

SCIENCE, TECHNOLOGY, ENGINEERING, ART AND MATHEMATICS: KEY
ELEMENTS IN THE EVOLUTION OF THE CONTEMPORARY ART QUILT

by

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DEDICATION

This thesis is dedicated to my loving husband Louis who continuously supported me in my program, and my son Zain who is hopefully inspired by his mom's hard work.

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LIST OF ABBREVIATIONS

Science, Technology, Engineering, Mathematics	STEM
Science, Technology, Engineering, Art, Mathematics	STEAM
Do It Yourself	DIY
Public Broadcasting Service	PBS
Acquired Immunodeficiency Syndrome	AIDS
Light Emitting Diode	LED
Banded Iron Formations	BIF
Chemical and Engineering News.....	C&NE
Studio Art Quilt Associates	SAQA
Deoxyribonucleic Acid	DNA
National Council of Teachers of Mathematics	NCTM
Studio Art Quilt Associates	SAQA

ABSTRACT

SCIENCE, TECHNOLOGY, ENGINEERING, ART AND MATHEMATICS: KEY ELEMENTS IN THE EVOLUTION OF THE CONTEMPORARY ART QUILT

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George Mason University, 2015

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This thesis demonstrates that advancements in communication, technology and media are providing new inspiration, tools and techniques to quilt artists and have enabled them to transform the 1960s art quilt into a new hybrid form: quilts that reference the sciences in new and specific ways and in doing so, create new access to the sciences. Science-infused art quilts have evolved naturally from art quilts because quilt artists desire to educate, inspire, and express and influence culture by artistically employing and referencing the sciences.

STEM (Science, Technology, Engineering, and Mathematics) has played a major role in the making and the enhancement of quilts up to modern day. Today, STEAM is a new innovation that couples the sciences with art and design; $STEM + Art = STEAM$, (Science, Technology, Engineering, Art & Mathematics). In the twenty-first century the public debate about innovation has focused increasingly on the role of art as an important source of creativity and a new term has been forged to designate the broadened definition

of the foundational fields: STEAM. To some degree, art quilts have always embodied the ideas embraced by STEM but twenty-first century quilts have evolved into still broader stylistic and conceptual categories and often function as the "A", the art component in STEAM.

INTRODUCTION

What is STEM? (Science, Technology, Engineering & Mathematics), according to both the National Research Council and the National Science Foundation, are all fields considered core technological foundations of an advanced society. The term STEM is commonly used in reference to our nation's economic competitiveness within and with other competing countries:

STEM “innovators” are defined as those individuals who have developed the expertise to become leading STEM professionals and perhaps the creators of significant breakthroughs or advances in scientific and technological understanding. Historical examples include Edison, Ford, Fleming, Pasteur, Einstein, and Curie. In an increasingly technological society, innovation is frequently an interdisciplinary endeavor and many traditional non-STEM fields require scientific, spatial, and quantitative talents.¹

The growing social movement STEAM is widely accepted by institutions, corporations and individuals.² Incorporating STEM with art and design can drive innovation.³ STEAM may be a new concept, but STEM has been influencing the arts for centuries. Formerly seen as an applied or decorative art, quilting today is seen as a form of expression that combines all the different skills as a perfect encapsulation of STEAM. Indeed, quilters and quilt historians have come to appreciate that throughout history and

¹National Science Foundation Board, *Preparing the Next Generation of STEM innovators: Identifying and Developing our Nation's Human Capital* (Washington, D.C., National Science Foundation, 2010). Accessed February 18, 2014. <https://www.nsf.gov/nsb/publications/2010/nsb1033.pdf>.

²Tymas-Jones, Raymond. “STEM + A ≠ STEAM.” *ArtsBlog: For Arts Professionals in the Know* (blog), July 16, 2014. <http://blog.americansforthearts.org/2014/07/16/stem-a-%E2%89%A0-steam>.

³ “STEM to STEAM”; <http://stemtosteam.org/>.

long before the term STEAM came about, quilting and quilts have been a perfect example of STEAM. Today, however, quilters purposefully embrace the concept of STEAM and understand their work as contributing to the foundational arts referenced by STEAM.

In order to establish a historical link between traditional quilts from the past, contemporary art quilts of the late twentieth century to STEAM quilts of the twenty-first century, three contributing themes will be discussed: aesthetics, quilts as social statements, and STEM influences. Within these themes are factors that include technology, processes, tools and materials, and cultural values. These themes and factors began to emerge during previous centuries and today demonstrate important changes in quilting and the development of the modern--day STEAM quilts.

My work is divided into three chapters. Each addresses a specific theme and incorporates scholarly resources, historical documents, regional newspapers and national periodicals, and curatorial and artist interviews. Chapter One establishes a historical timeline beginning with a brief history of quilts coming to America in the seventeenth century and demonstrates how through the centuries to modern day STEM has been a strong design, technical and functional influence in quilt making. Chapter Two highlights how each artist incorporates STEAM in their design. Chapter Three discusses and validates how STEAM quilts are a new style of quilt and considers the status and future development of STEAM quilts.

CHAPTER ONE: COMING TO AMERICA AND THE EVOLUTION WITHIN

The Early Colonial Period (1620-1780)

In the seventeenth century, exotic fabrics from the East found their way into Europe via the Dutch and East India Company in the form of chintzes and muslin. These were often made into quilts, as already evident in the so-called whole cloth, (a type of quilt made from one piece of fabric).⁴ *The Hunters Quilt*, ca. 1700, Figure 1, is a luxurious example of a whole cloth blue, silk quilt that was made for the European market. It renders scenes from a hunt, which is done with beautiful details of stylized leaves, flowers and fruit worked in arrangements throughout the quilt.⁵ During the mid-eighteenth century, England began to colonize India and with the development of Britain's East India Company Europe and its far-reaching trade, was also to a certain degree colonizing the Americas.⁶ When quilting came to Europe from the East via sea trade routes from India, Africa and the Orient, it began as a social craft among the wealthy. Lavish and expensive fabrics such as chintz, which contained floral designs, were selected to produce quilted bedding and clothing, which meant that only the affluent

⁴ Roderick K. Kiracofe and Mary Elizabeth Johnson Huff, *The American Quilt: A History of Cloth and Comfort, 1750-1950* (New York: Clarkson Potter, 1993), 4.

⁵ Sandi Fox, *Wrapped in Glory: Figurative Quilts & Bedcovers 1700-1900* (Los Angeles, California: Los Angeles County Museum of Art, Thames and Hudson Inc., 1991), 16.

⁶ Elise Schebler Roberts, *The Quilt: A History and Celebration of An American Art Form* (Minneapolis MN: Voyageur Press, 2010), 18.

owned quilts.⁷ As Europeans became fluent in quilting techniques, they began developing more elaborate quilting designs such as *The Central Medallion Quilt* from the late eighteenth century, Figure 2, reflecting the aesthetic tastes of their locations in the new world.⁸ This medallion quilt made in Alabama contains a center floral medallion with scroll-like vines and flowers around the border. As the quilt expert Roderick Kiracofe states, "quilts in the Southern colonies were very likely constructed with finer stitchery and more elaborate fabrics than those of the Northern colonies."⁹

The first women to arrive in America brought stitching *expertise* from Europe and a variety of quilting traditions.¹⁰ Just as in Europe, only wealthy Americans could afford quilted objects and even in their households, quilted items were extremely rare and were regarded as elite status symbols. Indeed, seventeenth-century New England inventories suggest that quilts were exceptional items and were highly valued.¹¹ Textiles were even less bountiful in the new colonies because of the high tariffs the British imposed on their importation.¹² Restrictive British regulations on fabrics imported to the colonies were designed to maintain hegemony in the textile markets; however, they ironically drove a significant step in the evolution of quilting in the new world. These regulations made textiles less bountiful. Some scholars suggest the restricted access to imported block printed fabrics encouraged crewel embroidery and appliqué, as for example in *The*

⁷ Ibid., 21.

⁸ Kiracofe and Huff, *The American Quilt*, 51.

⁹ Ibid., 55.

¹⁰ Ibid., 4.

¹¹ Judith Reiter Weissman, and Wendy Lavitt, *Labors of Love: America's Textiles and Needlework, 1650-1930* (New York: Knopf : Distributed by Random House, 1987), 37.

¹² Jennifer Harris, *Textiles, 5,000 Years* (New York: H.N. Abrams), 252–253. Most trade to North America was controlled by Britain through the British Acts passed between (1650 – 1696).

Courting Scenes Bedcover, also from the late eighteenth century (Figure 3). Items such as these were often made with recycled clothing and bed linens.¹³ This elaborate bedcover contains eleven panels, all of which were needle worked. The one depicted in Figure 3 is a dancing scene where the woman depicted holds her arms in an "S" curve, which was a very fashionable pose of the time.¹⁴

Seventeenth-century quilts were likely all imported with a few being made in the colonies themselves.¹⁵ When these rare seventeenth-century items were made, most fabric was hand-woven in the home, as illustrated in Figure 4, on eighteenth-century looms, which was labor intensive and time consuming.¹⁶ Quilts and coverlets were tinted with natural plant and vegetable dyes such as indigo (blue), quercitron (yellow), and red; (blue, derived from *indigo tinctoria* or *indigo suffruticosa*, grown in local indigo plantations), quercitron (yellow, brown or green, derived from the Eastern Red Oak) and red, derived from the locally grown madder root. Whole cloth quilts, which were the most common during the late seventeenth-century were made with colored wool called calamanco and were heat-pressed to create a shiny, glazed surface.¹⁷

All quilts demonstrated characteristics that today we would summarize as (STEM). Botanical designs were incorporated in many styles of quilting. A botanical design reflects an interest in the natural sciences and can therefore be characterized as STEM). Ornithological themes including exotic birds such as parrots and peacocks were

¹³ Ibid., 312. Appliqué: The application of fabrics cut to certain shapes or of embroidered motifs, to the surface of a ground material to form a design.

¹⁴ Fox, *Wrapped in Glory: Figurative Quilts & Bedcovers 1700-1900*, 22.

¹⁵ Sally Garoutte, "Early Colonial Quilts in a Bedding Context," *Uncoverings 1* (1980): 22.

¹⁶ Kiracofe and Huff, *The American Quilt*, 9.

¹⁷ Robert Shaw, *American Quilts: The Democratic Art, 1780-2007* (New York, NY: Sterling, 2009), 23.

influenced by Indian palampores (Indian bed-covers).¹⁸ Palampores were introduced to the colonies through Britain's East India Company. The depiction of indigenous birds such as pheasants, doves and quail reflected the quilters' observations of their own environment.

Quilts were almost always mathematical in nature utilizing symmetry and mirror imagery. Even the medallion patterns often contained mirror images around the borders of the central image. Many quilts also maintained some level of symmetry. Motifs and colors were often replicated on each side or corner creating a balanced appearance. Quilts were made in rectangles or squares and were often designed with geometrical shapes such as triangles, rectangles, and squares. Most likely, these early quilts were not made for keeping warm since other cheaper, warmer bedding options were available such as woolen blankets, bed rugs and coverlets.¹⁹ Making quilts during this time was neither economic nor practical; most likely they were made for simply showing off quilting techniques and to highlight wealth.²⁰

The Late Colonial Period (1780-1800)

The late eighteenth century brought only slight changes to quilting. The aesthetics of quilts often mimicked what was brought over by European settlers such as the medallion motif, tree of life patterns and whole cloth quilts.²¹ Although female members of the wealthier households continued to make quilts, their assisting servants learned to

¹⁸ Rosemary Crill and Thomas Ian, Victoria and Albert Museum. *Chintz: Indian Textiles for the West* (Ahmadabad: Mapin Publishing, 2008), 15.

¹⁹ Garoutte, "Early Colonial Quilts in a Bedding Context," 19.

²⁰ Ibid., 25.

²¹ Roberts, *The Quilt*, 28.

make quilts for their wealthy employers and in turn they began incorporating quilting into their own home lives.²² Eventually, techniques and processes were passed down from generation to generation and quilting gradually became a family and communal tradition in America. African American, Native American, and Hawaiian cultures were exposed to quilting through contact with the European culture and embedded quilting into their own practices.²³ Quilting democratized society and became a more common practice. For example, *The Medallion Quilt*, ca. 1860s, Figure 5, made by an African-American seamstress working as a house slave before buying her freedom with money earned from dressmaking.²⁴ This quilt displays elaborate geometric designs containing hexagons created by smaller groups of hexagons thus presenting successive subdivisions. These minority cultures expressed themes such as ethnicity, nationality, and belief systems in quilt aesthetics.²⁵ Quilted clothing such as petticoats, bonnets, corsets and skirts also became common in the new world.²⁶

The new American population expanded from small clusters of colonists to regionally governed colonies along the Atlantic coastline. Although these colonies became the United States and broke away from British rule, the American quilting styles continued to follow British and European trends such as the popular geometric design seen in *The Hexagon Quilt*, 1796 (Figure 6). This solid background quilt contains bright colored hexagons and a larger central hexagon medallion in the center. From the early

²² Ibid., 21.

²³ Shaw, *American Quilts*, 167.

²⁴ Ibid., 107.

²⁵ Roberts, *The Quilt*, 93.

²⁶ Ibid., 28.

eighteenth century onward, this pattern was referred to as the honeycomb or six-sided patchwork and was popular in Great Britain. This mathematical motif was often engineered in symmetrical designs. By the fourth quarter of the eighteenth century it became distinguishable as one of the earliest American patterns.²⁷

Even though the eighteenth century brought little change to mainstream quilting and embroidery, there were still hints of scientific influences in the needle arts.

Cartography was a growing science in the eighteenth century and rose in popularity with the development of national surveys. Other advancing technologies such as the reflector telescope and sextant allowed cartographers to make more elaborate and accurate maps.²⁸ Samplers, a piece of embroidery produced as a demonstration of skill in needlework, also brought to the US from Europe, became commonplace for schoolgirls to create. Some samplers were made with cartography in mind (Figure 7). This wool sampler made in 1797 was embroidered with silk and depicts a map of Europe created by student Elizabeth Hawkins at Miss Powell's Boarding School in Plymouth, England in 1797. Map samplers provided an opportunity for schoolgirls to demonstrate both their academic accomplishments and needlework skills.

Floras influenced by the East such as Indian palampores remained extremely popular, however, more scientifically correct floras drawn by Europeans such as Robert Furber, a Kensington nurseryman, became popular as well. Furber published the first

²⁷ Catherine Morris, ed., *Workt by Hand: Hidden Labor and Historical Quilts* (Brooklyn Museum, 2013), 102.

²⁸ *Encyclopaedia Britannica Online*, s.v. "Map (cartography)," Accessed January 30, 2014. <http://www.britannica.com/EBchecked/topic/363506/map>, 6.

illustrated English flower catalogue in pamphlet form in 1730.²⁹ His *Twelve Months of Flowers* inspired many gardeners. Before this publication, most gardening and seed exchanges occurred locally. With this mass publication and distribution, however, many people were exposed to his engraved plates and these illustrations readily became inspiration to quilt makers even 100 years after being published.³⁰ Furber later created *Twelve Months of Fruit* in 1732, also inspiring many quilt designs such as in, *Basket of Fruit Chintz Applique Quilt*, ca. 1840 (Figure 8). This quilt is designed with many baskets of fruit layed out in a central medallion design. The colors used in the quilt are modest but elaborately made.

The Evolution of Quilting in the Nineteenth Century

The nineteenth century brought abundant technical changes to the textile industry and in turn, to quilting. Before the cotton gin (1793), raw cotton had been grown in the U.S. only for domestic consumption, but around the turn of the century, it was grown for export. By 1820, America became the world's leading producer of raw cotton.³¹ This, along with the mass production of wool carding machines made cotton and wool affordable for everyone and consequently also changed the quilting industry. The end result was that more women could afford to produce quilts for their families.³² With the growth of industry, textile mills sprung up all over Eastern towns such as the Stevens

²⁹ John Hooper Harvey, *Early Gardening Catalogues With Complete Reprints of Lists and Accounts of the 16th-19th Centuries* (Phillimore: London and Chichester, 1972), 14.

³⁰ Lloyd Library and Museum, "Twelve Months of Flowers" Special Collection No. 111 Box 1 of 1," Accessed January 17, 2013. www.lloydlibrary.org/archives/inventories/furber.html.

³¹ David Jenkins, ed., *The Cambridge History of Western Textiles 1* (Cambridge: Cambridge University Press, 2003), 726–728.

³² Shaw, *American Quilts*, 24–27.

Linen Mill in Dudley, Massachusetts, ca. 1879 (Figure 9). The burgeoning textile industry had a profound influence on communities and families up and down the East Coast. They generated the dynamic financial improvement of many families and communities, assisting in the development of the middle class.³³ As stated by textile curator and scholar, Paul Rivard, “The industrial revolution, led by the manufacture of textiles, was in fact no revolution at all but rather an evolution which lasted for generations.”³⁴ Many households became multi-income, as the mills were the largest employers of women in these regions.³⁵

The emerging new technologies and beginning mechanization of production seem to be reflected in an ever-increasing exploration on geometrical designs in the quilts of this period. However, perhaps also in a reflection of the liberation from traditional standards technology brought about, we suddenly also find many asymmetrical, non-traditional patterned quilts. Significantly, these new types of quilts also depicted new themes, reflecting the changing nature of society, such as pictorial representations against slavery, in support of women’s suffragette, against poverty, inflation, and war.³⁶ New technologies like the cotton gin mill and the textile mills created new economies—such as Centennial Exhibitions—and these in turn bring together a display of new production technologies and current themes. Designs became even more asymmetrical as some quilt’s functions were not necessarily meant as bed coverings, but visual statements,

³³ Ibid., 41.

³⁴ Paul E. Rivard, *A New Order of Things: How the Textile Industry Transformed New England* (Hanover, NH: University Press of New England, 2002), 19–20.

³⁵ Shaw, *American Quilts*, 41.

³⁶ Roberts, *The Quilt*, 84.

pictorials and stories. Asymmetrical quilting styles such as the *Crazy Quilt*, ca. 1890, Figure 10, became popular after the 1876 Centennial Exhibition in Philadelphia, Pennsylvania. Japanese styles and designs were incorporated into American arts and crafts including quilting. This style of quilting replicated the crazed and crackled glazes seen on Japanese porcelains and the bright colored fabrics reflected the rich colors in the Japanese arts. These competing tendencies of other crafts, like machinery and technologies are also often reflected in quilts. American quilters took the crazy quilt a step further and furnished them into mourning quilts and would use scraps of clothing from deceased loved ones to remember them. These new trends in quilting signaled a shift in the traditional purpose of quilting for bed covers to decoration as throws or piano covers. Quilt making began to become accepted as an art form.³⁷

Traditional European designs slowly fell by the wayside as Americans developed their own aesthetic and cultural influences. The incorporation of traditional botanical prints in chintz, whole cloth and appliqués was still commonplace until mid-century. American quilters expressed their love of botany and gardening through quilting. The first periodical specifically dedicated to horticultural subjects was, *The Gardener's Magazine*, published in England by J.C. Loudon from 1826-1845, and was widely read in the United States. Loudon's wife, Jane Wells also wrote books on gardening for ladies. *The Ladies Flower Garden*, 1840 contained beautiful illustrations and engravings, which influenced many chintz designs produced by textile printers of the time, which then, in turn, appeared in quilted designs. William Curtis's *Botanical Magazine*, which began in

³⁷ Ibid., 233.

