An Innovative Technique for Reforming Cellulose Acetate in an Architectural Model of Rockefeller Plaza:
Challenges of Preserving Modern, Unstable Restorations

by
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ABSTRACT:

A large wood and plastic architectural model of Rockefeller Center (ca. 1935) had been displayed at the Visitor's Center at Rockefeller Center in an unsealed case for a decade. Fluctuations in temperature and RH and excessive UV light exposure caused the plastic walls of windows to shrink, warp and pull away from the wooden structures and caused wood veneer adhered to the plastic walls to buckle. FTIR identified the plastic as cellulose acetate with residual plasticizers. After consulting with plastics conservator Yvonne Shashoua, and inspired by a presentation at the 2017 Gels in Conservation Conference in London, the conservator borrowed a technique introduced in 2010 at the AIC Painting Conservation Specialty Group that utilized thermal blankets to reduce distortions in easel paintings. While there was no conservation literature on the use of heat and weights to reform plastic museum objects, the use of mild, controlled heat seemed like the only possible way to address the severe deformation of the plastic. Archival research revealed that the model had also been heavily restored in 1982. Color transparencies documented the alteration and, in many instances, replacement of the model maker's original materials during this restoration campaign. Determining how to preserve the object's original integrity despite a heavy restoration that replaced original material with unstable materials utilizing questionable techniques posed difficult questions for the conservator.

ARTICLE:

Rockefeller Center is an iconic architectural complex located in the heart of New York City on Fifth Avenue between 49th and 50th Streets (see fig. 1).

View of Rockefeller Center Complex
5th Avenue between 49th & 50th streets, New York City.

John D. Rockefeller Jr commissioned three architecture firms to build the structures between 1930 and 1939, but it is architect Raymond Hood who is most often given the credit for the grand design and style of the complex. The central tower is 30 Rockefeller Plaza, also known as "30 Rock". The structure on the left is La Maison Francaise, which I will call "France", and the structure on the right is the British Empire Building, which I will call "England". This black and white photograph (see fig. 2)

Fig 2. Architectural model of Rockefeller Plaza,
artist unknown, ca. 1935.
Wood, plastic, metal. 213 cm H x 61cm W x 198 cm D,
Museum of the City of New York, acc.no. 98.128
(Courtesy Rockefeller Archives).

dated to the 1930s shows the 213 cm high x 61cm wide x 198 cm deep detailed wood and plastic architectural model that was on prominent display at 30 Rockefeller Center for decades. The light tone of the wood veneer simulates the limestone cladding on the actual building facades.

In 1998, Rockefeller Center donated the model to The Museum of the City of New York. In 2007, the museum hired a restorer to stabilize and clean the model. The museum then loaned the model back to Rockefeller Center where it was displayed on the second floor Visitors Center for 10 years. Figure 3 shows the model as it appeared in 2017. The discolored shellac coating on the wood veneer no longer represents the warm white color of the limestone buildings today. Everyday, hundreds of tourists would enter the Visitors Center and view the model while waiting to take elevators to the Top of the Rock Observatory Deck on the 70th floor.

