When Surgery Meets Conservation: The Treatment of the Multi-material Sculpture Love Me by Sarah Lucas.

CHAPTER 19

When Surgery Meets Conservation: The Conservation Treatment of the Multi-material Sculpture *Love Me* by Sarah Lucas

F. Rocco,[a] T. Poli,[b] O. Chiantore,[b] A. Mirabile[c]

[a] SUSCOR – University Structure in Science for Conservation, Restoration, Exploitation of Cultural Heritage. University of Turin in cooperation with the Conservation – Restoration Center "La Venaria Reale", Via XX Settembre 18, Venaria Reale, 10078, Turin, Italy

[b] Department of Chemistry, University of Turin, via Giuria 7, 10125, Turin, Italy

[c] Paper Conservator, 11, rue de Bellefond – 75009 - Paris, France

ha formattato: Tipo di carattere: (Predefinito) Times New Roman, 12 pt

Formattato: Interlinea: singola

ha formattato: Inglese (Stati Uniti)

ha formattato: Tipo di carattere: (Predefinito) Times New Roman, 12 pt, Inglese (Stati Uniti)

ha formattato: Inglese (Stati Uniti)

ha formattato: Inglese (Stati Uniti)

ha formattato: Inglese (Stati Uniti)

Abstract

This paper focuses on the complex conservation of the multi-material sculpture *Love Me* (1998) made by the British artist Sarah Lucas. Due to a severe dent, the artwork's stability was compromised and the work cannot be safely exhibited anymore. The goal of this experimental study was to develop a treatment methodology to ease out the dent and find a consolidant able to secure the area from further damages. A novel traction system, borrowed from medical limb-lengthening surgery, was developed and several type of tie rods and protecting layers were tested. Moreover, innovative materials based on nanocellulose particles were evaluated as strengthening agents for the papier-mâché layers and compared to traditional strengthening products. Due to the lack of information obtained from the experimentation, the use of nanocellulose particles was not considered safe for the treatment which was done using more traditional materials, namely wheat starch and *Kozo* Japanese paper. Nevertheless, the results of the preliminary trials laid the foundation for the use of these products for conservation purpose.

19.1 Introduction

Since the mid-nineteenth century artists have had access to a wide range of innovative materials, which has facilitated their ability to renovate traditional aesthetic values[1-2]. Among them, sculptors have progressively abandoned bronze and marble for modern materials, embodying a leading role in the definition of contemporary art[1]. The industrial development of plastics has prompted artists to use second-hand objects and industrial materials as part of their sculptural language, instead of more traditional methods such as casting and modelling. Moreover, artists started to investigate the expressive potential of acrylic, polyester and epoxy resins for the creation of artistic, abstract or fanciful shapes[2]. More recently, the constant research of inedited way of expression has pushed contemporary artists to the limit of the concept of sculpture itself, including transient and edible materials as sculptural items[1]. The work of the English artist Sarah Lucas (born in 1962) is no exception. Along with many of her contemporaries and compatriots (e.g. Damien Hirst, Angus Fairhurst, Tracy Emin), Lucas became synonymous with the phenomenon of the YBA (Young British Artists) who dominated the Brit Art scene of the nineties[3]. Besides the shared themes and vocabulary in common with the other YBAs, Lucas developed her own individual and unconventional artistic language from the beginning of her artistic enquiry. Her work focuses on the relationship between sexes, social identity, death and destruction[3-5]. Lucas makes sculptures with ordinary "things"[6] – items, found objects, vegetables, cigarettes – all quotidian materials which bear the traces of use and become "epitome of commonness"[7]. The employment of simple materials underlay the provocative and gruesome qualities of her work where she plays with social cliché, verbal and visual representations of sexuality and masculine stereotypes[5].

One of the peculiar expression of Lucas' artistic research is the *Love Me* sculpture representing the lower part of a woman's body sitting on a chair (Figure 29.1(a)). The sculpture surface is completely covered with images cut from magazines, showing repeated female mouths (on the right half) and eyes (on the left half). Due to its exquisite artistic value, *Love Me* has been widely

exhibited in several temporary shows in Italy and abroad*. The constant transportation combined with careless handling during installation/de-installation and the intrinsic fragility of the constituent materials, has caused damages in several places, the most severe of which was a deformation, located on the right leg at the level of the artwork's "knee" (Figure 19.1(b)). The damage compromised the entire stability of the sculpture and the artwork could not be safely exhibited anymore. Therefore, in 2016 *Love Me* was transferred to the Center for Conservation and Restoration "La Venaria Reale" for restoration purpose. The main focus of the work was securing the damage and re-establishing the correct leg inclination in order to achieve structural stability, thereby limiting the risks of further damage and allowing the artwork to be showed again.

Analytical investigation was combined with the historical-artistic research and information provided by the artist herself via an interview, which allowed the characterization of the constituent materials and the discovery of the uncommon technique employed by the artist. The information obtained proved to be fundamental for the development of an experimental program and the conservation treatments. Due to the nature of the damage, a new restoration product based on nanocellulose particles was tested. Moreover, an innovative conservation strategy, more respectful to the original material than traditional methods, was successfully developed.

This contribution highlights the complex problems faced by conservators of twentieth century artworks made of non-traditional materials.

19.2 Love Me

19.2.1 Description of the Artwork and Artistic Meaning

* "Lei. Donne nelle collezioni italiane", Fondazione Sandretto Re Rebaudengo (Turin), 2003; "Glowbowl. Opere dalla collezione Sandretto Re Rebaudengo", Salle Quai Antoine (Principality of Monaco), 2007; "Espíritu y Espacio Colección Sandretto Re Rebaudengo", Ciudad Grupo Santander (Madrid), 2011 and "Tuttovero", Galleria Arte Moderna (Turin), 2015.

