Twelve Panels by Luca della Robbia: Conservation Issues

Sofia Marques
smarques@vam.ac.uk
Sculpture, Metals, Ceramics and Glass Section
Conservation Department
Victoria and Albert Museum
Cromwell Road
London SW7 2RL
U.K.

Keywords: terracotta, Luca della Robbia, fifteenth century, structural problems, adhesion, Paraloid B44®, Araldite SV427 / HV427®, aluminium strips

Abstract

This paper looks at a solution reached to solve major structural problems presented by a group of twelve glazed terracottas, probably commissioned around 1450 by Piero di Cosimo de’ Medici for the ceiling of his scrittorio, or study, in the Palazzo Medici in Florence. The Victoria and Albert Museum’s new display proposals aim to improve the understanding of the original function of these objects. However, they presented a challenge for conservators: to find an appropriate system of adhesion that would enable us to display these large fragmented objects made of porous terracotta on a vaulted ceiling, as they were originally intended to be viewed. This paper will emphasise the advantages of the use of Paraloid B44®, Araldite SV427 / HV427® and aluminium reinforcing strips.

Introduction

The twelve roundels, depicting the Labours of the Months, have been the subject of discussion and study by curators and conservators of the Victoria and Albert Museum both in terms of technology of production and conservation. They are thought to have been commissioned around 1450 from the Florentine sculptor Luca della Robbia (about 1400-1482) by Piero di Cosimo de’ Medici (known as Piero the Gouty) for his study in the Palazzo Medici in Florence. Although this room no longer exists, architectural plans of the original building and contemporary descriptions suggest that this study was a small room with a vaulted ceiling. This explains the form of the roundels, which are concave with varying curvatures that appear to indicate their placement on the ceiling. They are comparatively large and heavy for terracotta objects, measuring approximately 60 x 60 x 10 cm and weighing about 23 kg each.

The roundels had been displayed for almost forty years embedded into the wall vertically and placed on either side of an Italian Renaissance fireplace, but it has long been the intention of the V&A to display the roundels as part of a vault, as they were originally intended to be seen. It was therefore decided to remove, study and conserve the roundels in preparation firstly for their installation in the ‘At Home in Renaissance Italy’ exhibition (held at the V&A from October 2006
to January 2007) and subsequently for the new Medieval and Renaissance Galleries that will open in 2009. On their removal, it was discovered that the ‘roundels’ were, in fact, constructed as squares (Figure 1). The nature of previous interventions became more apparent and revealed important structural problems. Each of the panels had been broken into several pieces and, although the glazed surfaces at the front showed large areas with discoloured retouching, the extent of damage had not previously been fully understood. The panels would have originally been fitted into a larger decorative scheme on the vault, which is now lost.

The evaluation of the condition of the objects on their removal from the wall together with the curator’s wishes therefore set the parameters of our discussions on how to treat the objects. This paper presents a summary of the conservation treatment chosen in order to unveil more clearly these twelve exceptional works by Luca della Robbia that are so important both in terms of their technological achievement and their historical context. Moreover, the new display will help the viewer understand more fully the function of these decorative fragments from an important Renaissance ceiling (Figure 2).

Conservation Issues

The weight and structural weakness of each individual panel were the most important factors to be considered when planning a conservation approach that would allow the panels to be displayed in a vault. These objects have become extremely fragile and the concept of mounting them in a structure resembling the study presented new problems.

