Costume Design. Digitization and Representation of Outfits for Theatrical Scene

MASSIMILIANO CIAMMAICHELLA, IUAV, Venezia, Italy

The article highlights the central role of theatrical costume as a historical tool for constructing cultural and sartorial identity through performance. It focuses on contemporary practices of digitizing and designing customized garments tailored to the specific physical characteristics of the actors who will wear them. The authors outline a workflow that begins with iconographic research to inform the initial sketches and continues through to the creation of physical prototypes in the tailor's workshop. 3D modeling techniques, applied to both bodies and garments, make it possible to simulate the fit, refine the patterns, and ensure coherence across the entire production process. Notably, the recovery and reinterpretation of a dispersed and fragmented cultural heritage help revive the methods, knowledge, and artistic sensibilities of a profession now at risk of disappearing: that of the theatrical costume designer.

Keywords:
Attila, Cloth simulation, Pattern making, Santuzza Calì, Teatro La Fenice di Venezia.

SDH Reference:
Ciammaichella, Massimiliano. 2025. "Costume Design. Digitalization and Representation of Outfits for Theatrical Scene." Studies in Digital Heritage 9 (1): 90–100.

https://doi.org/10.14434/sdh.v9i1.41854

1. INTRODUCTION

The history of costume has evolved over the centuries, establishing, particularly in the West, two distinct lines of separation between male and female dress.

It is important to distinguish between cultures whose clothing traditions shape garments to the body through measured tailoring, and those that create dress by draping and wrapping layers of fabric. The latter approach is found, for example, in many contemporary Arab cultures and, in antiquity, characterized the clothing of the Greeks and Romans. For classification purposes, the anthropological model that divides clothing systems into "Arctic" and "Tropical" hemispheres can be useful (Laver 1969).

Although the term costume derives from the Latin costumen, meaning custom or habit, costume design shares with demo-ethno-anthropological disciplines the view that individuals adapt their attire to the normative conventions of the society they wish to be part of. In this sense, clothing functions as the body's primary covering, capable of expressing and unifying personal identity within a given community.

Author's address: Massimiliano Ciammaichella, Department of Architecture and Arts, Università Iuav di Venezia, Santa Croce 191, Tolentini, 30135 Venezia, Italy; email: massimiliano.ciammaichella@gmail.com

Figure 1: Emanuele Luzzati with the maquette of the Attila set-up, 1986. Photo by G. Arici and M. Smith. Courtesy by Historical Archive of Teatro La Fenice Foundation.

In the world of theatre, the construction of the character uses precisely the costume to narrate iconographically the culture to which it belongs, enhancing physical and psychic characteristics peculiar to the subjectivity on stage. This is a complex work that is modulated by negotiating directorial and scenic choices that do not necessarily coincide with the era in which the play is set. Thus, the costume designer must know the script very well even before formulating acceptable design proposals. This is independent of the type of performance to be represented, for the principle applies as much to opera, prose and improvisation as it does to dance, although they all need constant readjustments ready to ensure the ease of movement of the stage protagonists.

In the case of musical theatre, things become more complicated, as these are often large productions the performances are characterized by the presence of singers, dancers, and extras so that the imagery that is punctuated during the sequences of acts is developed around real ensemble pictures, rather than focusing on individual characters (Lo Sciuto 2016). It can be understood how a huge heritage of drawings helped to delineate the development of an internationally recognized practice, evidenced by the precious materials kept in the archives and museums of the sector, or is documented by the engravings for the celebrations of royal courts, such as the French court of King Louis XIV, in which the artist Jean Bérain demonstrated his extraordinary talent by also marking the

beginning of a modern fashion history, made up of images of male and female silhouettes to publish on the *Le Mercure Galant* magazine (Bérain 1678).

If the term *Fashion* first appears in 1648, within the work of the Benedictine monk Agostino Lampugnani (Lampugnani 1648), the earliest illustrations exhibit figures in plastic poses shot in three-quarter view. The context does not seem to take on any significance, so the models are positioned in front of a neutral stage backdrop – where some textual indications are given – and the very low ground line marks the horizontal trace of the supporting plane (Ciammaichella 2011).

