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Discoveries Made while Preserving the Star-Spangled Banner

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Abstract

Citizens of the United States of America choose to imbue their national symbol with special significance, especially those flags associated with history-making events, such as the Battle of Baltimore. We who are charged with caring for the Star-Spangled Banner have to recognize not just its uniqueness but how it fits into the tradition of flag-making, and we need to recover as much of its history as possible. We look to solve the puzzle of the artifact's identity, to rediscover what has been lost. Before any course of treatment can begin, careful examination of the artifact must be undertaken. In the course of nearly nine years of observation and treatment, we have assembled file drawers of technical reports, 4,000 images—including detailed images, even three-dimensional microscopic images—and undertaken structural and chemical analyses which provided insight into the breakdown of the protein, the type of wool used, the dye materials. Yet we have many unanswered questions. Ultimately, we need to conserve and preserve the flag so that future researchers using new technologies and insights might discover even more about this unique artifact. This paper attempts to share some of the information we have gathered along the way.

The Star-Spangled Banner

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1. INTRODUCTION

The Star-Spangled Banner, (Figure 1) the flag that inspired the American National Anthem, is approaching its 200th birthday. It was the garrison flag for Fort McHenry, which guarded the harbor entrance to the city of Baltimore, Maryland, during the War of 1812. While large (30 feet by 42 feet), it was not excessively so for a garrison flag of that era. At a cost of over four hundred dollars, it was one of the most expensive pieces of equipment at the fort.[1] Baltimore has always taken great pride in its association with the Star-Spangled Banner—both the flag and the National Anthem—and to recognize this, Fort McHenry was given permission by the U.S. Congress to fly the flag continually, often flying a full-scale replica of the historic flag.

Figure 1. Composite photograph, assembled from individual modern images

[1] For comparison, it is likely that the house that its creator, Mary Pickersgill, lived in cost about $1,500 at the time.

1.1 THE OUTBREAK OF THE WAR OF 1812

After years of embargoes[2] and protests to the British crown, the United States declared war on Great Britain on 18 June 1812, seeking to halt the impressments of Americans by the British Navy, establish free trade,[3] and secure recognition of the independence of the United States.[4] While citizens elsewhere may have been conflicted, the citizens of Baltimore enthusiastically supported the war.[5] By October 1812, Baltimore had sent 42 privateers and letters-of-marque to sea to harass and impede British trade,[6] causing the citizens of Baltimore to prepare for an attack that they felt was imminent. The defense of the port of Baltimore was placed in the hands of Gen. Samuel Smith and he sent the Maryland militia to garrison Fort McHenry. At the outbreak of the war, Fort McHenry was in no condition to defend Baltimore. Col. J. G. Swift, of the U.S. Engineers, strengthened the surrounding defenses and Col. Wadsworth, of the U.S. Ordnance Department, placed the guns from the abandoned French frigate *L'Eole* at Fort McHenry[7] and built nearby Fort Covington.

In March 1813, a squadron of ten armed vessels under the command of Admiral Cockburn blockaded the eastern seaboard of the United States except for Massachusetts, New Hampshire, and Rhode Island. The British forces succeeded in cutting off all sea trade to the city of Baltimore.[8] The raids on towns along the Chesapeake Bay were particularly harsh; the British forces plundered and destroyed all they encountered

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[2] Madison imposed embargoes beginning in 1805, which he hoped would "force all nations having colonies in this quarter of the globe to respect our rights". A partial non-importation law in 1806, an embargo in 1807, and a non-importation law of 1811 (which prohibited all British-made goods and all goods from the British Empire) followed. Restrictive measures included the "Enforcement Act of 1809 which gave customs officials broad authority to search and to seize property and permitted the routine use of the army, navy, and militia". By 1813, there was slack enforcement of the trade restrictions until October 1814, when Alexander Dallas became secretary of the treasury and pushed forward the strongest trade restriction of the war, the Enemy Trade Act of 1815. (Hickey, pp. 518–19).

[3] Both France and Britain sought to control trade while maintaining their supply chain during the Napoleonic Wars. Guernsey states, "The English war vessels about the American coast and the West Indies were for the purpose of protecting English commerce, and aiding in the obtaining of food supplies for the army in Spain. This was done mainly by means of licenses from British consuls (authorized by orders in council) to permit vessels of all nations to carry certain specified articles to certain ports in Europe. This prevented neutral trade, as now recognized by the law of nations. The British war vessels did not molest any vessel having a license. p. 83.

[4] There are some who argue that the intent was to annex Canada. Dr. Samuel L. Mitchell, a member of Congress from New York City, addressed members of the Tammany Society of New York, asking them if they were prepared to abandon the fruitful maritime pursuits in exchange for the frozen regions of Canada. They promptly replied that the nation's honor must be sustained. Anti-war sentiments, motivated in part by loss of trade and commerce, resulted in a petition against the war, urging that the embargo on American shipping enacted on 4 April 1812 for ninety days, be continued, and claiming "that a continuation of the restrictive measures (non-importation laws) now in operation will produce all the benefits while it would prevent the calamities of a war." The war bill had already passed the House. (Guernsey, pp. 16–17).

[5] Scharf, p. 84; Guernsey says a riot erupted in Baltimore directed against an editor who was opposed to the war. (p. 24) The war was not as popular in other large seaports; much anti-war sentiment existed among the merchants and bankers of New York City. The impact on shipping of the Act of Embargo and the Orders of Council in Baltimore may have reduced their support for the war.

[6] Scharf writes, "these 'skimmers of the seas' were the great thorns in the side of the enemy, and harassed and annoyed them in every quarter of the globe, and even at the entrance of their own ports in old England itself. They took and destroyed millions of property, and were, beyond all doubt, chief instruments in bringing about a permanent peace." p. 85.

[7] Schraf, p. 85.

[8] "The total annihilation of trade, which threw out of employment all classes of mechanics, and the exorbitant price of most of the necessaries of life, compelled a great number of worthy people to choose between emigration or dependence on charity." (Schraf, p. 86).

on both sides of the bay.[9] By the 16th of April, Cockburn's fleet was at the mouth of the Patapsco River, threatening Baltimore. Watch stations were set up and plans were made to sink old hulls in the channel to block access to Baltimore.

Fort McHenry had been provisioned by the Committee of Public Supply.[10] When Major George Armistead, U. S. Army, was sent to Fort McHenry in June 1813, the fort became a regular army posting. As part of equipping the fort, and under threat of attack, Armistead needed a national flag. The Star-Spangled Banner was commissioned through regular military supply channels.[11] General John S. Stricker and Commodore Joshua Barney ordered two flags[12] from Mary Pickersgill, a well-known flag maker in Baltimore. While the British harassment of the settlements in the Chesapeake Bay continued, Pickersgill assembled the flags in about 10 weeks, probably with the help of her daughter Caroline[13] and her nieces,[14] and an indentured servant, Grace Wisher.[15] Rebecca Young, Mary's mother, also a professional flag maker, was living in the household at the time and may have helped with its manufacture.[16] The flag was put into use very soon after its delivery to Fort McHenry.

1.2 THE BATTLE OF BALTIMORE

The defeat of Napoleon in the spring of 1814 allowed Great Britain to concentrate again on action against the United States. Cockburn's fleet was augmented by veterans of the Napoleonic Wars. Joshua Barney, placed in charge of the U.S. fleet, was tasked with harassing the Cockburn raiding parties. The forces of General Winder (United States) and General Ross (Great Britain) engaged near Bladensburg on 24 August 1814. The Americans were defeated and the British entered Washington. Federal buildings,

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[9] Lossing writes, "When, on his arrival in the Chesapeake, he (Ross) had been informed by Admiral Cochrane that he (the admiral) had been urged by Sir George Prevost, the Governor General of Canada (who was not satisfied with the terrible devastation of the Niagara frontier at the close of 1813), to retaliate in kind upon the Americans for the destruction of the government buildings at York and the village of Newark, …to destroy and lay waste such towns and districts upon the coast as may be found assailable."