Love Me represents a headless woman figure unseemly laying on a small secondhand chair, with wide-open legs. The sculpture's torso, devoid of arms, is fused with the chair-back, composing an inseparable shape.

The appearance of *Love Me* is reminiscent of the iconic Sarah Lucas' *Bunny* series of 1997. The *Bunnies* are life size decapitated sculptures realized by stuffing nude-colored ladies' tights with cushion padding and wire that were then gracelessly clamped on office chairs, provocatively suggesting sexual fatigue and female submissiveness[4-6]. Even if correlations between the artworks seem obvious, the images used in *Love Me*'s collage express something more deep and concealed. In order to completely understand the artwork's meaning, *Love Me* has to be investigated considering also two later works, *Hysterical Attack (Mouths)* and *Hysterical Attack (Eye)*. These artworks, realized in 1999 for the solo show *Beyond The Pleasure Principle* (Freud Museum, London), present the same form of *Love Me* and, like their relative, Lucas' *Bunny* sculptures, represent a feminine figure in a languishing way[4]. The *Hysterical Attack* sculptures are evenly covered with a mosaic-like collage reproducing only female mouths (*Hysterical Attack (Mouth)*) or only female eyes (*Hysterical Attack (Eye)*). The Freudian meaning of each *Hysterical Attack* seems to be 'scopophilia'[†], regarding the eyes-covered sculpture, and oral fixation in the case of *Hysterical Attack (Mouth)*[4]. With this in mind, *Love Me* where the two Freudian meanings are represented together in an allegorical artwork, could be read as a progenitor of the later works. In *Love Me*, Sarah Lucas focuses on the interchangeability between "mouths and sexual orifices, the gaze and the sexual act"[‡] in a celebration of erotic symbolism. In this way, the three works express a deeper psychoanalytical conception of the female body compared to the *Bunny* sculptures, because "they are caught between physicality and symbolism".

19.2.2 Executive Technique: The Artist's Interview

[†] Sexual pleasure derived chiefly from watching others when they are naked or engaged in sexual activity.

[‡] Information about the artist meaning, the manufacturing process and the restrictions about the conservation treatment were given directly by the artist via interview.

The characterization of *Love Me*'s constituent materials and the identification of the technique employed by Lucas proved to be highly difficult. With the exception of the visible surface, all the elements used to create the sculpture's shape were hidden and impossible to characterize at first glance. Therefore, in order to provide insight into *Love Me*'s technique, it was decided to directly contact the artist.

Lucas emphasized the closeness of *Love Me* to the *Bunnies* "[*Love Me*] may be regarded as a discrete subgroup or variant of the *Bunny* series", suggesting the use of woman nylon tights filled with cushion padding as stuffing material. Moreover, the artist explained in general her sculpturing technique: "an internal armature was created using chicken wire covered with newspaper" (see Figure 19.2(c)); the wire was then placed inside the tights, which were filled and firmly secured to the back of the chair. Subsequently, several layers of images, cut out from "colour glossy magazine and black-and-white images from newspaper newsprint", were glued directly to the "surface of the work, using wallpaper paste". The artist has a long history in using newspaper images as artistic device[3-4]. At the beginning of her carrier Lucas cut out dirty photos from tabloids like *The Sunday Sport* and *The Daily Mirror* and exposed them on the gallery wall to the embarrassment and annoyance of the public[4]. Tabloids were used for two reasons: firstly they are mass produced materials available to a wide range of consumers and secondly they are tremendously cheap[3-7]. Lucas' characteristic technique features the re-utilization of existing and discarded things, all coming from her near surroundings, is visible also in *Love Me*'s chair, which, as the artist pointed out, is a "readymade and well-used".

Finally, to level out the artwork surface and fix the collage, *Love Me* was covered with a clear industrial acrylic varnish, which is almost undetectable on the back and more consistent on the front because "this is the side most often viewed".

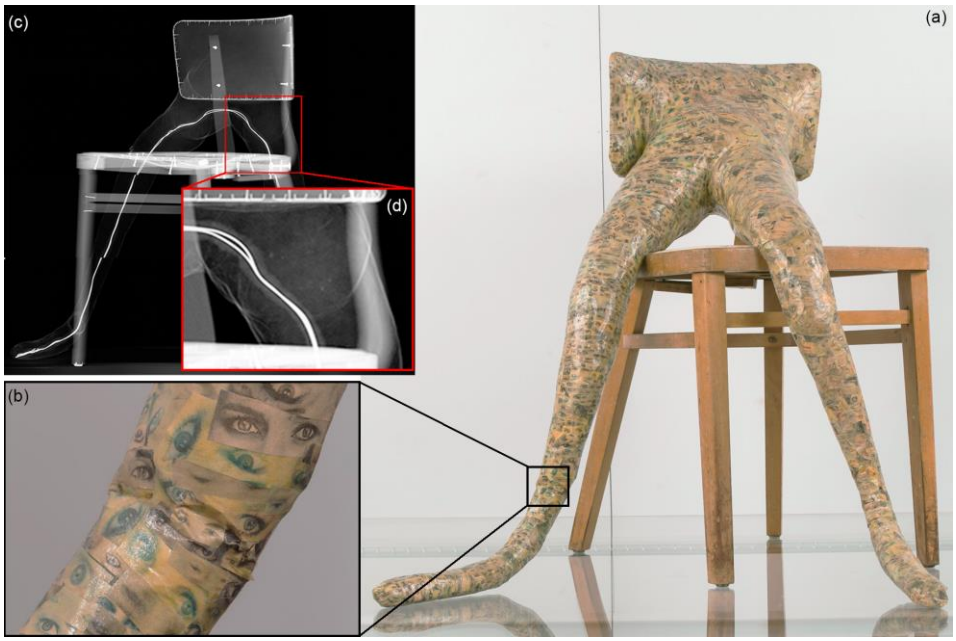

Figure 19.1 *Love Me*. Front side view (a); detail of the dent located on the sculpture's right leg (b); X-Ray radiography of the sculpture which highlights the iron wire used by the artist as internal armature (c) and detail of the newspaper used to cover the (d).

