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The Analysis and Treatment of Food Artifacts: A Sugar Paste Wedding Cake Topper and President Grover Cleveland's Wedding Cake

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ABSTRACT

The analysis and conservation treatment of President Grover Cleveland's wedding cake and a 20th-century sugar paste wedding cake topper serves as a case study for the treatment of food artifacts. Analysis of the Cleveland cake, conducted in order to clarify historical understanding and inform the treatment plan, involved identification of cake ingredients with X-ray radiography, X-ray fluorescence (XRF), Fourier transform infrared spectroscopy (FTIR), and Gas chromatography-mass spectrometry (GC-MS). Conservation treatment of the food artifacts included consolidation, joining fragments, and filling losses. Treatment of the associated cake boxes involved stain reduction, light bleaching, and inpainting.

1. INTRODUCTION

Food artifacts are a proportionally small but growing subject of concern for the conservator. Objects with food elements are found in archaeological, archival, and increasingly, contemporary fine art collections. Preservation issues for food artifacts primarily involve inherent chemical instability and vulnerability to pest damage. Approaches to the conservation of food artifacts vary, from discarding the food element and retaining the container to extensive scientific analysis and conservation treatment. A survey of these approaches was undertaken in order to determine how food artifacts are dealt with and understood by cultural heritage collections.

A piece of President Grover Cleveland's wedding cake (fig. 1) and an early 20th-century sugar paste wedding cake topper (fig. 2) were examined as case studies of food artifacts. Both objects studied and treated during this project belong to the Buffalo and Erie County Historical Society (BECHS), founded in 1862. BECHS is the largest historical society in Western New York and one of the oldest in the country. Its collection includes over 80,000 artifacts and the primary building site is the only remaining permanent structure from the Pan-American Exposition of 1901. The pieces were analyzed with polarized light microscopy, XRF, FTIR, and GC-MS. The conservation treatment focused on stabilization through consolidation, fragment joining, and housing. This project was conceived to contribute to the body of information about the analysis and treatment of food artifacts, as well as to stabilize the pieces so that they may be stored safely or exhibited.

Fig. 1: President Grover Cleveland's Wedding Cake (CNS 096619A)

Fig. 2: Sugar Paste Wedding Cake Topper (CNS 106630)

2. APPROACHES TO THE CONSERVATION OF FOOD ARTIFACTS

A study of the chemical structure and current practices in the analysis and conservation of food artifacts was undertaken in order to provide context for the treatment of the cake and sugar ornaments. Information regarding the chemical composition and degradation of food was drawn from the field of food science (McGee 2004). The food industry and related government agencies are the primary driving force for analysis of food, both for engineering and food safety.

Food artifacts may be classified into three broad categories, including archaeological matter, archival materials, and contemporary fine art. Artifacts from each type present their own set of issues and goals, though the conservation materials and analytical techniques overlap. For archaeological materials, food may be a key element in the interpretation of a culture and dating the material may be a primary objective (McLaren and Evans 2002). Food elements in archival materials may either be objects collected for historic interest or incidental materials stored with other artifacts, requiring evaluation of value and the necessity of analysis or stabilization treatment. Food in contemporary art, given its relative newness, may have less inherent stability than food materials from an earlier time period (Wharton, Blank, and Dean 1995). Contemporary pieces with food may not require analysis for historical interpretation, but could involve preventive consultation or collaboration with the artist to mitigate degradation issues.

For each category, representative cases were selected to highlight specific approaches. These include residue analysis at the Gordion Excavations in Turkey, planning and stabilization at the Minnesota Historical Society, and collaboration with living artists by Christian Scheidemann. These cases are provided as examples of how individual objects were approached and should not be understood as a prescription for treating other artifacts.

2.1 CHEMICAL COMPOSITION AND DEGRADATION

Food products consist of four basic types of molecules: water, lipids, carbohydrates, and proteins. Water is the primary component of most foods and its pH affects the behavior of other molecules. Lipids are the fats, oils, and emulsifiers in food, which function as hydrophobic membranes between water molecules and provide texture and flavor. Carbohydrates include sugars, starches, and gums. These molecules are derived from plants and give food both flavor and bulk. Proteins are mostly derived from animals and are the most active and sensitive of the food molecules. Enzymes are a type of protein that catalyze reactions and are a critical part of food deterioration (McGee 2004).

The process of cooking food instigates chemical reactions in the ingredients that determine the texture, flavor, and structure of the end product. The reactions that take place during cake baking may be divided into three stages, including expansion, setting, and browning. The first stage occurs as the temperature of the batter rises, releasing carbon dioxide from leavening and expanding air bubbles that were mixed into the batter. Vaporization of water molecules contributes to the growing air bubbles. In the second stage proteins will coagulate, or bond together, and starches will absorb water, swell, and gelate. This causes the cake to take a set shape. Finally, flavor-enhancing browning occurs on the surface and the cake will shrink slightly. Browning takes place via caramelization and/or the Maillard reaction, which occurs in many different types of food including meat, coffee, onions, milk, and bread. The Maillard reaction is a complex series of non-enzymatic reactions between an amino acid and a reducing sugar (Daniels and Lohneis 1997). Heat is a critical factor in the speed and result of these reactions. Most kinds of cake must be baked at moderate temperatures of 350-375 °F in order to avoid coarse texture or uneven shape (McGee 2004).

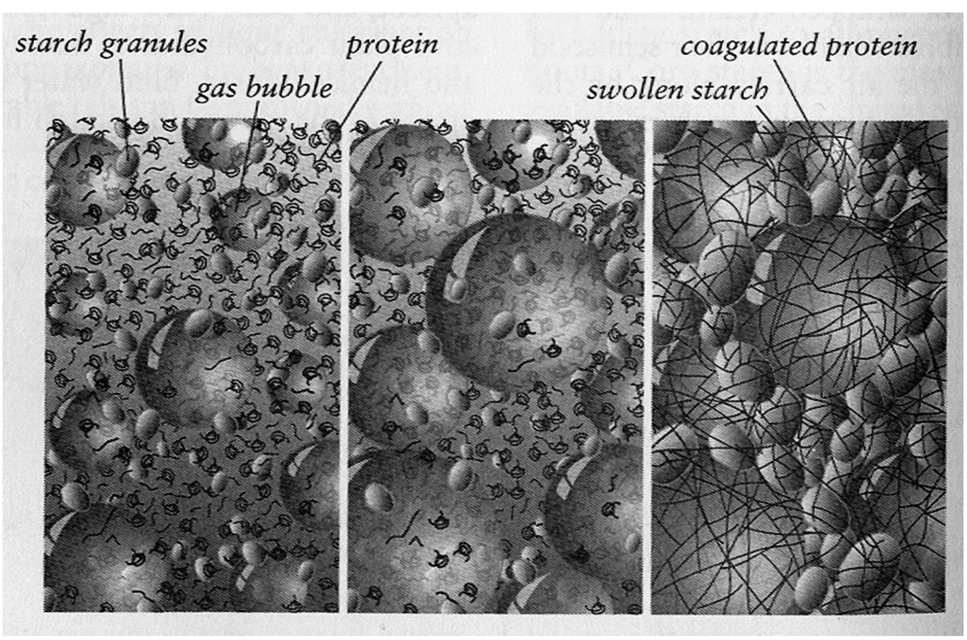


Fig. 3: As a cake bakes, starches swell, proteins coagulate, and gas bubbles expand.

Food degrades via several different chemical reactions. Evaporation of moisture causes food to become stale, brittle, or wilted. Oxidation causes rancidity in fats, breaking apart fat chains and causing spoilage. Unsaturated fats have a double bond that makes them far less stable than saturated fats. The instability of unsaturated fats instigated a tremendous amount of research in the food industry during the last century into hydrogenation, which adds hydrogen atoms to unsaturated fats. Hydrogenated fats have a much longer shelf life than unsaturated fats, though the health consequences may negate most of the benefits. Carbohydrates, and particularly cellulose, are comparatively stable molecules in food. One problem that food with high sugar content may experience is sugar bloom, which occurs when changes in temperature or relative humidity draw moisture from the air to the surface of the object. This may cause some of the sugar in the object to dissolve in the moisture, leaving a rough, white patch when the moisture evaporates. Enzymes are a primary catalyst of food degradation, increasing reaction rates and modifying food structures by combining or altering other molecules. Bacterial enzymes instigate spoilage by breaking down food for their own energy, a process that is slowed by refrigeration.

One of the most promising options for controlling the degradation of food, in addition to refrigeration, is through storage membranes that create a microclimate. This is a method currently being tested by the U.S. Navy, as long deployments at sea make it difficult to serve fresh food to crews (Chesler 2010). To increase the lifespan of produce, the Navy has partnered with Apio, Inc., a food technology company that developed a filtering membrane called BreatheWay. Fruits and vegetables degrade though respiration, taking in oxygen and releasing carbon dioxide and ethylene gas. BreatheWay controls the ratio of oxygen and carbon dioxide inside a package and reportedly made lettuce last 70% longer, cantaloupe 150% longer, and broccoli 300% longer in Navy trials. Primaira LLC, another company working with the Navy, has created an electrical device to convert ethylene gas into water and carbon dioxide. Initial trials by the Navy report substantial improvement in the preservation of produce and the device is currently the subject of further trials.

2.2 ARCHAEOLOGICAL RESIDUE ANALYSIS: GORDION EXCAVATIONS

Archaeological food materials are most often found as residues, though intact food objects are sometimes discovered in frozen, arid, or other anaerobic environments. Analysis of archaeological food materials is often concerned both with dating and identification of specific compounds in order to gain information about the diet, technology, and trade of a culture. Analytical techniques may include some combination of spot testing, morphological examination, XRF, radiocarbon dating, lipid and protein analysis with GC-MS and FTIR, and SEM (McLaren and Evans 2002). Once analysis is complete, the materials may be retained or discarded as deemed appropriate. In all cases, sufficient samples of the materials should be retained for future testing as analytical methods and equipment evolve.

Gordion, located in modern Yassihüyük, Turkey (fig. 4), is a major archaeological site in Anatolia. It was occupied for more than 4,000 years and was the royal capital of the powerful Iron Age kingdom known as Phrygia. Archaeologists and researchers from the University of Pennsylvania and other institutions have extensively studied the site since 1950 and have conducted over 30 annual excavation campaigns. Gordion was a major center of population and contained many fortifications and elite burial mounds, including what is thought to be that of the fabled King Midas's father (fig. 5). Food residues from this tomb have been the subjects of extensive analysis and the results have created a rich body of information about the culture of the site.