1787 included detailed color illustrations that inspired many quilts makers.³⁸ They also influenced block quilting (a quilt made of equal sized blocks of fabric either pieced together or appliquéd) such as this *Baltimore Album Quilt*, ca. 1845-1855, Figure 11, which often-contained large embroidered wreaths, fruit trees, cornucopias, and stylized floras.³⁹ This quilt's color palette of red, green and yellow jumps off the crème-white background fabric. There are twenty-five elaborate unique motifs offering asymmetry, however the motifs are aligned in rows of five by five presenting overall symmetry and balance.

Along with these experimental changes came new technologies including the sewing machine, synthetic dyes, and commercial batting. All allowed the benefit of creating more elaborate designs, colors and compositions. The invention of the automatic sewing machine by Elias Howe (1819-1867) was patented in 1846 and later improved by Singer; it brought many changes to the world of quilting.⁴⁰ Not only did the sewing machine speed up quilt making, but it also decreased the time it took to make items such as sheets and clothing. This in turn gave women more time to make and design quilts. Decorative stitching was still preferred by hand, but the sewing machine was increasingly used to sew appliqués and for the making of pieced quilts.⁴¹ Even quilters of today use both hand and machine stitching in the same quilt.

³⁸ Patricia Cox Crews, *A Flowering of Quilts* (Lincoln, Nebraska: University of Nebraska Press, 2001), 15.

³⁹ Weissman and Lavitt, *Labors of Love*, 59.

⁴⁰ J.M. Gregory, "A History of the Sewing Machine to 1880," *Transactions of the Newcomen Society* 76 (April 01, 2006): 128. Accessed February 13, 2013. <http://pubs-newcomen.com/tfiles/76ap127.pdf>

⁴¹ Shaw, *American Quilts*, 126.

Synthetic dyes are a prime example of science's influence on art. New dye technologies were developed in the mid-century creating many new colors in turn creating brighter and more colorful quilts. Sir William Henry Perkin (1838-1907) accidentally discovered a bright purple dye in 1856 as a result of the search for malaria treatments.⁴² Frederick Bayer also discovered the color magenta in 1858, and aldehyde green, the first non-combined green dye of any kind, was developed in 1869. These dyes and many other brilliant colors were mass-produced and available to the American market.⁴³ The new dyes were more colorfast, brighter than natural dyes and did not require mordanting or vatting.⁴⁴ These new dyes prompted quilters to hand-dye their fabrics to get variations and effects. These new developments in chemistry also influenced the materials and design of quilts. With dyes becoming readily available and easily manipulated, quilters began to dye select pieces of material to fit their design.

Even the underpinning of quilts underwent a change in the wake of changes in the textile industry as evident in the use of commercial batting. Before commercial batting, quilters would use wool or cotton left over after processing, rags, or old clothes and even old quilts. Textile manufacturers learned they could make profit off their cotton waste and began commercially producing batting in 1830.⁴⁵ The company of Stearns & Foster further developed bonded batting, which bonds the top and bottom layers with a resin and was available in long, flat sheets.⁴⁶

⁴² Jenkins, *The Cambridge History of Western Textiles 1*, 802.

⁴³ Shaw, *American Quilts*, 127.

⁴⁴ Jenkins, *The Cambridge History of Western Textiles 1*, 764.

⁴⁵ Shaw, *American Quilts*, 128.

⁴⁶ *Ibid.*, 131.

Media outlets created a boom in quilt popularity via published patterns in magazines, catalogs, and the commencement of exhibitions. Magazines including *Godey's Lady's Book*, published patterns as early as 1835.⁴⁷ They published quilt block patterns and other catalogs and began to profit from selling quilt patterns. Sears and Wards offered a variety of patterns for a dime a piece with the purchase of other materials.⁴⁸ Patterns also disseminated via quilt exhibits at agricultural fairs, which began to emerge around the country. Women would sell quilts and others would enter their work in juried competitions yielding cash prizes.⁴⁹ Not only advancing technologies in the textile industry but also an emergent media culture shaped quilt making and tied what was a handicraft in numerous ways to the world of commerce and technology.

With this public boost from media outlets, quilting also flourished in popularity as it continued to grow into a more formal social activity. Beginning with the quilting bees and parties during the early and late colonial periods, the first American guilds came into being. While quilting bees and parties were more informal, quilting circles and guilds are often formal constituting charters, and defined as incorporated organizations.⁵⁰ The Mormon communities that settled in Utah in the mid-nineteenth century incorporated their own textile history and most likely created the first state-quilting guild.⁵¹

Technical innovations, such as mass production, changed the pace of life affording more time for creativity and experimentation in activities such as quilting,

⁴⁷ Ibid., 85.

⁴⁸ Laurel Horton, *Quilting in America: Beyond the Myths* (Nashville, Tenn.: Rutledge Hill Press, 1994), 36.

⁴⁹ Shaw, *American Quilts*, 85–87.

⁵⁰ Roberts, *The Quilt*, 122.

⁵¹ Ibid., 124.

which continued to develop into the twentieth century. Quilt historian, Robert Shaw, suggests, “The last three decades of the nineteenth century and the first decade of the twentieth arguably comprise the greatest era of quilt making in American history.”⁵² This epoch produced many new masterful designs, from block-style, crazy quilts, and several asymmetrical pictorials reflecting issues in society of the time. Quilts were being made for everyday practical use, special occasions, for commemorative souvenirs, exhibitions, to tell stories, to be expressive, make political statements and to mourn. They were made by women of all levels of society and by women of multiple cultures.

Along with these new scientific inventions used to make quilts, new echoes of STEM-themed quilts began popping up during this time of free-form exploration. Housewife Sarah Ellen Harding Baker (1847-1886) created the *Solar System* quilt in 1876 (Figure 12). She used the quilt as a visual aid during lectures she gave on astronomy throughout Iowa.⁵³ Her design mimics illustrations from astronomy books of the mid-nineteenth century and is modeled after a representation of the Copernican theory of the solar system.⁵⁴ Astronomy was an acceptable interest for women in the nineteenth century and was occasionally fostered in their education although most female astronomers were self-educated.⁵⁵ Baker also took full advantage of the new technical

⁵² Shaw, *American Quilts*, 119.

⁵³ Doris Bowman, “Solar System Quilt Curatorial File,” (Washington, D.C.: Smithsonian National Museum of American History, n.d.).

⁵⁴ Hiram Mattison, *A High-School Astronomy: In Which the Descriptive, Physical, and Practical Are Combined, With Special Reference to the Wants of Academies and Seminaries of Learning*, (New York: Mason Brothers, 2012), 15.

⁵⁵ Pamela E. Mack, “Staying from Their Orbits: Women in Astronomy in America,” Edited by Simon & P. Farnes, *Women of Science: Righting the Record*, Special Issue (1990): 72–73.

inventions used in quilt making such as synthetic dyes, the sewing machine and commercial batting to create her astronomy themed quilt.⁵⁶

Quilting in the Twentieth Century

The twentieth century for quilting was filled with highs and lows. World War II, and The Great Depression brought many social and cultural changes. It furnished a myriad of technological changes, and a revival of not only quilt making but the use of traditional tools and materials in conjunction with new ones. It is a century of looking back to tradition and moving forward with modern ideas, influences and technology. It is within this climate that the art quilt was born.

The twentieth century began with the end of the Victorian era (1837-1901) and entered into a new phase of American history. World War I (1914-1918) sparked a rise in nationalism that was echoed within the quilting community. In a curious twist, modern technology—here armament and the war machinery—influenced once more the craft of quilt making. As soldiers were being sent to fight abroad, the U.S. government urged homemakers to make quilts as bed coverings at home so that manufactured blankets could be sent overseas with the American soldiers.⁵⁷

The 1930s were wrought with economic depression with the fall of the stock market in 1929. The quilting craft went in new directions, and women were making do with what little they had by settling for worn-out clothing, fabric scraps, and feedsacks to create quilts and other household items for their families. During this time, interest in

⁵⁶ Bowman, “Solar System Quilt Curatorial File.”

⁵⁷ Kiracofe and Huff, *The American Quilt*, 186.

quilting escalated. This peak in quilting activity was supported by a wide dissemination of patterns in printed media including newspapers, magazine articles, and mail catalogs. Newspapers such as the Omaha World Herald published a series of patterns in 1938 that included state bird and flowers for each of the forty-eight states such as Florida seen in (Figure 13).⁵⁸ Quilters cut the patterns out and traced them onto cloth blocks. Along with these popular patterns, media published other pattern sets, which frequently included a flora or fauna theme.⁵⁹ Newspaper columns were so popular that women created scrapbook collections of weekly patterns.

The popularity of fairs and exhibits that were developed in the nineteenth century continued into this century. The “Century of Progress” exhibition in 1933-34 for Chicago’s one-hundredth birthday celebration was a catalyst for the Sears, Roebuck and Company to spearhead a national quilt contest. The contest had 25,000 entries.⁶⁰ Following the Depression, World War II (1941-1945) once again brought many cultural changes to society. Quilt making as a domestic activity continued during the war even as women replaced men in the factories, particularly for fundraisers as they had already during World War I.⁶¹

Although there was a waxing and waning of the quilt medium during the first half of the century, it was also a time of revival. In 1924, the New York Metropolitan Museum of Art had conferred status on arts and crafts by opening a new wing devoted to

⁵⁸ Louise, “Quilt Papers: Series Quilts – Newspapers and Magazines,” *Quilt Papers*, July 6, 2007, <http://quiltpapers.blogspot.com/2007/07/series-quilts-newspapers-and-magazines.html>.

⁵⁹ Louise, “Quilt Papers.”

⁶⁰ Kiracofe and Huff, *The American Quilt*, 197.

⁶¹ *Ibid.*, 199.

them.⁶² In the public's eye, this brought the craft of quilting equal to the fine arts. The quilters combined appliqué, embroidery and quilting to reflect the sophisticated designs influenced by Art Nouveau and Art Deco, which offered new sources of inspiration and materials.

Before the industrial age, quilts and textiles were made from linen, wool, silk and cotton. The science of synthetic fibers came into being during the first half of the century developing such new fibers as Rayon, Nylon, Acrylic and Polyester. Acrylic, developed by DuPont was available by 1950 and was used for quilts and clothing.⁶³ It was lightweight, warm, less expensive and similar to wool. Many fabric blends became popular and well-known quilt makers began to design for commercial fabric companies.⁶⁴

Crossing the Threshold Into the New Millennium

The second half of the century brought even more changes in quilting as the country came into the modern age. Quilt making resurfaced as a social and cultural revival and saw a number of academically trained artists switching from painting and sculpting to modern arts and crafts like quilting, which rivaled traditional fine arts.⁶⁵ The modern arts and crafts movement brought mixed ideas incorporating the traditional hand craftsmanship with modern contemporary art.⁶⁶ Artisans began to experiment with new techniques and materials, drawing from various cultures around the world. Quilting

⁶² Ibid., 210.

⁶³ "DuPont Heritage Timeline." Accessed February 12, 2014.
http://www2.dupont.com/Phoenix_Heritage/en_US/1941_detail.html.

⁶⁴ Shaw, *American Quilts*, 291.

⁶⁵ Ibid., 306.

⁶⁶ Ibid., 26.

matured from a functional necessity into a modern, expressive art form coined ‘art quilts’.⁶⁷ This and the back-to-nature movement brought an emphasis on non-technological production during the 1960’s were a few of the catalysts for the resurgence of American quilting.⁶⁸ The resurgence brought a new function and aesthetic to quilts, and a new chapter in the history of quilting. As quilt author, Elise Schebler Roberts, describes, “The purpose of the art quilt is to communicate an idea, challenge aesthetic traditions, or experiment with materials.”⁶⁹ Art quilts comprise many different themes, materials, styles and techniques. They can express a vast array of themes ranging from politics, to architecture, portraiture, humor, and especially the sciences.

The art quilt is a fiber art, which came into being as a serious academic discipline under the influence of the feminist movement of the 1970’s. A pivotal exhibition, highlighted the collection of Jonathan Holstein and Gail Van Der Hoof. Guest curated by the two collectors, the exhibition took place at the Whitney Museum of American Art, titled *Abstract Design in American Quilts*.⁷⁰ It propagated the idea that quilters could be artists.⁷¹ While many art quilts during this time reflected modern abstract and Op-Art paintings, not all quilts were works of art and not all quilt artists make art quilts. Regardless of the approach to quilting that artists and crafters took, quilting still transformed as new technologies emerged during this half of the century. Strip piecing

⁶⁷ Ibid., 288.

⁶⁸ Roberts, *The Quilt*, 84.

⁶⁹ Ibid., 224.

⁷⁰ Jonathan Holstein, *Abstract Design in American Quilts: A Biography of an Exhibition* (Louisville, Kentucky: Kentucky Quilt Project, Inc., 1991), 42.

⁷¹ Shaw, *American Quilts*, 309.

and the rotary cutter are advances that assisted the boom of quilting in the last quarter of the twentieth century and kindled the evolution of the art quilt.⁷²

Many elements, some new, advanced the art quilt even further into common practice. Strip piecing and rotary cutters, digital sewing machines, computer programming, the DIY movement and more experimentation with dying were all key. These new technologies led to quilt artists advancing their tools & materials, techniques and processes of learning.

Although not necessarily modern inventions, strip piecing was created by the Seminole Indians in Florida and the rotary cutter was invented in Japan to cut silk for kimonos, both are utilized in modern ways.⁷³ In Strip Piecing, the quilter takes strips of fabric, sews them together and then crosscuts them to form seamed units or blocks, which bypass the need to cut and sew small pieces of fabric together.⁷⁴ Art quilt artists often utilize this technique to create optical illusions within their quilts. Strip piecing evolved into speed piecing and revolutionized how-to-books on quilting for a new generation of quilters. The major appeal of the rotary cutter was to ease the cutting of fabric. Even quilters who did not use strip piecing use rotary cutters to speed the process of making quilts.⁷⁵

The forward trend continued when the sewing machine went digital. Modern digital sewing machines offer a larger variety of stitches, touch-screen controls and

⁷² Ibid., 288.

⁷³ Ibid., 288–289.

⁷⁴ Ibid., 288.

⁷⁵ Eleanor Levie, *American Quiltmaking: 1970-2000* (Paducah, Ky.: American Quilter's Society, 2004), 53–54.

sensors that adjust to various fabric thickness. They can also trace embroidery, thread a needle, make a knot at the end of a seam, and cut thread.

Computers appear in the 1950's and computer programming evolved in the 1960s followed by industrial programming in the 1970s.⁷⁶ Singer introduced the world's first computer-controlled sewing machine in 1978.⁷⁷ Programming evolved from operating machines to operating intelligent applications and became common enough that Internet access offers free downloadable programs such as digital quilt patterns and programs that allow the user to create their own quilt patterns.

Amidst these new technologies, new developments in society also influenced quilt makers. A rebirth of the DIY (Do It Yourself) movement took hold in the 1970s, beginning with the old pattern of personal involvement and use of skills in upkeep of houses, clothing, and the maintenance of cars. This expanded into the world of quilting among many other crafts.⁷⁸ New books, catalogs and magazines published patterns and how-to documents on quilting. The DIY movement expanded into television with the creation of new networks and shows.⁷⁹ Many other networks began producing DIY-style shows including "Craft in America", which premiered through PBS (Public Broadcasting Service).⁸⁰ These DIY outlets created a new generation of quilters and crafters. Anyone

⁷⁶ P.J. Brown, *Starting with UNIX* (Reading, Mass.: Addison-Wesley, 1984), 4.

⁷⁷ "History | Singer Sewing," Singer, Accessed February 18, 2014, <http://www.singerco.com/company/history%20?iframe=true&width=100%&height=100%#1978>.

⁷⁸ Teal Triggs, "Scissors and Glue: Punk Fanzines and the Creation of a DIY Aesthetic," *Journal of Design History* 19, no. 1 (March 20, 2006): 69–83. doi:10.1093/jdh/epk006.

⁷⁹ Kelly McLain, "New Generation of Makers Embrace the DIY Movement," *IQ Intel*, (May 15, 2015), accessed May 12, 2015, <http://iq.intel.com/new-generation-of-makers-embrace-the-diy-movement/>.

⁸⁰ "Craft In America," *Craft In America* video, 2012, <http://www.pbs.org/craftinamerica/index.php>.

could learn to quilt meaning that quilting stayed a social craft, but changed from the context of learning from family, to learning through self-exploration.⁸¹

Although hand dying is not a contemporary concept, many quilt artists began dying fabric and made them commercially available to quilt makers. Fiber-reactive dyes developed in 1956 and fueled experimentation. Fiber-reactive dyes were colorfast and brighter allowing quilters to vary and experiment with techniques such as tie-dye and rubber-stamping. Along with a variety of brighter colors, these new chemical dyes would adhere to many different types of fabrics not restricting quilters to just cotton or wool allowing them to experiment with many new materials such as ribbons, batting, cellulosic fibers, rayon and acetate. Modern day quilters still use a mixture of mineral and synthetic dyes to get a wide range of colors and effects. This is the beginning of the art quilt expanding into a new realm of discoveries, materials, technologies, and modern culture, a scientific one.

While we have considered many new technologies noted above and their influence on the form of quilts and quilting materials, new technologies have also provided quilters with new pictorial inspiration. Of particular note is the fascination with the images beamed back since the 1990s by the Hubble Telescope and made available on the web.⁸²

⁸¹ Ladyofashion, "Blog Love and the New Generation of Quilting," *Fashion Tales: Emerging Talent, Food, & Sophisticated Living* (blog), 2011, <http://www.fashiontalesblog.com/2011/03/blog-love-and-new-generation-of.html>.

⁸² The Hubble Space Telescope was launched in 1990. The telescopes detail images not only changed how scientists look at the universe, but also has become visual inspiration for artists such as quilters. Hubble images are free online at <http://hubblesite.org/gallery/>.