19.3 Materials and Characterization

In order to confirm the information about the artwork's materials provided by the artist, selected samples collected from the sculpture, were analyzed by spectroscopic and chromatographic techniques, namely infrared spectroscopy[§] (FTIR) and pyrolysis-gas chromatography/mass spectrometry[**] (py-GC/MS). The industrial varnish employed by the artist was investigated by

[§] FTIR transmission spectra (64 scans) recorded using a diamond anvil cell (High Pressure Diamond Optics, Inc.) were obtained on a Bruker Vertex 70 spectrophotometer coupled with a Bruker Hyperion 3000 IR microscope equipped with an MCT detector (Infrared Associates, Inc.), working in the spectral range from 4000 to 600 cm^{-1} with an average spectral resolution of 4 cm^{-1}. The silicon wafer paints were analyzed in the optical bench in transmission modality in the range 4000-400 cm^{-1}.

[**] Py-GC/MS analyses were carried out with a CDS Pyroprobe 1500 (Analytical Inc., USA) filament pyrolyzer directly connected to a GC/MS system. The GC was a 6890N Network GC System (Agilent Technologies, USA) gas chromatograph with a (5%-Phenyl)-methylpolysiloxane (30 m, 0.25 mm i.d., 0.25 µm) capillary column. The temperature of pyrolysis is 600 °C, the temperature of pyrolysis interface is 300 °C and the temperature of the injector is kept at 280 °C. The carrier gas was helium (1.0 mL/min) and split ratio was 1/20 of the total flow. The mass

means of FTIR and py-GC/MS analyses. Micro-samples of coating were removed from the artwork using a scalpel and immediately evaluated to avoid contaminations. Multiples samples, collected from different areas across the artwork, were analyzed in order to obtain a representative investigation. In all the infrared spectra acquired from different areas of the sculpture, see Figure 19.2(a), it's possible to see the exact correspondence among the reference spectrum (green line) of a methylmethacrylate-co-n-buthylacrylate polymer and three spectra of the varnish coming from the sculpture (blue, light blue and red lines). Typical absorption bands of an acrylic backbone are clearly present. In the region between 3100 and 2800 cm^{-1}, it is possible to observe both symmetric and asymmetric stretching of the methylenic groups (CH_2 and CH_3) at 2954 and 2874 cm^{-1}. The intense peak at 1734 cm^{-1} is due to the carbonyl C=O stretching which is a characteristic peak for acrylic compound. Two sharp peaks at 1240 and 1169 cm^{-1} were recoded. Those bands were attributed to the stretching of the C-O group, the former, and the stretching of the C-C, the latter. The nature of the copolymer has been also confirmed by py-GC/MS analyses, as shown in Figure 19.2(b), were the characteristic ions of MMA and nBA monomers have been detected.

In order to investigate the nature of the adhesive employed by the artist for adhering the cut out images, it was decided to detach a newsprint fragment from a not visible area of the sculpture. A spectra was acquired from micro-sample collected from a tiny dense accumulation of adhesive located on the back of the fragment (Figure 19.2(d)). Figure 19.2(c) shows the infrared spectrum of the adhesive. The signals are compatible with a product based on polysaccharides (starch, wheat paste) or modified cellulosed based one. The identification is critical due to the difficulty in the sampling of the adhesive. Moreover, the possible presence of the paper as contamination in the sampling can alter the results. Paper, which also consists in cellulose, presents a spectrum characterized by the same typical absorption bands of other saccharides, namely a strong C-O

spectrometer coupled to the GC apparatus was a 5973 Network Mass Selective Detector (Agilent Technologies, USA). Mass spectra were recorded under electron impact at 70 eV, scan range 40-600 m/z. The interface was kept at 280 °C, ion source at 230 °C and quadrupole mass analyzer at 150 °C. All instruments were controlled by Enhanced Chem Station (ver. 9.00.00.38) software.

stretching in the region ranging from 900 to 1100 cm^{-1}. As reported during the interview (see Section 19.2.2), Lucas glued the images with an ordinary wallpaper paste. Wallpaper paste are normally commercialized in two formulations: dry mixture of cellulose ethers or as an aqueous dispersion of vinylic/acrylic compounds and cellulose ethers. Since none of the bands identified can be related to a synthetic material, it was concluded that the artist had brushed the cut out newsprint and tabloid images with a pure cellulose-based paste.

The position and form of the internal armature was detached examining the sculpture by means of X-Ray radiography[††]. As can be seen from Figure 19.1(c), the radiography allowed to reconstruct and locate the internal armature. The artist employed a 1.5 mm thick single wire which was twisted several times in order to provide more support to the sculpture. The armature runs across the two legs and forms a semicircle in the lower part of the sculpture's torso. Moreover, contrasting the image it was possible to identify the presence of a second material, which, as the artist explained, was connected to the newsprint used to cover the armature (Figure 19.1(d)).

19.4 Conservation Concept

Establishing a preservation plan for contemporary artworks is always a compromise between many different considerations, which could sometimes conflict with one another[8-9]. Discussions concerning ethics in contemporary art restoration need to take into account the artist's idea and, sometimes, the owner's will[8]. Regarding the study case presented in this paper, the direct consultation with the artist highlighted her preference for a "less interventionist as possible" treatment, focusing on the "respect of the original materials" using conservation products which "are similar to those employed in the creation of the original sculpture".