Fig. 4: Map of Gordion

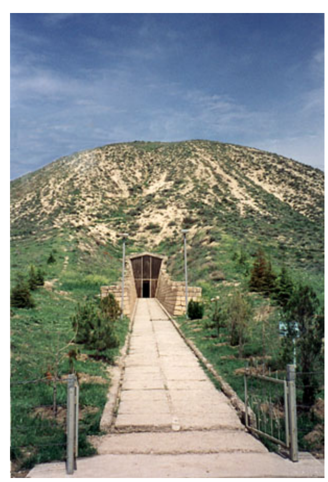


Fig. 5: Mound containing Midas' tomb

The tomb was discovered early on in the site excavations and was reached 40 meters below the upper surface of the tomb with a drilling rig. A wooden structure measuring 5 x 6 meters formed the inner chamber and is the earliest known wooden structure in the world (ca. 700 B.C.E.). The body had disintegrated, but the other organic materials in the tomb were well preserved. Several of the bronze drinking vessels contained organic food residues from the funerary feast and were all shipped to the University of Pennsylvania Museum for study. Analytical techniques available at the time were limited, but 40 years later Dr. Patrick McGovern and his research team took up the project of identifying the food residues.

Analysis was performed on 16 shiny, dark residues from several different bronze drinking vessels (fig. 6) to reconstruct the tomb funerary feast. FTIR, liquid chromatography, and GC-MS were used in a complementary manner and consistently produced results that identified the beverage in the vessels as a fermented mixture of grape wine, barley beer, and honey mead. The focus of the analyses was placed on identifying the 'fingerprint' regions of particular compounds. Tartaric acid, which only occurs in a substantial amount in nature in grapes, was detected alone or with its potassium or calcium salts in all of the residues. Calcium oxalate, which settles out in beer formation, suggested the presence of barley beer. Calcium oxalate is common in nature, but the high levels found in the drinking vessels were unusual and barley beer was considered the most likely source. Lastly, beeswax and gluconic acid suggested the inclusion of honey mead, as beeswax is difficult to filter out when processing honey. Dr. McGovern also identified this type of fermented beverage on a range of Mycenaean and Minoan drinking vessels from other sites, suggesting that it was a part of several ancient cultures (McGovern *et. al.* 1999).

Fig. 6: Gordion Drinking vessel

In addition to the fermented beverage residues on the drinking vessels, spongy brown material was found in several pottery jars (fig. 7) inside the tomb. Analytical testing, again performed with FTIR, liquid chromatography, and

Fig. 7: Pottery with stew samples

GC-MS, led to the identification of fatty acids that are characteristic of sheep or goat fat. The samples included cholesterol, triglycerides, phenanthrene, and cresol, which suggest that the meat was barbecued while on the bone. Gluconic, tartaric, and oleic/elaidic acids respectively suggest the presence of honey, wine, and olive oil, which may have been used to marinate or flavor the meat. A high protein pulse, likely lentils, was also present in the samples along with herbs and spices. These ingredients were probably prepared together as a stew, a hypothesis that is supported by the uniform composition in several different samples and a lack of bones, pits, or seeds (McGovern *et. al.* 1999). In this instance, the right combination of analytical equipment and researcher expertise made it possible to determine compelling information from food artifacts that may not have been known otherwise.

2.3 ARCHIVAL COLLECTIONS: MINNESOTA HISTORICAL SOCIETY

Food in archival collections may either be primary objects, or items that are of historical interest in and of themselves, or secondary objects, or materials that accompany the object of interest. The Cleveland cake and cake topper are examples of primary objects in an archival collection, while a secondary object may be something like the flour stored in an antique flour tin. Preservation strategies vary depending on the value and nature of the material and may include analysis of the material, stabilization, or discarding the food material but retaining the container. Primary concerns for such materials are pest damage, which may be prevented with fumigation or barrier films, and biohazards that may cause risk to staff and collection visitors.

Paul Storch, Senior Objects Conservator at the Minnesota Historical Society, shared several specific examples where conservation treatment was performed on archival food artifacts (Storch 2010). He joined a group of broken gingerbread cookies using either Paraloid B-72 or wheat starch paste. Other baked goods have been treated through

Fig. 8: Civil War hardtack in the Minnesota Historical Society collection

dessication, vacuum impregnation with 2-3% B-72 in acetone (as a consolidant and pest-deterrent), and air-drying in a fume hood. Storch also noted that he discarded food from containers to reduce demands on storage in consultation with curatorial staff. He encapsulated containers that would be destroyed though opening with either MarvelSeal or Kapak film, a heat-sealable polyester/ polyethylene laminate. Samples were taken from the containers that were emptied and the samples were stored in a lab refrigerator.

To manage the institution's response to food and other potentially hazardous materials in the collection, Storch created a reference procedure flow chart for the handling and classification of these materials. His plan (see Appendix VII) details a careful, deliberate policy for assessment and sampling, including photography, spot testing, and content disposal according to government regulations. This set of procedures should serve as a model for other collections containing food artifacts. The techniques of analysis are available to a wide range of collections and the methodical step-by-step plan is clear and easy to emulate.

2.4 COLLABORATION WITH CONTEMPORARY ARTISTS: CHRISTIAN SCHEIDEMANN

Over the past century, artists have increasingly used non-traditional or ephemeral materials that present both ethical and technical challenges for the conservator. Food is one example of such materials and has been utilized by artists such as Dieter Roth, Zoe Leonard, and Claes Oldenburg. Christian Scheidemann, a contemporary art conservator in private practice in New York City, has substantial expertise working with food (Scheidemann 2010). His approaches vary with different food materials and include removing lipid residues by soaking the object in acetone and consolidation by soaking the object in various solutions of Paraloid B-72 in solvent. He has also performed freeze-drying, sucrose replacement of water, Funori injections, fumigation, and aerosol misting. Food in contemporary art is sometimes intended to degrade and must be approached on an individual basis.

Perhaps more than any other conservator, Scheidemann has collaborated with living artists to stabilize materials. Some projects, such as his collaboration with sculptor

Robert Gober, involve preventive stabilization of materials that the artist has made or acquired. When Gober was beginning to work on a sculpture called “Bag of Donuts,” consisting of a white paper bag containing a dozen doughnuts, he consulted with Scheidemann to determine how to remove the grease from the doughnuts so that the paper would not be stained. Scheidemann treated the doughnuts by soaking them in a tank of acetone for four days, during which the solvent was replaced each day. The

Fig. 9: Treatment of the Gober donuts

doughnuts were periodically placed on blotting paper to monitor the progress of grease removal. The doughnuts were then placed in a solution of Paraloid B-72 to compensate for loss in weight and volume. Lastly, the doughnuts were powdered with cinnamon to improve appearance (Mead 2009).

In other collaborations with artists, Scheidemann has been involved with the fabrication of the object itself. Scheidemann describes one such collaboration with artist Matthew Barney:

> Matthew phoned me to ask if I could bake a big pound cake in the shape of an extended pill (*Hubris Pill*). His cake, which he showed in the installation *OTTO-Shaft*, had been destroyed by rats in the parking garage, which was the site of the installation. It took us about one year to find a bakery that was willing to let us experiment with paste in their work space. Finally, we found a solution, a technique to build up a pound cake in the

> mold Matthew had sent. The problem was that either the inside was still raw after an hour of baking time or the outside started to turn black after 90 minutes. So we made a construction with wire mesh containing a void inside and it worked. Eventually, the grease had to be extracted with chemicals and the space of the grease had to be replaced by synthetics (Williams 2001:1).

In this instance, Scheidemann's involvement goes beyond the conservation lab into the artist's studio. This example is representative of the difference between the practices of conservators working with contemporary art and those working with art from previous eras.

3. HISTORICAL BACKGROUND AND OBJECT DESCRIPTIONS

3.1 THE CLEVELAND CAKE

3.1.1 Wedding cake origins and history

The history of the wedding cake involves innumerable variations depending on region and social status. The interweaving of grains into wedding rites was common in multiple ancient cultures, as grains were a common symbol of fertility and prosperity. One example is Ancient Rome, where grains were incorporated into weddings both conceptually and literally. Ceres, the Roman goddess of growth and agriculture, was also associated with marriage and fertility. The term itself for patrician legal marriage was *confarreatio*, which originated from the sharing of a loaf of *far*, or spelt. Patrician weddings in Ancient Rome utilized grains tangibly by throwing sheaves of wheat at the bride and later though the groom breaking a bread loaf over the bride's head as a visual consummation of the marriage (Charlsley 1992).

Though grains were incorporated into wedding ceremonies since antiquity, nothing resembling a modern flour-based sweet cake was associated with weddings until around the 17th century in England. Cakes had become popular in elite British society by the mid-17th century and were not exclusively linked to weddings or any other particular event. Cakes could be served for Twelfth night celebrations, christenings, anniversaries, birthdays, or other celebrations. Cakes served at weddings were generally the largest and most formal. They were often baked in a hoop to make them round, and in the 19th century it became standard practice to stack three tiers of cake on pillars and frost them elaborately. Cakes of this period for royal weddings involved great feats of engineering and measured up to seven feet tall with many tiers. The surfaces could be decorated with pearls and sugar paste ornaments (Charlsley 1992).

Fig. 10: Undecorated plum cakes


Fig. 11: Croquembouche


Fig 12: Plum pudding

Wedding cakes were far from standard or universal. Given their cost, cakes began as a delicacy available only to the upper class and became available to middle and lower classes only in about the last hundred years. Most recipes for cakes of the 17th century in Britain describe plum cakes, a general term that refers to cakes with dried fruit that may or may not be plums. Early plum cakes had a high ratio of flour to sugar and fat and were more similar to modern bread than cake. Cakes in Continental Europe have historically been lighter and less yeasty, including sponge cakes and croquembouche (fig. 11), which are stacked pastry filled with cream and dipped in toffee. Alternatives to wedding cake in Britain include bride's pie, which generally included minced meats or a hen filled with eggs as a symbol of fecundity. Plum puddings (fig. 12) were also served at important events in Britain, especially Christmas celebrations. These desserts often contained suet, the fat from the cavity adjacent to a cow's kidneys, instead of butter and were steamed in a muslin bag or animal's intestines rather than baked. Particular attention will be given here to cakes of the British tradition, as the Cleveland cake is a descendent of this line of baking (Charlsley 1992).

The first known recipe for cake made explicitly for a wedding was published in 1655, on the occasion of the marriage of a daughter from the Manners of Belvoir, a prominent English family. The recipe describes a large plum cake enclosed in a pastry case. It includes flour, ale-yeast, eggs, butter, sugar, currants, musk, ambergris (wax from the intestines of sperm whales dissolved in rosewater), mace, cinnamon, and nutmeg. During the early 18th century, a shift took place in Britain away from bready cakes towards richer cakes with more butter, eggs, and almonds. Wine and rum were sometimes used in the 18th century and candied oranges, lemons, cherries, and brandy became popular ingredients in the 19th century. The proportion of these ingredients varied over time and from place to place. Professional bakers generally prepared wedding cakes, though home baking was sometimes done for smaller cakes for other celebrations in the

18th and 19th centuries. Home baking became more common in the 20th century as kitchen equipment benefitted from improvements in technology. Light, Continental-style sponge cakes gained popularity in the 20th century, though plum cakes remain dominant in Scotland (Charlsley 1992).

