, second entry.

[http://sillok.history.go.kr/id/kpa\\_10506010\\_002](http://sillok.history.go.kr/id/kpa_10506010_002), accessed 11 January 2018.

<sup>75</sup> Annals of the Choson Dynasty. 10 June 1627, second entry.

[http://sillok.history.go.kr/id/kpa\\_10506010\\_002](http://sillok.history.go.kr/id/kpa_10506010_002), accessed 11 January 2018.

<sup>76</sup> Annals of the Choson Dynasty. 14 September 1628, fourth entry.

[http://sillok.history.go.kr/id/kpa\\_10609014\\_004](http://sillok.history.go.kr/id/kpa_10609014_004), accessed 6 December 2017.

<sup>77</sup> БОБРОВ, ХУДЯКОВ 2008: 410.

## Cost

In 1539 CE, sources first mention of the cost of paper armor, with Korean court records indicating that a single suit of paper armor (of unspecified construction) was priced at one *dong*. Fortuitously the very next record on the same day cross references the value of a *dong* to a common trade good and a service equivalent to fifty rolls of hemp cloth (a common trade good in Choson Korea), which is also the price needed to borrow (but not purchase) a horse<sup>78</sup>. The same record shows that problems in rot and/or mold had yet to be completely solved, as the inspections specifically mention checking for both issues<sup>79</sup>. Later records indicate that paper armor (most likely of quilted construction) was relatively cheap in terms of both materials and labor when compared to metal armor but do not provide any form of direct pricing or exact comparison<sup>80</sup>. To date, no sources have been found regarding the pricing of either *jingasa* or *dahl*, but further research into records of the Dutch East India Company may be worthy of investigation.

Within Central Asia the use of padded and/or quilted armor, including that of paper construction, were much less expensive than armor of metal construction while still providing a useful amount of protection. With the cost of an individual set of “elite” armor reaching 10 rubles, soldiers from South Siberia (who could perhaps not afford more expensive metal armor) used padded or quilted armor made of cloth and/or paper to great effect<sup>81</sup>. Sadly, so known sources outline the exact cost of these padded garments other than to indicate that they presented a less expensive option, a case which was likely also true in both China and Korea as well.

## Conclusions

While the notion of using paper as an armor material may be surprising to some, it was in fact used in one form or another from approximately 850CE to 1900CE across a region stretching from Japan in the East to Persia in the West. Additionally, although it never fully supplanted more “traditional” armor materials such as cloth, leather, or metal, it remained a low-cost alternative by a number of cultures for occasional use. Originating in what was most likely a form of scale armor, in time paper was utilized in a variety of armor styles, including scale, lamellar and quilted construction as well as being developed into shields and as fletching for crossbow bolts<sup>82</sup>. That this unique technological development has largely been forgotten can be attributed to the extremely small number of surviving artifacts coupled with the fact

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<sup>78</sup> Annals of the Choson Dynasty. 30 January 1539a, first entry.

[http://sillok.history.go.kr/id/kka\\_13401030\\_001](http://sillok.history.go.kr/id/kka_13401030_001), accessed 2 December 2018; Annals of the Choson Dynasty. 30 January 1539b, second entry. [http://sillok.history.go.kr/id/kka\\_13401030\\_002](http://sillok.history.go.kr/id/kka_13401030_002), accessed 2 December 2018.

<sup>79</sup> Annals of the Choson Dynasty. 30 January 1539b, second entry.

[http://sillok.history.go.kr/id/kka\\_13401030\\_002](http://sillok.history.go.kr/id/kka_13401030_002), accessed 2 December 2018.

<sup>80</sup> Annals of the Choson Dynasty. 10 June 1627, second entry.

[http://sillok.history.go.kr/id/kpa\\_10506010\\_002](http://sillok.history.go.kr/id/kpa_10506010_002), accessed 11 January 2018.

<sup>81</sup> БОБРОВ, ХУДЯКОВ 2008: 641.

<sup>82</sup> NICOLLE 1999: 181.

that paper never became the primary armor material for any given culture at any time in history.

Although paper armor appears to have been first created as an emergency measure in time of stress, the fact that paper armor continued to exist across such a large geographic area for more than a millennium is testament to its functionality. In contrast with this is the fact that paper never supplanted the use of cloth, leather or metal at any place or time during its existence. Viewed in tandem, these two observations provide a great deal of insight into the use of paper as armor. In its favor, paper provided a low-cost lightweight material that could be fashioned into a variety of shapes and forms by essentially unskilled labor and was particularly well suited to cold weather<sup>83</sup>. Depending on the exact method of construction, this meant that paper could be converted to individual scales or lamellae *en mass* by the inhabitants of a city under siege. Additionally, the creation of armor from paper allowed the production of armor without diverting critical materials such as metal needed for the production of weapons, thereby utilizing what otherwise would potentially be an overlooked resource.

Particularly in times of peril, the division of labor across a broad section of the population would have likely been necessary: experiments by the author indicate that the creation of such lamellae is quite easy, but surprisingly time consuming. Again, estimates by the author suggest that creation of sufficient unglued lamellae of 4cm by 6cm in size to create a single knee-length suit of armor would require approximately 60 hours of labor. This figure does not include the time needed to ream, punch or drill the holes needed to affix the lamellae to a backing or each other, nor does it include time required for lacing. The addition of these additional steps would likely put the total number of hours needed to 100 or more, depending on scale size and whether scale or lamellar construction was used. With further additional time, these lamellae could further be glued into solid pieces and given some degree of protection against both wear and weather through the use of paste, and varnish and/or lacquer. Quilted construction could possibly be faster, but testing has yet to be done on this point.

These advantages of low cost and the possibility of unskilled production were however balanced by a relative lack of durability. Lamellae would need to be sealed if armor was to see extended use, and even then sources indicate that properly varnished and lacquered lamellae were subject to both mildew and rot over time<sup>84</sup>. The result can be seen in the historical record: a number of cultures used paper in different forms of armor – but most typically on a secondary or supplementary basis. Overall, the level of protection provided by paper armor clearly did not provide the greatest possible protection, or else it would have become more common. Paper armor did however provide sufficient defense to be useful, and could be produced faster, and in significantly larger quantities at less cost utilizing unskilled labor, making it well suited for emergency use.

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<sup>83</sup> Annals of the Choson Dynasty. 10 June 1627, second entry.  
[http://sillok.history.go.kr/id/kpa\\_10506010\\_002](http://sillok.history.go.kr/id/kpa_10506010_002), accessed 11 January 2018.

<sup>84</sup> Annals of the Choson Dynasty. 30 January 1539b, second entry.  
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### Summary

#### Paper Armor, the Forgotten Defense

This paper investigates the history and construction of paper armor, tracing its roots from Tang dynasty China, across Asia and India and into Western Europe. Source material is examined in detail to provide clues as to paper's first use in armor, how its construction style evolved, its migration, and effectiveness against period weapons from its point of origin through nineteenth century. While paper armor was by no means invulnerable, provided an inexpensive defense against swords, arrows, spears and even muskets for over a thousand years.

**Keywords:** Paper, Armor, Shield, Military, Scale, Lamellar, History, Asia