[††] X-Ray investigation was performed with the General Electric Eresco 42 MF4 X-Ray generator with a tube voltage of 90 kV, anodic current set at 10 mA and with 3 mm focal spot. Five digital images were recorded as 12-bit TIPP and transformed using an image software program.

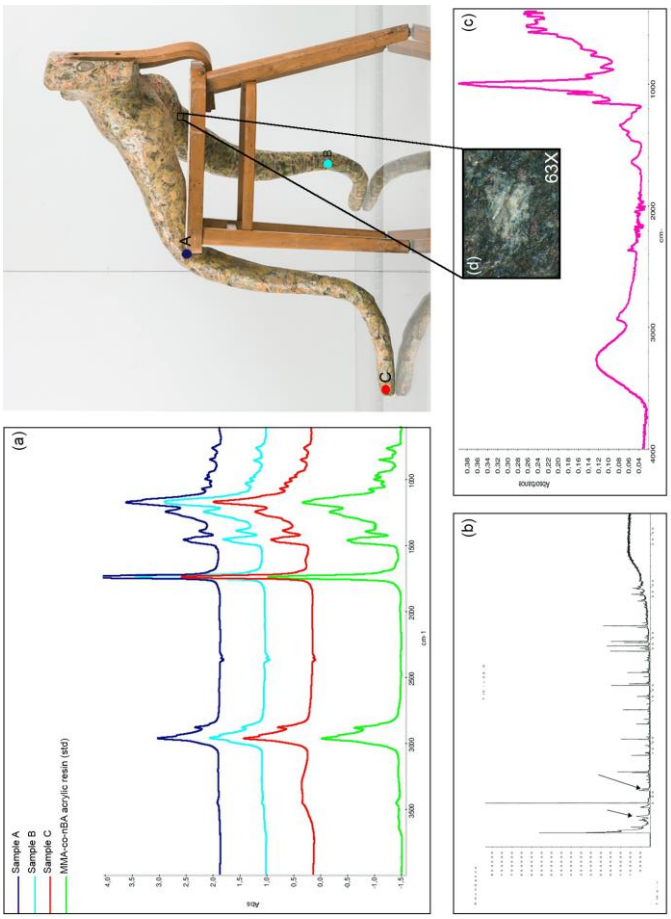

Figure 19.2 Analyses performed on the sculpture: Infrared spectra of varnish from three samples A, B, and C (blue, light blue and red lines) taken from different areas of the sculpture compared with the reference spectrum of a MMA-co-nBA acrylic resin (green line) (a); Pyrolysis spectrum of a sample coming from the varnish. The arrows show the signal referable to the presence of the two co-monomers: MMA and n-BA(b); Infrared spectrum of the cellulose-based adhesive (c) sampled on the back of a superficial paper piece (d).

Moreover, Lucas emphasized that the treatment "should be invisible – not affecting the stability or outward appearance of the work". Our primary concern was to a large extent the stabilization and protection of the piece and, only secondly, re-establishing its aesthetic coherence. Based on the restrictions posed by the artist, paper conservation literature and relevant study case were extensively reviewed[10-21]. The survey of globe and papier-mâché literature provided treatment

options for the restoration of dents. In his review of globe restoration, Bayes-Cope[15] proposes to split the cover paper and fill the dent with a plaster compound of papier-mâché, chalk, zinc and parchment size. Alternatively, another approach is cutting out neighboring areas and pushing out the dent using scalpels and blades[16-17]. Both methods were considered to be too much invasive for the restoration of *Love Me*. After a careful weighting of the possible options, it was decided to develop an innovative external traction system to ease out the dent without operating on the original material.

Moreover, it was realized that for restoring the dent it would also be necessary to reinforce the area to prevent the reformation of the damage. For the strengthening of aged paper, different materials are available. Natural polymers, such as wheat starch and cellulose ethers or synthetic polymers based on polyvinyl acetate (PVAc) are especially useful[10-11,18]. Alternatively, a widely used conservation method consists in laminating paper with a stronger material, to strengthen the object[13-14]. The material most used is Japanese paper due to its low basal weight and long fibers[10-11,13-14,19]. Despite the extended range of possible materials and methods, reinforcement of deteriorated papers on a large scale has proved to be problematic[16]. Lately, the range of possible products has been increased with the introduction of nanomaterials based on micro- and nanocellulose particles[22-25] and bacterial cellulose[26]. Cellulose nanocrystals and microcrystals have been added as reinforcing filler at the water-soluble thermoplastic adhesive Aquazol 500® with the aim of improving its properties as lining adhesive for oil paintings restoration[22-23]. Nanocellulose, in the form of aqueous and water-ethanol suspension, and bacterial cellulose have recently been employed for consolidation of paper[24;26] as well as commercially prepared cotton canvas[25]. Cellulose nanomaterials show specific properties that made them particularly suitable for the restoration of cellulose-based artworks: they have high strength and degree of crystallinity as well as good optical and thermal properties[22-26]. They are non-toxic and biocompatible with cellulose, hence they should not alter the chemical composition of paper[22-26], which is in line with the minimal intervention principle of restoration[8-9] and the restrictions stated by the artist. Therefore, for all the

ha eliminato:
ha eliminato: Recently
ha eliminato: [22-25]
ha eliminato: Nanoc
ha eliminato:
ha eliminato: has
ha eliminato: .
ha eliminato: Cellulose nanomaterials are
ha eliminato: therefore
ha eliminato: [5]
ha eliminato: Moreover, they have
ha eliminato: good optical, thermal and mechanical properties[22-25].
ha eliminato: F

above-mentioned reasons, it was decided to test novel materials based on cellulose nanocrystals and nanofibrils as newsprint reinforcing agents.