In America, Colonial-era practices for baking wedding cakes were directly descended from British traditions. Plum cakes, referred to as black cakes in America, were the standard choice for wedding cakes. In the late 18th century, this changed with the creation of white pound cakes without fruit and light angel food cakes, referred to as white cakes. Whiteness was a unique feature in American cakes and a complete departure from British tradition. White and black cakes coexisted in America and were both served at weddings for decades. Black cakes remained popular in tradition-oriented areas of the East Coast until the 20th century, when white cakes became the near-universal choice for wedding cakes.

In the late 19th century, the practice of having one cake named for the bride and one for the groom became popular, particularly in the Southern states. The bride's cake was often white and was the primary cake served at the ceremony. The groom's cake was generally black and was either served at the wedding, given as a favor for guests to take home, or sent to individuals who were not able to attend the ceremony. In tiered cakes, the bottom layer was sometimes the dark groom's cake and the upper tiers were white bride's cake. Groom's cakes of this period involved substantial variation and may have included fruit, nuts, alcohol, molasses, carrots, or a number of other ingredients not usually found in the white bride's cake. Unmarried women were encouraged to sleep with a piece of the groom's cake under their pillows to encourage dreams of their future groom (Charlsley 1992). The tradition of the groom's cake remains popular in the South today, though chocolate and humorous novelty cakes have almost entirely replaced spiced plum cakes.

3.1.2 President Grover Cleveland and Frances Folsom

Grover Cleveland (March 18, 1837-June 24, 1908) was the 22nd (1885-1889) and 24th (1893-1897) President of the United

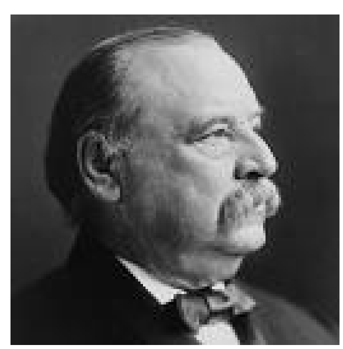


Fig. 13: President Grover Cleveland

States. He is the only American president to serve two non-consecutive terms and is also the only president to be married in the White House. President Cleveland was born in Caldwell, New Jersey and spent much of his early career in Buffalo, New York. He was elected Sherriff of Erie County in 1871, Mayor of Buffalo in 1881, and Governor of New York State in 1882. Cleveland had a reputation as a blunt, honest politician. As president, he opposed imperialism and high tariffs and supported the gold standard.

President Cleveland and Frances Folsom were married at 7 p.m. on June 2, 1886 in the Blue Room of the White House. President Cleveland was a legal guardian of Ms. Folsom following the death of her father, Oscar Folsom, who was Cleveland's first law partner. Cleveland supervised her education from age 11 and began a romantic correspondence while she was a student at Wells College. Frances Cleveland became the youngest First Lady in American history at age 21. The wedding was announced only four days before the event. As Ms. Folsom returned from a trip to Europe just prior to the ceremony, President Cleveland made many of the wedding arrangements himself. He organized the floral decorations and music and wrote individual invitations to a small group of family, friends, and Cabinet members. On the morning of the wedding, the couple autographed each of the paper cards on the cake boxes. Rev. Byron Sutherland of the First Presbyterian Church performed the ceremony.

Fig. 14: Frances Folsom Cleveland

A large bride's cake was served at the wedding along with 150 individual groom's cake slices in boxes. The bride's cake was reported to weigh approximately 25 pounds and was simple in design, with plain frosting overall and frosting scrollwork around the edges. A raised center layer had frosting C and F initials and was decorated with a wreath of orange flowers. The bride's cake was served at the wedding, while the boxes of groom's cake were given

Fig. 15: The Cleveland Wedding

as wedding favors or sent to those who were unable to attend the ceremony. The two boxes in the BECHS collection were given to one of Mrs. Cleveland's aunts and to Charles Goodyear, Grover Cleveland's former law partner. The piece of cake may have been retained because of the significance of the event as well as the custom of saving groom's cake.

3.1.3 Object description

Fig. 16: Box A, lace closed

Fig. 17: Box A, lace open

Two separate cake boxes were examined and treated as part of this study. Box A is a two-part cake box that contains a piece of President Glover Cleveland's wedding cake. The interior and exterior of the box is covered with ivory satin. Ivory needlepoint lace edging is attached with adhesive to the long interior sides of the bottom part of the box. The cake is dark brown and is wrapped in tin foil. A paper card with the signatures of Grover Cleveland and Frances Folsom in brown ink is adhered to the lid. The lid is painted with the monogram "GF" and the date "June 2nd, 1886" in raised gold paint. A sprig of green myrtle leaves is painted behind the gold writing. Box B is a second satin two-part cake box without cake inside. It contains an ivory silk ribbon that was used to tie the box.

Fig. 18: Box B

The design concept for the cake boxes was created by the New York caterer J.A. Pinard and was translated into a working design by a Mr. Whitehouse of Tiffany and Company. The Spooner Manufacturing Corporation of West 27th Street, New York City manufactured the cake boxes. Approximately 12 women made 150 cake boxes over a short period of time.

The basic box structure appears to be made of paperboard. All sides are covered with satin, a warp-dominated weave with high luster that is made from silk fibers. The satin is attached to the box structure with adhesive, evident in X-ray radiographs. The needlepoint lace is made from cotton thread, as determined with polarized light microscopy. The lace is adhered to the box with adhesive. The decorations on the box lid appear to be painted by hand.

3.2.3 Condition

Box A is structurally sound and retains its original shape. The fabric is well adhered to the box substrate. The exterior fabric has minimal staining and surface abrasions. The interior fabric is discolored overall and has multiple large, dark stains from contact with the cake. Cake crumbs and residue are imbedded into the surface. The interior of the lid has a stamped gold label that reads TIFFANY & Cº, UNION SQUARE. The lace is largely intact but is heavily stained and soiled. Small tears in the lace are apparent in the body and along the edges. The painted design on the top of the box has several areas of abrasion and loss. The paper name card is well adhered to the fabric and has a light amount of surface dirt and grime. The cake in Box A is poorly bound and is actively crumbling. Approximately 30% of the cake remains. No mold or active biological deterioration is observed. The metal foil is brittle and fragmented.


Fig. 19: Detail of cake

Box B is in good condition overall. The long sides of the box are bowed inwards. The exterior fabric has minimal staining and surface abrasions. The interior fabric is lightly discolored overall and has multiple small, light, localized stains. The interior of the lid has a stamped gold label that reads TIFFANY & Cº, UNION SQUARE. The painted design on the top of the box has several areas of abrasion and loss. The paper name card is well adhered to the fabric and has a light amount of surface dirt and grime. The ribbon is wrinkled and frayed along the edges.

3.2 SUGAR PASTE WEDDING CAKE TOPPER

3.2.1 Sugar paste origins and history

Sugar ornaments are one of the oldest forms of confectionary. The practice originated in early modern Europe and was available only to the wealthiest strata of society. Sugar ornaments served to articulate the taste, wealth, and power of the patron and were served at major feast events such as coronations, weddings, and papal visits. The subject matter varied in accordance with prevailing contemporary artistic trends, ranging from rococo Chinoiserie to neo-classical equestrian war trophies. Particularly ornate sugar ornaments were often colored, silvered, or gilded to resemble bronze or polychrome sculptures. Some historic sugarpaste ornaments could be eaten, but did not have an appealing flavor and were generally not consumed (Charsley 1992).

Fig. 20: A sugar paste triumphal arch with gilded war trophies from the House of Savoie.

Sugar paste reached its peak of sophistication and importance during the 17th century. Sugar paste sculptures were highly influential in decorative art practices and were the model for early European porcelain figurines. The creation of the first porcelain factory at Meissen in 1710 diminished the interest in sugar paste, though for several decades porcelain and sugar paste were often displayed together in table settings. The practice of making sugar sculptures in America was encouraged by the French Revolution

Fig. 21: Sugar paste flowers and pavilion with marzipan fruits

(1789-1793), which forced many talented French confectioners that catered to the aristocracy to relocate (Coutts and Day 2008).

Sugar table ornaments decreased in popularity in the 19th century, as fresh flowers and fruit table settings gained popularity in Europe and America. World War I ushered in an era of more modest social practice, rendering ornate sugar ornaments nearly obsolete although sugar paste was still used in simpler confectionary. This wedding cake topper is representative of this later type of sugar ornaments. The stylistic quality of the topper suggests that it was designed for a middle class family and it is similar in style to toppers from the 1930's (see fig. 22). Ornate sugar paste ornaments regained popularity in Britain and America in the 1980's and are again a popular feature at weddings and other formal occasions. However, the level of artistry in current practice is drastically less refined than the sugar ornaments produced in previous centuries and patronage is no longer confined to the wealthiest level of society.

Fig. 22: A wedding cake topper from the 1930's

Recipes for sugar paste vary, but generally include some combination of heated sugar, the crystalline disaccharide produced from sugar cane or sugar beet, and gum tragacanth, the natural gum polysaccharide obtained from the dried sap of several species of shrubs (genus *Astragalus*) found in the Eastern Mediterranean. Egg white, rose water and lemon juice were also sometimes included in order to add flavor or alter working properties. Sugarpaste differs from marchpane, a shapeable paste of almonds and sugar, and fondant, which generally contains gelatin, glycerine, or shortening.

Fig. 24: Gilded sugar paste trophies made from the mold in fig. 23

The fabrication process involves kneading the gum tragacanth and sugar mixture with water and beating it with a mortar and pestle into a paste. Once formed into a paste, the mixture may be pressed into a mold, carved with tools, or shaped in any number of other ways. Sugar crystallizes as the water evaporates, providing structural strength, while gum tragacanth makes the sugar mixture more elastic and workable. After individual elements are shaped, compositions may be arranged by joining pieces with heat. Sugar paste dries quickly on the surface but remains soft on the inside, often resulting in surface cracking and slumping. This necessitates the use of armatures in larger works and limits the amount of moving or handing that sugar sculptures may endure.

3.2.2 Object description

The object is a composite wedding cake topper from the early 20th-century. The cake topper consists of a sugar paste bell that is held in position with a vertical support over a platform and base. The bell is framed with floral ornaments made of metal wire, paper, and fabric. The fabricator and circumstances of use are unknown.

The term sugar paste refers to a sugar and gum tragacanth substance that may be rolled, molded, and modeled. The bell is made of molded sugar paste and lace and has the word “MARRIAGE” written in gilded block lettering across the body. A small bud-shaped green and white clapper hangs from the interior of the bell. The bell is held in an angled position with a metal wire and sugar paste support above a circular sugar paste platform. The platform is adhered to a base that is made of both molded sugar paste and unmolded pastry. The base has interior lace inserts that are visible though decorative openings.