[10] Frank A. Cassel, "Baltimore in 1813: A Study in Military Affairs", Vol. 33, No. 3, Dec. 1969, pp. 349–361.

[11] The Quartermaster Department, with a quartermaster general as its head, was reestablished by an act of Congress on March 28, 1812, when the war with England was imminent. The new commissary general of purchases was also created by this act and made responsible, "to conduct the procuring and providing of all arms, military stores, clothing and generally all articles of supply requisite for the military service of the United States." The use of military agents was discontinued at this time.

[12] Mr. James Calhoun, Jr., officer U. S. Army, deputy commissary of purchases at Baltimore, ordered and purchased the flag. [National Archives Entry 35—Letter Book "B", Commissary General's Office, 1813–1814, pp. 244–245. The receipt states, "Received the within Flags, G. Armistead, Major, Commandant. Fortifications voucher number 10, August 19, 1813."

[13] A letter from Mrs. Caroline Purdy, of Baltimore, to Mrs. Appleton, furnishes the names of the makers of this historic flag. Mrs. Purdy says: "It was made by my mother, Mrs. Mary Pickersgill, and I assisted her. My grandmother, Rebecca Young, made the first flag of the Revolution, under General Washington's directions, and for this reason my mother was selected by Commodore Barney and General Striker (family connections) to make this star-spangled banner, being an exceedin(g)ly patriotic woman. The flag being so very large, my mother was obliged to obtain permission from the proprietor of "Claggett's Brewery", which was in our neighborhood, to spread it out in their malt-house, and I reme(m)ber seeing my mother down on the floor placing the stars. Preble, p. 733, 1880.

[14] Elizabeth Young, Mary's niece, signed the receipt for payment when she delivered the flag to the fort.

[15] Research undertaken by Marilyn Zoidis, as part of the Star-Spangled Banner Project, showed that an African-American indentured servant lived in the Pickersgill household when the flag was made.

[16] In census records, Mary's brother is also listed as a flag maker, but Caroline Purdy does not mention any involvement by him.

including the President's house and the Treasury, were burned.[17] Baltimore was to be next. On 11 September, the enemy vessels were within twelve nautical miles of Baltimore. Early on 12 September, troops began to land and the fleet positioned itself to attack Fort McHenry and the city.[18] Scott Sheads, historian at Fort McHenry, has recently uncovered a note saying the flag was damaged on the 12th when a shell passed through it. This is the only contemporary mention of battle damage to the flag, although there is documentation that Armistead hired Pickersgill after the battle to repair damage to the flag.[19] The recent examination may have revealed the area damaged by the shell on the 12th. The note says it was in the middle of the flag and there is a tear almost in the center of the flag which had been repaired at some point in the past. (Figure 2)

Figure 2. Possible 1814 cannonball damage in the blue-white area

[17] Lossing states, "Up to this time the conduct of the British had been in accordance with the rules of modern warfare. Now they abandoned them, and on entering the national capital they performed deeds worthy only of barbarians. In a proclamation issued by the President on the 1st of September he submitted the following indictment: 'they wantonly destroyed the public edifices, having no relation in their structure to operations of war, nor used at the time for military annoyance ; some of these edifices being also costly monuments of taste and of the arts, and others depositories of the public archives, not only precious to the nation as the memorials of its origin and its early transactions, but interesting to all nations as contributions to the general stock of historical instruction and political science.'" p. 932. The towns of Frenchtown, Frederick, Georgetown, Hampton, and Havre de Grace were attacked, Lossing says, "The same fate awaited the materials in the office of the *National Intelligencer*, the government organ, whose strictures on the brutality of Cockburn had filled that marauder with hot anger. These, and some houses on Capitol Hill, a large rope-walk, and a tavern, comprised the bulk of private property destroyed, thanks to the restraining power of General Ross. Several houses and stores were also plundered. The unfinished Capitol, in which was the library of Congress, the President's house, a mile distant, the Treasury buildings, the Arsenal, and barracks for almost three thousand troops, were soon in flames, whose light was plainly seen in Baltimore, about forty miles northward. In the course of a few hours nothing of the superb Capitol and the Presidential mansion was left but their smoke-blackened walls.

[18] Schraf, pp. 90–91.

[19] A letter from Mrs. Caroline Purdy, of Baltimore, to Mrs. Appleton states, "many shots piercing it (the flag), but it still remained firm to the staff. Your father, Colonel Arm(i)stead, declared that no one but the maker of the flag should mend it, and requested that the rents should be bound around. Preble, p. 733, 1880.

Between 13 and 14 September, Fort McHenry sustained a 25-hour bombardment.[20] On the morning of 14 September, Francis Scott Key, a Georgetown lawyer detained by the British some eight miles away, saw the large flag flying over the fort and was inspired to write the words that became our National Anthem.

2. EARLY HISTORY OF THE FLAG

The Star-Spangled Banner was used at Fort McHenry for no more than five years, and probably less than two.[21] Lt. Colonel George Armistead acquired the flag before his death on 25 April 1818. Upon his death, it went first to his widow, Louisa, then after she died in October 1861 to her daughter, Georgiana Louisa Frances Gillis Armistead, who was born at Fort McHenry on 25 November 1817. There is an inscription on Star #10, (Figure 3) signed by Georgiana Armistead Appleton. The inscription reads:

> *this precious relic[22] of my father's fame [large hole where fabric has been roughly cut out] ???day of Octr 1861 Georgiana Armistead Appleton*

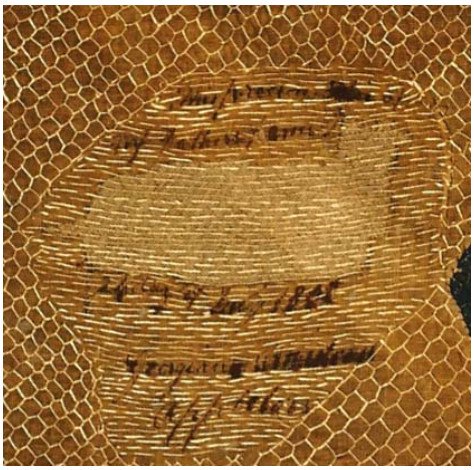

Figure 3. Georgiana Armistead Appleton's 1861 inscription on a star

Previously the date was read as 1876, and it was thought that this referred to Georgiana Appleton's intention to give the flag to the new U. S. National Museum which was started at the Philadelphia Centennial Celebration. It was speculated that she had changed her mind when the director decided not to exhibit the flag for fear it would be damaged. I believe the date is actually 1861 and refers to the bequest of the flag to her upon her mother's death in 1861.

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[20] Lossing: "The bombardment of Fort M'Henry lasted twenty-five hours, with two slight intermissions, and it was estimated by Armistead that during that time from 1,500 to 1,800 shells were thrown by the enemy. A few of them fell short, but a greater number burst over the fort, throwing their fragments among the garrison. About 400 shells fell within the works, some of them, afterward dug up, weighing 210 and 220 pounds. "Wonderful as it may appear," said the commander in his report, "our loss amounts only to four men killed and twenty-four wounded. The latter will all recover." The wife of a soldier, while conversing with her husband before the tents outside of the fort, was cut in two by a cannon-ball. A shell fell into the magazine, but did not explode."

[21] Receipt for new flag, dated 1815, location for its use is not specified. In the Flag House collection.

[22] Louisa Armistead also referred to the flag as a "precious relic".