Other developing interests in the sciences also found and are finding their way into quilting. Among them is the fascination with fractals. A fractal is “a geometric shape with components that are self-similar at multiple scales.”⁸³ Quilts, much like fractals, are geometric and are often composed of self-similar units. Indeed, many quilt artists profess a fascination with fractals and their repeating symmetry, bright colors and mathematical nature, which are the very foundation of most traditional quilts.

The invention of the electron microscope in contrast to the macroscopic images of the Hubble Telescope makes microscopic images available to the naked eye. This invention was first publicly demonstrated in 1931.⁸⁴ The Internet contains thousands of websites that display these microscopic images and magnify nature such as insects, plants, viruses and even organs in the human body.⁸⁵ Modern day quilt artists incorporate these magnified images in their quilts perhaps to make these images more tangible compared to a strictly two-dimensional painting or photograph. A quilt with its malleable surface can add texture to these images and endow them with a sense of magnified reality.

These new technologies coupled with the Internet are a fecund resource for scientific imagery and have created a new social network for quilters, artists, and scientist alike. The Internet has also fostered the growth of scholarship through online museum collections of art quilts. In addition, the internet has also become a host for specific

⁸³ Louis Cantrell, interview by Stacy Cantrell, Fairfax, Virginia, November 2, 2011.

⁸⁴ Martin M. Freundlich, “Origin of the Electron Microscope,” *Science* 142, no. 3589 (October 11, 1963): 185. doi:10.1126/science.142.3589.185.

⁸⁵ Joseph W. Francis, “Use of Internet Resources in the Biology Lecture Classroom,” *The American Biology Teacher* 62, no. 2 (February 2000): 90. doi:10.2307/4450845.

organizations dedicated to the advancement and education of the art quilt. Art quilt artists who choose STEM as their focus are at the forefront of this modern phenomenon. STEM-focused art quilts result from the transformation of traditional quilts, the evolution of quilting techniques and tools, and the development of new technologies with globalization.

As demonstrated, from the early colonial period up to the present, there are historical links between STEM, traditional quilts, and contemporary art quilts. As contemporary art quilts just as the definitive quilts have expanded and sectioned into various styles, STEM is apparent as the underpinning of all quilts. The progression of art STEM quilts to STEAM quilts will be discussed in the following chapter and it will be shown how STEAM quilts are developing into a new style in the contemporary art quilt medium.

CHAPTER TWO: STEAM QUILTERS AND THEIR ART

Developing New Cultural Values

Craft naturally progresses from era to era as cultural values change, and thus the crafts preserve our heritage and history. In addition, the crafts foster new traditions or new styles. Studies of cultural values cross multiple disciplines, but to limit and contextualize the discussion to art quilts, I adopt social theorists Clyde Kluckhohn's and W. H. Kelly's definition of culture as, "that complex whole which includes artifacts, beliefs, art, all the other habits acquired by man as a member of society, and all products of human activity as determined by these habits."⁸⁶ I also adopt a definition of cultural values with respect to quilting from E. McClung Fleming, noted author and former head of the Education Division of the Winterthur Museum. His article, "Artifact Study: A Proposed Model", offers a practical application for cultural analysis. Fleming notes, "one form of cultural analysis deals with the functions performed by the artifact".⁸⁷ Quilting offers a perfect example: generational teaching, techniques, tools and materials, quilting styles, and the social statements art quilts make.

⁸⁶ Clyde Kluckhohn and W. H. Kelly, "The Concept of Culture," In *The Science of Man in the World Crisis* (New York: Columbia University Press, 1945), 82.
https://archive.org/stream/scienceofmaninth031937mbp/scienceofmaninth031937mbp_djvu.txt.

⁸⁷ E. McClung Fleming, "Artifact Study: A Proposed Model." *Winterthur Portfolio* 9 (1974): 157.

I define cultural values in quilting as values that the majorities of quilters tend to share and agree upon and which are often validated or catalyzed by key quilt makers of their eras. From a heritage viewpoint, cultural values in quilting can also be characterized by an examination of quilts from past eras to explain why specific quilts were preserved as valued objects.

A few examples illustrate how changing cultural values influence the natural progression of quilting from era to era. In the early colonial period one indication of the cultural value of quilting was how coveted they were. Quilts were highly valued and often owned and made by the elite and wealthy and the quilt makers were the trendsetters of their day. The elite made many of these quilts with the assistance of their slaves, a collaboration that would later promote entirely new demographics of quilting.

In the late colonial period, textile designers and woodblock printers influenced values in quilting aesthetics. John Hewson (c. 1745-1821) was located in Philadelphia and was known for customizing orders for women.⁸⁸ Hewson was one of the most influential calico printers of the eighteenth century and had a heavy influence on many quilt patterns including mainly floral motifs.⁸⁹ Quilts containing his motifs are highly valued in museum collections today.

The nineteenth century included a great many technical and scientific advances and quilting supplies became more affordable, which afforded women more time to quilt. The popularity of botany for women was a huge cultural influence on quilting during this

⁸⁸ Kimberly Wulfert, "The Man of Many Vases: John Hewson, Callico Printer," *Folk Art Magazine*, (2007): 62.

⁸⁹ *Ibid.*, 68.

century. Quilter and quilt historian Susan Curtis observes, "they studied botany to fill their leisure time with productive activity and to understand the spirituality of nature. And by using floral motifs in their decorating, women believed that they could educate and provide moral guidance for their families."⁹⁰ There were many aesthetic and structural consistencies among flowers, gardens and quilts during this era. Many design preferences for flower gardens were similar to those quilt patterns.⁹¹ Several publications encouraged such consistencies such as *Godey's Lady's Book and Magazine*, *Gardener's Magazine*, and *The Gardener's Monthly*.

The twentieth century brought even more technical and scientific advances along with a social and cultural revival of the quilting arts. One cultural value that held true during this dynamically changing era was quilting for social change. With the occurrence of many wars, women's suffrage, prohibition, the Great Depression, labor unions, civil rights, and more, quilters reflected their responses to contemporary social and political issues in their quilts. Cultural values inescapably evolved over the centuries and made quilting fecund for the expression of these new values. One example that changed the course of quilting from a cultural standpoint is activism in health. The AIDS epidemic that began in the 1980s brought significant losses to the world.⁹² A quilt was made to remember the losses of friends and family who had died of AIDS-related issues. The quilt initiative grew, and the AIDS quilt became the most effective statement quilt of

⁹⁰ Susan Curtis, "Blessed Be God For Flowers: Nineteenth-Century Quilt Design," In *A Flowering of Quilts*, ed. Patricia Cox Crews, (Lincoln: University of Nebraska Press, 2001), 11.

⁹¹ Ibid., 15.

⁹² "A Timeline of AIDS," AIDS.Gov, 2011, <https://www.aids.gov/hiv-aids-basics/hiv-aids-101/aids-timeline/>.

all time, The AIDS Memorial Quilt. It remains the largest community art project in the world and was nominated for a Nobel Peace Prize in 1989.⁹³ In addition to fabric, the quilt's panels incorporated a host of personal items and non-traditional materials. Non-traditional tools and materials are a popular aspect of art quilts. Figure 14, *Liberace*, ca. 1987, is a quilt panel in honor of Valentino Liberace (1919–1987). Liberace was a professional pianist best known for his flamboyant performances and outlandish costumes. His quilt panel reflects his style with the use of metallic gold and silver fabrics and thread. His name is an enlarged copy of his autograph. The quilt also displays a grand piano with a candelabra on the top, which became a standard at his performances.

Modern Era Cultural Values

As cultural values evolved over the centuries new artists created and practiced new values in quilting. The community and culture of art quilting is and has been constantly progressing, and is now becoming a crossover art, one that includes multiple disciplines. One developing value that these artists share is their tendency to be polymaths. Author and professor of psychology at Ohio State University, Christine Charyton states, "Polymaths excel in multiple areas and tend to make transdisciplinary discoveries." STEAM quilt artists appear to be potential polymaths synchronized with technology, the sciences and art. Three out of the four artists I interviewed for this thesis are considered polymaths. Leslie Lerrerdink Gardner, a contemporary art quilt artist from Colorado states after attending a program with three professional quilt artists on

⁹³ Shaw, *American Quilts*, 305.

creativity, "My takeaways were to experiment, be a polymath to explore new topics, be intentional about why you make art."⁹⁴

Ernst Haeckel (1834-1919), a nineteenth century polymath excelling in biology and art, discovered thousands of new species. His work changed the face of modern biology. As an artist, Haeckel was able to sketch and make watercolor drawings of his findings; his illustrations titled, *Art Forms in Nature*, 1904. They became immediately popular in his time and are still so popular today that fabrics printed with Haeckel's designs are available for quilters and sewers.⁹⁵ Haeckel's works have influenced artists and scientists to this day, as for example artist Barbara J. West. West's quilt titled, *Mandala's of Science: Thalassicolla Lagica*, 2003 was influenced by Haeckel's discovery of Mediterranean Sea plankton in 1860 (Figure 14). West takes artistic license in her design by selecting her own colors for her quilt. She incorporates a variety of spheres to highlight close-ups of sections of the plankton and uses beads to emphasize finger-like protuberances. She uses such quilting techniques as couching to accentuate the cylindrical nucleoli and embroidered patches to indicate protoplasm.⁹⁶ Irenäus Eibl-Eibesfeldt, founder of the field of human ethology, describes the correlation between scientists and artists, "scientists and artists rarely embody fundamentally different personality types. Moreover, artists are just as curious as scientists. They enjoy

⁹⁴ Front Range Contemporary Quilters (FRCQ) Facebook page, accessed September 16, 2015, <https://www.facebook.com/frcq.artquilters/posts/10153047814815208>.

⁹⁵ Zazzle.com is a website where Ernst Haeckel printed fabrics can be purchased for upholstery, quilting and crafts, <http://www.zazzle.com/ernst+haeckel+craft+supplies>.

⁹⁶ Barbara J. West, "Mandalas of Science I: Thalassicolla Pelagica." Radiolaria.org, n.d., <http://www.radiolaria.org/west/>.

experimenting, which enables them to learn astonishing things."⁹⁷ Artists' interests in STEM subjects are reflected in their work thus turning them into modern day pseudo-polymaths or budding Renaissance men and women.

Learning how to quilt has significantly changed over time. For traditional quilt making, there are modern quilt guilds, local quilting bees and the handing down of skills generationally. Aside from these traditional means, art quilt quilters often learn through a variety of means. Some do learn the basic skills of sewing and quilting from family members; however, many art quilt and STEAM quilt artists learn through social media. The Internet is a broad gateway to learning on social media. Websites such as YouTube offer thousands of how-to videos on quilting and quilt-related skills. Conducting a search on 'how to quilt' on the YouTube website produced almost 65,000 results. Conducting the same search on Google produced over 33,000,000 results.

Other new learning venues include how-to books and television series. Ubiquitous craft supply merchandising companies such as Walmart, JoAnn Fabrics, Michaels, Barnes & Noble, Amazon, and Craftsby carry numerous books on the various art styles of quilting. Many digitally transmitted television, cable, and online content streaming networks are dedicated to quilting shows and videos such as HGTV, QNNTV.com, quiltinaday.com/television/, and thequiltshow.com. Online social networks also offer quilting lessons through blogs, newsletters, Facebook groups, and chat rooms where learners can ask questions and receive feedback. The breadth of quilting styles, materials,

⁹⁷ Ernst Haeckel, *Art Forms in Nature: The Prints of Ernst Haeckel*, 12th ed. (Munich, Germany: Verlagsgruppe Random House, 2011), 19. Haeckel's illustrations were originally published in sets of ten between 1899-1904 and two full volumes in 1904.

and skills among STEAM quilt artists seems to serve as a breeding ground for creating new processes and techniques. Self-teaching via social media is a contemporary cultural value that serves artists by providing many avenues for learning and rich sources of inspiration.

Unprecedented techniques along with new design systems can be considered a new cultural value with STEAM quilters. STEAM quilters are innovators utilizing technologies never before used in the quilt medium. Throughout quilting history, quilters have often applied new technologies to their craft; however, STEAM quilters now incorporate new technologies into their quilts as materials, not just in their processes or tools. Some common techniques of traditional quilting are appliqué, piecing, and hand and machine stitching. Many STEAM quilters still use these techniques but they also incorporate new techniques and materials such as mini computer processors, LED lights and copper conducting wire. By using unprecedented techniques and materials and creating new design systems, they are setting a new standard. For example, art quilt artist Rose Rushbrooke is the first artist to use Mandelbrot sets created with a computer program to make fractal quilts.⁹⁸ She then developed a technique to hand piece them together.⁹⁹

These artists mingle new cultural values while continuing to draw from traditional ones. As cultural values of quilting changed from strictly functional use to include

⁹⁸ Jeff Berkowitz and Lifesmith Classic Fractals (Firm), *Fractal Cosmos: The Art of Mathematical Design* (Oakland, Calif.: Amber Lotus, 1994), 1. A Mandelbrot set is named after IBM scientist Benoit Mandelbrot. The Mandelbrot set is a set of complex numbers that is fractal when plotted.

⁹⁹ Rose Rushbrooke, "Fractal Arts Quilt Gallery 1", Accessed February 9, 2014, <http://www.rosrushbrooke.com/fractal-art-quilts-1.html>. An HGTV video of how she creates her fractal quilts can be viewed at <http://videos.hgtv.com/video/fractal-quilts-69598>.

various non-functional uses, these artists' quilts are made for non-functional use in the form of display. The STEAM quilts they make are not for conventional use. Instead of making them for family members to use or as gifts, they are designed to hang on walls in homes, galleries and museums. Aesthetics also plays a more unique role for these artists. Sometimes they quilt for reasons free of aesthetics even though their quilts may be strikingly beautiful. They often tend to focus on either scientific correctness or abstraction. Many of them continue to practice traditional quilting processes such as using recycled materials, hand stitching and hand dyeing.

The Artists

The artists discussed in this section serve as examples of how STEAM quilts have naturally evolved from art quilts. Technological advances in communication modes and media have afforded these quilters easier access to new tools and materials, which in turn has offered new sources of inspiration. The development of this phenomenon empowers artisans to express and influence cultural values in new ways. STEM has become mainstream in the world of quilting. Resources such as recent innovations, social media, and the Internet are today what are considered common. Ease of accessibilities to these resources is an important factor for STEM becoming mainstream in quilting and acts as a catalyst for art quilt artists to develop into STEAM quilt artists.

Interviews of STEAM quilt artists are key to validating the context of their artwork rather than basing the affirmation on viewing the artwork alone. They explain their art and why they make it. In order to understand their art and from where it develops, the artists reveal their artistic journey and how their art evolved into STEAM

quilts. As with any burgeoning art form, it is important to understand the artist's intentions, background, and cultural influences on their art.

My interviews for this thesis explore the relationship between the artists and their art. The artists evolve beyond art quilting by incorporating unprecedented tools, processes and materials. They are contemporary art quilt pioneers forging new ways of expressing their art. As with many emerging art artists, their relationships to their artwork are groundbreaking meaning they take risks and embrace change, they are rigorous in their approach to creation and embrace new challenges. They struggle to find a unique voice in a noisy art medium. Their aim is to be an artist with a STEM background or to have a love of STEM topics, utilize the Internet and social media, and exercise new cultural values.

They respond to new exposure to ever expanding fields of practice, research and publications. Their art emerges from a vast variety of materials and means. By reflecting their exposure to new fields of practice in their artwork, it in turn brings art and STEM education to the mainstream, which is a goal of STEM education pioneers. Margaret Wertheim, a science writer and cultural historian who created the hyperbolic crochet coral reef suggests that the problem with people shying away from science is that, "it is presented in ways that are pretty alienating to many people." Something like the crochet project or a STEAM quilt, "demonstrates that science can be a tactile, enjoyable,

aesthetically pleasing experience-which is a powerful way to introduce all sorts of people to some deep scientific areas."¹⁰⁰

In some ways, their engagement in STEM makes these artists different from other artists. They tend to view their art from a different perspective. They find beauty in unusual scientific images such as a magnified image of a kidney or the iron bands in a rock formation. These artists are a part of the crafts-as-art movement. As critic and philosopher Arthur Danto has argued that what transforms craft into art is not the rejection of function but what lifts it from the plane of the well made and useful to the plane of significance, giving it meaning and a philosophy. Like many other artists who have fallen into the craft-as-art movement, these artists struggle with artistic identity. Some see themselves as crafters, others as artists, but this group goes a step further to include scientists. Arthur I. Miller, noted author and Professor Emeritus of History and Philosophy of Science at University College in London has interviewed several artists-scientists. In his research he explains that, "many artists told me that for them the distinction between artist and scientist is already meaningless. They regard themselves not as artists or scientists, but as researchers."¹⁰¹

In this section, I highlight four art quilt artists: Sue Benner, Jimmy McBride, Virginia Abrams, and Cheryl Sleboda. Each artist encompasses the use of one or more STEM fields in their craft. As Carolyn Ducey, Curator of Collections at the International

¹⁰⁰ Maria Elena Buszek, "Crochet and the Cosmos: An Interview with Margaret Wertheim," in *Extra/Ordinary: Craft and Contemporary Art*, ed. Maria Elena Buszek (London, England: Duke University Press, 2011), 283–284.

¹⁰¹ Arthur I. Miller, *Colliding Worlds: How Cutting-Edge Science Is Redefining Contemporary Art* (New York: W. W. Norton & Company, 2014), 342.

Quilt Study Center and Museum states when discussing what is new in the contemporary art quilt world, “The biggest change is artists embracing more technology for their own quilts by their own hand-dyed fabric, by using photo manipulation, by using interesting combinations”.¹⁰² These artists demonstrate modern cultural values, traditional cultural values and pull from conventional and modern resources to create and develop their craft.

Sue Benner

Sue Benner from Dallas Texas is an art quilt artist who exemplifies STEM in her work. She holds a Master's degree in Biomedical Communications and Illustration. Benner utilizes her science education extensively in her art quilts. In an interview, she states how her education in biology plays a major role in her work:

[I] began college as a chemistry major and soon shifted to molecular biology—a very new major at the time. I fully intended to go to graduate school in the subject or medical school and finished all the requirements. I worked in a soil chemistry lab as my part-time job. But the whole reason I got interested in art again was the visual excitement of the microscopic biological world.¹⁰³

By doing this, Benner wanted to find a way to communicate what she was seeing. Fabric design as well as a drawing class gave her the basic tools to express herself and two semesters of art history gave her the context.

Benner works with many technologies to make her biology-inspired quilts. She took a fabric design course at the University of Wisconsin, which motivated her to expand on her dyes. When referring to her education in dyes she states: “Actually, we weren’t taught the science of it at all at that point and later I pursued that information

¹⁰² Carolyn Ducey, interview by Stacy Cantrell, Lincoln, Nebraska, October 4, 2012.