The floral ornaments consist of two stems that arch from the center over the bell to the left and right sides. Each of the stems has multiple secondary stems with individual fabric leaves and flowers of varying sizes and shapes. The ends of both primary stems have a small green and white sugar paste bud that is similar to the bell clapper. The primary metal wire support stems are wrapped in paper and the secondary stems are wrapped in thread. A small sugar paste dove rests above the center where the two primary stems meet.

All of the sugar paste elements in the topper appear to have been shaped by casting in a mold. There is a vertical seam in the back of the bell, suggesting that the bell was formed in a flat mold and then shaped into its three dimensional form while still flexible. The topper is supported with two metal wires that run from the base up the back.

Fig. 25: Sugar paste cake topper, front

Fig. 26: Sugar paste cake topper, back

3.2.3 Condition

The object has sustained substantial structural damage and is actively deteriorating. The base is underbound and crumbling, requiring very careful handling. The sugar paste elements are partially crushed and have multiple fractures and areas of loss. The fabric, wire, and paper ornaments appear to be bent out of their original alignment. The fabric flowers and leaves are stained from contact with the metal and are lightly frayed. There is no evidence of previous conservation treatment.

Fig. 27: Detail, crumbling pastry base

The base is in very poor condition overall. The unmolded pastry elements are very weak and are actively fracturing. There are ten fragments stored with the object and several are too weak to handle. The bottom is particularly fragile and has several large fractures and an area of loss in the center. The surfaces of the molded sugar paste elements are also very friable and unstable. The base is substantially darker in color than the bell and platform. This may be because the base is made of brown sugar and the other pieces are made from refined white sugar.


Fig. 28: Detail, crushed sugar paste bell

The sugar paste elements of the object have undergone substantial structural damage but are not actively fracturing. All sugar paste elements have rigid surfaces and are not friable. The back and bottom proper left edges of the bell have been crushed inwards, creating several fragments and areas of loss. The dove appears structurally stable but has a small area of loss on the tip of the proper right wing. The proper right wire in the back support is detached from the sugar paste element. The back support has several large horizontal cracks and is bowed inwards towards the bell. This suggests that the bell was originally positioned higher in relation to the platform. The shifting position of the bell may be a combination of a single blunt force and inherent inadequacy of the back structural support. The platform is structurally stable and appears to be well adhered to the base and back support. A moderate layer of dirt and grime is present overall.

The fabric leaves are wrinkled and lightly frayed along the edges. The leaves near the center of the object have bent center wires and are folded. Several of the leaves have light brown stains that are the product of contact with the metal elements. The wires with small flower attachments appear to be bent out of their original alignment. The paper wrapping around the wires appears to be in good condition and is securely attached to the wire.

4. MATERIAL ANALYSIS

4.1 THE CLEVELAND CAKE

4.1.1 Objectives

The primary goal for the materials analysis of the Cleveland Cake and associated cake boxes was to identify the materials in order to inform treatment decisions and clarify historical understanding. The fibers in the lace and cake box covering were identified in order to gather information about how the fibers would react during aqueous stain reduction treatment. Detailed investigation into the ingredients of the cake was undertaken to contribute to the historical knowledge of 19th c. wedding cakes and allow classification of the cake as either a plum cake or a molasses and alcohol cake. Identification of the cake ingredients and the metal foil surrounding the cake was necessary prior to consolidation treatment. Knowledge of the materials aided in identifying an optimal consolidant/ solvent solution and helped to predict how the materials would react during consolidation. In addition to informing treatment decisions for this object, the process of conducting analysis on the cake contributed to the general understanding of how to best approach food artifacts.

4.1.2 Optical Microscopy

Examination of material samples with optical microscopy is a useful technique for identifying pigments, fibers, and layered structures. Materials may be identified using several different characteristics based on their physical and optical characteristics. Various types of illumination may be useful in identification, including darkfield, brightfield, ultraviolet, and polarized light. Chemical stains may be utilized to selectively color a class of materials in conjunction with specific illumination methods. The fibers in the lace and cake box covering were examined with polarized light microscopy to get a better understanding of how the fibers would react during aqueous stain reduction treatment. Images were captured digitally using an AxioCam MRc5 camera and software connected to a Zeiss Axio M microscope. Two small samples were taken from frayed edges of the lace in box A, including one sample from the thinner base area and one from the thicker decorative element of the point lace.

Both samples were identified as cotton using fiber morphology. Cotton fibers have several concentric layers, a distinctive lumen structure, and spiral twists in an S shape. Fiber samples from the box covering of box A and the ribbon in box B were identified as silk. Silk fibers are transparent, have no lumen, and have a smooth tubular structure.

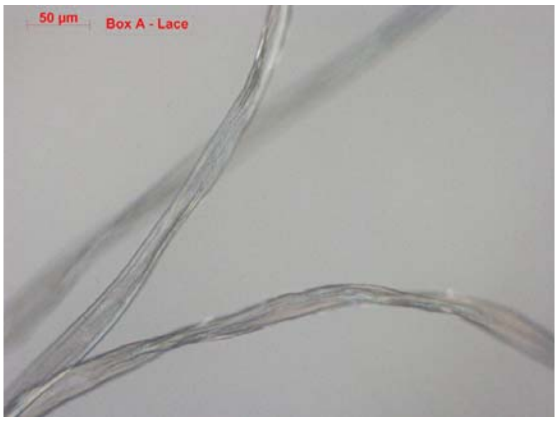


Fig. 29: Cotton fiber in lace from Box A

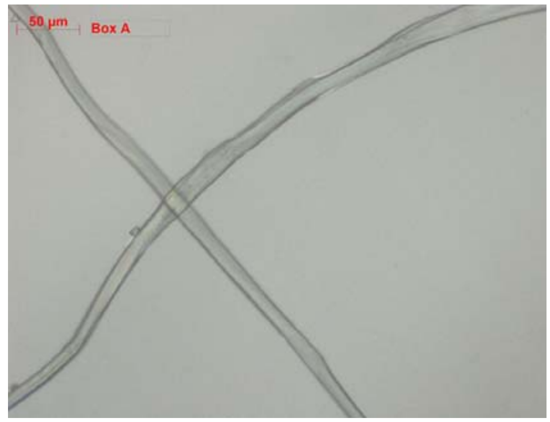


Fig. 30: Silk fiber in covering from box A

4.1.2 Ultraviolet-induced fluorescence

Ultraviolet (UV) radiation is the portion of the electromagnetic spectrum between visible light and x-rays (fig. 30). Its wavelengths span from 10 nm to 400 nm, divided into UVA (320-400 nm), UVB (280-320 nm), UVC (185-280 nm), and UVD (10-185 nm). The most common use of UV radiation in material examination is inducement of

Fig. 31: The electromagnetic spectrum

visible fluorescence, in which UV radiation hits the object, interacts with the material, and is re-emitted as lower energy visible radiation. UV-induced fluorescence may be perceived by the human eye and documented with photography. Many materials used in art such as oils, gums, resins, and adhesives have a characteristic visible UV-induced fluorescence that aid identification of artistic materials and methods as well as previous restoration efforts. UVA is the safest UV region for both the object and the conservator, but materials may behave differently under shorter wavelengths and examination with multiple regions of UV radiation may be useful (Warda 2008:69).

The cake and cake boxes were examined with two high-pressure mercury vapor UVA lamps (301 W/cm^2). The cake fluoresced orange, as expected of organic food materials (far left in fig. 32). The metal foil wrapped around the cake did not fluoresce. The unstained areas of satin fluoresced blue-white. The stained areas of satin and lace in box A fluoresced yellow-orange, suggesting that the overall staining was from exposure to the cake as opposed to metallic staining. Several spots on the interior bottom of the cake box A did not fluoresce. These spots are small pieces of tin from the foil wrapped around the cake. Metallic staining may also be present. The fluorescence of the painted myrtle leaves varied in the two box lids, suggesting that the paint formula was not consistent. The paper elements also varied in fluorescence. The paper card on box A fluoresced more yellow than the card on box B, which may be due to variations in paper formulation or penetration of cake oils.   Photographs were taken using a Nikon D100 camera with PECA 916 and Kodak 2E filters.

Fig. 32: UVA-induced fluorescence, cake and box A

Fig. 33: UVA-induced fluorescence, box B

4.1.3 X-ray radiography

X-rays have shorter wavelengths and higher energies than ultraviolet radiation and consist of the region in the electromagnetic spectrum from .01-10 nm. X-ray radiography may be used to differentiate materials and determine the composition and thickness of materials. In radiography, the subject is irradiated with x-rays of a specific energy and images are produced based on relative atomic weight. Regions with a lower atomic weight will transmit more radiation and appear dark in the radiograph, while areas with higher atomic numbers will transmit less radiation and appear white.

Computed x-ray radiographs of the cake and cake boxes were taken as part of their structural examination. Radiography was done using a Philips MCN 101 x-ray tube with a 1.5 mm focal array and 40° emergent beam angle. The radiographs were made using a Kodak Industrex HR Flex 2174 imaging plate without filtration and scanned on a Kodak/Carestream Health ACR 2000 scanner. Exposure for the cake radiograph was 6kV, 3000 mAS (5 minutes, 10mA), 15"FFD, without tube filtration. Exposure for the cake box radiographs was 6kV, 9000 mAS (15 minutes, 10mA), 16"FFD, without tube filtration.

Radiography of the cake was performed to study potential variations in consistency, which might indicate the presence or absence of dried fruit or nuts. The cake is wrapped in a foil made of tin, which has a much higher atomic weight than the organic cake material. A radiograph was taken at a 60° angle in an attempt to shoot the x-ray through two sides of the cake that have little to no tin covering. Unfortunately, enough tin

Fig. 34: Cake radiograph setup

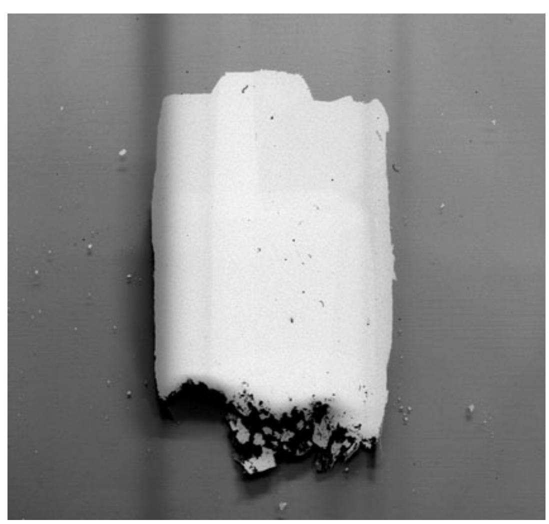


Fig. 35: Cake radiograph

was present on these sides that x-ray transmission was blocked and radiography of the cake material was unsuccessful.