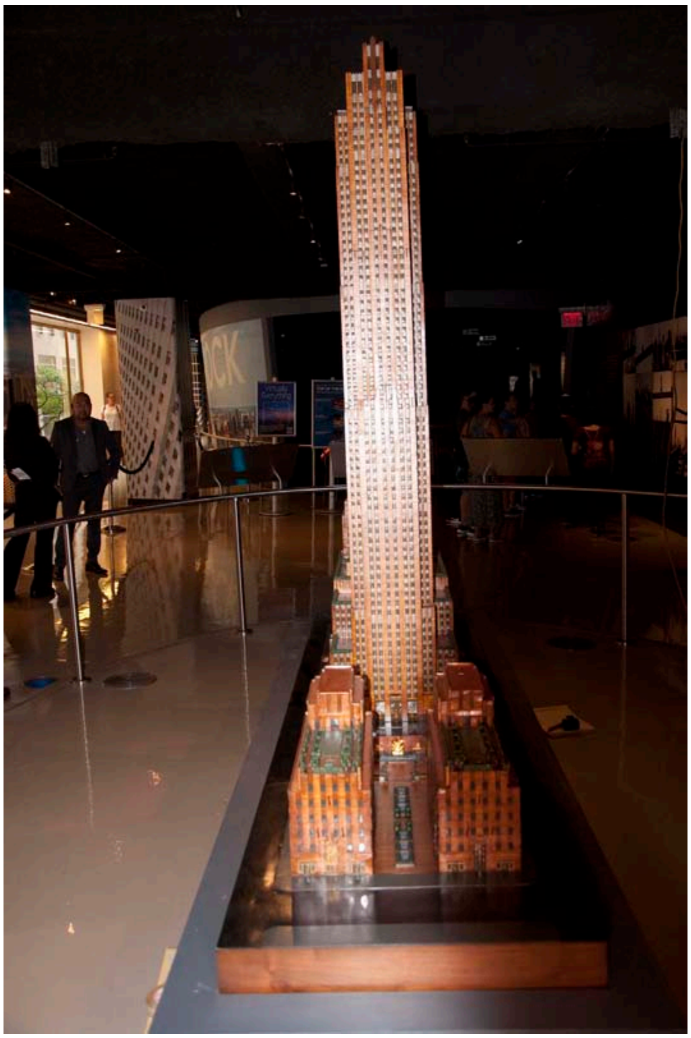

Fig. 3. Model displayed at 30 Rockefeller Center Visitors Center, 2017.

One day, a security guard at the Visitor's Center noticed that the corners of France and England were opening up and that the wood veneer on the sides of the structures was buckling (figs. 4, 5).

Fig. 4. England.


Fig. 5. France.

The Museum of the City of New York contacted me and asked me to assess the condition of the architectural model. It was immediately apparent that the condition of the model was so unstable that it needed to be removed from the non-climate controlled visitor center as soon as possible.

Once the large model was in the conservation studio, I removed France and England from their recessed base and put them on their sides so that I could better understand how they were made. The structures are hollow core, post and beam construction with mortise and tenon joins adhered with animal glue. The ground floor shops and windows are constructed from wood and plastic pieces glued together on the interior of the structure. Pieces of 9.5 mm thick plastic sheet are screwed to the exterior of the wooden framework to create a wall of windows. Window mullions are painted on the inside surface of the plastic. On the exterior wall of windows, wood veneer is attached to the plastic sheet with what I thought was animal glue.

I asked curators, architectural historians and other conservators to examine the model with me and to share their thoughts about how best to preserve this impressive object. Everyone seemed to agree on one thing: the model appeared to be an early, rare architectural model by architect Raymond Hood.

As I was trying to figure out how best to treat the model, I read Yvonne Shashoua's book, "Conservation of Plastics: Material Science, Degradation and Preservation". Shashoua is Senior Researcher specializing in modern materials at the National Museum of Denmark. Shashoua writes that cellulose nitrate and cellulose acetate, both of which were widely used in the 1930s, degrade in the presence of high RH, elevated temperatures and UV light; exposure to these elements causes the loss of original plasticizers and results in shrinkage, brittleness and distortion of the plastic. (Shashoua 2016) Rapid fluctuations in temperature and RH at the Visitor's Center and excessive UV light exposure caused the plastic walls of France and England to shrink, warp and pull away from the metal screws that were used to secure the thin plastic sheet to the wooden structure. Additionally, severe shrinkage of the plastic substrate caused the wood veneer laminate to buckle.

One of the first things I did when the model came to the studio was to send a sample of the plastic for analysis. FTIR Spectroscopy identified the sample as cellulose acetate with residual plasticizers. Once I knew I was not going to be working with flammable cellulose nitrate, I began contemplating the use of heat to reform the warped cellulose acetate walls. While there was no conservation literature on the use of heat to reform plastics in museum collections, the use of mild, controlled heat seemed like the only possible way to address the severe deformation of the plastic. What I hadn't figured out yet was where I was going to get my heat and how was I going to regulate the heat so that I could soften the deformed plastic but not melt it.