19.5 Experimentation

Considering what was discussed in the conservation concept, an experimental research was carried out. The aim of this study was to evaluate the best less interventive as possible method for easing out the dent and to test the behavior of nanocomposite materials as strengthening agents for papier-mâché. The treatment operability was complicated by the three-dimensionality of the work, the position of the damage, and the soft internal core of the sculpture which could be easily deformed even by light pressure. Taking into consideration these issues, a fundamental requirement was that the fixator would be self-supporting to not rest on the sculpture. Regarding the use of nanocellulose, the central issue was discover if these new materials could offer an alternative to traditional paper adhesive and consolidant.

ha formattato: Non Evidenziato
ha eliminato: on mock-ups
ha eliminato: experimental work
ha formattato: Non Evidenziato
ha formattato: Inglese (Regno Unito)

19.5.1 Reinforcing Agents

Two different types of nanocellulose were tested: cellulose nanocrystals (CNC) and mechanically isolated cellulose nanofibrils (CNF). CNC in powder form was purchased from CelluForce (Canada). It was produced from bleached kraft pulp by sulfuric acid hydrolysis. CNF in the form of aqueous suspension was provided by the Finnish company UPM, in collaboration with the Finnish Centre for Nanocellulosic Technologies. The CNF was produced from birch pulp containing *ca.* 20% of hemicellulose and traces of lignin. CNF had a thickness of 4-10 nm and a length of several micrometres whereas CNC had similar diameter, 5-10 nm, but was smaller in length, *ca.* 100 nm. The reinforcing agents were prepared by dilution with a 1:1 w/w hydroalcoholic solution of water :

ha eliminato:
ha formattato: Tipo di carattere: Corsivo
ha formattato: Tipo di carattere: (Predefinito) Times New Roman
ha formattato: Tipo di carattere: Corsivo

ethanol. In total five formulations were tested: a) cellulose nanocrystal 0.5-1-3% (CNC0.5, CNC1 and CNC3) and b) cellulose nanofibrils 0.2-0.4% (CNF0.2 and CNF0.4).

19.5.2 Mock-ups Preparation

Reinforcing treatment tests were conducted on newspaper samples cut into strips, 10 x 80 mm, using common newsprint paper (45 g/m^2). A set of specimens was cut in cross direction (CD), fibre direction perpendicular to the direction of the web, whereas the second set in machine direction (MD), fibre direction longitudinal to the direction of the web. Tridimensional samples were employed to evaluate the potential of the external traction system.

Based on the results obtained from the scientific analyses, tridimensional mock-ups were prepared by stuffing nylon tights with kapok (natural cellulose fiber) and iron wire as internal armature. Subsequently, the surface was covered with black-and-white newsprint pieces and colourful tabloid images glued with the Metylan®, a methylcellulose adhesive supplied by Henkel®. The specimens were varnished with Plextol D498® (n-BA/MMA copolymer), acrylic water based resin provided by Kremer Pigmente. Dents were created by bending the samples manually, simulating the sculpture's damage.

19.5.3 Application of Cellulose

Nanocellulose solutions were applied on newspaper samples with a 10 mm wide brush. The brush was dipped in the reinforcing agents and applied onto pre-specified surface areas using slight and controlled pressure. The solutions were brushed on the specimens' surface two times. Every brushing is defined as a forward – back movement. Successive nanocellulose applications were done six hours after the previous.

19.5.4 Testing Method

Tensile tests were performed using Discovery Hybrid Rheometer HR-3, equipped with two grips for performing linear Dinamic Mechanical Analysis (DMA). The measurements were carried out at a constant extension rate of 94 μm/s with the initial distance between the grips of 40mm. The ultimate tensile strength (UTS) before break was measured by dividing the average breaking force of the specimen width and then expressed in kNewton per meter (kN/m).

The specimens were conditioned at 21 ± 1° and 50% relative humidity in a closed environment with a solution of glycerol and demineralized water for 24 hours. Six measurements were performed for each series and the average values were calculated.

19.6 Results and Discussion

19.6.1 Realization and Tuning of the Traction System

As mentioned above in Section 19.4, it was decided to not follow the common restoration procedure for re-shaping dents but to construct an innovative external traction system inspired by surgical operations. The objective of the external traction system was to provide a homogeneous lengthening of the area in order to mechanically tackle the damage without cutting the original material.

After a review of medical limb-lengthening surgery literature, an external circular fixator similar in shape to the surgical instruments used in leg-lengthening surgery was constructed. The circular fixator was composed by four iron rings, two movable and two stable, four 8 mm threaded connecting rods and bolts (Figure 19.3). By rotating the bolts the upper and lower rings can be pulled apart very gradually. Moreover an external arm was constructed. The arm allows the cylindrical fixator to be oriented in the x, y and z dimensions, permits at the structure to be self-supporting, and improves the fixator stability.

ha eliminato: can

Different methods for connecting the artwork leg to the circular fixator rings were studied. These included: a) fish hooks and nylon thread, b) safety pins and nylon thread, c) 10 mm x 100 mm *Kozo* Japanese paper tie rods (machine-made Japanese mulberry paper, 10 g/m^2) and bulldog clips, d) 10 mm x 130 mm 70% polypropylene-30% cellulose pulp (PLP5) tie rods and bulldog clips. Additionally, two methods for securing the tie rods to the artwork surface were evaluated: protecting the surface with a cotton medical dressing (a, b) or adhering a 30 mm x 180 mm Japanese paper sheet with wheat starch directly onto the area (c, d) (Figure 19.4). The areas above and below the samples dent were protected by these two methods and the tie rods were firmly secured to the movable rings. Subsequently, the two rings were pulled apart very gradually until the damage was recovered.