Radiography of the cake boxes was undertaken in order to determine more information about how the boxes were constructed. Radiographs were taken at several different angles in order to examine both corner joins and planar surfaces. The support material covered in fabric is probably paperboard, based on its physical flexibility and its transmission of x-rays. Radiography revealed that the fabric is adhered to the support with adhesive, as several distinct adhesive spots are apparent. The corners of the support appear to be lightly joined with adhesive or simply held in place by the fabric.

Fig. 36: Cake box radiograph, 90° angle

Fig. 37: Cake box radiograph, 60° angle

4.1.4 X-ray fluorescence spectroscopy

X-ray fluorescence (XRF) spectroscopy is a qualitative or quantitative, non-destructive method of analysis that involves exciting a material with X-rays and studying the emission of characteristic "secondary" (or fluorescent) X-rays to determine the elemental composition. Elements with a low atomic weight (below magnesium) may not be reliably detected, though a vacuum or a helium-purged environment may be employed at the sample site to clarify detection of light elements. XRF is a surface sensitive technique, but analysis is not limited to surfaces alone.

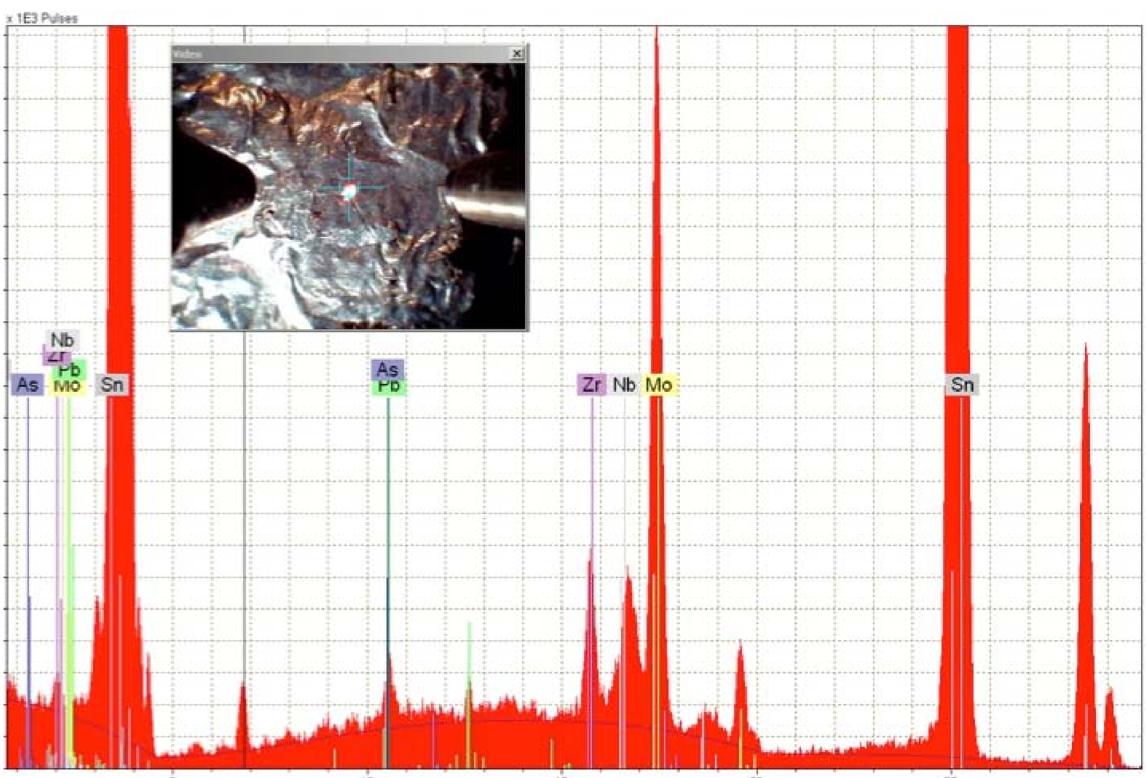
The metal foil on the cake box was analyzed with XRF to determine the metal alloy. An x-ray fluorescence spectrum was collected using a Bruker ArtTAX energy dispersive X-ray spectrometer system. The excitation source was a molybdenum (Mo) target X-ray tube with a 0.2 mm thick beryllium (Be) window, operated at 50 kV and 700 mA current. The x-ray beam was directed at the artifact through a masked aperture of 1.0 mm in diameter. X-ray signals were detected using Peltier cooled XFlash 2001 silicon drift detector (SDD). Spectral interpretation was performed using the ArtTAX Control software. Spectra was collected over 60 seconds (live time) with no filter. The results are summarized in Table 1, followed by the spectrum and a discussion of findings.

Table 1: Summary of results of XRF analysis

Sample area	Sn	Pb
Metal foil, cake	M	T

M=major element, m=minor element, T=trace element

Figure 38: XRF spectrum for metal foil



The metal foil is tin. Zirconium and Niobium are a result of the tube settings and is not actually present in the object. Lead may be used in tin alloys.

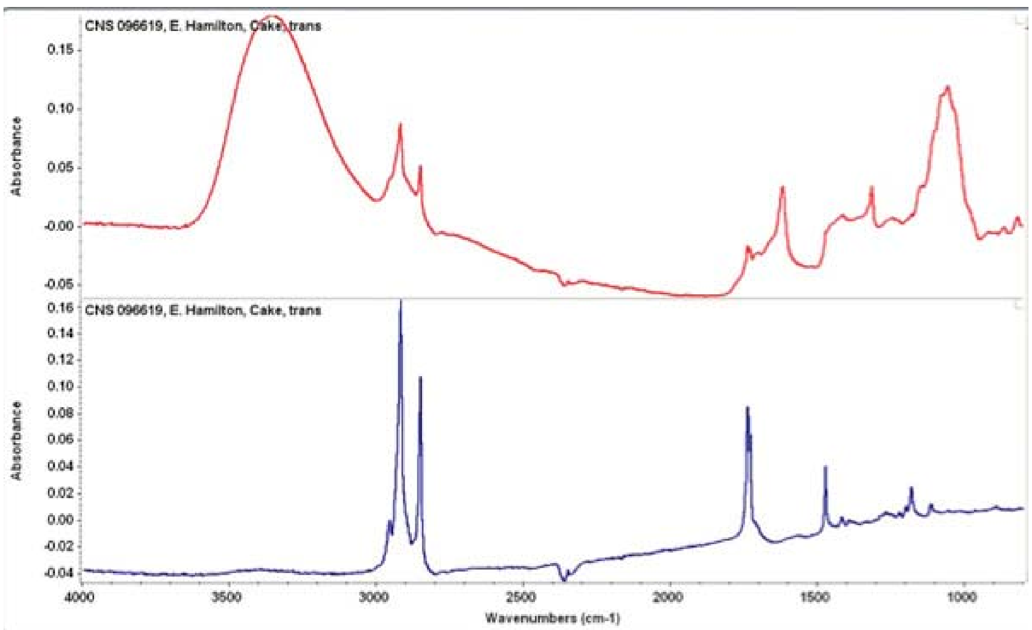
4.1.5 Fourier-transform infrared spectroscopy (FTIR)

Fourier-transform infrared spectroscopy is a method of analysis used to identify the molecular composition of primarily organic and organometallic materials. It works by measuring a sample's absorption of mid-IR radiation (2500 nm to 10,000 nm or 4000 cm^{-1} to 1000 cm^{-1}). Chemical bonds or functional groups may be identified by characteristic absorption bands, providing a molecular fingerprint for the sample. The analytical procedure is non-destructive but requires removing microscopic samples from the artifact.

FTIR analysis was performed on the cake to contribute to the identification of ingredients. A sample was taken from a small crumb already detached from the main body of the cake. Two distinct spectra were observed (see fig. 39). The first spectrum has strong absorptions at 3300 cm^{-1}, 2950 cm^{-1}, 2850 cm^{-1}, 1650 cm^{-1}, 1300 cm^{-1}, and 1050 cm^{-1}. This indicates the presence of polysaccarides and lipids. Honey was the closest library match, but investigation into historical recipes suggested that the inclusion of honey was unlikely. Instead, the peaks in the spectra may be a mix of polysaccarides from dried fruits, molasses, table sugar, wheat flour, and other ingredients. The second spectrum is simpler, with absorption peaks at 2950 cm^{-1}, 2850 cm^{-1}, 1750^{-1}, and 1450^{-1}. This is similar to library spectra for several lipids including shea butter and deer fat. FTIR spectra for lipids do not vary significantly, making identification of lipid sources difficult with this analytical method. Analysis with FTIR was not conclusive as the number of ingredients in the cake complicated the identification of ingredients.

Infrared spectra were collected using a Continuum microscope coupled to a Magna 560 FTIR spectrometer (Thermo Nicolet). Samples were prepared by flattening them in a diamond compression cell (Thermo Spectra Tech), removing the top diamond window, and analyzing the thin film in transmission mode on the bottom diamond window (2 mm x 2 mm surface area). An approximately 100 um x 100 um square microscope aperture was used to isolate the sample area for analysis. The spectra are the average of 32 scans at 4 cm^{-1} spectral resolution. Correction routines were applied as needed to eliminate interference fringes and sloping baselines. Sample identification was aided by searching a spectral library of common conservation and artists' materials (Infrared and Raman Users Group, http://www.irug.org) using Omnic software (Thermo Nicolet).