I found the answer to those questions in London at a conference entitled "Gels in the Conservation of Art." One of the presenters, Tomas Markevicius, talked about his use of a thin, flexible mat with an ultra steady heating system to heat agar gels used in the cleaning of painted surfaces. I thought perhaps I could use such a tool for heating the cellulose acetate walls on the Rockefeller model. While Markevicius said that his prototype mat was not available and not suitable for my needs, he did recommend that I consider using a silicone thermal mat like the one that he and Nina Olsson introduced at the AIC Paintings Conservation Specialty Group in 2010.

I now had a plan. I called Shashoua in Copenhagen and ran my idea by her. Yvonne told me that while she had never used heat to reform plastic museum objects, she thought my idea was a good one. “Give it a try,” she said. She gave me her blessing

After my treatment proposal and budget were approved by both the museum and Rockefeller Center, I was granted access to the Rockefeller Archives. The archivist told me that she had previously been a restorer and that she had led a major restoration of the Rockefeller model in 1982. While the archivist was unable to find any written reports or recall any of the materials or techniques used in that restoration, she did provide me with detailed transparencies documenting her alteration and, in many instances, replacement of the model maker’s original materials. As I reviewed the color transparencies at the archives, I learned that the street level shops and most of the windows on 30 Rock were replaced in 1982 with new cellulose acetate and large areas of wood veneer were also replaced. Decorative plastic tiles and pinnacles on 30 Rock were recreated and other decorative elements such as shrubbery and fountains were repainted. A fresh coat of orange shellac was also applied to all wood surfaces.

While the Rockefeller archives offered tremendous insight into the history of the model, the archivist could not tell me what I really wanted to know – who built the model and when?

I began my treatment with the 49th street Rainbow Room (see figs. 6, 7).

Fig. 6. Rainbow room.

Fig. 7. Rainbow room. Detail of warped cellulose acetate.

It detached easily from 30 Rock, it was small and it was the easiest way for me to try out my new heating technique. I separated from the shrunken, warped and fragmented 19 mm thick plastic walls from the wood structure by removing all 68 metal screws that had been used in the 1982 restoration. The warped wood floor was severely delaminated and could not be reused. I had a new wood floor laser cut to match the footprint of the restored floor. I reformed and flattened the warped plastic fragments using a silicone rubber heating mat manufactured by Instrumentors Supply in Oregon (see fig. 8).

Fig. 8. Custom made silicone rubber heating mats, control box and external thermal couples manufactured by Instrumentors Supply.

The mat is 1.4 mm thick. It is comprised of two layers of silicone rubber that sandwich an internal heating grid spaced at 38 mm intervals across the entire dimension of the mat. The silicone mat is resistant to moisture, solvents and compression. It comes in stock sizes up to 91 cm x 305 cm, but Intrumentors Supply will custom make any size needed. The control box for the mat, which is sold separately, is a precision digital temperature controller that drives a solid-state relay to run the heater. External thermo-couples detect and record temperature and can be positioned anywhere on the artifact being treated. I had my control box preprogramed not to exceed 60° Centigrade because, according to Shashoua, the glass transition temperature of aged cellulose acetate is between 45° and 60° Centigrade. (Shashoua 2018)

I reformed the acetate fragments by heating the blanket to 60°C and by applying weights (fig. 9)

Fig. 9. Rainbow room, flattening warped cellulose acetate fragments using heating mat and weights.

for 30 minutes. After I turned off the heat, I left the weights in place for one hour while the plastic cooled back to room temperature. When I removed the weights, the acetate fragments were flat.