¹⁰³ Sue Benner, e-mail message to author, September 8, 2014.

myself." Because of her science background, the steps it took to use dyes didn't intimidate her. "Later I developed different ways to work with the dyes in a much more abstract expressionistic way."¹⁰⁴ Benner incorporates Procion MX and H dyes, which are cold reactive and hot water textile dyes, and dye painting. For example, Benner's quilt titled, *Seminiferous Tubules*, 1980, Figure 15, demonstrates her early use of dyes. Her dyed pastel and bold colors move from concentrated to diffused and bring a sense of depth to the images in her quilt. Seminiferous tubules make for an interesting quilt topic; however, she illustrates complex biology in very controlled detail. She used tissue and cell structures as direct subjects with an occasional twist on the interpretation. Her quilt is a dye-painted and batiked fabric illustration quilted by hand. Benner illustrates the science of her art when compared to actual microscopic images of seminiferous tubules, a large portion of testes¹⁰⁵ (Figure 16). Other technologies that Benner incorporates in making her quilts are mono printing, (printing with an image or lines made once), several sewing machines, Photoshop for photo manipulation and visualizing subjects while also using digital cameras on a daily basis.

Benner draws from many sources of inspiration, but above all on her scientific subject matter: "My education in molecular biology and medical illustration still figures in my work with an underlying sense of structure and organizing principles. I see a direct connection between the concept of quilt and the assembly of units to make a larger

¹⁰⁴ Sue Benner interview, September 8, 2014.

¹⁰⁵ *Encyclopedia Britannica*, s.v. "Animal Reproductive System," Accessed February 24, 2015.
<http://www.britannica.com/EBchecked/topic/498613/animal-reproductive-system/75950/Male-systems>.

whole.”¹⁰⁶ *Kidney Quilt*, 1984, Figure 17, expresses this connection as the quilt is made of many sections to create various images of cells. Within each geometrically shaped space are various groups of cell types. Each one indicates the fabric representation of a petri dish. There is structure in the outlying sections while the cell areas express a more conceptual presentation.¹⁰⁷

Benner is also influenced by mathematics. "I am not afraid of math," she states. "It was actually one of my favorite subjects growing up. I use math all the time in my work. I have a very experimental approach to my series. I think of the parameters, what I hold constant, what I vary. I am always problem solving and love this aspect of my work. Yet, I am producing something that is still a quilt."¹⁰⁸ Benner references images online and draws inspiration from Discover Magazine, Scientific American, Nova, other scientific TV shows, and NPR science shows. She also reads books on various scientific and mathematical subjects. When it comes to social media such as Facebook and Instagram, she utilizes these sites for posting photos and promoting her work.

Like a majority of modern non-traditional quilters, Benner taught herself to hand and machine quilt and later joined the Quilter's Guild of Dallas to learn more formal techniques. She is an award-winning artist who also teaches, lectures, and juries. She is also a published author contributing to the advancement of her field.¹⁰⁹ "When I began making quilts of biological subject matter, there was no one that I knew of that was doing

¹⁰⁶ Sue Benner interview, September 8, 2014.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

¹⁰⁹ Ibid.

so. Now there is a wealth of artists using that subject matter in various ways in the medium".¹¹⁰ Benner is an example of the many accomplished scientists who become artists. According to an article by Joyce Lovelace, *American Craft's* contributing editor, "Science inspires their art, while art informs their scientific research".¹¹¹

Jimmy McBride

Jimmy McBride considers himself to be a sculptor using craft to tell his story. "I consider my quilts a sculptural type of work," he further clarifies, "I like towing the line between high art and craft." McBride is a crossover artist using modern tendencies of fine artists transitioning over to the craft of quilting. This is becoming more commonplace today. McBride began at the Academy of Art College in San Francisco, and then later moved to the Art Institute in Chicago to develop his fine arts. After graduating from Chicago he moved to New York for graduate school. When this didn't work out, he created a home studio. He explains his transition: "I was chugging along and I was doing painting in the studio and some sculpture but nothing was really panning out so I told myself I was going to take a break from art for a while and just do something else. For some reason, I always wanted to make a quilt and I had all this free time so I might as well just do it, so I made a quilt. It just kind of snowballed from there."¹¹²

Unlike Benner, McBride was taught the basics of sewing and quilting by his mother and benefitted from the tradition of passing down quilting from generation to

¹¹⁰ Ibid.

¹¹¹ Joyce Lovelace, "Art + Science2." *American Craft Magazine* (2014): 72.

¹¹² Jimmy McBride, interview by Stacy Cantrell, Brooklyn, New York, April 16, 2011.

generation. To hone in on advancing his techniques, McBride discusses how he accesses YouTube to learn more: "I got the basics down on how to do it and then I started looking at all the YouTube videos and I was like, Oh that helps out a lot! It gave me the little tricks of the trade that I was missing."¹¹³ McBride grew up near Amish settlements in Indiana and was exposed to Amish style quilting; he states, "I grew up knowing about Amish quilts and the Amish way of life so that made a big impression. So I knew about quilts from early on."¹¹⁴

McBride's main inspiration comes from outer space both real and fictional. He discovered that NASA's Hubble Telescope images were available for free on the Internet, and he uses them to make quilt representations of nebulas, black holes and solar systems. He is also inspired by people writing science fiction and along with each quilt comes a back-story of a man in space creating quilts of images he sees go by while traveling across the universe. McBride explains how this inspiration developed, "The first Hubble image quilt that I made was for a friend who was having a baby. I didn't know what to get her so I made a solar system quilt." McBride wanted to do another one so he started thinking of a back-story to them. "Who is making them? Why? The conceptual back-story to it is the most integral part of the whole thing." He loves Star Wars and Space Opera and battles, but then he made a declaration, "But you know if you think about it, space is going to be much more mundane".¹¹⁵ *Ambush in Quadrant 4 on the Far Side of the Pleiades*, 2009, Figure 18, tells a fictional story of an ambush on the Pleiades Space

¹¹³ Ibid.

¹¹⁴ Ibid.

¹¹⁵ Ibid.

Station by rival native peoples in this area of the galaxy. McBride even incorporates his storyline into his use of fabrics, "Made with fabric from three colonies and one space station and thread from a trading market on a far moon and a nice old lady." This large quilt was hand and machine quilted with recycled cotton fabrics.¹¹⁶

Another influence on McBride was the Arts & Crafts movement that began in the 1880's; he combines the traditional techniques associated with this movement and mixes them with his new technological and astronomical inspirations. "To the Arts & Crafts movement, it has been repurposed and re-advertised. People are enjoying that things are hand made again," he proclaims. McBride suggests this phenomenon belongs to the same category as scores of people wanting organic food, and people wanting to return to the simpler things. "I feel like part of this new movement." McBride explains his uses of all store-recycled clothing for his fabrics, "Reasons are 1. I really like that aspect of the traditional quilts that Amish did." Amish people will buy extra fabric that they buy for their clothes and use them in their quilts. Women would use their husband's old clothes. McBride's second reason is, "2. Like my character, there are no fabric stores in space. He has to trade. Even then, there is limitations with matching, fabric types".¹¹⁷

Not only does STEM inspire McBride's art, art can also inspire and teach others in STEM fields. Similar to Sarah Ellen Harding Baker's "*Solar System*" quilt, Figure 12, which she used to teach astronomy back in the 1870's, McBride's quilts offered the same experience to a planetarium audience: "I spoke at the planetarium at the Hudson River

¹¹⁶ Jimmy McBride, *Ambush in Quadrant 4 on the Far Side of the Pleiades*, 2011, http://jimmymcbride.com/artwork/1188111_Ambush_in_Quadrant_4_on_the_Far_Side_of.html.

¹¹⁷ Jimmy McBride interview, April 16, 2011.

Museum. During one point (a scientist) at the planetarium had the people looking at the quilts and pointing out the nebulas and then pointing at the sky and showing where they were. Like this one is over Australia. I found that so cool and did not think of my quilts as something to learn on before that. It really gave me a new perspective."¹¹⁸ A Giant Hubble Mosaic of the Crab Nebula (M1) taken in 2005, Figure 19, is more commonly known as the *Crab Nebula* taken by NASA's Hubble Telescope. According to NASA scientists, the Crab Nebula is about 6,500 light-years away from the constellation Taurus. McBride's quilt version, *The Crab Nebula*, 2008, Figure 20, displayed at the Planetarium, is a stunning interpretation made with plaid fabrics incorporating several colors to emphasize the various oxygen and hydrogen atoms. He uses several hundred pieces of cut fabric to emphasize the tangled filaments intertwined giving the Nebula its specific shape. Like McBride's other space quilts, he explains how his character made this quilt, "Made with fabric given to me by inhabitants of the arctic rain forests of Tao'Ne and traders on a distant mining station, thread from old vacuum blankets."¹¹⁹

McBride's art offers three statements that contribute to the progression of STEAM quilts. The first is that he blends the traditional with STEM. He uses recycled fabrics coupled with traditional hand sewing along with modern tools such as sewing machines, rotary cutters and the Internet. The Internet influenced him with astronomy and science fiction. His other statement is that fine artists can become crafters and incorporate their education in learning new art forms as he did as a sculptor turned quilter. His third

¹¹⁸ Ibid.

¹¹⁹ Jimmy McBride, *M1 V2 (The Crab Nebula) Quilt*. Quilt, 2011, http://jimmymcbride.com/artwork/2001615_M1_V2_The_Crab_Nebula.html.

statement is anyone can learn a new craft by exploring social media and the Internet.

McBride honed his techniques and skills with YouTube how-to videos and demonstrations.

Virginia Abrams

Virginia Abrams, also a self-taught quilter who found quilting in 1997. Similar to Sue Benner, Abrams is a scientist-turned-artist who discovered she could use her science background to create art. She states, "My formal education was in organic chemistry and biochemistry, and it was a life changing discovery that I could combine my long-time pursuit of chemistry and sewing to dye fabrics and piece those hand-dyed fabrics into art quilts." Dyeing her own fabrics is her favorite part of quilting. She boasts, "I had the sewing skills and doing the geometry didn't bother me and I started right up dying the fabric because I had the chemistry skills to do so and I hand dyed my cotton fabrics and it was wonderful. I just loved it."¹²⁰

Abrams relies heavily on her science background to expand her artistic vocabulary. Not only does her knowledge of chemistry allow her to understand dyes; it was the way she was taught. She explains, "When you have a science background, you are interested in different things I think than if you're background is all art." The concept of reading a book to learn her coursework was important. Abrams does not have an art

¹²⁰ Virginia Abrams, interview by Stacy Cantrell, September 11, 2014.

background. "To think about making quilts, and I was going to learn how, I read a whole lot of quilting books."¹²¹

Abrams, who was taught to sew by her mother, started making traditional quilts like Amish quilts and copying designs by famous art quilt artists. Abrams chose quilting because she liked its tactile nature. After her quilting skills improved, she began making her own designs. "Art quilts are just very appealing because they are something you can put on the wall," she points out. Abrams early quilt designs were based on a microscopic image of a mini microphone and then went into a more organic direction.

Abrams uses her chemistry skills in her processes and materials; however, in subsequent studies she was also inspired by physics, geology and biology. Abrams titles her series of art quilts, which were based on research and analysis to ensure accuracy in her water reflection designs, *Reflections*. She discusses the work, stating, "What causes a reflection, especially in water? It's the water's movement and then whether or not you have refraction going through, the light going through the water." Abrams uses a Nikon D80 camera to capture lake reflection at high speeds. She uses thousands of reflection images to study the physics of refraction and clarifies, "Trying to take the pictures at exactly the right time of the reflections of the lake is paramount depending on wind and other elements".¹²² In her art quilt, *Reflections II*, 2012, Figure 21, Abrams captured abstract forms of reflections from her photo images along the edge of Seneca Lake, New York. She depicts a moment in time that only lasted a microsecond and will never be

¹²¹ Ibid. See also Virginia Abrams YouTube video on her dyeing and sewing techniques at <https://www.youtube.com/watch?v=wYkJWgRSbhA>.

¹²² Ibid.

duplicated again. Abram's works as described by creative arts writer John Hopper, is "... the combination and arrangement of elements that is the important point to remember when contemplating the nature of Abrams' work. In what can appear to be an almost scientific fascination with the symbiotic partnership of the elements that are part of the makeup of the natural world, the artist draws our attention to the complexity of each moment."¹²³

Geology, another inspiration for Abrams was emphasized in her quilt, *Banded Iron Formation*, 2009 (Figure 22). Banded iron formations, (BIF) are precipitated sediment formations consisting of 15 percent or more iron. They are typically older than 1.7 billion years.¹²⁴ "The curvilinear irregular forms are great inspirations for pieces," she describes on her website. Abrams organic rock formations are highlighted in ribbons of red fiber contrasted by black, giving a similar appearance to a photonegative. Abrams confers, "I use improvisational curved pieced construction techniques to create abstract designs based on shapes from the natural world".¹²⁵

Biology is another subject Abrams explored in her nature-inspired quilt designs. Her *Lipid Cells*, 2009 quilt is an artistic reproduction of the image of fat cells (Figure 23). Abrams studied several images from C&NE news, (Chemical & Engineering News), which is a weekly magazine published by the American Chemical Society. "A lot of

¹²³ John Hopper, "Virginia Abrams Reflections," *Ttb - Inspirations* (June 16, 2010), <http://thetextileblog.blogspot.com/2010/06/virginia-abrams-reflections.html>.

¹²⁴ *Encyclopaedia Britannica Online*, s.v. "Banded-Iron Formation (BIF)," Accessed February 27, 2015. <http://www.britannica.com/EBchecked/topic/51509/banded-iron-formation-BIF>. See entry for full definition.

¹²⁵ Virginia Abrams interview, September 11, 2014.

those were images of fat cells, and they were just beautiful", she reveals.¹²⁶ Her inspiration for this quilt was a particular image of a mouse's ear. "The red lipid cells in the subcutaneous fat layer are superimposed over a green image showing the varying concentration of liquid dimethylsulfoxide injected into the tissue".¹²⁷ Although her description is beyond general understanding, when compared to the original image, Figure 24, taken in 2008 by Brian Saar, a research assistant at Harvard University, one can clearly see her understanding of the scientific as well as the artistic composition. The contrasting red cells against green liquid are a striking interpretation with her expert dyeing techniques.

Abrams, not as computer savvy as the other artists discussed in this thesis, uses other types of technology in her tools, materials and processes. She operates an overhead projector to expand her images, self-designs and cut templates, and uses a high-speed digital camera and a Bernina digital sewing machine. Abrams does not use social media such as Facebook, although many people post images of her quilts on Pinterest, which offers her a large Internet presence in the art quilt medium and in turn inspires artists, scientists and anyone who views her work. She has a professional artist website and frequents the SAQA, (Studio Art Quilt Associates), website.

Cheryl Sleboda

Cheryl Sleboda is a technical project lead for a comic book company in Baltimore, Maryland, but she also creates art quilts as her true passion. She has several

¹²⁶ Ibid.

¹²⁷ Jill Jensen and David W. Fraser, *Art Meets Science* (Storrs, CT: SAQA members, 2010), 4.

technical certificates for computer software and programming. This background in technology gave her the comfort level to expand into this dimension with her quilting. Her specialty is working in e-textiles, which are fabrics that incorporate digital components. She creates art quilts with LED lighting, microprocessors, and other electronic components. Cheryl discusses her reasons for adding these types of technology to her work, "I really enjoy the intersection of technology and textiles. I believe that thoughtful addition of e-Textiles to my designs create another level of interaction with the viewer of my artwork. My work can interact with people through the addition of light play, through sound reactive technology, and through touch and motion."¹²⁸

She first became aware of the work in e-textiles in 2009 by observing fashion students incorporating this type of electronics in their designs. She researched what types of materials the design students were using and was introduced to conductive thread. She observes, "Conductive thread is a textile element, which allows an electrical current to flow from point A to point B. From there I started making works with electronics in them in early 2010. Almost all of my research was conducted through the Internet."¹²⁹

To expand her knowledge of this technology and to assure that her e-textiles were at a professional level, Sleboda began using what is called the LilyPad Arduino board. The Arduino board is an open source microcontroller (computer chip) designed for wearable fabrics and e-textiles. This board can be sewn to fabric with conductive

¹²⁸ Cheryl Sleboda, interview by Stacy Cantrell, e-mail message to author, September 25, 2014.

¹²⁹ Ibid.

thread.¹³⁰ In her quilt titled *Shattered*, 2010, Figure 2, Sleboda was able to apply this technology to make LED lights appear to fade in and out in different sections of her quilt.¹³¹ Her quilt only measures 8 X 8 inches but LED lights offer the viewer another dimension of viewing. The lights are placed in strategic areas to highlight her different sections, which are geometric shapes and angles. Sleboda even incorporates fabric weaving and ruching among other sewing techniques in this cream monochromatic quilt.

Sleboda explores another phenomenon she discovered on the Internet in her quilts: bioluminescence.¹³² She points out, "Underwater creatures have a great deal of bioluminescence and they make great subjects for e-textile design."¹³³ Sleboda has many art quilts showcasing animals with bioluminescence. Her quilt titled, *Aequorea Victoria*, 2010, Figure 26, renders a deep-sea crystal jellyfish, which emits blue LED light in its tentacles. Sleboda works the jellyfish in a shimmery sheer pink fabric amidst shades of deep blue currents in the background. This quilt is suggestive of the mysteriousness we associate with the deep sea while capturing a sense of playfulness.

Similar to McBride, Sleboda uses the Internet for inspiration, learning and training. "While I don't have a particular biology background, it's easy enough to research online. Almost all of my research for a project is done on the Internet," she further details, "I have also primarily educated myself on circuitry 101 and the Arduino

¹³⁰ Leslie Birch, "Leah Buechley: Crafting the Lilypad Arduino." *Make Media Inc.*, July 18, 2014. <http://makezine.com/2014/07/18/leah-buechley-crafting-the-lilypad-arduino/>.

¹³¹ Cheryl Sleboda, "LilyPad Arduino Quilt by Cheryl Sleboda," *YouTube*, 2011, <https://www.youtube.com/watch?v=aX4IOO1IGts>.

¹³² Deborah Cramer, *Smithsonian Ocean: Out Water, Our World* (New York: Smithsonian Books in association with Harper Collins Publishers, 2008), 56. Bioluminescence is a chemical reaction in deep-sea dwelling animals. It is critical for survival where there is no sun.