Fig. 39: FTIR Spectra for Cleveland Cake

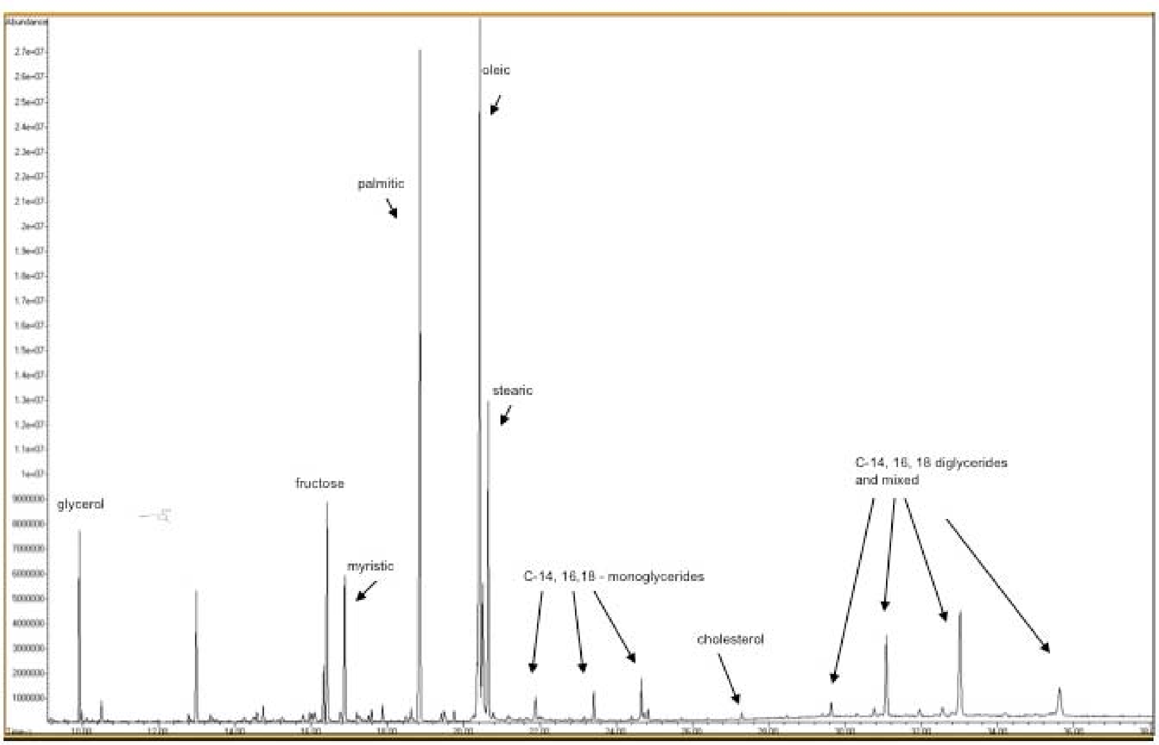


4.1.7 Gas chromatography-mass spectrometry (GC-MS)

The final analytical technique employed to identify the cake was GC-MS. Dr. Chris Petersen from the Winterthur Scientific Research and Analysis Laboratory performed the analysis. The results include several different fatty acids in a ratio consistent with butter, but nothing that could be used to conclusively identify lard, molasses, or suet, the distinguishing ingredients. The most interesting part of the analysis is the presence of fructose without other sugars that would be expected such as sucrose and glucose. This may be because the other sugars have degraded over time or because the solvents used to extract the ingredients could not extract these particular sugars. Further interpretation of the analysis is currently underway, but conclusive identification of the cake ingredients with scientific instrumentation is unlikely.

Successive sample extractions were performed with hexane and chloroform on a cake crumb. Samples were analyzed using the Hewlett-Packard 6890 gas chromatograph equipped with 5973 mass selective detector (MSD) and 7683 automatic liquid injector. The Winterthur RTLMPREP method was used with conditions as follows: inlet temperature was 300°C and transfer line temperature to the MSD (SCAN mode) was 300°C. A sample volume (splitless) of 1μL was injected onto a 30m×250μm×0.25μm film thickness HP-5MS column (5% phenyl methyl siloxane at a flow rate of 2.3mL/minute). The oven temperature was held at 55°C for two minutes, then programmed to increase at 10°C/minute to 325°C where it was held for 10.5 minutes for a total run time of 40 minutes.

Fig. 40: GC-MS results for Cleveland cake



4.2 SUGAR PASTE WEDDING CAKE TOPPER

4.2.1 Objectives

Materials analysis was performed on the cake topper with the goal of obtaining further knowledge about how the object was constructed. Examination with UV-A radiation was undertaken to identify the presence of coatings or adhesives. The shape and condition of the metal armature was studied with x-ray radiography. The ingredients of the sugar paste were investigated with FTIR spectroscopy. Given that the white sugar paste platform and bell are very different in appearance from the brown sugar paste base, it was thought that the two regions varied in their ingredients. This series of analyses contributed to the understanding of the object's technology and informed treatment decisions.

4.2.2 Ultraviolet-induced fluorescence

As the piece was being photographed before treatment, several fragments from the cake base detached. No UV-A photographs were taken at this time as it was decided that stabilization treatment was necessary before the object could be safely handled for an extended photography session. However, the object was briefly examined with UV irradiation at this stage and no coatings or adhesives were apparent from previous treatment.

Fig. 40: Cake topper, UV-A irradiation

The object was examined with two high-pressure mercury UVA vapor lamps (301 W/cm^2) after the treatment was completed to demonstrate that the plaster fill in the bell is easily detectable through this examination technique. The fill fluoresces green and the boundaries between original material and restoration are clear and distinct. The fabric white sugar paste elements fluoresce bright white. The brown sugar paste elements fluoresce orange. Photographs were taken using a Nikon D100 camera with PECA 916 and Kodak 2E filters.

4.2.3 X-ray radiography

Computed x-ray radiographs of cake topper were taken in order to study the structure of the metal wire armature. Radiography was done using a Philips MCN 101 x-ray tube with a 1.5 mm focal array and 40° emergent beam angle. The radiographs were made using a Kodak Industrex HR Flex 2174 imaging plate without filtration and scanned on a Kodak/Carestream Health ACR 2000 scanner. Exposure for the radiographs was 30kV, 120 mAS (24 seconds, 5mA), 40" FFD, without tube filtration.

Radiography revealed that the armature in the back support is a single wire that loops up from the base to the top and back down to the base. The wires bend inwards towards one another on the bottom and extend into the surface of the platform. The wire in the clapper is an extension of the wires in the fabric ornaments and is wrapped in a loop around the back support armature. The metal wire does not extend into the buds.

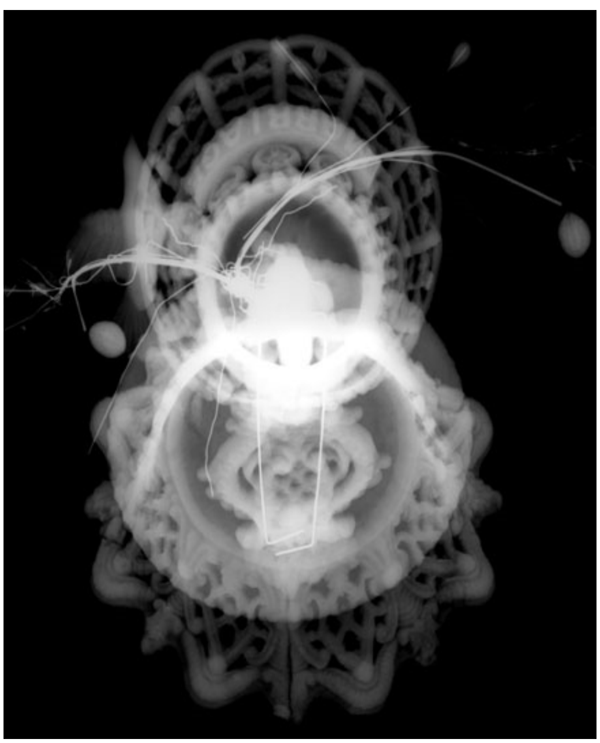


Fig 41: Cake topper radiograph, upper back

Fig. 42: Cake topper radiograph, right side

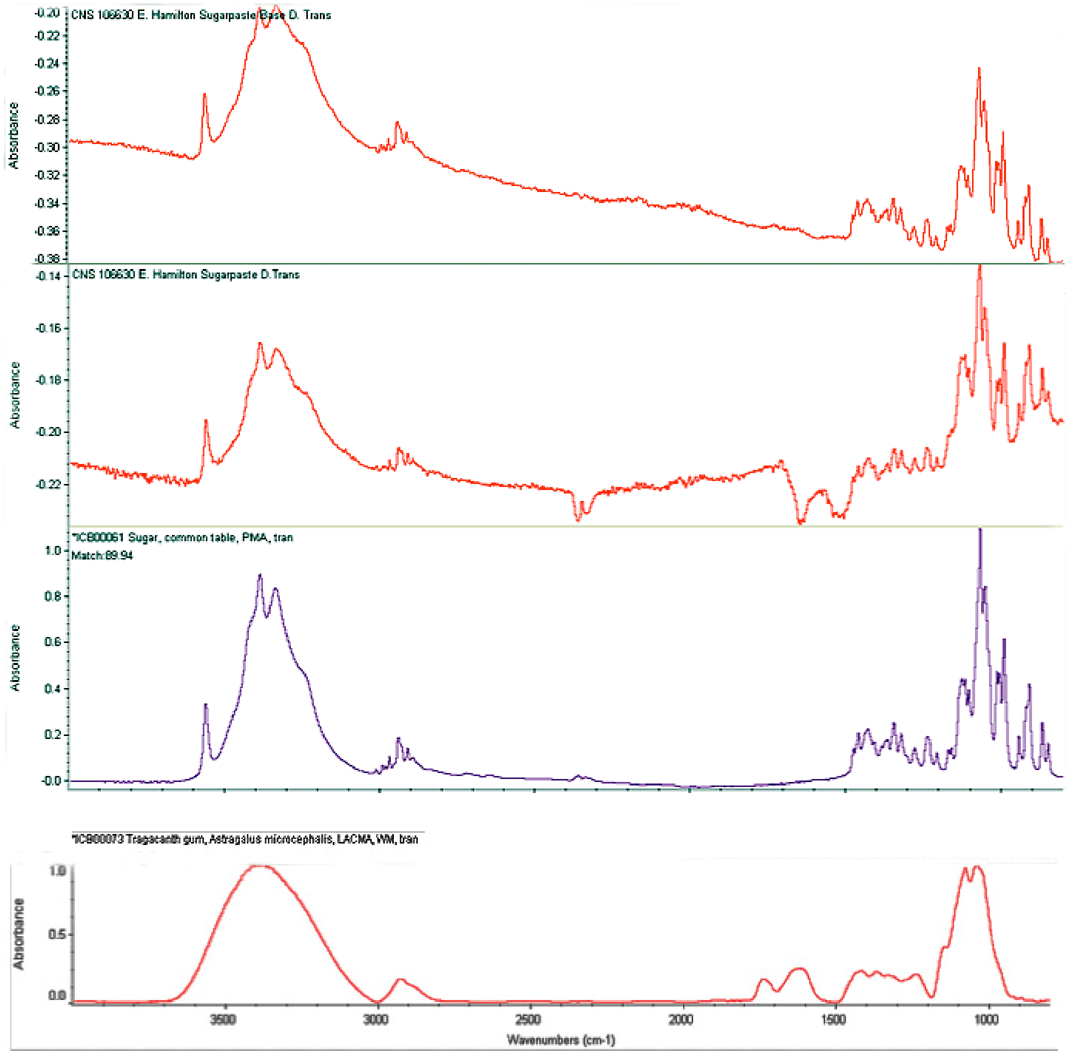
4.2.3 Fourier-transform infrared spectroscopy

FTIR analysis was performed on fragments from the sugar paste elements to contribute to the identification of ingredients. Samples were taken from fragments of the white sugar paste bell and the brown sugar paste base in order to compare their spectra and determine the ingredients. The visual appearance of the two sampled areas is very different in color. This may be because the bell is made from refined white sugar and the base is made from brown sugar, or because of different aging behavior or other variation in ingredients. Investigation into historical formulations for sugar paste suggest that gum tragacanth, egg white, rose water, and lemon juice were often included in sugar paste to alter the working properties. The goal of FTIR analysis was to identify the presence or absence of these ingredients in order to form a better understanding of how the object was constructed.