Next I had to join the fragments. There is a dearth of literature on the joining of cellulose acetate, so I turned to Shashoua again. In her book, she suggests using epoxies, polyurethanes, acrylics or cyanoacrylates for adhering acetate. I chose Epotek 301 epoxy to join the 49th street Rainbow room fragments. I taped the fragments together as I would if I was repairing glass, and then fed the epoxy in at the joins. The epoxy worked well, but it was messy and excess adhesive had to be cleaned up with acetone.

At this point in the treatment, I was able to attend Shashoua's Conservation of Plastics course at CCI. At the course, I learned about the solubility parameters of plastics and of the solvent/adhesive systems used in joining plastics. When I went back to New York City, I decided to alter my treatment plan for the 50th street Rainbow room. To mend the wall fragments, I used Plexigum PQ611. Plexigum is an Isobutylmethacrylate that is soluble in Shellsol and xylene. I made a 50% solution and put it in a tube for easy application. Plexigum was much easier to work with than Epotek and, since it is reversible, I could remove excess glue residue with Shellsol, and the joins were clear and stable.

Next, I adhered the assembled cellulose acetate walls to the wooden structures with high tack fish glue from Talas. For some reason, the fish glue did not provide a strong enough bond between the relatively heavy acetate walls and the thin edges of the wood floor and roof. I tried a 50% solution of Paraloid B72 in acetone and it worked well. I adhered the silver plastic roof tiles to the acetate walls Plexigum. Lastly, I attached a laser cut piece of clear polyester sheet where the shrunken acetate had left an open void in the structure. Because of budgetary constraints, I simply inserted the clear fill material and did not attempt to make the fill invisible (fig. 10).

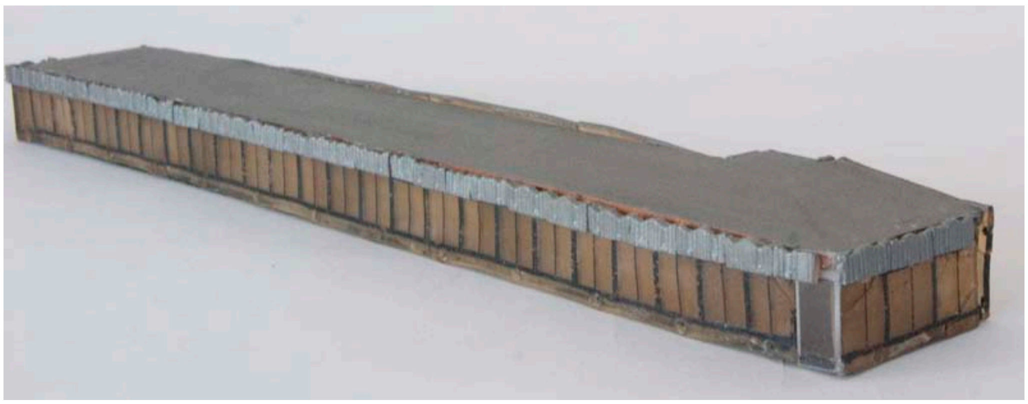

Fig. 10. Rainbow Room, After Treatment.

After the Rainbow rooms, I decided to concentrate on the tower (see fig. 11).

Fig. 11. 30 Rock, 49th street façade.

30 Rock was in relatively good condition. The client did not want to pay for the removal of the darkened shellac coating, so I spent most my time reattaching loose decorative tiles and treating the deformed acetate and wood veneer walls above the second story windows (see fig.12).