By the 1860s, the flag was already damaged with many holes.[23] It remained with the Appleton family throughout the U.S. Civil War. In 1873, Admiral George Preble, a historian writing a book about the history of the U.S. flag, borrowed the flag from Georgiana Armistead Appleton. Preble writes to her that he repaired torn seams[24] in the flag (Figure 4) and had the flag tacked to canvas sailcloth to stabilize it for the first known photograph.[25]

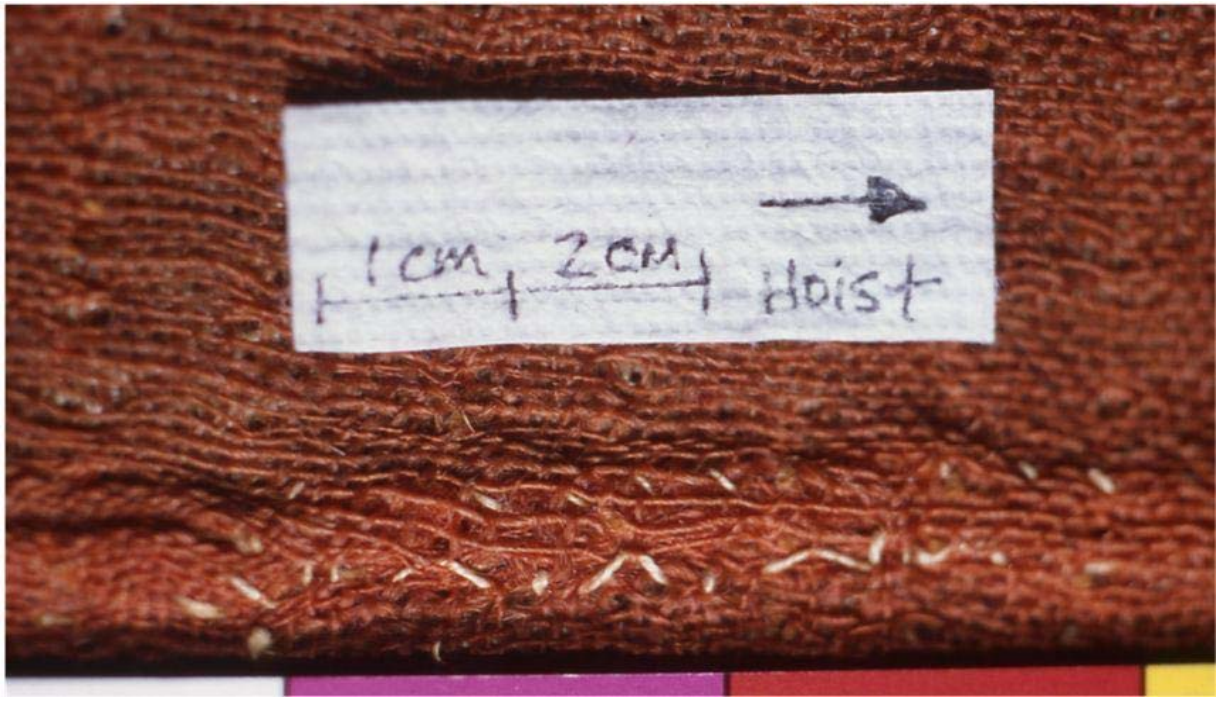

Figure 4. Seam that may have been repaired by Admiral Preble in 1873

[23] Lossing says, "The Star-spangled Banner itself, the old garrison flag that waved over Fort M'Henry during that bombardment, is still in existence. I saw it at the house of Christopher Hughes Armistead (a son of the gallant defender of the fort) in Baltimore during the late Civil War. It had eleven holes in it, made there by the shot of the British during the bombardment."

[24] Examination of the flag identified possible areas for these repairs. "The majority of the stitching in the seams is high quality, but not always consistent. For example, there are areas where the stitches are smaller and closer together, areas where the stitching is not perfectly straight, and areas where the stitches look more like whip-stitches than running stitches. The width of the seam also is not always uniform—Red 3/White 3 seam appears narrower than others. The overlapping of fabric to form the seams is fairly consistent with each piece (i.e. partial bunting width or full bunting width) having one edge on top and the other underneath the adjacent section. Inconsistencies occur where both edges of the partial bunting width are underneath the full bunting width on either side of it. These occur at Red 1 partial bunting width, Red 4 partial bunting width, White partial bunting width, and Red 7 partial bunting width. Also, Red 5 partial bunting width (center seam, below canton) is sewn on top of the fly stripe bunting widths on either side, but the upper edge is under the canton bunting widths." D. Kessler, March 2003.

[25] "The flag of Fort McHenry, whose broad stripes and bright stars inspired Key's song, still exists in a tolerable state of preservation. Our illustration is engraved from a photograph taken at the Boston Navy Yard in 1874. It has, or rather had, fifteen five-pointed stars … For the purpose of having its frail threads photographed, the flag was stitched upon canvas." [Preble's description of the flag, 1880 edition, p. 732]

All that remains of the support added by Preble may be one tiny sample of canvas. (Figure 5) He went on to say that the flag was too fragile to fly it from a pole as he had originally intended. Strands of shattered cloth, repaired areas, and patches are visible in the photograph.

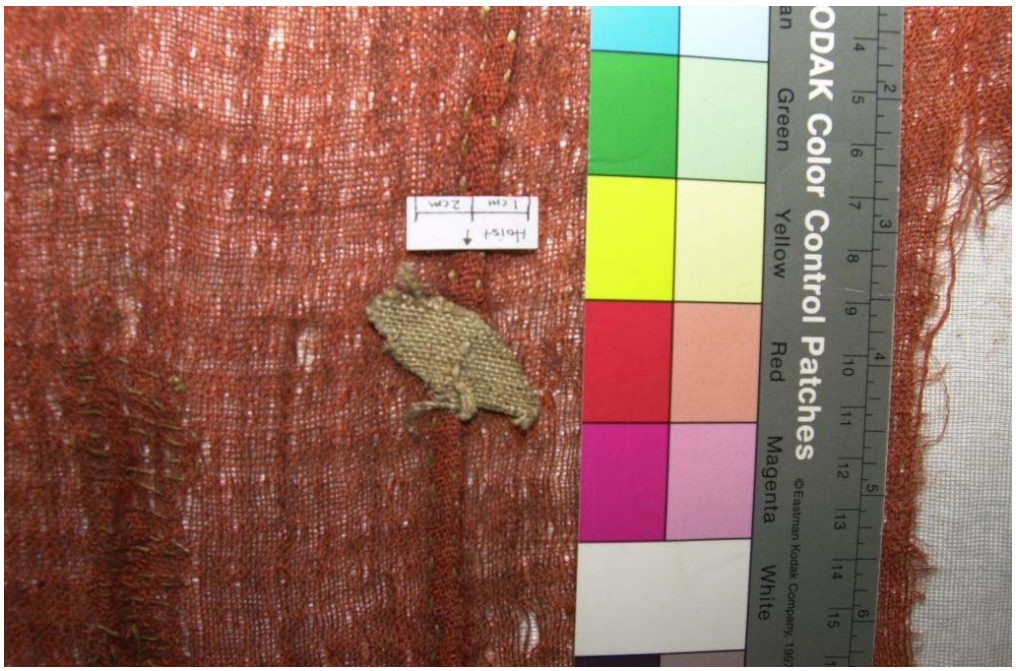

Figure 5. Fragment of canvas, perhaps added by Preble in 1873

Mementos were removed from the flag as early as 1818[26] and the practice continued at least until the 1880s. Comparison of the photographs taken in 1874 and in 1907 show that fragments of the flag had been removed during that time. The flag stayed with Armistead's descendants until it was loaned to the Smithsonian Institution by Armistead's grandson, Eben Appleton, who had been storing the flag in a vault at a New York City bank. The practice of removing mementos alone, however, cannot account for the more than twenty per cent of the flag that is missing today.