Infrared spectra were collected using a Continuum microscope coupled to a Magna 560 FTIR spectrometer (Thermo Nicolet). Samples were prepared by flattening them in a diamond compression cell (Thermo Spectra Tech), removing the top diamond window, and analyzing the thin film in transmission mode on the bottom diamond window (2 mm x 2 mm surface area). An approximately 100 um x 100 um square microscope aperture was used to isolate the sample area for analysis. The spectra are the average of 32 scans at 4 cm^{-1} spectral resolution. Correction routines were applied as needed to eliminate interference fringes and sloping baselines. Sample identification was aided by searching a spectral library of common conservation and artists' materials (Infrared and Raman Users Group, http://www.irug.org) using Omnic software (Thermo Nicolet).

The best library match for both spectra is common table sugar. Both spectra have major absorption peaks at 2900 cm^{-1} and 1050 cm^{-1} and similar minor peaks. Sugar is likely present in such a high proportion that identification of other ingredients may not be possible with this method of analysis. The presence of gum tragacanth, egg white, and rosewater were not conclusively confirmed or eliminated. The major peaks of a library gum tragacanth spectrum correspond with the peaks of table sugar, making it difficult to conclusively identify gum tragacanth in the samples.

Fig 43: FTIR spectra for sugar paste base and bell fragment



5. TREATMENT

5.1 THE CLEVELAND CAKE

5.1.1 Objectives

The goals for the treatment of the Cleveland cake included structural stabilization of the cake and creation of barrier housing. The cake was very dry and actively crumbling, necessitating consolidation treatment in order to prevent further structural failure. Barrier housing allowed the cake to be stored in its box without the risk of staining the satin further. Crumbs in the box were collected and retained untreated for potential future analysis.

The objectives for the treatment of the cake boxes differed based on their condition. Cake box A, which is associated with the extant cake piece, had extensive stains. Stain reduction treatment was performed as possible with the goal of reducing distracting spots and bringing the box closer to its original appearance. Box B served as a model of comparison in estimating the original colors of the lace and satin covering. Both box A and B had areas of loss in the painted details. These losses were compensated to bring the overall appearance closer to the original design.

5.1.2 Material mock-ups and practice treatments

Given the unusual nature of the materials, a series of material mock-ups were fabricated in order to gain experience with potential techniques for conservation treatments. As the chemical composition of the Cleveland cake was unknown until near the end of the study, several different fruit and molasses cake mock-ups were made with varying ingredients. The mock-up cakes should not be understood as precise replicas of the original cake, but rather as practice models for treatment options. Little variation was observed in the working properties of the different cakes during trial treatments, so the composition of the mock-up cakes will not be addressed at length.


Fig. 44: Desiccation of mock-ups

Practice consolidation treatments were performed on the cake mock-ups to determine the optimal methods. To make the mock-ups as similar to the Cleveland cake as possible, the mock-ups were cut into cubes close in size to the original and placed in a vacuum desiccator for 48 hours. This dried out the samples and increased friability and brittleness.

Consolidants that were considered for this experiment included Paraloid B-72, Aquazol, funori, sucrose, polyethylene glycol (PEG), isinglass, and other adhesives commonly used in conservation. Solvent testing was performed on cake crumbs under magnification to observe structural changes. Water, acetone, ethanol, and xylene were tested as possible solvents. Water appeared to soften the structure on contact, but the other solvents did not have an apparent effect. Water-based consolidants were eliminated as a result of this testing. Paraloid B-72, an ethyl methacrylate and methyl acrylate copolymer, was selected as the optimal resin both for its solubility in non-aqueous solvents and its long-term stability and efficacy as a consolidant.

Practice treatments included different application methods of Paraloid B-72 in solvent in varying concentrations. Techniques included full immersion, injections, surface application with an eyedropper and by spraying, and curing (solvent evaporation) both in and out of a vapor chamber. While concentrations of up to 20% resin in solvent were found to be effective consolidants, solutions of 5% were also deemed adequate and were less visually apparent after solvent evaporation. Immersion successfully consolidated both the interior and surface of the cake, while injections reached only the interior and dropping/spraying consolidated only the surface. Curing inside a solvent


Fig. 45: Solvent testing


Fig. 46: Consolidant injections

vapor chamber was found to reduce surface sheen, as the resin was not pulled outwards as the solvent rapidly evaporated. Acetone, ethanol, and xylene were all acceptable solvents.

5.1.3 Cake consolidation

A solution of 5% Paraloid B-72 in ethanol was selected as the optimal consolidant due to the solubility parameters of the object and evaporation rate of the solvent. Solubility testing was performed on a minute cake crumb in ethanol under magnification and no structural changes were observed. Ethanol has a moderate evaporation rate, allowing adequate time for the resin to bond and evaporating nearly completely in air. The application method chosen was a combination of syringe injections and eyedropper surface dispersal. Immersion would have likely produced the desired results in the cake, but the tin wrapping on the surface was so loosely adhered that full immersion in liquid might have easily dislodged it.

The cake was placed on a sheet of silicone release mylar in a vapor chamber made from a glass aquarium with a lid. An open container of ethanol was placed in the chamber and allowed to sit overnight. This was done to prepare the cake for consolidation, allowing solvent to enter the cake surface into to encourage penetration by the consolidant. After 24 hours, three syringes of 5% Paraloid B-72 in ethanol were injected into the middle of the cake. The consolidant solution was generously applied to the cake surfaces with a plastic eyedropper. The cake was allowed to sit in the vapor chamber with the container of ethanol for five days. This was done to prevent rapid solvent evaporation, allowing the resin ample time to bond and form structural strength. After five days, the ethanol container was removed and the lid of the chamber was left ajar to enable slow replacement of ethanol vapor with air. After one week, the object was removed from the chamber. The consolidation treatment was highly effective and the stability of the cake was markedly improved.

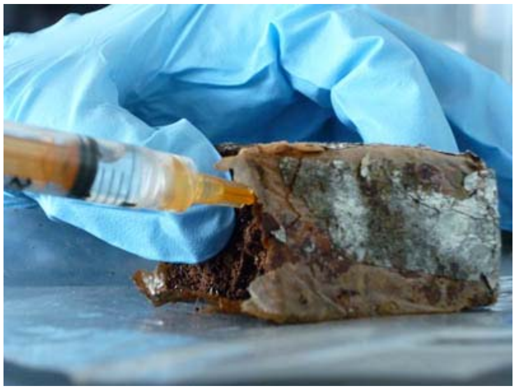


Fig. 47: cake injection

Interestingly, the consolidation treatment had the effect of increasing the odor of the cake. Though it did not smell strongly before treatment, after treatment the cake had a heavy, sweet smell similar to that of molasses. This suggests that the cake is in fact a baked plum cake.

5.1.4 Cake box cleaning and stain reduction

Crumbs of the cake were collected and retained as samples for possible future analysis. The cake boxes were vacuumed with a variable suction HEPA filter vacuum. The paper cards were surfaced cleaned with grated vinyl eraser crumbs. This reduced the surface dirt and grime but did not have a pronounced effect on the tone of the paper.

Fig. 48: Surface cleaning with eraser

The lace was detached from box A in order to facilitate stain reduction treatment. The box and lace were attached with a water-soluble adhesive. To detach the lace, a small amount of deionized water was brushed on the surface and gentle pressure was applied. The lace was wet cleaned in a bath of 0.3% Orvus paste in deionized water for 15 minutes. The wash tray was rocked gently during this time and the textile surface gently patted. After the Orvus solution was drained out, the lace was flushed with five rinses of deionized water to ensure complete removal of the surfactant. The lace was dried between blotters under moderate weight. The appearance of the lace improved substantially from this treatment. The most severe brown stains were nearly completely removed and overall yellowing was also reduced. A second wet treatment following the same procedure was conducted to determine if further stain reduction could be accomplished with this method. The second bath produced negligible improvement.

Fig. 49: Wet cleaning in Orvus paste bath

Aqueous light bleaching was performed on the lace to further reduce staining. The lace was placed in a tray of deionized water that was conditioned to approximately pH 9 with calcium hydroxide. The lace was placed on hollytex and a fiberglass screen inside the tray and submerged in the bath. The tray was covered with UV filtered Plexiglas and the lace was bleached for 2 hours at 10,000 foot candles, turning over the lace midway through. The lace was dried between blotters under moderate weight. Minimal stain reduction was achieved with this cycle of light bleaching.

Fig. 50: Light bleaching set up

A second campaign of light bleaching was undertaken using deionized water conditioned to pH 9 with ammonium hydroxide. The tray was set up as in the previous cycle and the lace was bleached for 2 hours at 10,000 foot candles, turning over the lace after one hour. This course of bleaching reduced the overall yellowing of the lace and also lightened some of the remaining dark spots. Bleaching brought the overall tone of the lace to a very close match with the ivory color of the unstained, untreated lace from box B. It may be possible to reduce the remaining stains with additional light bleaching, but further treatment was not considered necessary given the display of this object. When placed against the satin box, the color blends well with the satin and the remaining stains in the lace are no longer distracting.

Loose threads in the lace were secured with small amounts of wheat starch paste to prevent unraveling. The lace was reattached to the box with wheat starch paste. Overall, this combination of wet treatment with Orvus paste and light bleaching was highly successful in reducing the lace stains and improving the visual appearance.

Fig. 51: Lace before cleaning treatment

Fig. 52: Lace after cleaning treatment

5.1.5 Paint compensation

Losses in the painted decoration on the lids of the boxes were compensated to bring the overall appearance of the boxes closer to their original appearance. To prevent the paint from spreading into the satin, a barrier layer of 2% methyl cellulose in water was painted in the areas of loss. The raised profile of the paint was built up with Golden PVA paint and the surface was toned with Golden Acrylic paint.

Fig. 53: Cake box before treatment

Fig. 54: Cake box after treatment

5.1.6 Housing

Barrier housing was created so that the cake could be stored inside its box without causing further staining or damage. The housing consists of two pieces of MarvelSeal, which are cut and formed to shape around the cake. The top piece may be removed for display.

Fig. 55: MarvelSeal barrier housing

The cake boxes were placed in a storage box made from acid-free blue corrugated board. Cake crumbs were placed in a glass vial and stored with the object.

5.2 SUGAR PASTE WEDDING CAKE TOPPER

5.2.1 Objectives

The cake topper was in a state of active, severe deterioration when it arrived for examination. The base of the topper was very friable and it crumbled with minimal movement or handling. The first priority in treatment was to stabilize the base through consolidation. This prevented further breaks from occurring and made it possible to join the pastry fragments that had already separated from the main body. Once the base was stabilized, the structural and cosmetic issues of the rest of the topper could be addressed. The bell was partially crushed, requiring realignment, joins, and fills to make the piece structurally stable and visually cohesive.