¹³³ Cheryl Sleboda interview, September 25, 2014.

programming language online through websites and YouTube."¹³⁴ Sleboda also takes advantage of social media such as Facebook, blogging, and other websites to connect to fiber artists, advertise her artwork and stay on top of trends and innovation in fiber. Cheryl also runs her own website where she displays her artwork, blogs, offers lectures, workshops, webinars and videos. She is present on Etsy (a website that is an online marketplace for crafters) and sells her patterns.

Sleboda's latest technologically--inspired quilt designs include a new e-textile platform called "Aniomagic," which offers programmable boards that allow you to combine motion or sound detection with lighting elements. She explains, "Aniomagic, which you program through your computer screen or smartphone screen, [which] makes this super accessible to people who may want the e-Textile effects without the programming background".¹³⁵ Her work titled, *Dunkelheit*, 2011 (meaning darkness in German), demonstrates sound and light technology (Figure 27). The quilted fabric is black and the LED lights are triggered by sound. Soft blinking appears with ambient background noise and gets brighter when sound gets louder.

Sleboda, demonstrating a heavy technical influence in her aesthetics also uses technology in her processes, tools and materials. Along with the Arduino board and Angiomagic boards, Sleboda has a long list of technological tools and processes. She uses a Janome 4900 QE sewing machine to make all of her quilted work. She also sells a laser--cut acrylic template that she designed for her fabric manipulation work. She sells

¹³⁴ Ibid.

¹³⁵ Ibid. Angiomagic, "Aniomagic - About Us," Accessed February 24, 2015. <https://www.aniomagic.com/support/about.php>.

kits of electronic components for people to try e-Textiles for themselves, and has distributor accounts at many electronic supply companies for her components.

Being a huge proponent of the modern art quilt movement, Sleboda construes her reasoning for art quilts being intertwined with STEM:

The Modern Quilt movement, which can in itself be seen as an art quilt movement, relies heavily on geometric designs with large expanses of negative space. There have always been quilters who come from different paths (geologists, scientists, doctors, nurses, teachers), who retire and take up quilting as their hobby to fill their time. I think their work is reflecting a lifetime of those experiences. There's a much easier chance to embrace new technologies with quilters now than there was in the past because some of the stodgy "old guard" who had to make quilts the traditional way are no longer the majority. The introduction of the rotary cutter vs. cutting fabric with scissors was a major leap, and the next one seems to be here with die cutting machines, fabric fusible glues, and other tools to make the hobbyist have an easier time of working.¹³⁶

Sleboda's influence on crafters and quilters is far reaching with her use of the Internet. By teaching, blogging and selling kits, she inspires a new generation of quilters to incorporate engineering and technology into their art. Artists like her help expand STEM knowledge into quilting with her online demonstrations and videos. She takes the fear and mystery out of using STEM for quilt artists to become STEAM quilt artists. She is a leader in the STEAM quilt medium, thus setting the standards for new art quilt cultural values.

These artists' contributions to the STEAM quilt movement are paramount. Their quilts demonstrate the themes that transition art quilts into STEAM quilts: aesthetics, quilts as social statements, and STEM influences. Within these themes are factors

¹³⁶ Cheryl Sleboda interview, September 25, 2014.

including technology, processes, tools, and materials and cultural values. Each artist in their own way exemplifies these practices. Sue Benner and Virginia Abrams are part of an exclusive group whose careers began in science and evolved into the arts. These artists offer a unique perspective on subject matter and bring new content to the art quilt medium. Their study of beauty is refreshing and opens up new avenues of subject matter and advances the use of tools, processes and materials.

Jimmy McBride and Cheryl Slebods are part of a growing generation of Internet-educated artists. The epitome of the DIY movement, they have become professional art quilt artists. McBride blurs the line between fine artist and crafter while Sleboda inspires a new generation of quilters equipped with technological and engineering skills. They demonstrate how powerfully tools such as the Internet and social media can influence an individual's life direction. Being the opposite of Benner and Abrams, McBride was purely trained in art yet found inspiration in the sciences and in turn influences artists and scientists alike. Sleboda's demonstrations of incorporating technology and engineering into quilting are encouraging a new generation of artists to explore combining the worlds of art and STEM into STEAM. These quilt makers a hybrid mix of artists, scientists, engineers, self-taught crafters and Internet learners--are fostering new common cultural values and demonstrate how sophisticated and complex a contemporary art quilt artist may be. Their work embodies the intellectual and artistic sophistication of a contemporary STEAM quilt.

CHAPTER THREE: THE SCIENCE OF IT ALL

What Makes STEAM Quilts an Emerging Style?

Many styles are defined in quilting and often progress into other styles. For example, the role of women in developing Baltimore album quilts began in the city of Baltimore during the 1840's and 1850's. Factors such as the prosperous financial state of the community, improvements in fabric manufacturing and in dying influenced colors and designs along with the quintessential appliqué elements. These women began to form a specific style with defined similarities. This style then became popular throughout the United States and began morphing into new various versions of appliqué quilts.¹³⁷ This was a natural evolution in quilting and it is reasonable to speculate that new styles will emerge in art quilting as they did in traditional quilting.

In the 1970's as contemporary art quilts were becoming more recognized, they began to emerge as a new style in quilting. The birth of the Quilt National and the creation of the Dairy Barn Arts Center in Athens, Ohio, in 1979 gave art quilts a public platform to be displayed and discussed. Hillary Morrow Fletcher attended the first Quilt National and later became the director of Quilt National. She had this to say about this emerging style, "That first Quilt National was so mild by comparison, almost

¹³⁷ Shaw, *American Quilts*, 66–72.

transitional."¹³⁸ As noted author and quilter, Eleanor Levie explains, these first few exhibitions at Quilt National "awakened an excitement in many people who weren't turned on by traditional quilts."¹³⁹ Influenced by Quilt National, the quilt guilds of San Diego organized Quilt San Diego in 1985 to promote quilting as an art form and soon the budding style was emerging across the country and later developed into an international style.¹⁴⁰

The art quilt medium is now forty years old and new styles continue to emerge. STEAM quilts are a natural evolution from the contemporary art quilt. Just as Baltimore Album quilts spread across the country and developed into other styles in the nineteenth century, contemporary art quilts also spread and are now developing into new styles. As art quilts were shown more commonly in galleries and museums and as new technologies coupled with social media developed, the art quilt gained nearly unlimited exposure. Having new avenues of exposure often prompts interest in art mediums and in response the public's reactions often spark new styles. A development of a new style is often a national or global reaction to older art forms in an environment of new technologies, new materials, new communications, and transition into new mediums. Here the artist is oftentimes the critical catalyst. For example, Andy Warhol was a catalyst for the Pop Art Movement through his experimental use of many different mediums and new technologies. As notable fiber artist and scholar Barbara Harms declares, "One thing is

¹³⁸ Levie, *American Quiltmaking*, 118.

¹³⁹ Ibid.

¹⁴⁰ Ibid.

certain, art quilting is here to stay. It is rising in popularity, and this art form is evolving in many new innovative directions as well. Exciting things are happening."¹⁴¹

How it is Categorized

In her lecture "Art Quilts: Emerging Genres", Barbara Harms further characterizes different genres in art quilts and defines six basic categories and their sub-categories. Her classifications or genres are based on the various art movements such as abstract expressionism, optical art, or folk art; she also considers art quilts influenced by traditional quilts such as whole cloth and pieced quilts as a separate stylistic category. Genre or style classification group objects together based on defined similarities. With this generally understood definition, I argue that my classification of STEAM quilts is a legitimate definition of an emerging style developing from contemporary art quilts. And like any other styles in art, each can overlap with other styles. Several STEAM quilts could be categorized into other art quilt styles such as mixed media or pictorial quilts.

Patricia J. Keller, quilt scholar and material culture expert suggests that quilt historians must discover the criteria by which a community of known contemporaries judged a quilt maker and their quilts.¹⁴² Understanding what traditions a community shares and what the quilt makers introduced as what was new and accepted within a community can help classify quilt categories. What was accepted forty years ago in the

¹⁴¹ Barbara Harms, "Art Quilts: Emerging Genres," Lecture, Carnegie Center for Art, New Albany, Indiana, February 1, 2011. <http://existentialneighborhood.blogspot.com/2011/02/formnot-function-lecture.html>.

¹⁴² Patricia J. Keller, "Methodology and Meaning: Strategies for Quilt Study," *The Quilt Journal* 2, no. 1 (1993): 3.

quilt and art community differs greatly from what is accepted in today's contemporary art and art quilt culture.

Further Classification

Within the STEAM quilt style, there may be useful sub-categories to consider. These sub-categories could be defined in the same manner as other classifications of quilt styles. For example, pieced quilts, a major style of quilting, encompass many sub-categories. The two most common are log cabin and crazy quilts. Although these are understood as pattern styles, log cabin and crazy quilts were so popular in the late Victorian era that they became cultural icons.¹⁴³ Just as the name of the style, STEAM, implies multiple categories, (Science, Technology, Engineering, Art and Mathematics), each of these categories could be sub-divided to offer more precise classification. For instance, example of sub-classifications of STEAM quilts might be fractal quilts or space art. Jimmy McBride's quilts featuring nebulas and galaxies would fall into this latter sub-category.

Influence of STEM

"The creative research process for artists includes exploring new stimuli and fresh ideas while expanding technical skills to enhance the impact of the art itself,"¹⁴⁴ explains Dr. Raymond Tymas-Jones, Dean of the College of Fine Arts at the University of Utah. The creative research process Dr. Tymas-Jones speaks of emphatically includes STEM.

¹⁴³ Shaw, *American Quilts*, 143.

¹⁴⁴ Raymond Tymas-Jones, "STEM + A ≠ STEAM."

He further discusses, "As in the Renaissance, the 21st century global community provides opportunities for the artist to inform the scientist and visa-versa."¹⁴⁵

Although STEM is a contemporary term, many influences we describe with the acronym STEM today were already present in the past. Throughout history, the various fields gathered under the heading STEM today—science, technology...--have played a strong role in the arts, including fiber arts. For example, the *Bayeux Tapestry*, ca. 1077, depicts the first known picture of Halley's comet,¹⁴⁶ (Figure 28). The tapestry from medieval times was all hand embroidered, a technique very common in quilting. Naturalists Charles Darwin and Ernst Haeckel have influenced art from the nineteenth century onward. A contemporary art quilt artist who also has a BA in anthropology, Joanna Rogers made a collection of mixed media textiles including several quilts attributed to Charles Darwin (1809-1882), titled *Darwin's Wardrobe* (2006). Rogers remarked about her collection, "If Charles Darwin were still voyaging around the world, these are some of the items he might have recently acquired – either as specimens or gifts to enhance his collection."¹⁴⁷ One of her quilts titled *Mourning Quilt for the Lost and Disappearing Birds of Canada*, 2009, Figure 29, is created with twenty-four separate squares. Each section has an image of a different bird native to Canada but today extinct, extirpated or endangered. Her incorporation of feathers endows the quilt with physical reality and underscores the seriousness of her topic. The top layer of her quilt, made with

¹⁴⁵ Raymond Tymas-Jones, "STEM + A ≠ STEAM."

¹⁴⁶ On the far right of the tapestry the comet appears. News of the comet was brought to King Harold II from English astrologers who took it as an omen for the upcoming battle between the English and Normans, later known as the Battle of Hastings in 1066.

¹⁴⁷ Joanna Rogers, "Joanna Rogers: Fibre Art and Mixed Media." Artist Website, *Darwin's Wardrobe*, Accessed August 21, 2015. <http://www.pendercreatives.com/joanna/pages/darwins.html>.

hand painted silk organza, is folded into origami birds dipped in dye then unfolded so that the image displayed of a bird remains. Roger's quilt expresses a profound loss of habitat.¹⁴⁸

Other STEM influences come from the science community itself. As Maura C. Flannery, department editor for *Biology Today* and quilter explains: "There is a whole trend in contemporary art that rests on the use of biological processes in art making. Many involve genetics, including the genetic manipulation of organisms. This is hardly surprising considering that one of art's roles is to deepen our understanding of our culture by forcing us to look at things in new ways."¹⁴⁹ Flannery continues to discuss how biomedical companies are becoming patrons of the arts and sponsoring many exhibits. Many of these exhibits feature contemporary art quilts. Flannery discusses the similarities between biology in quilting, touch and silence in another article, "Biology and Quilting", 2001. She argues that touch in quilting is vital regardless of whether it derived from hand stitching, cutting or batting. It is also vital in biology; she explains, "As in quilting, touch can be significant in scientific inquiry, especially in biology, where there are so many rich textures: the surface of a leaf, the fur of an animal, the hairs of a caterpillar, the slime of a newt."¹⁵⁰

Scientific discoveries tend to have the strongest influence on quilters interested in the sciences and are typically quickly reflected in their designs or approaches to the medium itself. As noted artist, scientist and researcher Ellen Levy states, "In response to

¹⁴⁸ Joana Rogers, "Mourning Quilt for the Lost and Disappearing Birds of Canada," Email to the author, August 22, 2015.

¹⁴⁹ Maura C. Flannery, "Biology as Art," *The American Biology Teacher* (2007): 306–307.

¹⁵⁰ Maura C. Flannery, "Biology and Quilting," *The American Biology Teacher* (2001): 689.

the extraordinary implications of these discoveries, artists have engaged genetic structures, process and interventions as topics for their art."¹⁵¹ Levy further clarifies, "Artists will always respond and contribute to changing ideas and representations passed down through new discoveries."¹⁵² A key example began with James Watson's and Francis Crick's announcement of their discovery of the structure of the genetic molecule, deoxyribonucleic acid, (DNA) in 1953. Art quilt artist Beverly St. Clair is a prime example of how quilt artists find inspiration in scientific discovery. St. Clair became motivated to make her genome quilts after hearing a lecture on the Human Genome Project, which evolved from the discovery of DNA.¹⁵³ "I was impressed by the beautiful shapes of the proteins illustrated and the interesting patterns made by the microarrays. I realized that I could use a simple quilt block to represent each of the four bases in DNA: cytosine, guanine, adenine, and thymine."¹⁵⁴ St. Clair's quilt titled, *YAP (Y alu Polymorphism)*, 2013, Figure 30, is a rich example of how artists may respond to scientific discoveries. In her artist statement for this quilt, St. Clair explains the genetic information of a Y chromosome through generations of males without exchanging genes with a second Y chromosome. Its genetic sequence changes slowly, which allows scientists to trace the migration patterns of humans through centuries. In this quilt she portrays a short stretch of transposable DNA from an Italian male. She uses shot silk, also

¹⁵¹ Ellen K. Levy, "Contemporary Art and the Genetic Code: New Models and Methods of Representation," *Art Journal* 55 no. 1 (1996): 20.

¹⁵² Ibid.

¹⁵³ "An Overview of the Human Genome Project," National Institute of Health, 2003, accessed February 28, 2015, <http://www.genome.gov/10001772>. The Human Genome Project was the international collaborative research program whose goal was the complete mapping and understanding of all of the genes of human beings collectively known as our 'genome'.

¹⁵⁴ Beverly St. Clair, "Genome Quilts." *Genome*, 2013. <http://genomequilts.com/quilts/genome-quilts-3/>.

known as changeable silk, which appears iridescent due to how the silk is woven. Her choice of fabric works well with her subject, polymorphism, which means "multiple variety". Just like the Y chromosome slowly changing, so does the shot silk because it changes appearance in light when viewed from various angles. Upon closer examination of the stitching, a double helix pattern emerges drawing the viewer into a magnified world of man's genetic history.

The education community exerts a steadfast STEM influence on artists, especially quilters. This process begins during primary school and can continue throughout an artist's career. Flannery once again eloquently describes her connection to art and science and the parallels of both, "A quilter doesn't begin working on a quilt without some previous experience or planning any more than a scientist walks into a lab and begins mixing solutions. Both quilting and science are crafts that must be learned, and the best way to learn each is by doing, by being apprenticed to experts."¹⁵⁵

A unique aspect of the influence of STEM in the education community directly involves quilts. Some notable educators use quilts for teaching in STEM fields, reminding us of the earlier educational nineteenth century examples presented in chapter 1 (Figure 7 & Figure 12). Math educators Charlene Morrow and Tom Bassarear presented a paper at a National Council of Teachers of Mathematics (NCTM) meeting and discussed the mathematical connection to quilting, "Quilts - a useful item, visually appealing, steeped in history, and an integral part of our culture - can also be the jumping

¹⁵⁵ Maura C. Flannery, "Quilting: A Feminist Metaphor for Scientific Inquiry" *Qualitative Inquiry* 7 (2001): 633.

off point for many mathematical investigations."¹⁵⁶ In 1998, geometry teacher Susanne Westegaard developed activity sheets for students to reinforce coordinate geometry concepts for seventh through twelfth graders by using quilt blocks. Westegaard noted the power of quilts in education, "The history behind many quilt patterns offers an opportunity for cross-disciplinary projects with art and social studies classes."¹⁵⁷ Exposing students to quilting in their STEM education classes can encourage students to explore different areas of inquiry and crossover artists such as STEAM quilt artists. Westegaard's *Activity Sheet 5*, 1998, Figure 31, shows how she uses a quilt block sample containing coordinates and equations. This quilt block activity not only teaches students to find geometric shapes such as triangles, squares, circles and hexagons but also gives them the confidence to later design their own quilt blocks and execute them in a mathematically accurate way.¹⁵⁸ Many primary and secondary school classes incorporate quilting in their teaching of geometry and mathematical concepts. This exposes a whole new generation of young people to the art of quilting. All of the artists interviewed for this thesis are influenced by STEM whether it be from a degree in science or because they happened upon an interesting website about solar systems.

Influence of the Internet

The recent impact of STEM on twenty-first century art quilting can mainly be attributed to access to the Internet. The majority of art quilt artists use the Internet in

¹⁵⁶ Charlene Morrow and Tom Bassarear, "Mathematical Ideas Embedded in Quilts." Paper presented at the 74th Annual National Council of Teachers of Mathematics(NCTM) Meeting, San Diego, CA, 1996, accessed September 23, 2015, <http://mathforum.org/mathed/nctm96/humanistic/morrow.html>.

¹⁵⁷ Susanne K. Westegaard, "Stitching Quilts into Coordinate Geometry," *Mathematics Teacher* 91, no. 7 (1998): 587.

¹⁵⁸ *Ibid.*, 588–9.

some fashion. Museum and gallery websites, social media sites and personal websites all offer limitless possibilities for STEAM quilters to make their mark on the contemporary art world. The Internet has become a valuable tool for STEAM quilt artists as to so many other artists to learn and teach and advertise and display.