This compositional imprint persists to this day, as costume and fashion designers also insert small fabric swatches in order to foreshadow the materiality of clothes and accessories. Another point of contact is the measure of tailoring approach, through which the costume designer's work can approximate that of the Couturier. However, the latter professional figure set off on an inexorable decline in the late 1990s, and today the only surviving Italian, parading in the prestigious location of Paris Fashion Week[1], is Giorgio Armani with the *Privé* collection[2]. For what concern the work of the costume designer, however, if one excludes major lyric operas, the revision of the ever-decreasing costs for productions has led tailors to reassemble stage clothes already used in other shows, while it continues to persist in film, crediting the work of celebrities such as, for example, Milena Canonero who has won four Oscars[3] and numerous awards for her costumes.

Traditional methods of the drawing continue to be primary tools for ideation and conceptualization of designs in the making, which still have to confront tailors to translate the intent of those who conceived them, but digital representation methods allow for the simulation of fits on 3D avatars, through advanced cloth simulation algorithms that verify the textiles draping according to their specific physical characteristics, all the way to the flat development of patterns.

All this offers considerable potential, in terms of saving resources and time, ensuring full control over the entire creative process. Moreover, where prototypes can no longer be retrievable and only the iconographic sources of sketches and stage photos remain, reenactments and reproductions of well-known performances by theatre masters can ensure the circularity of a cultural heritage all to be rediscovered.

2. ATTILA

The case study on which the research focuses concerns the opera: Attila, set to music by Giuseppe Verdi to a libretto by Temistocle Solera (Solera 1850), directed by Gianfranco De Bosio, which premiered at the Teatro La Fenice di Venezia on May 27, 1986.

The sets are by Emanuele Luzzati, an eclectic artist, costume designer, film animator and illustrator of children's storybooks who takes us back to the playful atmospheres of theatre-making for which he has produced more than four hundred performances.

[1] https://www.fhcm.paris/fr.
[2] https://www.armani.com.
[3] https://www.oscars.org.

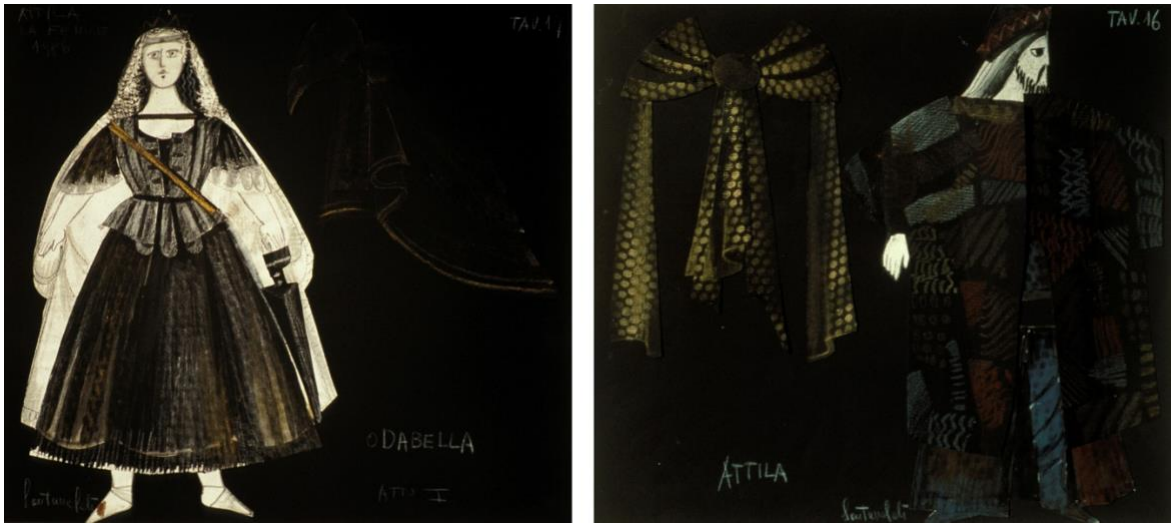

Figure 2: Santuzza Calì, drawings for costumes design of the Attila Opera, 1986. Photo courtesy by the Institute for Theatre and Melodrama of the Giorgio Cini Onlus Foundation in Venice.