2.1 HISTORY AT THE SMITHSONIAN

Before the flag was loaned to the Smithsonian Institution for exhibition in 1907, Secretary Charles D. Walcott expressed his hope, "I trust, therefore, that Mr. Appleton may be induced to place this worthy relic where it can always be seen by the public."[27] Appleton agreed to the loan and the flag was folded, placed in a canvas bag, and shipped to the Smithsonian in a box. The canvas attached in 1873 made it difficult to fold the flag, causing wrinkles and sharp creases in the bunting. When the flag arrived at the Smithsonian in the summer of 1907, it appeared "badly moth-eaten".

[26] The first fragment removed was presented to the widow of one of the soldiers who fought at the Battle of Baltimore, to be buried with her husband.
[27] In a letter to Mr. J. B. Baylor, on 4 June 1907.

Later, Assistant Secretary Rathbun went on to say,

> *After spreading it out, we find it in such better condition than was apparent from the edges. It is however, very frail and delicate, especially in places.*[28]

The arrival of the flag at the Smithsonian created a large number of requests for pictures of the famous flag and, due to its fragile condition, it was decided that only the donor-approved picture taken by Smithsonian officials would be distributed to the various newspapers. The flag, still loosely tacked to its heavy canvas backing, was hung on an exterior wall of the Smithsonian Castle[29] and pictures were taken of it on 10 July 1907. It was taken down the same day and "securely locked up"[30] until the large exhibition case being prepared for the flag was ready. (Figure 6)

Figure 6. The flag hanging from the Smithsonian Castle in 1907

[28] Letter from Rathbun to Appleton, 11 July 1907.
[29] The "Castle" is the first Smithsonian Institution building and now serves as the chief administrative facility for the institution.
[30] Letter from Rathbun to Appleton, 15 July 1907.

In 1914 Amelia Fowler, a flag restorer, who had worked on the collections at the U.S. Naval Academy, was hired to preserve the Star-Spangled Banner. She stitched the flag to linen using her patented method.[31]

3. TECHNICAL EXAMINATION OF THE FLAG

Much has been written regarding the basis for the design of the American flag. The act which created the flag, the most recognized symbol of the United States today, briefly stated:

Resolved, That the flag of the United States be made of thirteen stripes, alternate red and white; that the union be thirteen stars, white in a blue field, representing a new Constellation.

The act of 13 January 1794 changed the design to 15 stripes and 15 stars for those flags put into use after May 1795. Much was left to the discretion of the individual maker, creating a variety of interpretations and designs. It wasn't until the Executive Order of 24 June 1912 that the flag design became mandated.

If the origin and intent of the first design is not well documented, the construction of early flags—that is, the actual making of the flags—is documented even less. While flag making was a recognized profession, as seen in advertisements and listings on public censuses, and the names of some makers (mostly women) are recorded, there are few technical accounts of flag making in the early years of the United States. There are a few references to the quality of buntings in period advertisements; but technical aspects regarding source of materials, dyes, stitching of seams, and method of attachment to halyard, staff, or flagpole are not well known. Period prints illustrate battles but provide insufficient detail regarding construction of early flags. In their drawings, M. A. Lotter and G. F. Lotter[32] illustrate some 18th-century methods used on American ships to attach their colors. These illustrations suggest that rectangular flags were hoisted on rings similar to those used for sails or were tied to their staffs.[33] These illustrations do not show a sleeve on the flag; nor is there even any indication that they are wool flags.[34] G. R. Cooper's small volume on 13-Star flags[35] compiles some technical information regarding weave count and stitching on a limited number of flags. But this provides little guidance for War of 1812 flags, as construction details might have changed. B. J. Lossing and R. Chartrand provide illustrations but no details of manufacture. Attempts to draw conclusions about typical construction for the time period are

[31] Fowler provided very brief notes on her treatment of the Star-Spangled Banner. She does indicate that when the treatment was completed she ironed the flag to press the stitches into the fabric of the flag. She does not talk about any method used for aligning the warps before stitching to the linen. Research is on-going to try to determine more of her working methods. A photograph taken during the work shows tags placed on the flag as the areas were worked. In examining the technique of the stitches, a range of expertise is found. Usually great care is taken to sew in the opening of the weave, but not always. The rows are usually aligned well but in some areas, the rows expand and contract, sometimes even compressing many rows into a single row. This may indicate areas where one needle worker began and another ended her section.

[32] *Tableau de Tous Les Pavillons Que Lon Arbore Sur Les Vaisseaux Dans les Quatre Parties du Monde, Avec Une Explication de tous les Agrés et Manoeuvres des Vaisseaux* (Augsburg, 1793).

[33] The illustrations were reproduced in an article by Hugh F. Rankin, "The Naval Flag of the American Revolution". *The William and Mary Quarterly*, 3rd Ser., Vol. 11, No. 3. (July 1954), pp. 339–353. Illustration provided by the Mariners Museum, Newport News, Virginia.

[34] The flag captured from the USS *Chesapeake* is silk, not wool.

[35] Cooper, Grace Rogers, *Thirteen-star flags: keys to identification.* 1973. Washington, Smithsonian Institution Press.

hampered by the limited number of flags available for study. There are seven[36] known 15-star national flags dating to shortly before and after the start of the War of 1812—five associated with forts and two associated with ships.[37] Comparison shows some similarities: wool bunting (except the *Chesapeake* ensign), rope sleeve, and linen sewing thread, but also many differences in manufacture which impact condition and longevity. Some are in better condition than the Star-Spangled Banner, some in worse condition. There are a limited number of others flags manufactured in the same period, which add limited information.

3.1 DESCRIPTION

The Star-Spangled Banner was requisitioned as a 30-foot by 42-foot national color.[38] The flag has fifteen stripes and fifteen stars, as authorized by the Flag Act of 1794. A 29.5-foot by 34-foot section of the flag remains.[39] The canton, or blue field, contains twelve lengths of bunting. It is nearly square, now measuring approximately 15 feet 3 inches by 15 feet 8 inches.

The flag was made of long-fibered wool bunting.[40] The long-staple fibers combined with the worsted processing[41] provided durability for fabric used under such stressful conditions. The main countries for bunting manufacture were England, France, and Germany; bunting was not manufactured in the United States until the mid-19th century. Because of the relatively small production it continued to be a hand-made product, hand-spun and hand-woven, even after mechanized processes were introduced. At the time of the War of 1812, England was the most likely source for the material used to make the Star-Spangled Banner.[42] The conflicts in Europe had disrupted trade with the continent, but American merchants were still trading with England in spite of the declaration of the embargoes due to their lax

[36] B. L. Dunnigan states that he is aware of at least seven captured U.S. national flags of the War of 1812 surviving in Great Britain in 1998; the Drummond family had, in addition to the Fort Niagara flag, one captured at Fort Ontario at Oswego, New York. A fire in Megginch Castle caused considerable damage to both flags. Prevost also had colors from Fort Mackinac. The Maritime Museum at Greenwich has the flag captured by the HMS *Borer* and the one from the *Chesapeake*. The Lexington flag is actually a banner, since it was not intended to be used on a flag pole.

[37] A fortunate outcome of the publicity regarding this project is the discovery of additional flags and their documentation.

[38] Major Armistead had been stationed at Fort Niagara when its large garrison flag, 24 feet by 28 feet, was in use. Armistead is attributed with saying that he wanted a flag so large the British would have no trouble seeing it. But it probably relates more to the efficiency of the optics in spyglasses of the period. With two to three times magnification, a large flag would be a better target for locating the fort.

[39] An article in the *Boston Globe* dated 15 June 1877, p. 5, states the dimensions as 29 feet by 32 feet.

[40] Bunting is a narrow-woven worsted fabric, having an open weave structure which allows it to be lofted by a light breeze. Bunting was being produced through a cottage industry system in England, with women usually hand weaving the wider 19–22-inch widths, and children often weaving the narrower ones.

[41] Worsted is defined as yarn with fibers lying parallel to each other, and one where short fibers have been removed by combing.