Learning and teaching through the Internet has become a very popular means of quick, informal, and private education. Websites such as YouTube.com, Craftsby.com or McCallsquilting.com offer many classes and videos on how to quilt or on specific quilting techniques. Artists who wish to teach quilting techniques can establish accounts on these websites and create 'how-to' videos. "Anyone who wishes to work in quilts as an art form by necessity must have the technical skills to make a quilt. That sort of knowledge can be self-taught through a book, television program, or the Internet," explains artist, critic and curator Sandra Sider.¹⁵⁹ In addition, many quilt museums also have an online presence, such as the National Quilt Museum.¹⁶⁰ Many of the museums have Internet education sections that link to many workshops and camps for children and adults, as for example The International Quilt Study Center and Museum.¹⁶¹ Links on their website contain portals to their collections so that the online visitor can view quilts, and offer access to online resources such as downloadable publications, podcasts and videos.

Many STEAM quilt artists are also teachers on the Internet. They teach by developing their personal websites and offer videos or daily blog entries. Artist Cheryl

¹⁵⁹ Sandra Sider, "Educating the Quilt Artist: Critiques and Mentoring Have Fostered the Quilt-Art Community." *Fiberarts Magazine* (2007): 42–3.

¹⁶⁰ The National Quilt Museum Online; <http://quiltmuseum.org/>.

¹⁶¹ The International Quilt Study and Museum online; <http://www.quiltstudy.org/>.

Sleboda produces a blog where she offers daily advice on quilting techniques, processes on using new tools or materials, such as incorporating melted crayons. Her website is a compelling display of art quilt learning and teaching.

The Internet has also become a valuable tool for artists to advertise and display. Just as Sleboda uses her website for advertising her teaching skills, she also advertises her work as an artist. Many artists have websites, however if they do not, there are many places for them to advertise and display their work online. Social media sites such as Facebook offers hundreds of groups for quilting. Artists have the opportunity to display and sell their work. Another unique aspect of advertising on the Internet is the development of the online galleries. Many of them advertise a request for proposals and offer online exhibitions and artist profiles on their websites. One website, ArtShow.com offers a platform for artists to submit work for online gallery exhibitions, enter contests, submit publications and even apply for grants. Organizations such as the Studio Art Quilt Associates (SAQA) offer art quilt exhibition events and call for entries on their websites. This gives STEAM quilters the opportunities to display and advertise their work as much as possible.

What Roles Does This New Style Serve?

Social Roles

STEAM quilt artists contribute in many different ways to this new style. As noted previously, most STEAM quilt artists are educators teaching about their new tools, materials and processes. Other social roles include exposure and acceptability. The more

exposure these art quilt artists get, the more accepted and understood their art will become. For example, quilter and author Sylvia Landman offers an article on how to create fractal art quilts. In doing so, she not only makes new scientific concepts available to a larger audience but thus also stimulates experimentation in quilting based on scientific research.¹⁶² Artists like Landman and Rose Rushbrooke are perpetuating these emerging STEM tools, materials and aesthetics in art quilts.

Many STEAM quilt artists successfully enter their work into exhibitions, galleries and private collections. See, for example, artist Sue Benner's work, which has been reproduced in numerous publications exposing the public to her STEAM quilts. Through her extensive exposure, her style of quilting is becoming more acceptable by her quilting peers, which in turn plays a valuable role in developing a new style and creating modern cultural values in quilting.

Political Roles

Whether these artists realize it or not, they are 'craftivists' in this new style.¹⁶³ They are activists who move this new style forward into a new STEM influenced era of crafting. They are actively pushing the boundaries of quilting incorporating items never before seen in quilting. A powerful example of contemporary art quilting as mentioned above in Chapter one, in craftivism is the AIDS quilt. The AIDS quilt was begun in 1987. It is made up of over 48,000 quilt panels that are dedicated to over 90,000 people who

¹⁶² Sylvia Landman, "Fractal Art Quilts." *Quilter Page*, (2003), <http://www.roserushbrooke.com/fractal-quilt-article.html>.

¹⁶³ "Craftivism"; <http://craftivism.com/books/craftivism-the-art-of-craft-and-activism/>. Craftivism is a worldwide movement that operates at the intersection of craft and activism.

have died from AIDS and the quilt is still growing; it thus serves not only as a memorial but also as an educational tool to the public about HIV prevention. The mission of the project was created "to foster healing, heighten awareness and inspire action in the age of AIDS."¹⁶⁴ As author/curator Anthea Black explains about exhibitions that include "craftivism": "The strength of craftivism is the ability to create community and share knowledge in the most unlikely places, and textile-based craft is among the most easily transportable, affordable, teachable and accessible forms of craft to use."¹⁶⁵

Craft can generate political dialogues. STEAM quilts have the ability to generate a strong dialogue between STEM, art and women; not feminism, but women. Currently the country is experiencing a shortage of women in STEM fields. The federal government is looking for ways to engage and encourage women to study in STEM fields. STEAM quilts open the door for these discussions. STEAM quilting could help bridge the gap between women and STEM. Virginia Abrams and Sue Benner were women who worked previously in STEM fields who later became artists. By incorporating their STEM experiences into their art, they inspire a new generation of women to move toward learning about STEM.

What Makes STEAM Quilts Self-Propagating and Growing?

What encourages STEAM quilts to be self-propagating is that quilting can be an escape from the computer and the digital world, which dominate modern culture. Quilting

¹⁶⁴ The NAMES project Foundation, *The AIDS Quilt: The AIDS Memorial Quilt*, and continuing 1987, <http://www.aidsquilt.org/about>.

¹⁶⁵ Anthea Black, "Super String," Stride Gallery, 2006, Accessed October 5, 2015, http://www.stride.ab.ca/arc/archive_2006/super_string_main/super_string.htm

is a type of 'going back to crafting' activity, something real and intrinsic. However, this type of art often brings the artist back online. Crafters often search for instruction, tips, feedback and online communities. This has become part of the process of advancing their art. They look for the newest ideas, technology and aesthetics. Ironically, this activity in turn feeds back into the digital environment thus propagating their style to the online world and intermingle their activities with the digital culture. STEAM quilts show that there is an interface between textiles and technology.

As modern culture continues to develop technically, there will be new discoveries and new inventions that artists will want to explore and visualize. Science writer and art historian Martin Kemp made this statement pertaining to the reactionary relationships between science, art and technology: "Every age of science and technology has been committed to its own rhetorics for communication both within and beyond the profession. Style is one of the ways through which we can gain access to a remarkable range of questions about makers, materials, patronage, broadcasting, and reception."¹⁶⁶ Author Stephen Wilson, an authority on the convergence of art and science also comments on the necessary conditions for the future of artists, "Artists also cannot thrive in isolation, and in a techno-cultural society it is simply suicidal for them to ignore the momentous developments in science. They must find robust ways in which to engage the broader humanistic implications of this research if they are to help the larger culture understand

¹⁶⁶ Martin Kemp, *Visualizations: The Nature Book of Art and Science* (Berkeley and Los Angeles: University of California Press, 2000), 4.

and take on the transformations it proposes."¹⁶⁷ The artists featured in this paper have accepted this challenge in many different ways. STEAM quilt artists are moving the art quilt medium towards a greater blending of these worlds.

Exhibitions and Shows

Science community exhibitions or exhibitions highlighting STEM topics and art are other important channels for STEAM quilts. For example, The Bridges Organization hosts an annual international conference titled, "Bridges: Mathematical Connections in Art, Music, and Science." This conference began in 1998 and hosts 90-100 artists' works every year. Their organization's mission is to encourage mathematical connections in art, music, and science.¹⁶⁸ It also encourages hosting as many art mediums as it can for the annual art exhibition. Almost every year, one or more STEAM quilts are selected. In 2008, artists Elaine Krajenke Ellison displayed four of her art quilts; among them *Leonardo's Claw and Il Leone Di Venezia meet the Cosmati*, 2006 (Figure 32). As she describes her work, "Leonardo da Vinci's work with trying to "square the circle" generated many interesting designs-amongst them Leonardo's Claw. In this quilt, the gold claw area is equal to the square that is inscribed in the claw! The Cosmati tiles divide the circle into 35 equal areas-very much similar to the Cosmati tiles in the 12th and 13th century."¹⁶⁹ Ellison's all-cotton geometric design is striking to view. The round quilt

¹⁶⁷ Wilson, Stephen. *Art + Science Now: How Scientific Research and Technological Innovation Are Becoming Key to 21st-Century Aesthetics* (New York, New York: Thames & Hudson Inc., 2010), 200.

¹⁶⁸ The Bridges Organization; <http://bridgesmathart.org/mission-statement/>.

¹⁶⁹ Elaine Krajjienke Ellison, *Leonardo's Claw and Il Leone De Venezia Meet the Cosmati*. Art Quilt, 2006, <http://www.bridgesmathart.org/art-exhibits/bridges2008/ellison.html>. To watch a short video clip of Ellison discussing her quilt see, <https://www.youtube.com/watch?v=nLIS0pmInEs>.

resembles Cosmati marble work mosaic tiles one would see inside a basilica or indoor pavements in Italian Romanesque architecture.¹⁷⁰

Many other exhibitions are highlighting STEAM quilts most notably art quilt organizations. In 2009 SAQA held an exhibition titled, "Art meets Science". It was a juried exhibition that included art quilts that combined STEM. Juror David Fraser explains his selection process, "In choosing the quilts for this exhibition I focused primarily on three qualities; visual strength, technical mastery and an intellectually interesting representation of a scientific idea or process."¹⁷¹ One of the entries titled, *Blue Boobs Are Best*, 2010, demonstrates a prime example of a STEAM quilt (Figure 33). Artist Sara Kelly quilted a thermogram of her breasts. She states: "'Blue Boobs'" is an interpretation of my breast thermography image taken in 2009... "I painted the image on whole cloth and beaded the blue parts to make them "'best.'"¹⁷² She explains that the colors in her green, blue, yellow and red quilt are symmetrically balanced and mostly of cool colors, which means her breasts are healthy.¹⁷³ The idea of turning a thermogram into a quilt is groundbreaking and intimate; it demonstrates modern cultural values in her STEAM quilt.

Globalization

¹⁷⁰ Lucy Trench, ed, "Cosmati Work." *Materials & Techniques in the Decorative Arts: An Illustrated Dictionary* (Chicago, Illinois: John Murray Publishers Ltd., The University of Chicago Press, 2000), 98. Cosmatic work is a type of mosaic decoration developed in the 12th century in Rome by marble workers. It is called *cosmati*, named after the Cosmatus family. They were leaders of this technique. This work was often found in indoor architecture such as thrones, altars, and columns.

¹⁷¹ Jensen and Fraser, *Art Meets Science*, 3.

¹⁷² Sara Kelly, *Blue Boobs Are Best*. Quilt, 2009, <http://sarakellyartquilts.blogspot.com/2010/01/blue-boobs-are-best-235-x-29-2009.html>.

¹⁷³ Jensen and Fraser, *Art Meets Science*, 32.

STEAM quilts are growing due to globalization. Outlets such as the Internet, peer reviewed journals, and curated exhibitions all play very important roles in expanding this new style. Many previously curated exhibitions have played a valuable role in getting this style recognition, and many more will follow. But the most effective and quickest way this style is expanding globally is through the Internet.

Images can go viral over the Internet. Ideas can be spread all over the world through online media. Exhibitions have taken on a role on the Internet. Most online galleries cater to contemporary art. Robert Shaw, noted curator and quilt expert, explains that America is at the forefront of quilting today and more than it has ever been in history. Taking a nod from the United States, a global conversation in quilting has begun in other countries. "More voices join that conversation every year, and the Internet has made it possible for quiltmakers to converse in real time no matter where they are. This new ease of communication will undoubtedly play a major part in the shape of quilts and quilting in the years to come."¹⁷⁴

Peer reviewed journals such as *Leonardo* play another important role in the globalization of STEAM quilts. *Leonardo* is the journal of the international society for the arts, sciences and technology. The journal was founded in 1968 in Paris by kinetic artist and scientific pioneer Frank Malina who wanted to create an international platform for artists and others who use science and developing technologies in connection with the arts. *Leonardo* states that it is, "a nonprofit organization that serves the global network of

¹⁷⁴ Shaw, *American Quilts*, 14.

distinguished scholars, artists, scientists, researchers and thinkers through our programs focused on interdisciplinary work, creative output and innovation.¹⁷⁵

As previously mentioned, exhibitions are ever more frequently curated for a global online community. Many museums have a large online presence and offer online exhibitions along with their physical exhibitions in the museums. For example, the Smithsonian American History Museum offers images of its exhibitions along with text panels online. Commercial galleries are at the forefront of the trend and many are beginning to include craft mediums such as art quilting. Others, such as Upstream People Gallery, are purely online galleries. They encourage artists to submit their work to several juried online international exhibitions and most exhibitions accept all media.¹⁷⁶

Where is This New Style Going?

There is a future for this new art quilt style that is grounded in the sciences and rooted in art. Globalization coupled with the Internet will ensure that there will be places to display, advertise, and study these amazing art quilts. Artists such as Sue Benner, Jimmy McBride, Virginia Abrams, and Cheryl Sleboda are gaining recognition and acceptance through exhibitions whether through an online or a physical gallery or museum. Continuing art collaborations with the science community will also ensure that this style is being carried forward. As Author Stephen Wilson sums it up, "In the coming decades we will see astonishing and provocative developments in science and

¹⁷⁵ *Leonardo*, Journal of the International Society for the Arts, Sciences and Technology; <http://www.leonardo.info/isast/isastinfo.html>.

¹⁷⁶ Upstream People Gallery; <http://www.upstreampeoplegallery.com/about/default.asp>.

technology. Artists will be there, ready to ponder, celebrate and critique."¹⁷⁷ He also notes that many of these twenty-first century artists are, "practitioners [who are] opening these new chapters in the history of art, [while] many more await study and evaluation."¹⁷⁸ STEAM quilts encompass, "a new chapter in the history of art, a truly hybrid culture in which scientists and artists are vitally inspired by each other's work."¹⁷⁹ STEAM quilts, as I have termed them, will become a substantial quilting style within the twenty-first century.

¹⁷⁷ Stephen Wilson, *Art + Science Now: How Scientific Research and Technological Innovation Are Becoming Key to 21st-Century Aesthetics* (New York:Thames & Hudson Inc., 2010), 201.

¹⁷⁸ Ibid.

¹⁷⁹ Ibid.

FIGURES



Figure 1 - The Hunters Quilt.
Maker unknown. ca.1700. Published in *Wrapped In Glory: Figurative Quilts & Bedcovers 1700-1900*.
Photo courtesy Los Angeles County Museum of Art. Gift of Cora Ginsburg.



Figure 2 - The Central Medallion Quilt
Made by member of the DuMont family, ca. late 18th century. 86" X 101".
Cottons, Reverse or inlaid applique and stipple quilted. Mobile, Alabama.
Published in *The American Quilt*, page 51.
Photo courtesy Shelburne Museum.



Figure 3 - Detail panel from The Courtying Scenes Bedcover.
Late 18th century. Quiltmaker unknown. Linen and cotton; appliqued and embroidered.
Photo courtesy of Los Angeles County Museum of Art.

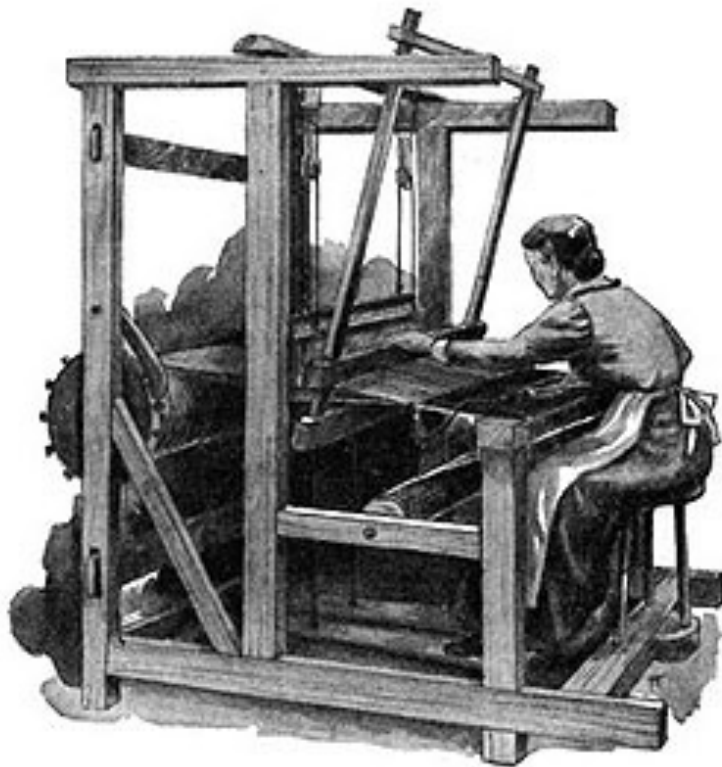


Figure 4 - Image of an 18th century loom.

“A Hymn to “Home Manufactory” and Relocalization,”” accessed January, 28, 2014,
<http://www.concordma.com/magazine/autumn08/homemanufactory.html>.



Figure 5 - Medallion Quilt.

Elizabeth Hobbs Keckley. ca. 1860s. Silk, embellished with tassels, hand-pieced, hand-appliqued, and hand-quilted. Keckley was a master African-American seamstress. She was a house slave before buying her freedom with money earned from dressmaking.

Photo courtesy Kent State University Museum. Gift of Ross Trump.