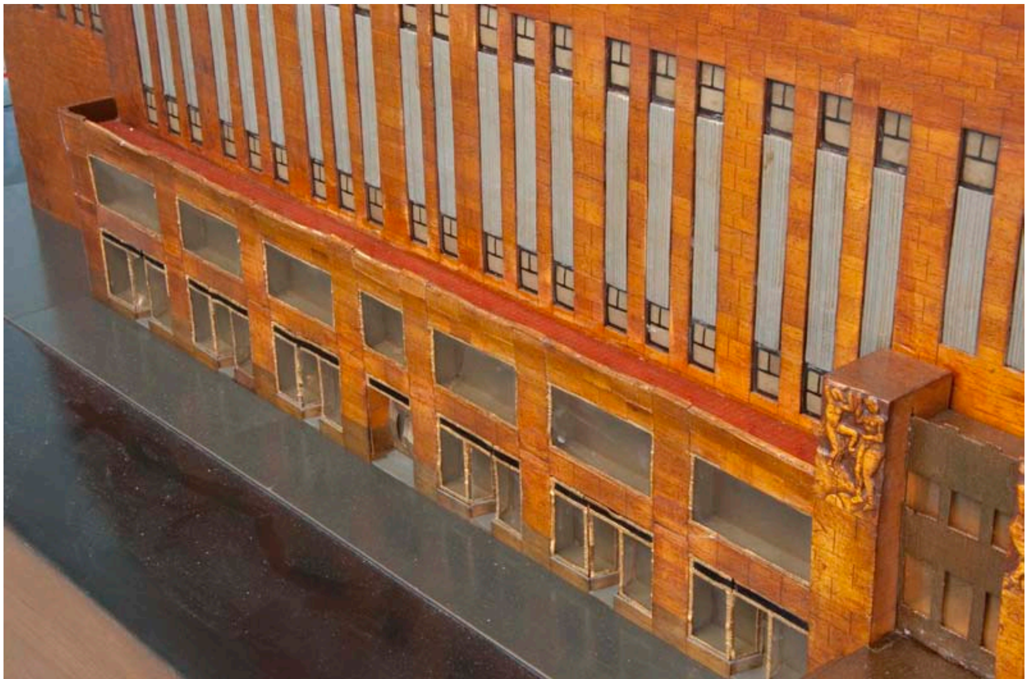

Fig. 12. 30 Rock, 49th street façade, Before Treatment, detail of warped wall above second floor windows.

I used the same silicone rubber mat that I had used for the rainbow rooms. My tests indicated that the mat worked best on the acetate and wood laminate when it was heated to 60° C for four hours. Longer dwell time was needed in order for the heat to transfer from the mat through the wood veneer to the acetate. I applied pressure to the heated plastic using wood boards, clamps and mat board shim (see fig. 13).

Fig. 13. Heating mat and clamping rig set up for 30 Rock.

The clamping rig was left in place overnight in order to insure that the plastic had completely cooled. The treatment was very effective in reducing the deformation (see fig. 14).