[42] In December 1812, Madison proposed certain products, such as British woolen goods, be barred altogether from U.S. ports, and that the ransoming of ships not be allowed either. (Hickey, 531). While the Thirteenth Congress had refused to enact an embargo in the summer of 1813, it did pass an embargo later that year. It never enacted a law to outlaw British woolen goods. These restrictions were opposed by Republican leaders such as Samuel Smith of Baltimore. (Hickey, 521). However, enforcement was lax, as Secretary of the Treasury William Jones, a Philadelphia shipbuilder, devoted little time to the restrictions from May 1813 through February 1814. (Hickey, 520). This suggests that woolen goods were arriving from England into Baltimore in the period from 1810 through 1812, when the war began.

enforcement.[43] American merchants caught in England when war was declared between England and the United States were not allowed to remove specie but instead were required to take its value in "goods", which actually temporarily increased the amount of British goods available in the United States.

Pre-war and early in the war period, better quality materials were available.[44] The flag from Fort Niagara in New York and the flag captured by the HMS *Borer* would have been made earlier than the Star-Spangled Banner.[45] By the summer of 1813, the blockades were more effective and less material was coming into the Mid-Atlantic region, although trade may have continued across the border between New York and settlements in Canada.[46] Cargoes captured as prizes by privateers came into southern cities such as New Orleans and Savannah for sale.[47] During the early part of 1813, Baltimore was blockaded and cut off from world commerce. This blockade[48] would have created a shortage of woolen materials at the time the flag was made. It is likely that any available materials, regardless of quality, would have been used to complete the Star-Spangled Banner quickly before the city was attacked.[49] The bunting of the Star-Spangled Banner is single-ply, rather than the more typical 2-ply bunting. Variations in the selvedges suggest that the bunting widths were not all woven by the same person.[50] There is a very large range of diameters found in the fibers sampled from the flag. This might indicate that the cloth was produced at a time when material was scarce, as would be expected during wartime. Perhaps the finest quality materials were not put at risk by running the blockades and being seized as prize cargo. The

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[43] Madison imposed a non-importation law in1811 which prohibited all British-made goods, and prohibition of all goods from the British Empire followed. Restrictive measures included the "Enforcement Act of 1809, which gave customs officials broad authority to search and to seize property and permitted the routine use of the army, navy, and militia." By 1813, there was slack enforcement of the trade restrictions until October 1814 when Alexander Dallas became secretary of the Treasury and pushed forward the strongest trade restriction of the war, the Enemy Trade Act of 1815. (Hickey, pp. 518–19).

[44] Borders with Canada remained porous throughout the war. Active trading in Canadian regions included the lucrative fur trade. Swagerty states, "In the wake of the War of 1812, international policy shifts necessitated new paradigms in American fur-trade interests throughout the West. The 1794 Treaty of London (Jay's Treaty), which had allowed British and Canadian agents to continue the Indian trade on American soil, was rescinded by the U.S. Indian Trade and Intercourse Act of 1816.

[45] The garrison flag for Fort Niagara, which may have been made as early as 1809, was the typical 2-ply bunting. The smallest known flag, quickly created for Fort Hill, was heavily pieced together from small triangles of fabric, suggesting that in the remote location in Maine there was restricted access to the needed materials.

[46] http://www.history.army.mil/books/amh/amh-06.htm. Hickey suggests that trade continued, Britain choosing to maintain exchange because of available foodstuffs needed by the army and also possibly because of the immigration across the Canadian border created strong ties between the residents of Canada and New York and New England.

[47] Some records suggest that dry goods and wool were seized from British ships and made available for sale in the States: *Rossie* in 45 days took prizes valued at $1,289,000; *Rolla* seized ships and cargo valued at $2,500,000, including the *Rio Nouva* (dry goods), *Apollo* (king's stores), and *Boroso* (dry goods); *Comet*, captained by Boyle, seized *Hopewell*, and *John* which was sent to Baltimore; a Scottish ship, *Adelphi*, from Liverpool (salt, dry goods); Boyle later commanded the *Chasseur* (*Pride of Baltim*ore) which captured 80 vessels—*Miranda*, *Martha*, *Melpomene* (brandy, wine), *Joanna*, *Mary, and Susan*; *Adventure*, *Arrow*; off the coasts of Spain, Portugal, France, and in the Irish and British channels.

[48] Non-importation acts were enacted beginning in 1806, with a brief period between 1810 and 1811 when there was unrestricted trade. (Hickey, pp. 517–18). A law enacted on 23 June 1812 prohibited any seaborne trade with the British Empire, but allowed use of British licenses to trade in non-British ports. (Hickey, p. 524).

[49] A similar explanation might apply to the construction of the Fort Hill flag, which was manufactured in a remote area of Maine, away from cities that were still receiving supplies.

[50] Commonly, the loom is warped with the selvedge pattern fixed. New warps would be tied to the old ends and continue the pattern. Different patterns suggest different looms and weavers. The cloth may have come from numerous sources before being sold as a lot. Boyle, a very successful privateer, lived on the corner opposite to Mary Pickersgill and might have been a source for her materials.

poorer quality of the material used for the Star-Spangled Banner probably reflects both a diminished English supply[51] and a lack of first-quality goods available due to the blockades.

The red and blue bunting widths contain two pairs of either double or triple warps with adjacent tightly packed 2–6 warps. While the edge treatment is similar, the number of warp threads bundled together varies between the red[52] and the blue. The white selvedges are a mixture of two pairs of multiple warps and 4 pairs of multiple warps, each type then being followed with adjacent tightly packed 2–5 warps.

The bunting width sections are woven in a nearly balanced plain weave pattern. There are approximately 23–28 warps per inch and approximately 25–30 wefts per inch, creating an open-weave fabric weighing an estimated 40–45 pounds when new. There is variation of the warp count along the length of the bunting widths, indicating areas where stress compressed the weave structure. Reduced warp counts would suggest that the fabric has stretched apart. In 1914, the flag was ironed, which further distorted the weave structure. The display of the flag may have altered the weave count, as there is some variation when compared to fragments removed from the Star-Spangled Banner prior to 1907, as the fragments would show in-use changes. Some patterns begin to emerge, suggesting partial bunting widths of Red Stripe 7, Red Stripe 8, Red Stripe 2, Red Stripe 4, and Red Stripe 5 might have come from the same bolt of cloth. The red wool was dyed using a madder dye with a tin mordant.[53] Madder was not a commodity produced in the United States, but rather imported from Europe and the Middle East. There is a very noticeable difference in the red dye lots. The partial widths used in Red Stripe 2, Red Stripe 7, and Red Stripe 8 appear to be about same color but spectrographic color readings could not verify similarities between them that made them different form the others, suggesting the color variation is due to the concentration of the dye or the pH of the dye bath.

There is visible dye variation between the different blue bunting widths suggesting they may not have been dyed at the same time. The blue is indigo vat dye. Indigo was produced in the Carolinas and sent to England as a commodity. While the loose weave of the bunting makes it difficult to confirm, the bunting was most likely woven then dyed in England rather than being supplied as gray (undyed) goods to the flag makers in the New World. Indigo is produced in India, Asia, and Africa. If supply chains to both the United States and India were disrupted during the Napoleonic Wars, poorer quality indigo might have been used, explaining the large dye lot differences seen in the flag. The white bunting is not dyed or bleached.

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[51] Gillian Cookson points out that about 1800 the rapid expansion of the worsted industry in England had created quality control problems. Some of the problems related to the use of children and other family members to produce the yarn. The seasonal demands of agriculture also created shortages in the summer as the labor force was redirected. Laborers were sought from workhouses and outdoor relief programs. More yarn was imported from Ireland after the 1770s although it was considered an inferior product. Machine-spun yarn became widely available in the early nineteenth century. By 1810 Norwich manufacturers were almost entirely reliant upon the West Riding for worsted yarn (p. 40).