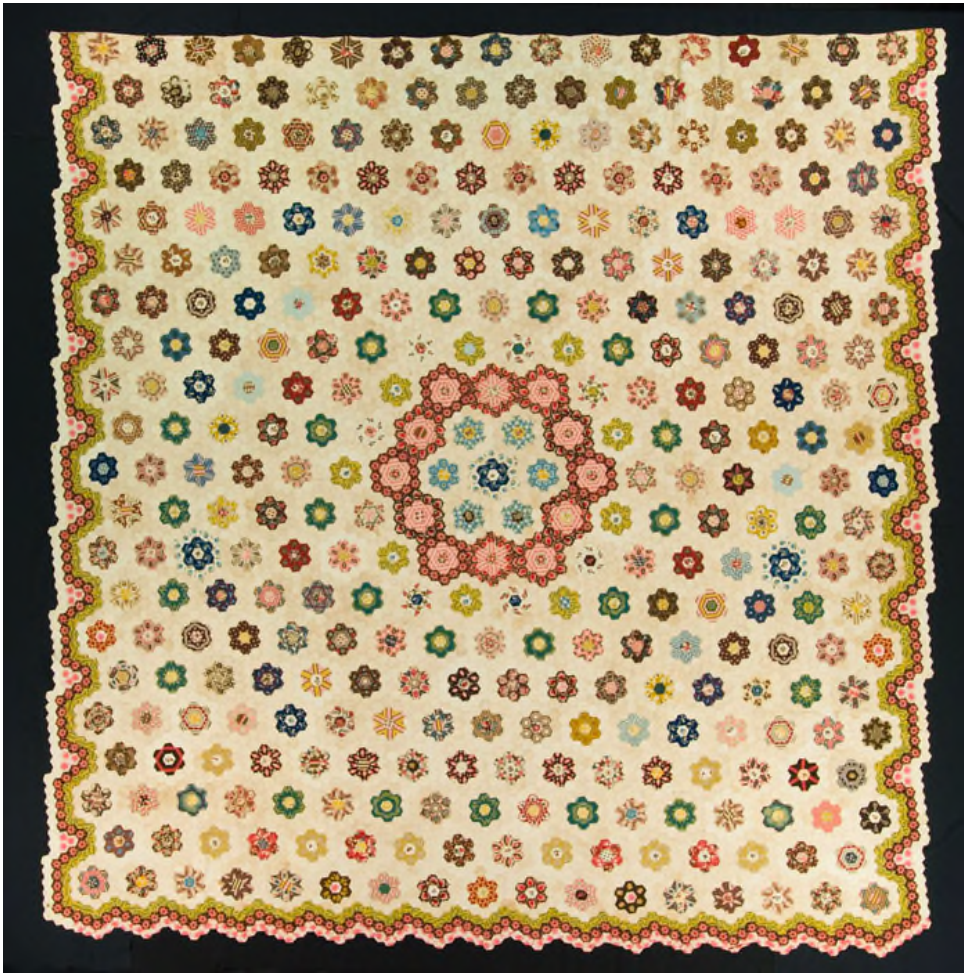


Figure 6 - Hexagon Quilt.

Anna Ruggles. Dated 1796.

From International Quilt Study Center & Museum, University of Nebraska-Lincoln, Byron and Sara Rhodes Dillow Collection. Published in *The Quilt Index*, <http://www.quiltindex.org/basicdisplay.php?kid=60-DC-16>. Accessed: 01/29/2014.



Figure 7 - Wool sampler embroidered with silk.
Elizabeth Hawkins, Miss Powell's Boarding School, Plymouth, England, 1797. Museum no. T.165-1959.



Figure 8 - Basket of Fruit chintz appliqué quilt.
ca. 1840 probably made by Margaret Eliza Darley Seyle Burges.
Gift of Anne Burges Lakes in 2010. These baskets show the influence of botanical drawings of Robert Furber
from his "Twelve Months of Fruit". *Photograph courtesy of the International Quilt Study Center & Museum.*

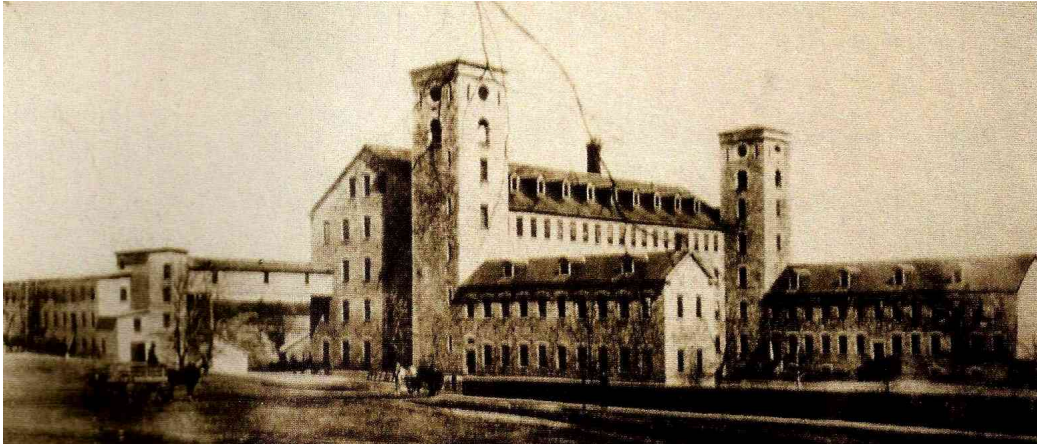


Figure 9 - The Stevens Linen Mill in Dudley, Massachusetts.
ca. 1870. On the left is a smaller stone building, which was the original Merino Wool Factory.
Photo courtesy Toltec Fabrics Inc.



Figure 10 - Crazy Quilt.
Lela Manchester. ca. 1890. From Michigan State University Museum, Michigan Quilt Project.
Published in The Quilt Index, <http://www.quiltindex.org/basicdisplay.php?kid=1E-3D-173D>, Accessed 02/04/2014.



Figure 11 - Baltimore Album Quilt.
 Maker – Unknown. ca. 1845-1855. Baltimore, Maryland. Cotton, silk, linen.
Photo courtesy University of Nebraska State Museum, Lincoln, Nebraska.

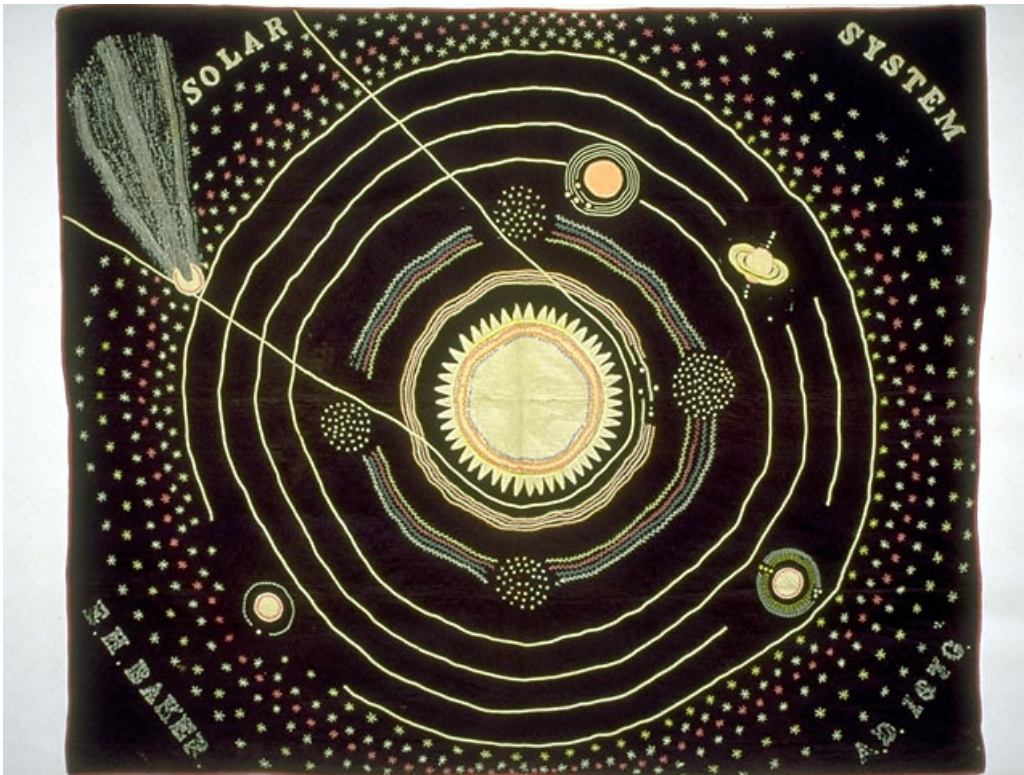


Figure 12 - Solar System Quilt.

Sarah Ellen Harding. 1876. Wool-fabric appliqué, wool braid, wool and silk embroidery.
Gift of Patricia Hill McCloy and Kathryn Hill Meardon.

Photo courtesy Smithsonian National Museum of American History, Kenneth E. Behring Center.

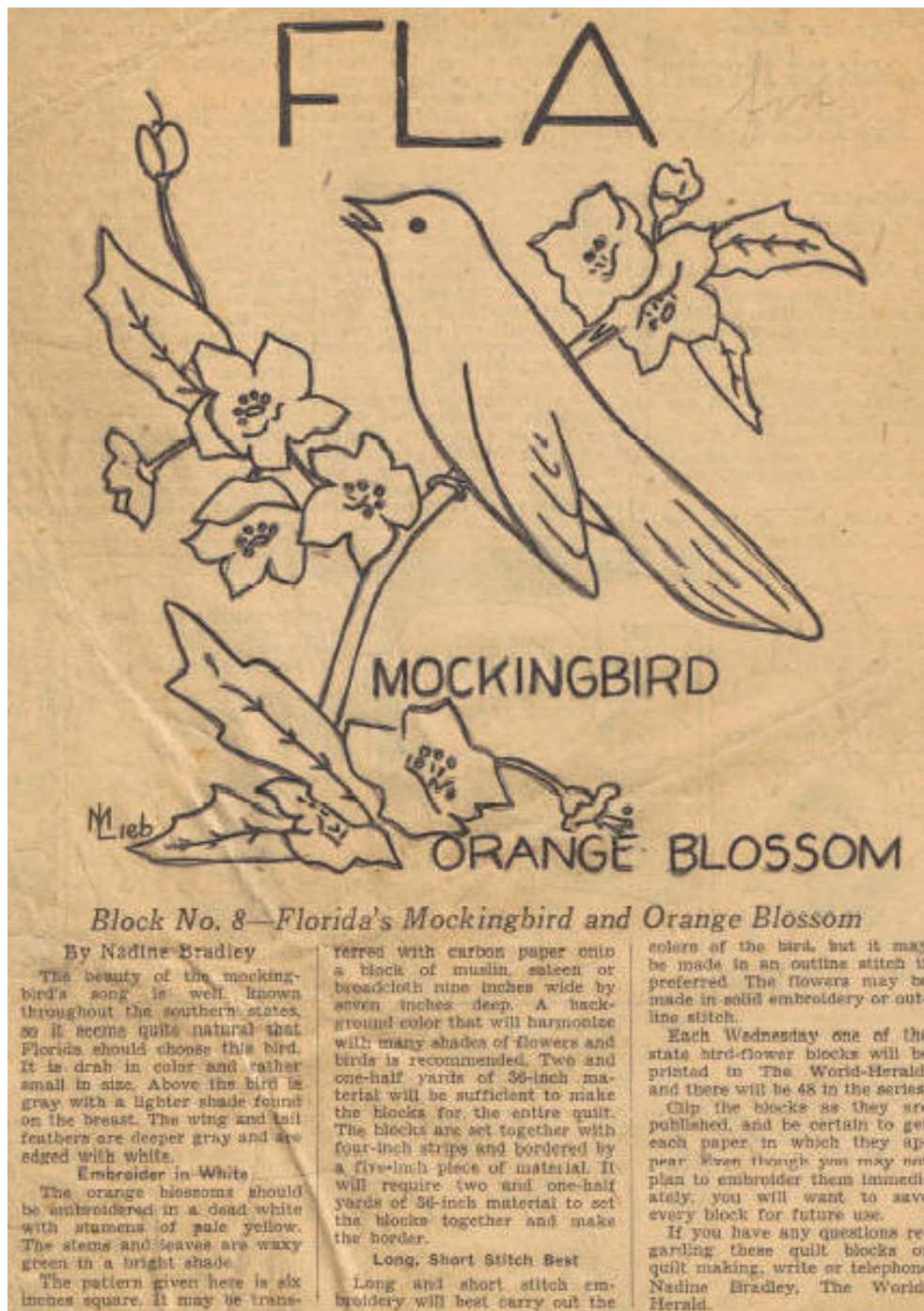


Figure 13 - Original clipping from the Omaha World Herald newspaper. Florida state bird and flower quilt pattern published in 1938. Photo courtesy of Kimberly Eaton.



Figure 14 - AIDS Memorial Quilt, Liberace.
ca. 1987-89. 3' X 6'. Techniques: Embroidery, machine sewing. The back panel reads: "In memory of Liberace, Mr. Showmanship. He showed me that there was a place in the world for more glitz! He made the world brighter and now the heavens have more sparkle."
Photo courtesy of AIDS Memorial Quilt.



Figure 15 - Mandala's of Science: Thalassicolla Latica.
Barbara J West, 2003. 57 3/8" X 7=60 1/8". Techniques: Hand and machine applique, machine pieced, machine embroidery, couching, beading. Materials: 100% cotton, glass beads, rayon yarn, cotton and rayon thread.
Photo courtesy of Barbara J. West.

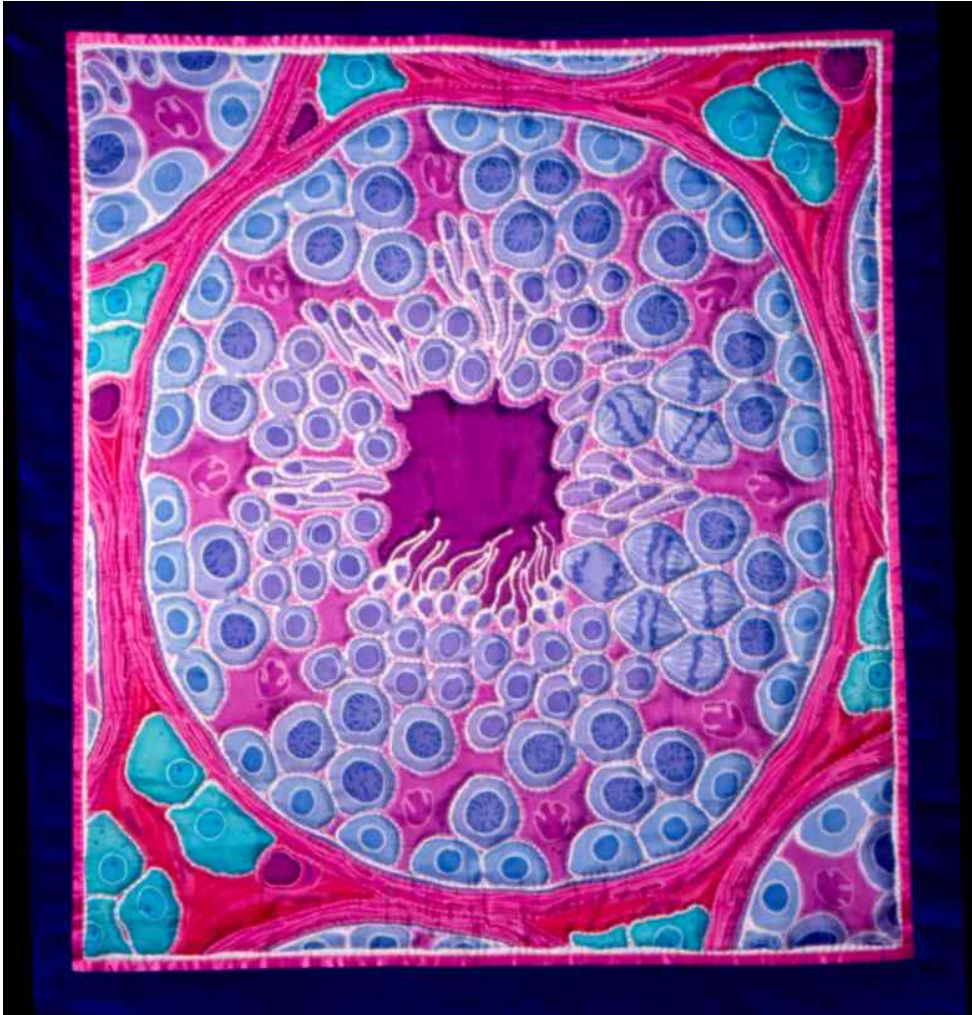


Figure 16 - Seminiferous Tubules.
Sue Benner 1980. Hand dyed silks.
Photo courtesy of Sue Benner.

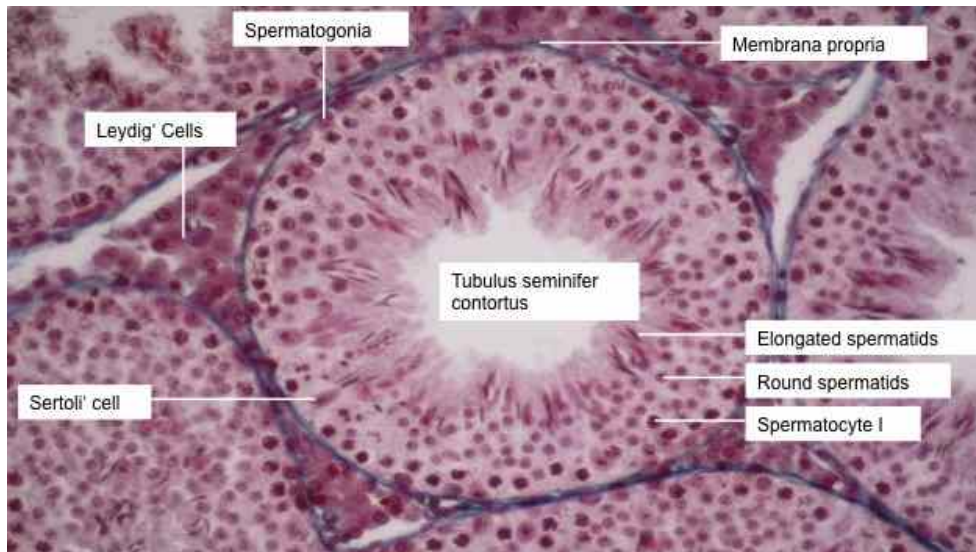


Figure 17 - Seminiferous Tubule (Boar).

Image showing the seminiferous tubule in the boar. Online Veterinary Anatomy Museum.

Photo published by University of Bern.

<http://www.onlineveterinaryanatomy.net/content/seminiferous-tubule-boar>, accessed April 20, 2014.



Figure 18 - Kidney Quilt.
Sue Benner. 1984. Hand dyed silk. 72" X 72".
Photo courtesy of Sue Benner.



Figure 19 - Ambush in Quadrant 4 on the Far Side of the Pleiades.
Jimmy McBride. 2009. Made from recycled cottons. 75" X 88".
Photo courtesy of Jimmy McBride.



Figure 20 - A Giant Hubble Mosaic of the Crab Nebula.
2005. NASA, ESA, J. Hester and A. Loll (Arizona State University).
Photo courtesy of NASA Hubble Space Telescope's Wide Field and Planetary Camera 2.
<http://hubblesite.org/newscenter/archive/releases/2005/37/> , accessed November, 2014.



Figure 21 - M1 V2 (The Crab Nebula).
Jimmy McBride, 2008. 87" X 78". Made from recycled cottons.
Photo courtesy of Jimmy McBride.



Figure 22 - Reflections 11.
Virginia Abrams. 2012. 43" X 33.5". Silk, hand dyed cottons, applique, machine quilted.
Photo courtesy of Virginia Abrams.