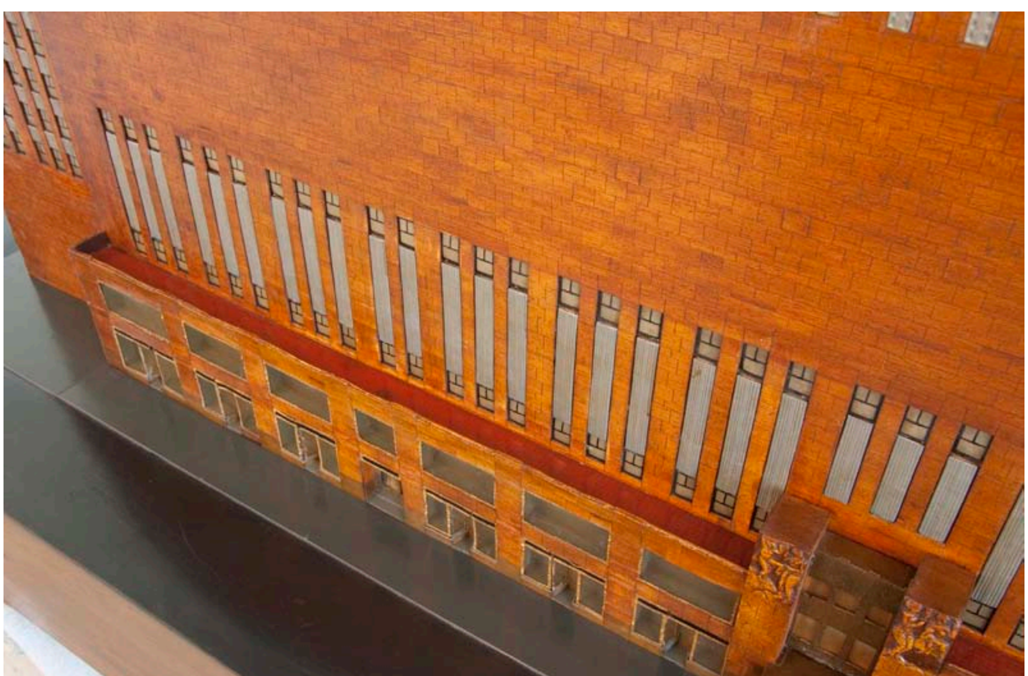

Fig. 14. 30 Rock, 49th Street façade, After Treatment.

I then moved on to France and England, which were in the worst condition. The wood veneer on the two structures had not been adhered to the acetate wall with animal glue, as I originally thought. Instead, it was applied with double stick tape during the 1982 restoration. The acrylic adhesive on the tape did not adhere well to cellulose acetate wall. Vertical strips of taped veneer could be easily removed with a small metal spatula (see fig. 15).

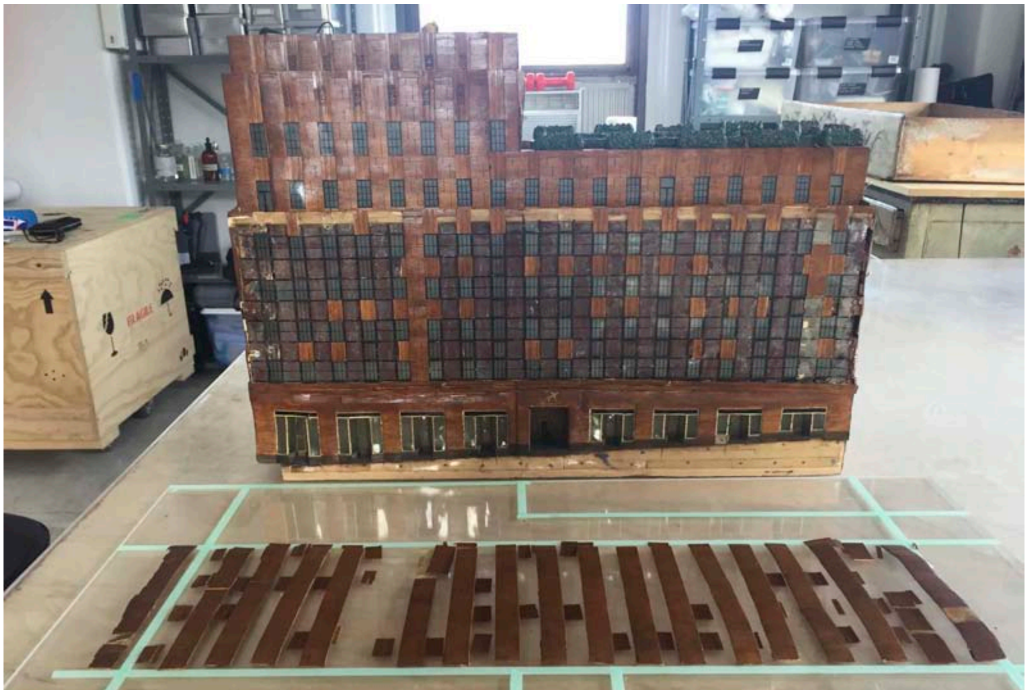

Fig. 15. England with strips of wood veneer removed from south façade.

I laid out the individual veneer strips on acrylic sheet so that I could record the proper location of each wood section for each building. Shrinkage of the tape substrate caused the wood veneer to buckle and become detached in many places.

Once I removed the taped veneer strips from the sides of the structure, I then mechanically removed old fill material at the corners that had been applied during the 2007 restoration (see fig. 16).