On removal from the wall where the panels had been embedded for many years, it was discovered that they had all been backed with plaster of Paris mixed with cotton wool and brick. This old backing was taken off in order to reduce the overall weight of each panel and reveal the whole object. It appeared that plaster of Paris was, in most cases, the only material joining the fragments together. Natural resin and thin iron pins were also found. On two occasions, polyester resin mixed with sand had been generously used and a surplus was apparent on the back of the objects (Figure 3). No records survive in relation to the earlier conservation treatment, but it was possibly carried out when the panels were installed in the 1960s.
Nature of the Terracotta and Firing Characteristics

To add to the difficulty, the terracotta was soft and porous. Analyses have shown that the clay used by della Robbia was very carefully prepared (Gabarit and Bormand 2002, Bouquillon et al. 2004). Considering the technology available at the time, the firing process was another complex area in which Luca would have had to excel. Overall, the firing temperature would not have exceeded 950ºC (Vaccari 1998), and it would have been impossible to maintain a constant temperature throughout the firing process, which implies that on such large pieces some areas are possibly softer and more porous than others. Close examination of the panels indicates the presence of original cracks and breaks, suggesting that Luca struggled to successfully fire these panels. In order to complete the ceiling he therefore may have produced additional panels that were lost in the firing process.

Method and Materials Selected for Treatment

The type of terracotta determined the selection of an adhesive. The intrinsic physical and chemical properties of the adhesive and its compatibility with its substrate were key elements for the successful reassembly of the fragments. The significant properties include strength, ageing qualities, glass transition temperature (Tg), viscosity, working time, degree of reversibility and overall hazard rating. In this particular case, a few more considerations had to be taken into account. The bonding of fragments relies on both the adhesive and gravity. Here, the forces of gravity are more negligible than if the panels were displayed vertically. Also important was the quality of contact between fragments, which unfortunately varied greatly from a close fit to hardly any contact. In addition, the fragments size varied considerably from a few centimetres...
to approximately a quarter of the entire object. Finally, for the current intervention, the decision was made to re-use the holes previously made for the iron pins in order to reinforce the new system of adhesion.

Although there were important limitations as to how much research and time could be assigned to the project, it was felt that a basic review of adhesives used on terracotta was required. For the purpose of this paper, only a few resins will be succinctly described.

A wide selection of resins has been used to adhere fragments of large or heavy objects together. Hard resins such as epoxy or polyester resins have often been resorted to, even on softer and porous materials such as plaster and terracotta. There will probably be instances, in practice, where no other option is viable because of the need to ensure a strong bond. The medium-hard resin group includes cellulose nitrate, polymers derived from polyvinyl acetate in solution and acrylic resins. Soft adhesives, which include natural resins such as mastic (Horie 1998) and shellac have also been used on objects of appreciable size and weight.

For the purpose of this project, soft resins were excluded because of their poor ageing properties, low glass transition temperature (Tg), insolubility over time, which make them unreliable when playing a major structural role.

Hard resins (polyester and epoxy resins) often seem to be the most immediate choice because of their strong power of adhesion. There is a wide range in use in conservation with variable properties. Polyester resins (such as Sebralit®) are probably more commonly used in sculpture conservation. They are used not only for their strong adhesion but also taking into account the weight of the fragments to be reassembled. Polyester resins cure rapidly and can be very useful for this reason but shrink during polymerisation (up to eight percent in volume) (Horie 1987) and therefore can cause stress to the substrate. The high viscosity of the resin can be a disadvantage when trying to align different fragments together.

Some epoxies are commonly used on ceramics but usually on much harder and non-porous substrates such as glass and porcelain. One of the disadvantages is the curing time, which can take up to seventy hours to complete (for example Araldite AY 103®). They perform very well in tight joins because they can be extremely thin (Williams 2002) but will be a problem when joining two fragments with very poor contact. Epoxy resins are overall not highly rated for their ageing properties and reversibility, although some are better, like Hxtal NYL-1® or Fynebond®. They can be expensive and difficult to use because of the accuracy needed in mixing the resin.

All of the above materials are mainly characterised by their high tensile strength, which is generically too high compared to the nature of the terracotta itself. The reversibility of some epoxy resins also appears to be a problem, especially when the adhesive is being used in between fragments rather than externally.