[52] The notes from the examination of the flag during its treatment state that the bottom of the full bunting width in Red Stripe 6 contains a weaving flaw which makes it difficult to accurately examine, but it is presumably similar to all the other red material.

[53] There is a reference in the file to a 1981 report from Max Salzman suggesting that both cochineal and madder were used. The report has been lost. Spectrographic examination in 2001 suggests the dye is madder with a tin mordant. There is a broad peak between 400-425 nm for cochineal but not for madder. No peaks were seen in the samples from the Star-Spangled Banner.

3.2 CONSTRUCTION

The blue field has both 19-inch and 13-inch bunting widths. Small variations exist between the stripes, but the stripes average 24 inches in width. Every white and red stripe contains a full bunting width and a partial bunting width. The full bunting widths are all approximately 18 inches wide plus a seam allowance. The partial bunting widths are approximately 6 inches wide plus the seam allowance. All the partial bunting widths have one selvedge, suggesting they were cut from 13-inch wide bunting. The sections were hand sewn together using a 2-ply linen thread. The seams are not true flat-felled seams but rather only the raw edge or one selvedge is tucked under, providing slightly more width within the stripes but a weaker seam. The seams are top stitched using a running stitch. The top and bottom edges of the flag are not hemmed; the unreinforced 2 x 2 selvedge provides the only structural stability to these edges. The large amount of damage to these edges indicates this was not sufficient to support the weight of the flag during use or handling. The original finish of the fly edge cannot be determined at this time as there is no remaining original edge, but it was probably a rolled hem, perhaps double-stitched as seen on later flags. Part of the fly edge is presently hemmed, but this was done after the fly edge had already been damaged. Additional pieces were removed after this hem was put in the fly edge.

The flag was made in three sections which were then joined together[54]—the canton, the stripes adjoining the canton, and the stripes below the canton. For Red Stripe 1 through White Stripe 4, the joined piece is on the proper left side of the stripe. From Red Stripe 5 through Red Stripe 8, the joined piece is on the proper right side of the stripe. This suggests that the flag was assembled into two sections (the canton and shorter stripes being one half, the long stripes the second), then those sections were joined. After removal of the 1914 treatment materials, markings were revealed which appear to be construction marks used for aligning seams when the flag was pieced together.[55] (Figure 7)

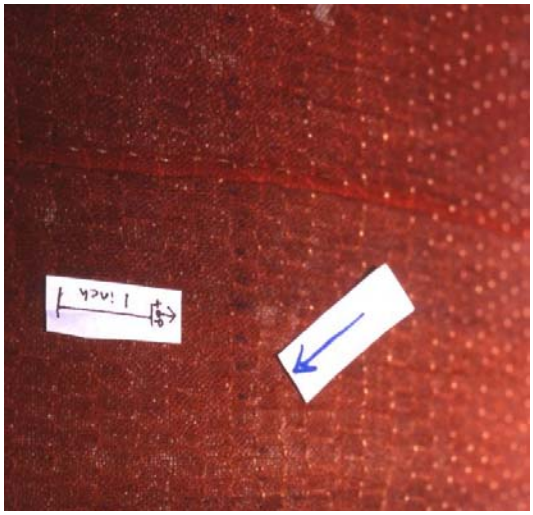

Figure 7. Construction marks, used for aligning seams

[54] The demarcation of the sections can be determined by the direction of the seams, whether the fold occurs on the top or the bottom of the seam.

[55] Mrs. Fowler used guide threads to lay out the stitching rows, so I do not believe that she made these marks. As there are so few marks visible, no samples were removed.

The stars are cotton and measure approximately two feet from point to point. There are now fourteen stars on the field, as one has been lost. The stars were sewn on the reverse [review] side, then the blue bunting underneath the star was removed from the obverse side and the raw edges were tucked under and stitched in place (reverse appliqué technique). This is the typical method used during the War of 1812 as cotton fabric was more expensive than wool bunting. Removing the bunting saved the cost of duplicating the stars. As Baltimore had operating cotton mills[56] at the time of the War of 1812, the cotton for the stars might have been of local manufacture.[57] The stars were very economically cut from the cloth—the grain direction is not consistent, suggesting the stars were laid out to minimize the amount of cloth needed. A number of the stars are pieced together, suggesting that cotton, even though manufactured in Baltimore, was costly or scarce at the time. This caused them to distort differently under the stress of use.

3.3 CONSTRUCTION OF THE HOIST

When the materials added in 1914 were removed, a remnant of a linen sleeve was still attached at the hoist end but the rope had been removed by cutting through the linen sleeve. The remnant of the sleeve attached to the Star-Spangled Banner was covered by the same linen used as a support on the back of the flag. While there are some loose threads, there is no loss of material. This suggests that the sleeve portion still attached to the flag was covered almost immediately after it was cut, and also that the rope portion was not handled very much after it was removed. The earliest photographs[58] show a linen sleeve attached to the flag in that location. There are stains on the sleeve suggesting the flag was used with this hoist in place. During the conservation project, the removed portion of the sleeve with the rope still attached was found.[59] (Figure 8)

The hoist appears to have been relocated on the flag. Damaged areas may have been doubled over to provide a solid area for the reattachment of the header after the battle.[60] No other example of a double-layer hoist end can be found on flags contemporary to the manufacture of the Star-Spangled Banner. This technique would not impart any additional structural stability to the area. The two layers of bunting are tacked together only at the seams, allowing them to distort and abrade each other. The seam is very uneven, unlike all the other construction seams in the flag. The first row of stars has been cut into the double layer, further weakening the hoist end. All the stars in the first row show evidence of alteration or repairs. The stitching around the stars in the doubled area uses different threads and seems to be made by a different hand than the construction seams in the flag. The use of a single row of stitching to attach the

[56] Cotton manufacturing increased in the early part of the 19th century; the War of 1812 spurred new development. Clifton in St. Mary's County had cotton yarn operations prior to 1834. Marks, p. 540.
[57] Other flags contemporary to the Star-Spangled Banner have linen stars, e.g. that of Fort Niagara.
[58] Examination of the photographs taken in 1873 in Boston and in 1907 (while the flag was hung from the Smithsonian Castle Building) clearly show cordage in a pole sleeve. In the Smithsonian photograph the flag is suspended from two points, suggesting that the traditional loops for attaching the flag to the hoist still existed. The fold pattern along the sleeve is typical of flags having cordage within a sleeve.
[59] It was confirmed that it was the missing portion by matching stains, seams, and individual threads in both sections. Because the evidence suggested that the hoist rope section had been attached when the flag came to the Smithsonian, the rope and linen section which had been removed was reattached to the remnant of the sleeve.
[60] A letter from Mrs. Caroline Purdy, of Baltimore, to Mrs. Appleton states, "Afte(r) the completion of the flag, she [Mary Pickersgill] superintended the topping (i.e. hoist) of it, having it fastened in the most secure manner, to prevent its being torn away by balls. The wisdom of her precaution was shown during the engagement, many shots piercing it, but it still remained firm to the staff. Your father, Colonel Arm(i)stead, declared that no one but the maker of the flag should mend it, and requested that the rents should be bound around." Preble, p. 733, 1880.

header differs from other contemporary flags, also suggesting this might be a later alteration. As expected, a very small amount of bunting was enclosed within the linen sleeve, which would prevent abrasion of the wool by the rope within the sleeve. Commonly, the bunting adjacent to the header is torn loose and worn.