ha eliminato: wide by

ha eliminato: long

ha eliminato: wide by

ha eliminato: long

ha eliminato: wide by

ha eliminato: long

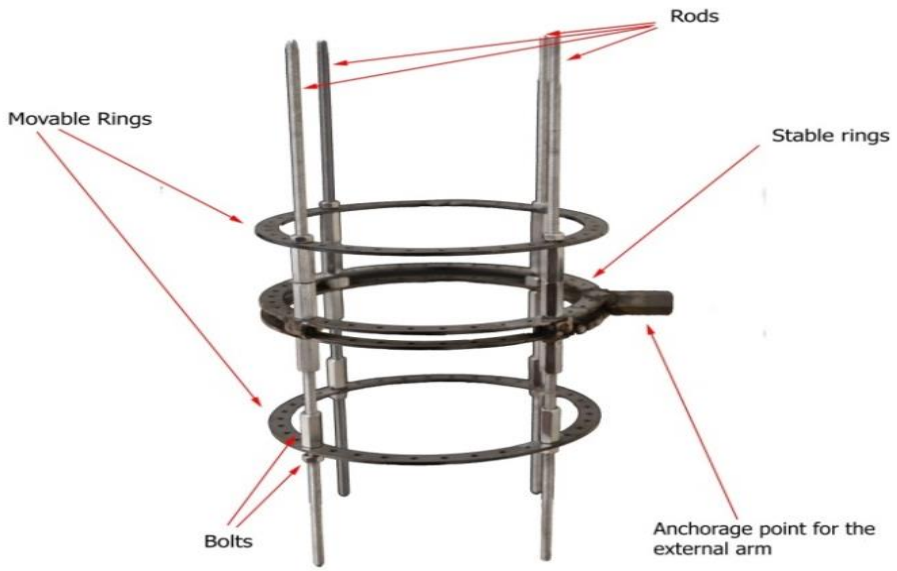

Figure 19.3 Schematic representation of the external traction system. The arrows show the different elements of the system.

Figure 19.4 System d) before lengthening. System d) is characterized by the use of two Japanese paper sheets as protecting layer and 10 mm wide by 130 mm long 70% polypropylene-30% cellulose pulp (PLP5) tie rods.

19.6.2 Evaluation of the Traction System

By each of the lengthening test methods it was possible to ease out the dent and re-establish the correct leg inclination. However, system a) and b) were not wholly satisfactory due to the dissimilar forces applied on each tie rod during the lengthening of the movable rings. Moreover, since the medical dressings were not firmly secured onto the specimen surface they slightly moved during the tests, jeopardizing the operation. Systems c) and d) provided the best results. The increased number of points of fixation between the artwork leg and the movable rings allowed a homogeneous distribution of the traction force and assured a safer operation. Furthermore, the bulldog clips considerably improved the anchorage to the circular rings and allowed all the tie rods to be put under the same initial tension. Nevertheless, some of the Japanese paper tie rods broke during the

lengthening while the PLP5 tie rods perfectly supported the stress, permitting a complete re-shaping of the damaged area.

19.6.3 Mechanical Properties of the Reinforced Newspaper Samples

Figure 19.5 shows tensile strength for newsprint specimens reinforced with different nanocellulose-based formulations measured in cross direction (CD). Mechanical properties of pristine samples as well as those of samples wetted with demineralised water are also given as reference.

It can be seen from the Figure that none of the reinforcing agents were able to significantly improve newspaper strength. Moreover, it was noticed that multiples nanocellulose applications decreased the overall newsprint strength as compared to untreated samples. These observations indicate that the treatment or the high moisture content of the nanocellulose suspensions have an overall effect on the tensile strength of the samples. It was supposed that the poor reinforcement provided by the nanoparticles was due to excessive water uptake by the cellulose fibers, leading to paper swelling and the loss of mechanical strength[26]. Cellulose-based materials are especially sensible to water absorption which, not only cause the reduction in sizing, but additionally can influence the formation of intra- or intermolecular bonds by moistening and drying[10]. The measurements also reported an higher decrease in tensile strength for CNF rather than CNC. As mentioned above (see section 19.5.1), cellulose nanofibrils consists of longer particles compared to CNC. The dimensional differences among the nanocellulose particles may influences the film-forming properties on paper substrates, hence it was assumed that CNF may not be able to penetrate much into the material. Similar observations have been reported when coating cotton canvases with aqueous dispersion of CNF and CNC[25].

In order to confirm this assumption, it was decided to repeat the test again with newspaper samples cut in machine direction (MD) since longitudinally oriented fibers are less sensitive to water

plasticizing action. Moreover it was decided to treat the specimens with only a single application of reinforcing agents and to also test CNC at 3%.

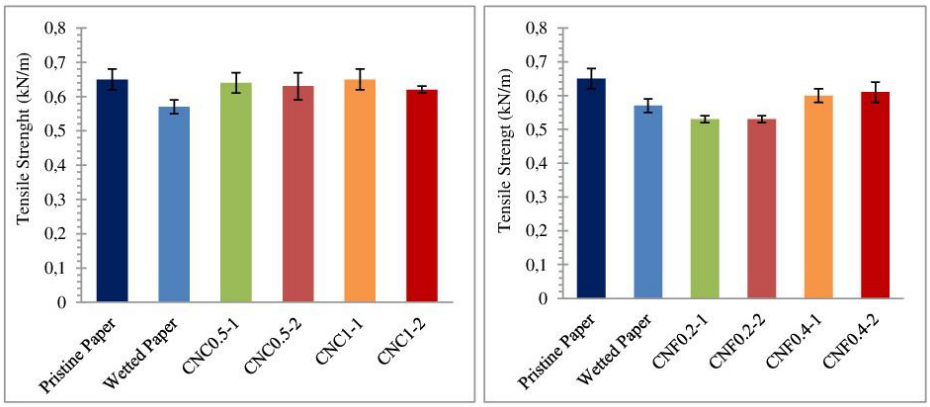

Figure 19.5 Tensile strength results from CNC and CNF test measured in cross direction