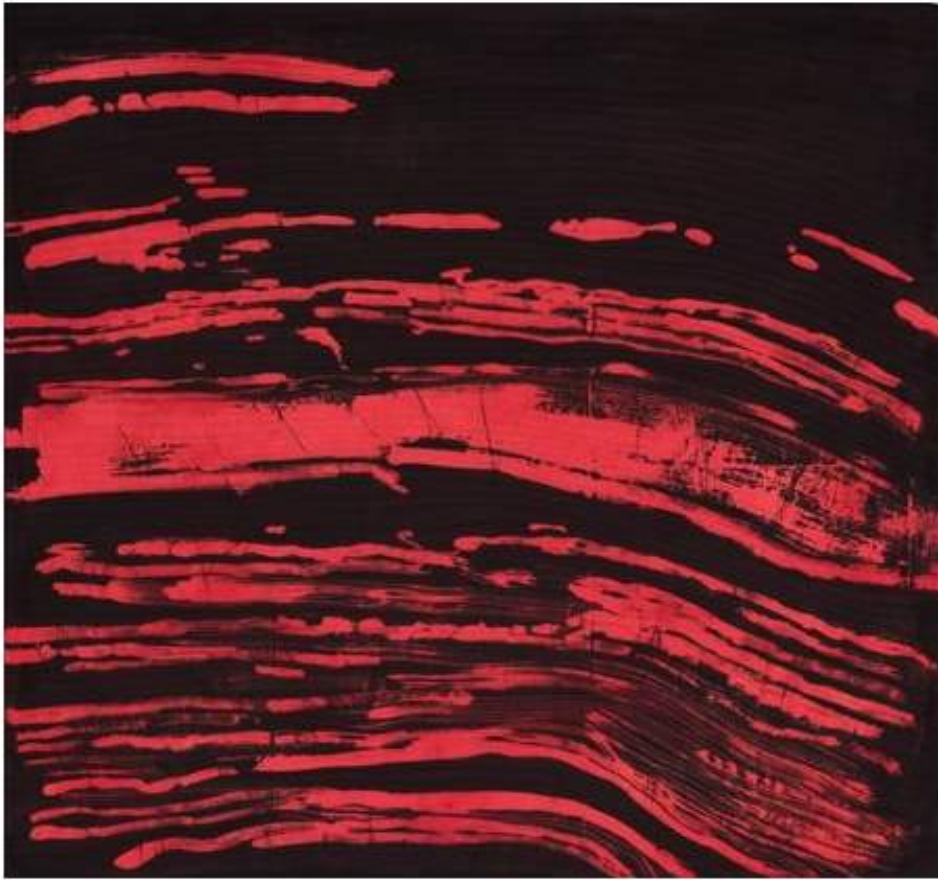


Figure 23 - Banded Iron Formation.
Virginia Abrams. 2009. 29" X 38". Hand-dyed cottons, cotton batting, machine pieced and quilted.
Photo courtesy of Virginia Abrams.

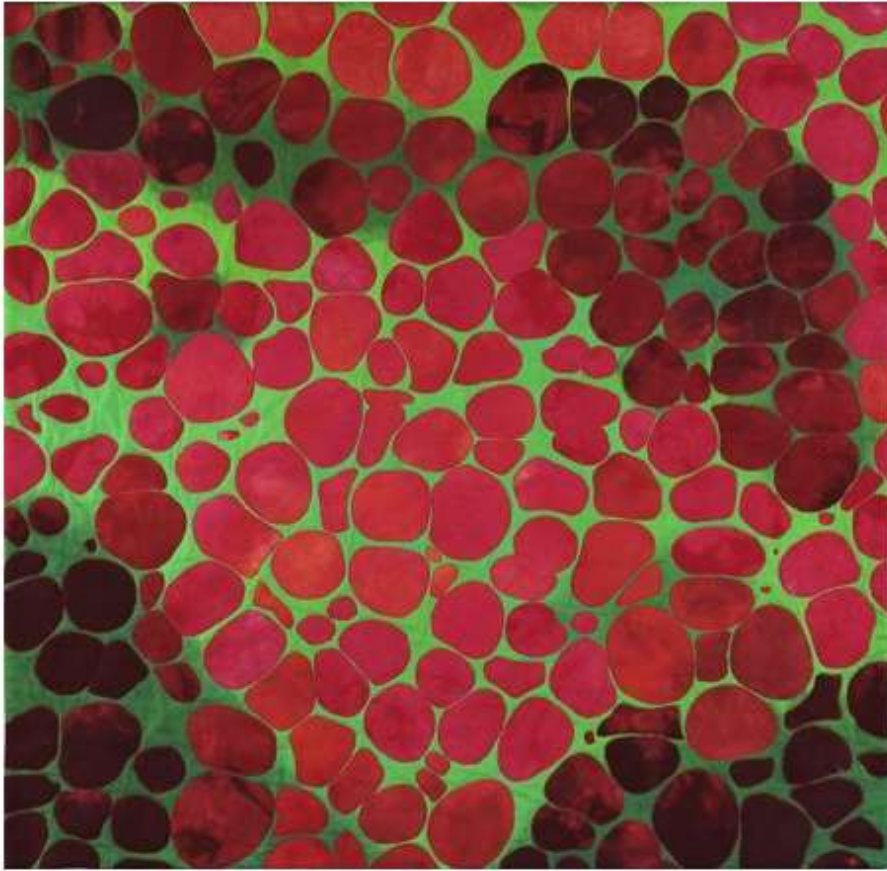


Figure 24 - Lipid Cells.
Virginia Abrams. 2009. 27.5" X 38". Hand-dyed cottons, cotton batting, machine pieced and quilted.
Photo courtesy of Virginia Abrams.

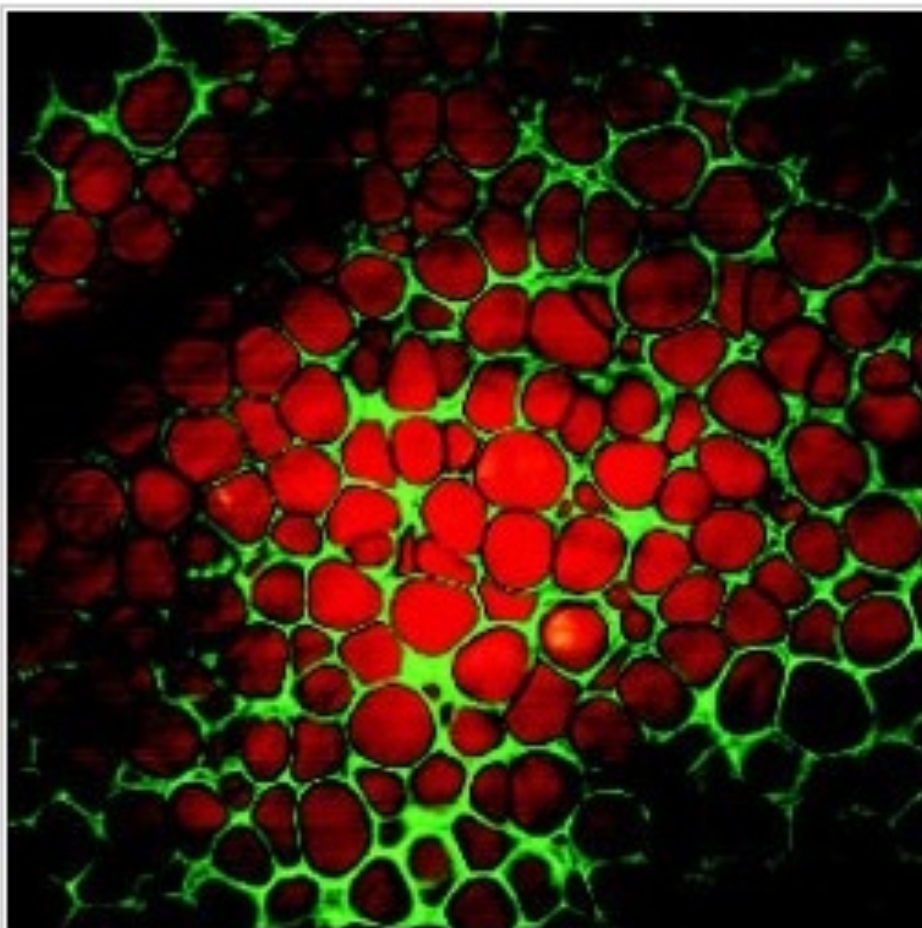


Figure 25 - Raman Microscopic image of Lipid Cells.
Chemical & Engineering News. Volume 86, Issue 51, p. 6. "High Sensitivity Imaging". December 22, 2008. A two-color SRS image shows the distribution of dimethyl sulfoxide (green) and lipids (red) in the subcutaneous fat layer under the skin.
<http://cen.acs.org/articles/86/i51/High-Sensitivity-Imaging.html>, accessed January 15, 2014.



Figure 26 - Shattered.
Cheryl Sleboda. 2010. 8" X 8". Cotton fabric, LED lighting, microprocessor. Pieced, appliquéd and machine quilted. *Photo courtesy of Cheryl Sleboda.*



Figure 27 - Aequorea Victoria.
Cheryl Sleboda. 2010. 8" X 8". Hand dyed fabrics, Blue LED lighting, microprocessor. Pieced, appliquéd and machine quilted. *Photo courtesy of Cheryl Sleboda.*



Figure 28 - Dunkelheit.

Cheryl Sleboda. 2011. 8" X 8". Hand dyed fabrics, LED lighting, beading, Schemer board from aniomagic. Pieced, appliquéd and machine quilted. *Photo courtesy of Cheryl Sleboda.*

This is a sound-reactive quilt. To see it on video, go to:

<https://www.facebook.com/video.php?v=10150345101962663&set=vb.131917343526110&type=2&theater>, accessed March 17, 2015.



Figure 29 – Bayeux Tapestry; Long Live The King – Scene 1. ca. 1070's. Artist unknown. Embroidery on linen with colored (crewel) wool yarns. Note: Halley's comet is in the upper right corner of this panel. *Photo courtesy of the Reading Borough Council (Reading Museum Service) Berkshire, UK. Photo is taken from the Victorian copy of the Bayeux Tapestry.* <http://www.bayeuxtapestry.org.uk/Bayeux14.htm>



Figure 30 – Mourning Quilt for the Lost and Disappearing Birds of Canada.
Joanna Rogers. 2006. 5' X 7'. Hand dyed silk organza, feathers, cotton and canvas.
Photo courtesy of Joanna Rogers.



Figure 31 – YAP (Y alu Polymorphism).
Beverly St. Clair. 2013. 35" X 35". Shot silk. Pieced.
Photo courtesy of Beverly St. Clair.

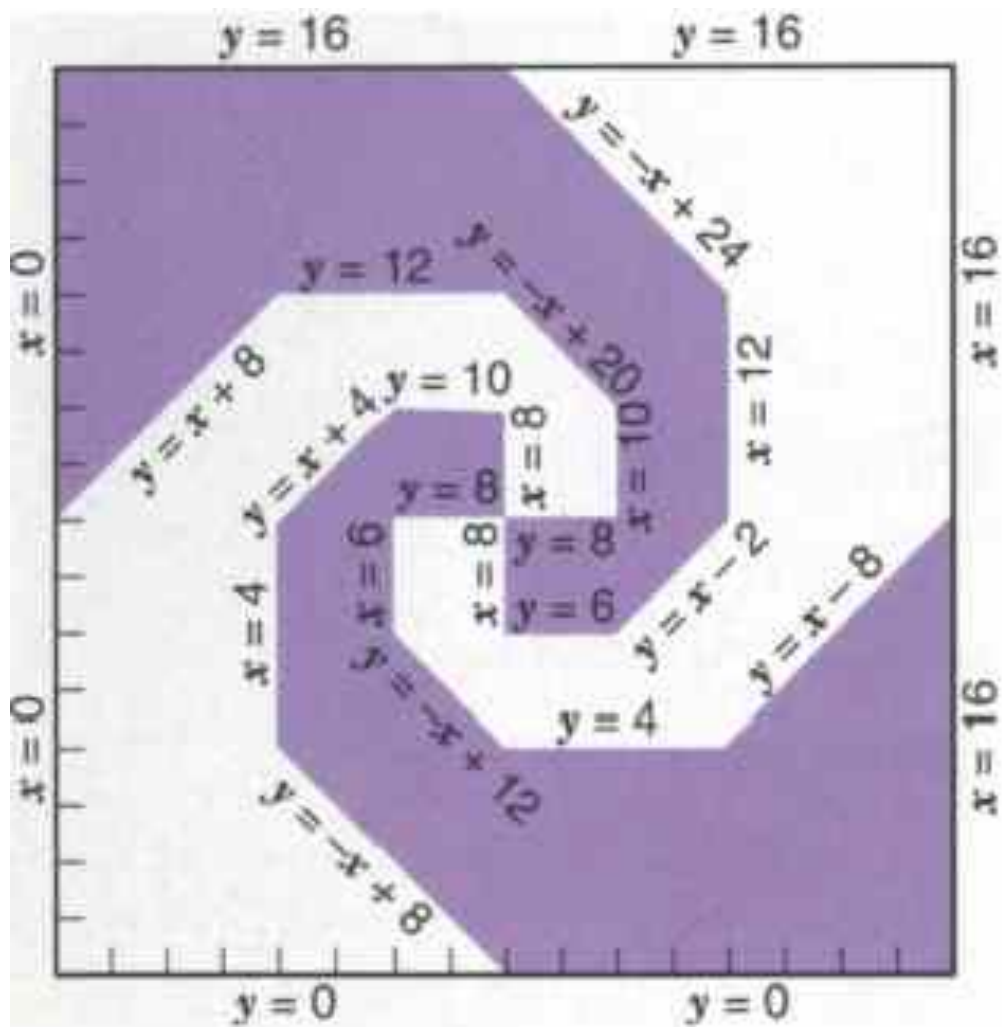


Figure 32 – Activity Sheet 5.
 Susanne Westegaard. 1998. Digitally created printout.
 Photo courtesy of "Stitching Quilts into Coordinate Geometry", page 587.

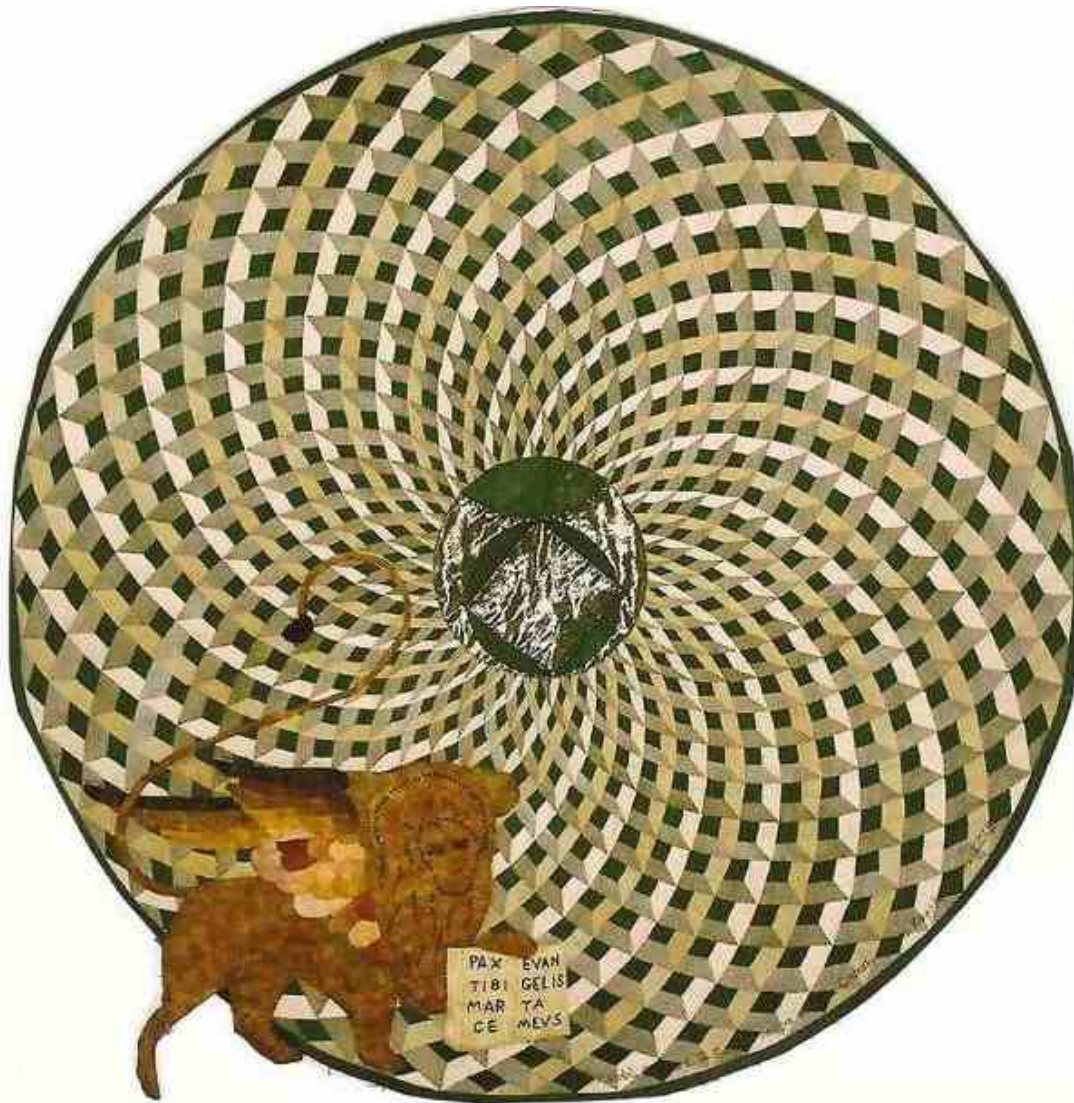


Figure 33 – Leonardo's Claw and Il Leone De Venezia Meet the Cosmati.
 Elaine Krajenke Ellison. 2006. 40.5" diameter. 100% cotton.
 Photo courtesy of Bridges on art collection. <http://www.bridgesmathart.org/art-exhibits/bridges2008/ellison.html>, accessed August 25, 2015.



Figure 34 – Blue Boobs Are Best.
Sara Kelly. 2009. 23.5" X 29". *Art Meets Science*. Storrs, CT: SAQA members, 2010, page 32.

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BIOGRAPHY

Stacy Cantrell graduated from University of Central Missouri in 1995 with a Bachelor of Arts in music/art. She went back to UCM to get a bachelor degree equivalent in Information Technology in 1999. While working in the IT field, she went back to school and received her master's degree in Business Administration from the University of Phoenix in 2008. Today, she is a professional artist and curator working in fiber arts with an emphasis on community participation.