Figure 8. The sleeve and rope being reattached

The lack of apparent damage on the Star-Spangled Banner suggests the header was placed in this position shortly before it stopped being used on a regular basis. Two patches occur on top of the sleeve, suggesting that the header was in this position while the flag was still being used and maintained. The placement of the stars into the doubled area, the number of obvious repairs in the attachment of the stars, the patches within the doubled area, the uneven, irregular seam line—all argue for this being a post-manufacture alteration. If a new header had been attached rather than the old one relocated, and if the flag saw limited use after the battle, we would not expect to find much evidence of use on the sleeve. Instead, we see distortions, ridges, and stains on the linen consistent with use. Distortions, folds, and creases in the linen header suggest the flag continued to be used while this header was in its current position. There are folds and creases above the tacking stitches holding the rope to the sleeve which would only have happened while the flag was hanging on a flagpole. Distinctive stains on the linen sleeve and the portion of linen still attached to the rope can be found. This stain continues into the bunting of the flag. This suggests that the rope, sleeve, and flag shared a history long enough for staining to have occurred, suggesting this is the original hoist, even if relocated. The most likely explanation is

there was damage to the hoist end. The hoist was removed, the damaged area was trimmed away, and the bunting was folded back on itself to create a solid area for reattaching the hoist. The extra blue bunting that covered the stars was then removed to make the stars visible on both sides. That the bunting was doubled over along the hoist rather than being removed[61] suggests the flag might already have been seen as an important relic, implying this was a post-battle repair.

Various methods of attaching the rope to the sleeve can be found in contemporaneous flags. While the rope and linen are firmly stitched together at the end and around the thimble on the Star-Spangled Banner, there is only intermittent stitching along the length of the sleeve, approximately every 20–24 inches.[62] The tacking stitches in the rope were likely a device to stabilize the rope while the hoist was stitched in position. The method of attaching the sleeve to the rope in the Star-Spangled Banner header suggests that the rope was expected to stretch or move, since it is not securely bound to the sleeve—although this may not account for the entire difference in the length of the rope compared to the length of the linen sleeve. If the weight of the flag had hung from the hoist rope one would expect to see distortions in the linen sleeve as it responded to the stress. The portion still attached to the rope has more distortions. Ridges have formed above the location of the stitches holding the linen sleeve to the rope. (Figure 9) They are caused by stress such as when flying on a flag pole. Planar distortions on the portion still attached to the flag may have been removed when of Mrs. Fowler ironed the flag to smooth the surface. Distortions of the weave structure, however, are still visible.

Figure 9. Ridges where the linen sleeve is attached to the rope

[61] Good parts of damaged flags were often reused to repair the damaged areas. This bunting was not removed and used to patch other areas of the flag.

[62] This corresponds to the width of the stripes. On the flag from Fort Sumter, the placement of the stitches also relates to the spacing of the stripes. This flag went into use in 1860.

On the large garrison flag from Old Fort Niagara, believed to date to about 1809, the rope is stitched to the sleeve following the twist of the cord, much as ship cording was "wormed" with each stitch lying in the crease of the rope ply.[63] This is also found on the "Don't Give Up the Ship" flag, also dating from about 1809. This seems similar to the stitching on square-rigged sails. This method of attachment would appear to be the most secure method for attaching the sleeve and the rope to one another (in the very limited sample pool available for examination). It may not have been necessary to tack the rope in position on smaller flags. On flags such as "Old Glory", 1834, and Fort Sumter, 1860, no stitching of the rope to the sleeve is found. Rope was not even used on much smaller flags, such as Fort Hill.

Admiral George Preble, then stationed at the Charlestown Navy Yard in Boston, had borrowed the flag from Georgiana Armistead Appleton in 1873 intending to photograph it flying from a flag pole as it did during the War of 1812. It is not known whether the hoist rope predates the flag's arrival in Boston.[64] There was an operating rope walk at the Navy Yard and it would have been possible for Preble to have a new header added to the flag. We know that after seeing its fragile condition, Preble changed his mind about flying the flag. Preble mentions the missing star. He wrote to say he had repaired seams in the flag so it could be photographed. He does not mention that the hoist was missing or that he repaired it. But since he mentions repairing the seams, it's likely that he would have mentioned putting a new header on the flag. It also seems likely that he would not have gone to the trouble and expense of putting a new header on the flag unless he intended to display it on a flagpole.

3.3.1 LINEN SLEEVE

The linen fabric used to create the sleeve was not woven on a ribbon loom;[65] rather it was cut from a wider fabric as indicated by the raw interior edges. Russia supplied cordage used in shipping and it is likely there was active trade with Russia at the time because of the ship manufacture and sailing industry in Baltimore.[66] Linen used for headers was commonly of Russian origin. Examination of the sleeve showed cut edges indicating the header was not a woven ribbon either, but rather cut from sheeting. Flag historian H. Madaus suggested that "Russian Linen" would have been in use until 1830. Russian linen is described as sheeting, rather than a ribbon weave, with two selvedges. The total sleeve width would have been 6¾ to 7 inches.[67] The linen sleeve is a plain weave, single ply, Z-twist warp and wefts, with an average weave count of 40 warps x 30 wefts per inch on the section attached to the rope, and 40 warps x 32 wefts on the section attached to flag; the number of warps is a constant since they are fixed on the

[63] Worming winds a small rope in the contlines (spiral grooves) of the strands of cables.
[64] Lossing examined the flag in 1860s; he mentions numerous holes in the flag. A missing hoist was not mentioned, nor was the missing star, even though we believe it was removed by then as Georgiana, when questioned by Preble, says the star was given to someone too long ago for her to remember.
[65] Multiple ribbons could be woven with one loom, creating strong edges by the selvedges. Such looms existed in England since 1745.
[66] Gabriel J. Adams states, "There is some evidence that linen was one of the first items traded between America and Russia. There seems to have been a black market exchange between Russia and Boston prior to the Revolution, and high grade Russian linen was one of the major commodities used in this trade." Crosby confirms, "Direct trade to Russia began after the Revolution ended. Russian production of tobacco forced a concentration on sugar, indigo, rice, and dyewood, which were goods typical of a cargo to Russia for over a century. The first vessel arrived at St. Petersburg from Boston in 1783, under Daniel McNeil. By 1784 this trade pattern had been established."
[67] The seam allowance is ½ inch, the amount attached to the rope is at least 1inch, and there is at least 4 ½ inches attached to the bunting.

loom and should be same regardless of where they are measured. Since weft count is affected by how tightly packed is the weave, it can vary depending on where it was measured—especially in hand-woven fabrics. Weft counts will also vary from use as seems to be the case with the Star-Spangled Banner. The measured lengths of the sleeve still attached to the flag and the portion still attached to the rope are not the same. The portion attached to the rope is about 3¼ inches longer. It is possible that the outside edge stretched more than the part attached to the flag, since this area is under higher stress levels.[68]

The small piecing seam had to have been done before the sleeve was sewn in position on the flag. (Figure 10) This might suggest the sleeve was manufactured at a time when cloth was costly or scarce as internal seams would weaken the construction or abrade the rope held within the sleeve. Most likely, this area was repaired, possibly post-battle, after a section of the hoist was ripped loose and torn, which allowed access to the interior for stitching. This supports the theory that the location of the header was changed.

Figure 10. Small piecing seam on the sleeve, possibly a post-battle repair

There is no apparent abrasion damage on the interior of the sleeve from contact with the rope, nor is there discoloration of either linen section from contact with the rope. The heavy coating of pitch might have diminished the amount of deterioration caused to the linen. Early flags, such as the one from Fort Niagara, and the one captured by the HMS *Borer*, do not show discoloration or deterioration either, presumably from the protection provided by the coating of pitch.[69] Later flags, such as the one from Fort Sumter and "Old Glory", both show significant damage to the linen sleeve and may represent a change related to coating the rope or the choice of rope material and may help date the manufacture of flags.