Comparative evaluation of the values obtained from the reference samples, pristine and wetted, and from the reinforced newsprint specimens, showed that samples treated with CNC at 3% slightly increased their tensile strength compared to reference specimens (data not shown). The mechanical behavior of CNC3 samples seemed to assess the capability of cellulose nanoparticles to act as effective reinforcing agents in newspaper specimens. Even if the measurements were not conclusive, the results shown that the tensile strength is directly affected by the amount of nanocellulose material applied on the surface and that CNC, which possess a lower aspect ratio, can penetrate more in depth into the porosity of paper, slightly improving the final mechanical properties. Therefore, paper consolidation treatments with nanocellulose particles will be a compromise between the highest concentration of nanoparticles and lowest water content of the suspension. Furthermore, it is worth noting that the substrate did not show distinctly change in the visual appearance which is imperative in art conservation. However, since the mechanical behavior of CNC and CNF were not completely known it was not considered safe to use the nanocellulose

ha eliminato:

particles for this restoration treatment. The research was consequently focused on traditional paper lamination methods[10-11,13-14]. Three different *Kozo* Japanese paper namely, RK 00 (3,6 g/m^2), RK 0 (5 g/m^2) and RK 2 (8 g/m^2) were evaluated. The Japanese papers were cut into small strips, glued onto the specimen surface with 5% w/w Culminal MC200® in water and let dry at ambient temperature (21°, 50% RH). Under direct visual observation, the Japanese paper RK 00 appeared completely invisible to naked eye, while both RK 0 and RK 2 were slightly visible. Tests on a tridimensional mock-up confirmed the structural consolidation provided by the Japanese paper RK 00, which was able to give enough support to contrast the reformation of the damage and, at the same time, being invisible after dry. The results obtained from these tests supported the use of *Kozo* Japanese paper RK 00 for the restoration of *Love Me*.

19.7 Treatment

As the mechanical results obtained from the nanocellulose experimentation were not decisive for leading to the use of those products in the artwork conservation treatment, the restoration was done following a more traditional technique.

Undamaged areas located above and below the dent were protected with a thin sheet of Japanese paper (RK 15, 10 g/m^2). The Japanese papers were cut into two strips 30mm wide by 180mm long and adhered onto the surface with wheat starch paste. The adhesive was prepared by diluting wheat starch powder (Zin Shofu®) in a proportion of 1:4 (powder to water), stirred, and cooked for approximately 1.5 hours, stirring until the proper consistency was achieved. After cooling for 24 hours under cold water, the paste was passed three times thought a sieve of horsehair and then diluted in water. The Japanese paper protecting strips were pasted with the adhesive with a horsehair brush and then placed on the artwork (Figure 19(a)).

Figure 19.6 Set-up of the traction system: Placing of the two Japanese paper protecting strips on the artwork (a); positioning of the forty PLP5 tie rods, half on the upper strips likewise on the lower (b); positioning of the artwork inside the external traction system and anchoring of the tie rods to the movable rings with bulldog clips (c).

A *Noribake* brush was employed for gently hitting the strips to remove bubbles and possible wrinkles. Each PLP5 tie rod (10mm wide by 130mm long) was pasted for 30mm with wheat starch and applied on the protecting papers for a total amount of 40 tie rods, half on the upper sheet and likewise on the lower (Figure 19.6(b)) Afterwards, the tie rods ring were further reinforced with a second layer of Japanese paper to secure the adhesion.

The artwork's leg was positioned inside the external traction system and the tie rods were anchored to the two movable rings with the bulldog clips (Figure 19.6(c)). The rings were slowly pulled apart until the dent was eased out. Localized humidity, often suggested to soften the papier-mâché layers[16,19-20] was not adopted and the treatment was carried out at ambient conditions (21°, 50% RH). Finally, a thin sheet of Japanese paper (RK 00, 3,6 g/m^2) laminated with 5% w/w Culminal MC200® in water was positioned where the dent was located in order to prevent the reformation of the damage. The sculpture remained in traction for a week. Subsequently, the force was diminished daily until it was possible to unlock the bulldog clips and remove the traction system. After treatment the artwork's leg regained its characteristic curvy shape and the dent was almost completely recovered and firmly secured.

19.8 Conclusion

Working on a multi-material, sculpture was an interdisciplinary experience that required the expertise of contemporary art and paper conservators, of conservation scientists and art historians. Scientific analysis combined with the direct information provided by the artist allowed the precise documentation of the materials used for the creation of the artwork and lead to an overall understanding of the artist's technique. Moreover, the dialogue with the artist turned out to be a crucial occasion to revealing the connection between *Love Me* and the two later works, *Hysterical Attack (Mouths)* and *Hysterical Attack (Eye)*, its relationship with the *Bunnies* series, and proved to be fundamental for the comprehension of Lucas's ideas about conservation. The restriction posed

by the artist stimulated vibrant discussions which led to the experimentation of novel reinforcing agents based on nanocellulose particles and the development of an innovative system to ease out dents in sculpture. The experimental mock-ups proved that it would not be safe to use nanocellulose for the restoration of *Love Me*. Mechanical analysis of the increase in strength of the newspaper were difficult to assess, due to the incomparable results obtained in machine direction (MD) and cross direction (CD). This was likely caused by the solvent swelling effect. However, the results of the preliminary trials laid the foundation for the use of these products as reinforcing agents for aged paper. Treating paper with cellulose nanomaterials would be in line with the principle of minimal intervention since nanocellulose is similar in nature to cellulosic paper. Finally, through this research it was possible to demonstrate that one of the crucial issues in tridimensional artworks conservation, such as dent restoration, can be tackled without adopting invasive and dangerous methods like cutting the neighboring areas or splitting out the paper. Thanks to the construction of an external fixator, the dent located on the artwork right leg, was completely eased out, re-establishing the correct leg inclination. Furthermore, the strengthening provided by the Japanese paper will protect and stabilize the area from future damages.