The next group of resins available encompasses the medium-hard resins. Cellulose nitrate, HMG® and the acrylic resins, Paraloid B72® and Paraloid B44® are the three examples discussed here. This type of resin might at first glance not appear appropriate, but from an early stage of the planning of this project, it was felt that an additional backing process could possibly complement the use of such resins to ensure the stability of the panels once installed in the vaulted ceiling.

Cellulose nitrate HMG® is easy to use, easily dissolves in acetone over time, and is reported to be perfectly suitable for the repair of porous earthenware. The ageing properties are potentially problematic because the resin becomes brittle, although the addition of a plasticiser makes it
more stable (Williams 2002). Its strength is reported to be comparable to Paraloid B72®. HMG® is commercially produced in small tubes (many would be necessary for this project), and the viscosity cannot easily be altered.

The stability of a resin is absolutely crucial, but more so in view of the position in which the panels would be displayed. Paraloid® B72 is recognised to be among the most stable and permanent conservation materials both chemically and mechanically. The adhesive, when prepared from the dry form (small white granules) is of better quality than the commercially available tube form (Nisole 1997). The results obtained on testing the affinity between this resin and a terracotta substrate that had been fired at a low temperature, have been the most successful (Nisole 1997). Very little shrinkage occurs on setting (Alloin 1997). The Tg of 40°C is, however, a major disadvantage when the resin plays a structural role in the cohesion of large objects.

The relative humidity (RH) of the gallery where the panels will eventually be displayed has in the past varied from being hot and humid in the summer to cold and dry in the winter. Average figures for RH range from 30 percent to 50 percent and the temperature varies between 18°C and 25°C with peaks in the summer that go up to 31°C. The museum aims to improve the fluctuations in RH of these galleries without having to use a cooling system, and we therefore have to take potential peaks in temperature into account. In addition, the sensors will be placed below the level at which the della Robbia panels will be displayed (around four metres for the panels), so the temperature is likely to be higher. The Tg of Paraloid B72® is, therefore, too low to be used in this case study. Paraloid B72® is overall not the most suitable material for bonding heavy objects because of the risk of flowing at room temperature (Nisole 1997).

Paraloid B44® was the last to be evaluated as a resin for fixing the fragments of the panels together. The Tg is 20°C higher than that of Paraloid B72®, which in this case is a great advantage. It is still classified as a flexible resin (Nisole 1997) although the film obtained is harder and far more resistant than Paraloid B72®. This resin also has very good ageing properties, the pH actually seems to remain more neutral over time when ageing in the dark (Nisole 1997). A 50/50 solution by weight in acetone is also more viscous, which is an advantage when the adhesion between fragments is poor.

The resources for direct research within this particular project were limited, therefore, only simple tests were carried out. In order to have an idea about the strength of the resin, a modern brick was broken in half and the join was coated twice with a low concentration of the same resin dissolved in acetone to reduce the porosity of the substrate and increase the adherence between the two halves. Then a 50/50 by weight solution of Paraloid B44® in acetone was applied with a brush, the two halves were pressed together, and were left to dry for seventy hours. The brick was hung on a hoist and a weight of 16.5 kg was added to the bottom of the brick and left for five months.

No alterations were observed during this period. No attempt was made to try to separate the two pieces because it would not have been possible to measure the point at which the resin starts to fail. It would, however, have been useful to see where the break would first occur and, if it had separated in the join, whether any of the terracotta was pulled off. The resin was effectively applied to terracotta fired at a higher temperature than the one studied here but elaborate tests have been carried out on similar clay bodies elsewhere (Nisole 1997). This test does not provide much information about the application of B44 on a ceramic with an inferior level of contact between the fragments.
Treatment of the Panels

Paraloid B44® was diluted in acetone because of its rapid rate of evaporation. However, the higher the concentration, the slower the setting time of the solution. Three days were still normally allowed to ensure a complete setting of the resin, although the resin considerably toughens after only a few hours of application. To the mixture 50/50 by weight (equivalent to 87.5 percent by volume of acetone), was added 0.4 percent of fumed silica as tests have shown that between 0.1 and 0.5 percent can actually improve adhesion whereas greater amounts decrease adhesion (Table 1) (Byrne 1984, Koob 1986, Kessler 1997, Alloin 1997).