[68] Sadler, in his 1892 volume on sail-making, states: "The question may arise in the mind of a student why a rope upon a sail needs to be put on tighter at certain parts than others. The answer is that there are forces affecting such parts of the canvas which displace the threads and cause those parts to stretch, while other threads are not affected on account of the pressure of the wind plying in the opposite direction upon the canvas… therefore a careful sail maker will find out if the strain at any particular point will cause the canvas to stretch, and to what extent, which will enable him to judge how to put on the rope so as to be fair when fully stretched." (p. 101).

[69] Pitch was used on hemp ropes to retard rotting. As it is common to find deterioration of the linen sleeve from contact with the rope, this would not seem to be a common practice for flag makers. The Star-Spangled Banner rope appears to have a tarry substance on it.

3.3.2 ROPE

The cordage used in the hoist is called "ordinary lay". Publications on rigging contemporaneous to the manufacture of the Star-Spangled Banner show "ordinary lay" to be the type attached to sails.[70] Star-Spangled Banner rope is S-twist (right), Z-plied (left), hawser (three-strand left-twist cord). The hoist rope is approximately 14 inches too short for the linen sleeve. While there are well-executed splices in the rope, there are also two areas of possible damage. There are two areas where the distance between tacking stitches does not fall within the established range, suggesting there has been a loss of material. Stitches are placed at 84½ and 115½ inches, a gap of 31 inches. The removal of a section 9 to 13 inches long is sufficient to explain the difference between the length of the rope and the length of the linen sleeve, if the rope was expected to stretch. There are two other areas of inconsistent tacking stitches. There is a gap of only 8¾ inches between the stitches at 173 and 181¾. Removal of a section at 11¼ to 15¾ is sufficient to explain the difference between the length of the rope and the length of the linen sleeve. There are stitches at 279½–281½ inches, only 2 inches apart.

Sail makers calculated that rope would stretch approximately one diameter for each yard in length. For a ½-inch rope over a 10-yard span that would increase the length approximately 5 inches; published tables for calculating the amount of stretch and guidelines for stitching existed to assist the sail maker in this critical task. If the header was attached by a sail maker, this calculation might have been used since the flag would fly in an orientation similar to a jib sail. The very small gap could suggest removal of a section of rope and linen. This would be a section approximately 18 to 20 inches in length. It is also possible that the rope was reused, that the thimbles plus a section of rope were saved and reattached to new rope when a new header was added.

There seems to be a somewhat shorter length of rope in the top section, 9½ inches less than the linen section, while in the bottom section it is only 4½ inches shorter. There are two possible explanations for the difference in length. Rope for use on ships was manufactured in lengths up to 300 yards. Continuous lengths were necessary so the rope would pass through the pulley, clues, and buckles without a problem. This would not be a consideration for the edges of a sail nor a flag where the rope was immobilized by stitching. Properly spliced rope[71] would have the joins in three different areas, according to Sadler, to prevent thickening of the rope and to reinforce the weakened area of the end. Some splices in the rope of the flag show only a slight thickness in the areas where new cordage was added. Presumably, if the rope was made at a shipyard, e.g. the Charlestown Navy Yard, Boston[72], it would have been done in the traditional manner. Texts showing the proper way of lengthening rope strands were still in publication as late as 1875.

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[70] Steel's *Elements of Mastmaking, Sailmaking and Rigging* (from the 1794 Edition), Edward W. Sweetman, New York, 1932.

[71] A short splice is made by untwisting the ends of two ropes, or the ends of one rope, and placing the strands of one opposite to and between the strands of the other, drawing them close together, and pushing the strands of one under the strands of the other; the same as the eye splice. This splice is used for block-straps, slings, etc., and the ends are tapered and served. A tapered splice, mostly used on cables, is made by unlaying a certain length of each cable, then placing them together, and interplacing the strands, as in the short splice, twice each way, and hauling tight each time; then inlaying the strands, or ends, successively, and reducing them, by cutting away one strand; then interplacing the two remaining strands, and reducing them to a single strand, which is again thrust through, and cut off. The splice is then served over with spun-yarn for something more than its whole length.

[72] There was a "rope walk" at the Charlestown Naval Yard during the time period considered.

The stitching differs at the top and bottom thimbles of the header. (Figure 11) The top corner typically is more damaged as it is under greater stress. As the bunting is also very badly damaged, this less-expertly done area might represent the last in a series of repairs. The area at the bottom edge, around the thimble, still seems to be firmly attached. Patches in the bunting and a seam in the linen sleeve, however, suggest this area sustained damage.

Figure 11. Damaged hoist end and thimble

3.3.3 IRON THIMBLES

Historical records indicate that special care was taken with the "topping of the flag".[73] The sleeve remnant from the Star-Spangled Banner contained a 3-ply rope with iron thimbles, used to attach the flag to the halyard. Metal rings would have been the more durable solution for attachment.[74] These hand-forged iron thimbles are consistent with manufacture in 1812–14.[75] The thimbles appear to be covered with pitch, also consistent with manufacture at that time.

[73] Thimbles are not commonly found on flag hoists of the era, as rope loops seem to be preferred. Caroline Purdy, Pickersgill's daughter, in a letter to Georgiana Appleton, mentions the care her mother took in "topping the flag" overseeing the work personally which suggests that the topping might have been done at the shipyards in Baltimore where tarred rope, iron thimbles, and sheeting would have been common materials.

[74] Kipping, p. 47, states iron clues were used because they were stronger and last longer than rope loops.

[75] Early thimbles—metal rings used on sails—were iron, coated with pitch. After 1860, the rings were galvanized to retard corrosion. Still later, brass replaced iron as the metal of choice. After 1840, a press would have been used to stamp out the rings.

We would expect that the top corner would be more damaged as it is under greater stress. As the bunting is also very badly damaged, this less expertly done area might represent the last in a series of repairs. The bottom area around the thimble still seems to be firmly attached. Patches in the bunting and a seam in the linen sleeve however, suggest this area was also damaged. This suggests that the flag was in use while this header was in the current position.

Use of materials and techniques typical of an early time period does not eliminate the possibility that the header was added later and the reuse of an old hoist is possible. However, by 1818, the regulation size of flags was reduced to 17 by 23 feet. If this header came from an earlier flag it would pre-date 1818. Evidence of wear supports the assumption that this is original header, positioned on the flag some time after its manufacture.

4. SIGNATURES

Georgiana Armistead Appleton and Amelia Fowler both mention signatures on the flag in the hand of George Armistead, commander of Fort McHenry. Preble, in his 1880 volume on the *History of the American Flag*, states,

> There can be no doubt as to the authenticity of this flag. It was preserved by Colonel Arm(i)stead, and bears upon one of its stripes, in his autograph, his name and the date of the bombardment.[76]

The locations of these signatures were not noted but likely areas were identified when the flag was recently examined. The wool yarns are damaged too badly to determine the words, or if this is indeed a signature. A white wool yarn fragment from this area was examined using Scanning Electron Microscopy/Elemental Dispersive Spectroscopy (SEM-EDS). A high level of iron was found, in amounts greater than any other sample tested, suggesting that there was iron gall ink in this area. At least one of the signatures may have been more visible when Fowler treated the flag as she used her straight stitches on a section of red bunting. (Figure 12)

Figure 12. Ink markings on white wool, perhaps Major Armistead's autograph (1813-1818)

[76] Preble, p. 732.

There are still mysteries to uncover in the history of this flag. Alterations were made to the flag while it was in the possession of the Armistead family. The mysterious "Λ" on White Stripe 5 has been shown to be the start of the "A" for Armistead.[77] The chevron is a twill weave fabric and therefore was not cut from the flag. The dye system used for its red differs from the flag and is also water soluble, unlike that of the flag. There is an embroidered "B" on the flag, and an inked marking, perhaps an "M". Was this for Baylor, Mrs. Armistead's maiden name, or for Baltimore, Maryland, the site of the famous battle? (Figure 13) This is a mystery for future researchers to solve.

Figure 13. The mysterious chevron—for Armistead?

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[77] Taylor.

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