5.2.2 Material mock-ups

Material mock-ups of sugar paste were made in order to gain a better understanding of the object technology. Preliminary attempts included heating white granulated table sugar in a double boiler with gum tragacanth and varying amounts of water. The sugar was heated to approximately 100° C and alternatively rolled into a ball or poured into a wooden mold. These attempts produced a non-workable paste that was either too granular or too runny.

In a subsequent attempt to make sugar paste, one pound of white confectioner's sugar was mixed with gum tragacanth and water without heat. Twelve ounces of sifted sugar was mixed with 1 tablespoon of gum tragacanth and two ounces of water. The paste was kneaded for approximately ten minutes gradually to form the desired consistency. The resulting paste was easily workable and was shaped by pressing it into molds and forming it freehand. Confectioner's sugar was applied to the molds as a parting

Fig. 56: Kneaded sugar paste

powder, and in most tests the paste could be removed from the mold without substantial difficulty. The paste became more easily workable over time, which may be a result of the starches in the sugar swelling from the water. Most pieces dried in air within 24 hours, although some of the larger pieces required over 72 hours to dry completely. The results are similar in appearance to the sugar paste elements in the cake topper, although that piece may have been formed with or without heat.

Fig. 57: Sugar applied as parting powder

Fig. 58: Sugar paste mock-up

5.2.3 Pastry consolidation and fragment joining

Consolidation of the pastry elements was the first treatment priority. First, the pastry body and fragments were brushed very lightly to reduce surface dust. This was done to prevent adhering the dust to the pastry during consolidation, which would complicate forming secure joins between fragments. The topper and fragments were placed on a sheet of silicone release mylar in a vapor chamber made from a glass aquarium with a lid.

Fig. 59: Cake topper consolidation set-up

A solution of 5% Paraloid B-72 in xylene was selected as the optimal consolidant due to the solubility parameters of the object. Crystalline sugar is readily

Fig. 60: Base before joining

soluble in water and polar solvents, so xylene was selected as the solvent for its low polarity. B-72 was chosen as the resin both for its solubility in xylene and its long-term stability and efficacy as a consolidant. The 5% B-72 in xylene solution was generously applied to the pastry elements with a plastic eyedropper. An open container of xylene was placed in the chamber with the object and allowed to sit for five days. This was done to prevent rapid solvent evaporation, allowing the resin ample time to bond and form structural strength. After five days, the xylene container was removed and the lid of the chamber was left ajar to enable slow replacement of xylene vapor with air. After one week, the object was removed from the chamber. The consolidation treatment was highly effective and the stability of the pastry fragments was markedly improved.

After consolidation was completed, the fragments were joined as possible. Edges were coated with a solution of 50% B-72 in xylene, which provided the necessary strength to join pieces together. Pieces were gradually pieced together and the bottom of the base was made nearly complete. Difficulties included the irregular, non-planar shape of the pastry and the inability to provide support from the interior once the shape was nearly complete. Several shaped sugar paste fragments that belong to the outside of the base were left unattached. These fragments would rest below the flat surface of the base if attached, making the topper tilt and receiving so much pressure that they would likely

Fig. 61: Palette knife used for support

Fig. 62: Base after treatment

not remain attached. These fragments were placed in a polyethylene bag and retained with the object.

5.2.4 Sugar paste joins and compensation

Crushed sugar paste elements were straightened mechanically and joined with a solution of 50% B-72 in 50/50 acetone and ethanol, bulked with glass micro balloons. This solution was chosen because the joins will have substantial pressure exerted upon them by the object, requiring high strength. Conservators generally choose adhesives that are not stronger than the material being treated. This is done so that if force is exerted on the object, the join will fail before a new break is formed in the object. However, in this instance the join already has such substantial pressure from the slumping bell that it was necessary to use an adhesive that is stronger than the sugar material to prevent immediate failure. Acetone and ethanol were chosen as a solvent solution for their combined evaporation rate and polarity. Acetone evaporates quickly and nearly completely, which in this situation was desirable so that the joins would not shift as might happen with a slow evaporating solvent such as xylene. Ethanol is a moderately fast evaporating solvent and was included to reduce the polarity of acetone. Micro balloons are free-flowing, finely divided particles that provide strength and decrease weight in resin solutions.

Fig. 63: Injections into sugar paste breaks

To remove pressure from the weak elements while treatment was undertaken, the topper was inverted and supported with a ring stand and foam ring. Small pieces of cotton blotter were cut to form a barrier between the ring stand clamp and the object. The B-72 solution was inserted into the small areas between fragments with a syringe. Fragments were held in place until the solvent evaporated and the joins had sufficient strength to be released. After the joins were secure, high spots were reduced with local application of ethanol. This treatment was successful and the bell is securely positioned in its original alignment.

A fill for the area of loss in the front of the bell was made from Kerr dental plaster. A mold was made from a neighboring area of the bell with 3M ESPE Express

Fig. 64: Taking impression

Fig. 65: Polysiloxane mold

STD, a polysiloxane putty. The plaster was tinted with dry pigments and adhered in place with the 50% B-72 in a 50/50 acetone and ethanol solution bulked with glass micro balloons. Small gaps were filled with Flügger spackle. The fill was toned with watercolors and the overall appearance is visually cohesive.

5.2.5 Wire and fabric ornament treatment

The wire and fabric ornaments were crushed inwards towards the body of the

Fig. 66: Cake topper before treatment

Fig. 67: Cake topper after treatment

topper, making the individual elements difficult to view. Several of the starched linen leaves and flowers were crumpled and inverted. These elements were straightened mechanically and positioned so that the composition was visually cohesive. Flowers and leaves were locally humidified between damp blotters to release folds and inversions. Soiled areas were surface cleaned with grated vinyl eraser crumbs. A loose wire on the upper branch was secured with 50% Paraloid B-72 in acetone.

5.2.6 Housing

The cake topper was placed in a storage box made from acid-free blue corrugated board. Fragments were placed in a polyethylene bag and stored with the object.

6. Results and Discussion

Consolidation and fragment joining of the two food artifacts treated in this study proved to be an effective treatment procedure and dramatically increased the structural stability of both objects. Substantial darkening occurred during the consolidation of the cake topper base due to solvent saturation. Darkening gradually diminished over a period of weeks as xylene evaporated from the object. The base is presently slightly darker than its color before consolidation, but further lightening will likely occur as evaporation continues. Undesirable surface sheen from the Paraloid B-72 resin was successfully reduced with localized application of the solvent used in consolidation treatment.

In addition to consolidation and joining of fragments, other treatments that are sometimes undertaken with food artifacts include freeze-drying and degreasing. Freeze-drying sublimates the water in food, allowing it to skip the dimensional changes that occur as water enters and leaves the liquid phase. Freeze-drying was not performed on the cake or cake topper because both artifacts were already very dry. Degreasing by solvent immersion or application over a suction platen may be performed to reduce the lipid content of a food artifact. Lipids may cause spoilage or discolor surrounding materials, so degreasing may reduce the condition problems can happen with food artifacts. While degreasing the cake may have reduced the potential for staining the satin box further, the fragile layer of tin on the outside of the cake was deemed too friable to undergo the mechanical force of immersion.

One method of analysis that was considered but not ultimately used to identify the ingredients in the cake was Enzyme-linked immunosorbent assay (ELISA) protein analysis. ELISA is a biochemical technique primarily used in immunology to detect the presence of antibody or an antigen. During analysis, an antigen is affixed to a surface and a specific antibody is washed over the surface to bind to the antigen. This antibody is linked to an enzyme, and in the final step a substance is added that the enzyme can convert to some detectable signal. This analytical method was not used in this project because the desired protein antibodies were not available. It would have been possible to test for the presence of milk and egg proteins using casein and ovalbumin antibodies, but these were assumed to be present and would not be indicative results.

7. Conclusions

The project began with the goal of stabilizing both food artifacts, with the additional hope that more information about the Cleveland cake's ingredients could be discerned. Both treatments were successful in stabilizing the pieces to prevent loss of original material. Paraloid B-72 was an effective consolidant for both objects as well as an adhesive for joining sugar paste fragments. Stain reduction of the cotton lace on the cake box with Orvus WA paste baths and light bleaching was also effective. Though historical research and scientific analysis of the cake ingredients with x-ray radiography, FTIR and GC-MS was not conclusive, the rejuvenation of the molasses scent during treatment permits tentative identification of the object as a baked plum cake.

8. Acknowledgements

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10. Sources of Materials

AYTEX-P, precipitated wheat starch, General Mills, dist. by Talas, 20 West 20th Street, 5th floor, New York, NY.

GLASS MICRO BALLOONS, Talas, 20 West 20th Street, 5th floor, New York, NY.

GOLDEN ACRYLIC PAINT (various pigments + acrylic dispersion) Golden Artist Colors, Inc., 188 Bell Road, New Berlin, NY 13411-9527; 607-847-6154

GOLDEN PVA (pigments dispersed in a proprietary blend of two PVA resins (probably AYAA & AYAC)), Golden Artist Colors, Inc., 188 Bell Road, New Berlin, NY 13411-9527; 607-847-6154

FLUGGER ACRYLIC PUTTY, (acrylic paste containing butyl methacrylate and calcium carbonate)

HOLLYTEX (spun bonded, non-woven polyester) Talas 20 West 20th Street, 5th floor, New York, NY 10011. 212-219-0770

KERR HARD DENTAL PLASTER, Kerr Corporation, 17117 West Collins Orange, CA, available from Patterson Dental Supply, 1031 Mendota Heights Road St. Paul, MN.

MARS-PLASTIC VINYL ERASER, #526 52, Staedtler, Nürnberg, Germany

METHYL CELLULOSE MC 64630 (non-ionic chemically modified cellulose; high viscosity), Fluka Chemical Corp., 980 S. Second Street, Ronkonkoma, NY 11779-7238; (800) 358-5287 or (516) 467-0980

ORVUS WA SURFACTANT PASTE (an anionic detergent that contains sodium lauryl sulfate) Proctor & Gamble, Cincinnati, OH 45202.

PARALOID B-72 (a copolymer of ethylmethacrylate and methyl acrylate) Rohm & Haas, Philadelphia, PA.

WINSOR & NEWTON WATERCOLORS, Gouache (pigments in gum arabic binder) Pearl Paint, 308 Canal Street, New York, NY.

11. Autobiographical Statement

Emily Hamilton earned a B.A. in art history from Reed College in Portland, Oregon in 2005. She gained pre-program conservation experience at the Reed College Library, the Portland Art Museum, and the Conservation Center for Art and Historic Artifacts. Emily completed graduate summer internships at the Brooklyn Museum of Art and the Sangro Valley Archaeological Project, organized by Oxford University and Oberlin College in Tornareccio, Italy. She will continue her education with a summer internship at the Gordion Archaeological Project in Turkey, operated by the University of Pennsylvania, and will complete her third year internship at the Sherman Fairchild Center for Objects Conservation at the Metropolitan Museum of Art. She has a particular interest in the conservation of modern and non-traditional materials.

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