<table>
<thead>
<tr>
<th>Practical use</th>
<th>Proportions (by weight)</th>
<th>Percentages (by volume)</th>
<th>Quantity of acetone (g)</th>
<th>Quantity of resin (g)</th>
<th>Quantity of fumed silica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution to coat the sides of the fragments</td>
<td>1:1/8</td>
<td>10.9</td>
<td>100</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Base solution</td>
<td>1:01</td>
<td>87.5</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Solution to bond fragments</td>
<td>1:1</td>
<td>87.5</td>
<td>100</td>
<td>100</td>
<td>0.4% by weight added to solvent before mixed with resin</td>
</tr>
<tr>
<td>Solution to fix the dowels</td>
<td>1:1/2</td>
<td>47.5</td>
<td>100</td>
<td>50</td>
<td>Add fumed silica to obtain a paste</td>
</tr>
<tr>
<td>Solution to fix gauze on the backs of objects</td>
<td>1:1/2</td>
<td>47.5</td>
<td>100</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Concentrations of Paraloid B44® Used in the Current Treatment.

Pre-wetting the sides of a porous substrate with a low concentration adhesive improves the adhesion between fragments (Kessler 1997, Castro and Carbó 1999). Two coats of 10.9 percent by volume of the solution were applied to the sides of the fragments of the object to reduce the porosity of the terracotta body.

A successful join is not merely defined by the adhesive selected but also a good contact between fragments. As previously raised, the contact between some fragments of the panels was poor. Circular carbon fibre dowels (4 mm diameter) were used in existing holes. A few more holes needed to be added. Half of the full concentration, which is 47.5 percent by volume, was mixed with fumed silica to obtain a paste to hold the dowels in place inside the holes. The overall cohesion of individual panels has, with this treatment, been achieved.

An additional measure, such as reinforcement at the back of each panel had been anticipated. The important characteristics to be considered for the type of backing system were weight, reversibility, properties of the materials selected, extent of protrusion at the back of each object and its compatibility with the mounting in the vaulted ceiling.

As mentioned above, the removal of the old backing system revealed the back of each panel. In terms of technology of production, it appeared that hollows had been made while the clay
was still fairly soft to reduce the thickness, especially on the sides of each panel. The concave curvature observed on the panels corresponds to the shape of the ceiling. It is believed an initial clay model was made, then a first mould produced, possibly in plaster, from which a few panels were then cast. So the clay was pushed in this mould, the back was possibly flattened with some kind of wooden ruler (marks suggest the use of wood), and the hollows were created (using tools and fingers) to facilitate the homogeneous drying of the clay.

These hollows could therefore potentially create a key for reinforcement if an impression were taken using a material such as an expanding polyurethane resin or a mixture of Paraloid B72® and micro-balloons. Both present disadvantages when following our criteria. A stainless steel welded frame surrounding the object with bridges was another possibility but the irregular shape of the panels meant it was not going to be practical. It would also add a lot of weight to the overall installation. This led us to use aluminium because it is light, rigid but malleable, stable, and available in various sizes and forms (Alloin 1997). It has the disadvantage of not being easily soldered, so a simple structure and fixing method had to be devised.

A viscous adhesive was necessary in order to locally fix the aluminium to the back of the panels. On this occasion, an epoxy resin, Araldite SV 427®, combined with the hardener H 427 was viewed as a potentially useful material. It has low shrinkage on curing (linear shrinkage of 0.6 mm/m), because the setting time is about fourteen hours. Also, it is not as rigid or strong as other epoxies because of the inert particles added to it. These particles limit the cohesion between the macromolecules of polymers, which is why the material is softer. It offers a good resistance to acetone and good adherence. Applied on terracotta with an interface of Paraloid B72®, it has proved to be reversible using a scalpel without causing damage to the substrate (Alloin 1997).