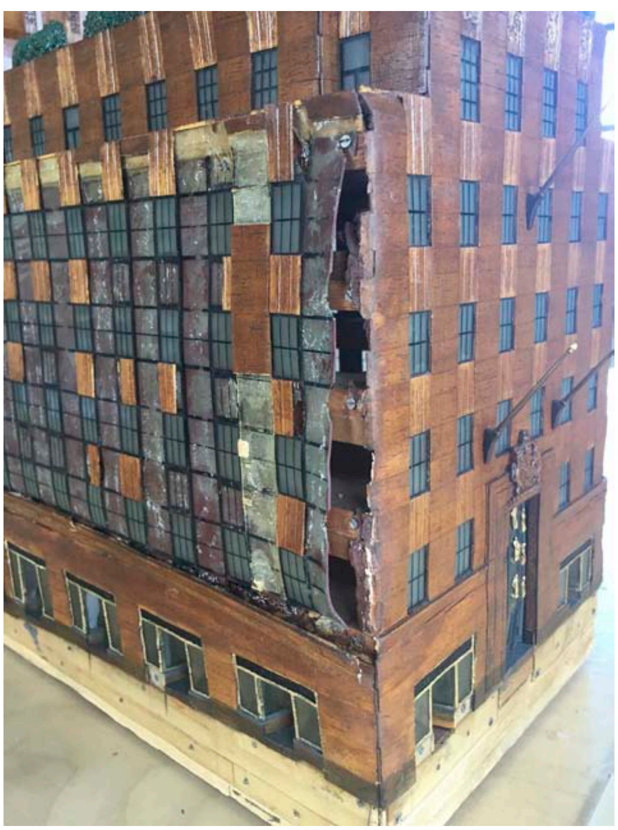

Fig. 16. England, detail of warped corner after removal of wood veneer.

I removed as many of the metal screws used to attach the acetate sheet as possible. Unfortunately, I could not remove all the veneer and all the screws, so I had to flatten the warped acetate sheet in situ. I heated the cellulose acetate walls to 60° Centigrade for 30 minutes using a larger silicon mat. I applied pressure to the warm acetate with weights that I left in place until the plastic had completely cooled (see fig.17).

Fig. 17. England showing heating mats and weights used for flattening warped cellulose acetate.

Once the walls were flattened, I adhered loose areas of the acetate sheet to the wood structural framework using high tack fish glue and weights (see fig. 18)

Fig. 18. England, with flattened and attached cellulose acetate. Visible at right of image is a void where the cellulose acetate sheet shrunk due to loss of original plasticizers.

To fill the void where the cellulose acetate shrunk at the corners, I glued small wood blocks at each floor landing in order to create more surface area to which I could adhere a wood veneer fill. I cut 9.5 mm thick basswood veneer to the shape of the void and glued it in place with fish glue. I then reattached the wood veneer and associated tape to the plastic walls and basswood fill using fish glue and weights (see fig.19).

Fig. 19. England, detail showing basswood fill and reattached wood veneer.

Because the acetate walls of the buildings and the polyester tape carrier had shrunk, the wood veneer sections did not fit neatly back into their original locations. I had no choice but to trim the tops of the individual wood pieces so that I could realign the vertical strips. Finally, I toned the basswood wood fills with watercolors to match the color of the degraded shellac coating (see fig. 20).

Fig. 20. England, After Treatment.

The treatment was a success. With the application of mild, controlled heat I was able to flatten the deformed cellulose acetate, which allowed me join the separated corners and re-adhere the wood veneer. Unfortunately, I don't have a photograph of all the treated structures together. 30 Rock, England and France went into storage as soon I finished treating them. The model remains in a storage facility in Brooklyn until 30 Rock prepares a climate-controlled display solution for the model.

REFERENCES:

Shashoua, Yvonne. Conservation of Plastics: Materials Science, Degradation and Preservation. London: Routledge, 2016.

Shashoua, Yvonne. "Conservation of Cellulose Acetate." Online interview by author. February 08, 2018.