This contribution highlights the complex problems that contemporary artwork restorers face when working on objects made with unusual materials and techniques, which can however lead to innovative ideas and solutions.

Acknowledgements

This contribution is part of the Master's thesis of the first author, developed at the Conservation and Restoration Center *La Venaria Reale* in fulfillment for the Degree in Conservation – Restoration of Cultural Heritage of the University of Turin (Turin, Italy). FR wishes to thank the people and Institutions that helped her during her Master's degree research: Sandra Vazquez Perez, head of the contemporary art lab at CCR "La Venaria Reale" for the quality of her supervision; and Francesca

Comisso and Sara Abram, contemporary art historians, for the support during the artist's interview; the Sandretto Re Rebaudengo Foundation (owner of the artwork) which entrusted her with this fascinating and amazing artwork; Professor Piero Baglioni, head of the Center for Colloid and Surface Science (CSGI, Florence) for having hosted her in the CSGI labs during the nanocellulose experimentation and Federico Demeo for having prepared the nanocellulose solutions and for having helped her during the mechanical tests.

Bibliography

1. J. Heuman, From Marble to Chocolate: the Conservation of Modern Sculpture, Archetype Publications, London, 1995, p. 172
2. O. Chiantore, A. Rava, Conserving Contemporary Art: Issues, Methods, Materials, and Research, Getty Pubblications, Los Angeles, 2013, p. 332
3. J. Stallabrass, High Art Lite: The Rise and Fall of Young British Art, Verso, London, 2006, p. 356
4. M. Collings, SL: Sarah Lucas, Tate Publishing, London, 2002, p. 125
5. Y. Dziewior, C. Grunenberg, B. Ruf, Sarah Lucas : Exhibitions and Catalogue Raisonné: 1989-2005: Kunstahalle Zürich, Kunstverein in Hamburg, Tate Liverpool, Tate Publishing, London, 2005, p. 195
6. L. Le Feuvre, Ordinary Things in *Sarah Lucas: Ordinary Things*, ed. L. Le Feuvre, Henry Moore Institute, Leeds, 2012, 9-15
7. G. Muir, It Must Be A Camel (For Now) in *In-A-Gadda-Da-Vida*, ed. G. Muir, Tate Publishing, London, 2004, 78-94
8. G. Ryan, Conservation of Outdoor Painted Sculpture at the Hirshhorn: Taking Lessons from the Preservation of Variable Media Art in *Conserving Outdoor Painted Sculpture*, ed. L. Beerkens and T. Learner, The Getty Conservation Institute, Los Angeles, 2014, 5-12

9. The decision-making model for the conservation and restoration of modern and contemporary art in *Modern Art: Who Cares? An Interdisciplinary Research Project and an International Symposium on the Conservation of Modern and Contemporary Art*, ed. I. Hummelen, D. Sille and M. Zijlmans, The Foundation for Conservation of Modern Art, Amsterdam, 1999, 164-177
10. S. Zervos and I. Alexopoulou, *Cellulose*, 2015, 22(5), 2859
11. I. Alexopoulou and S. Zervos, Journal of Cultural Heritage, 21, 2016, 922
12. R. Teygeler, Preserving Paper: Recent Advances in *Managing preservation for libraries and archives. Current Practice and Future Developments*, ed. J. Feather, Aldershot: Ashgate, 2004, p. 194
13. D.G. Suryawanshi, O.P. Agrawal, *Restaurator*, 17, 1996, 229
14. H. Bansa, R. Ishii, *Restaurator*, 18, 1997, 51
15. A.D Bayes-Cope, The study and conservation of globes, Internationale Coronelli-Gesellschaft, Wien, 1985, p. 80
16. D. van der Reyden and D. Williams, *The Paper Conservation Journal*, 1988, 2, 21
17. K. E. Leyshon, *The Paper Conservator*, 1988, 12, 12
18. C. Marchal, *Support/Tracé*, 2013, 13, 72
19. G. Fairclough, R. Harrison, *Icon News*, 2007, 10, 22
20. L. Dessennes, *Journal of Paper Conservation*, 2011, 12(3), 30
21. E. Nijhoff Asser, B. Reissland, B. J. W. Grob, E. Goetz, Lost fingers, scurfy skin and corroding veins – conservation of anatomical papier-mâché models, in *ICOM Committee for Conservation*, 15th Triennal Conference, New Dehli, 22 – 26 September 2008, ed. J. Bridgland, Allied Publisher, New Dehli, 2008, Vol.I, 285-292.
22. A. Cataldi, A. Dorigato, F. Deflorian, L. Berglund, A. Pegoretti, Polymer composite with micro- and nanocellulose for artwork protection and restoration, 2014, http://www.escm.eu.org/eccm16/assets/0550.pdf. Accessed 21 August 2018.

23. A. Cataldi, L. Berglund, F. Deflorian, A. Pegoretti, *Nanocomposite*, 1(4), 2015, 195

24. S. M. Santos, J. M. Carbajo, N. Gómez, E. Quintana, M. Ladero, A. Sánchez, G. Chinga-Carrasco, J. C. Villar, *J. Mater. Sci.*, 51, 2016, 1541

25. O. Nechyporchuk, K. Kolman, A. Bridarolli, M. Odlyha, L. Bozec, M. Oriola, G. Campo-Francés, M. Persson, K. Holmberg, R. Bordes, *Carbohydr. Polym.*, 194, 2017, 161

26. L. Völkel, K. Ahn, U. Hähner, W. Gindl-Altmutter, A. Potthast, *Herit. Sci.*, 5, 2017, 23