This process was slightly adapted for our purpose in view of the position in which the panels would be displayed. Aluminium strips (3 cm wide) were cut and placed over major breaks on the back of each panel. In order to maximise the adherence of the aluminium-terracotta interface, the extremities were roughened with a file and small holes were drilled. The strips were then bent to follow the curvature of the back (Figure 4). The areas of terracotta to which the aluminium would be fixed were coated with the concentration used to coat the sides of fragments. Then, squares of muslin were cut and fixed to these areas with a much stronger concentration – 47.5 percent by volume.

Figure 4. View of back of panel April after conservation treatment completed (7635-1861, Photograph by Sofia Marques).
The method had been previously tested on a broken modern brick. The preparation was as described above but the muslin was adhered with 10.9 percent by volume Paraloid B44® in acetone and no adhesive was used in between the fragments. The top half was held on the hoist. The tension applied was therefore greater than in the real mounting. This test showed that although the matrix is very loose, the muslin acts as an interface. The epoxy resin is not in direct contact with the terracotta body. On detachment, the terracotta was not damaged (although, in this case, the terracotta is less porous than the one studied). The muslin needs to be bonded to the substrate with a higher concentration resin to ensure a better adhesion between the terracotta-muslin-aluminium in combination with epoxy resin.

Finally, for the display within a vaulted ceiling, the collaboration between conservators and engineers contributed to the added stability of each panel, which, despite the increased stability after treatment, remain fragile objects (Figure 5).

Figure 5. Mock up of mounting system to be fixed onto structure resembling the ceiling of the study (Photograph: Robert Lambeth).

Conclusion

In our treatment of the twelve large fragmented panels by Luca della Robbia we have attempted to find solutions that were sympathetic to the nature of the material and that also allowed objects to be viewed in a vaulted ceiling as originally intended. Each panel can be individually removed and the back can now be seen, allowing our investigation into their technology to continue.

Acknowledgements

The author is grateful to Stéphanie Nisole, Élise Alloin and Sabine Kessler for kindly allowing her to consult their unpublished diploma theses; Peta Motture and Charlotte Hubbard, the Victoria and Albert Museum, for reviewing the text; her colleagues, Charlotte Hubbard, Victor Borges, Brendan Catney, Johanna Puisto, Lisa Wagner and Sarah Healey for contributing to the project.
References


Materials

Aerosil Cok 84®
Degussa AG
60287 Frankfurt am Main
Germany
distributed in the U.K. by Lawrence Industries
Tel.: +44 182 731 4151
www.l-i.co.uk)

Araldite AY103®
Ciba Polymers, Structural adhesives
Duxford, Cambs CB2 4QA
U.K.

Fynebond®
Fyne Conservation Services
St. Catherine’s, by Loch Fyne
Argyll PA25 8BA
U.K.
Tel./Fax: +44 141 357 4107

HMG®
H. Marcel Guest Ltd
Riverside Works
Collyhurst Road
Manchester M40 7RU
U.K.
Tel.: +44 161 205 5551

Hxtal NYL-1®
Conservator’s Emporium
100 Standing Rock Circle
Reno, NV 89511
U.S.A.
www.museumservicescorporation.com/consemp/catalog/index.html

Paraloid B72® and Paraloid B44®
Rohm and Haas (U.K) Ltd
Lenning House
2 Mason’s Avenue
Croydon CR9 3NB
U.K.
Tel.: +44 20 8686 8844
REN HV 427-1®
Huntsman Advanced Materials Ltd.
Everslaan 45
3078 Everberg
Belgium
Tel.: +32 2 758 9211
Fax: +800 376 92 09

Sebralit®
A. J. Lopez & Co. Ltd
Loco Residence
King’s Cross
Goods Yard, York Way
London N1 0AT
U.K.
Tel.: +44 20 8544 9980