The main design device is always a magic box, a *Maquette* in which to experiment, on a small scale, with the reinvention of reality through its representation made explicit by movable backdrops painted by the author himself (Conte and Luzzati 2001). Thus, it can be said that Luzzati (Fig. 1) reworks the canons of the eighteenth-century *Painted Scene*, structured by openwork drop-curtains and backdrop that recompose a setting (Ciammaichella 2024), never granting it photorealistic connotations. The pictorial line is perpetuated in imagery and visions that also make this art a precise linguistic condition, structured on the study of important references traceable to the work of Giuseppe Bertoja, from whom Luzzati himself draws inspiration for his sets-up.

In fact, the Venetian set designer had actively collaborated with Giuseppe Verdi, including for the 1846 debut of Attila, in the same theatre rebuilt after the 1836 fire, with an opera with a clear political appeal to a Venetian Risorgimento that, precisely in the Fenice, found the symbolic value of a rebirth from the ashes.

A study of the scene sketches, rich in chiaroscuro contrasts, reveals the impressionistic characteristics of an author who moves within the limits of Romantic naturalism, aided by the Master's directives in bringing out the passages of light and darkness in the settings, which range from the silent lagoon atmospheres to the devastation of the *Piazza di Aquileja*, destroyed by the Barbarians. Verdi's textual directions are respected philologically, in the images of the fires of a city from which a chorus of people and Huns rises (Muraro and Biggi 1998).

In the Luzzati's homage, on the other hand, the two-dimensional support of drawing describes the space of relationships, insofar as he himself declares that the set design, even before becoming the aesthetic device of the performance, must determine the actions and relationships of the actors interacting within it.

The stage does not seem to accommodate any other object forms or accessories, except for sporadic pieces of furniture such as a table and a platform, in the manner of a chariot for the protagonist. Thus,

it can be said that the stage is animated by the individual actions of the singers and actors who, with their costumes, describe a space within a story to be told, that of Attila.

It is well known how Emanuele Luzzati, even in his career as a costume designer, favoured the authorial approach in painting, directly on the actors' bodies, the fabrics of the costumes they wore, opposing a successful period of Luchino Visconti, completely dedicated to the refinement and perfection of the finishing touches to be entrusted to the great theatrical tailors, since most of the prototypes were made at home or were the result of collaborations with small artisan clothing laboratories (Luzzati and Cirio 2000).

This mode of expression and communication is confirmed by the long-standing association with Santuzza Calì, who is entrusted with designing the costumes for the entire opera. She, too, is a successful set designer. After graduating from the Academy of Fine Arts in Palermo, she moved to Salzburg to attend the Sommerakademie, a prestigious academy founded in 1953 by Oskar Kokoschka, the visionary and talented Austrian painter whose assistant she became for several years. Her entry into the theatre was due to Emanuele Luzzati, a friend and great associate, whom he met through the intermediary of Giulio Giannini, with whom she worked on a few cartoons.

In an interview with Marianna Zannoni in 2022, Calì said that when she designs costumes for an opera, she pays attention to both the essence of the character and how one sees that character dressed against the light. So, she focuses mainly on the silhouette in general, so much so that "if a character is bad, even if we are in the middle of the eighteenth century the hard, straight shoulders still she put them on him" (Zannoni 2023). One understands how the drawing on the silhouette anticipates the construction of the character, even before reflecting on the physiognomy of the actor who is to play him or her. But unfortunately, news reports and reviews tend to forget the important contribution made by set and costume designers, yet they offer realistic visions and models of performance inspired by the most diverse cultures. In the case of Santuzza Calì (Fig. 2), the research of the visual language chosen is striking, never oriented in the service of a mere archaeology of costume, understood as a form of slavish repetition of how it was and where it was. Even minor roles, such as those of the ragamuffins, are so realistic that their human condition is vividly enhanced (Biggi 2024).

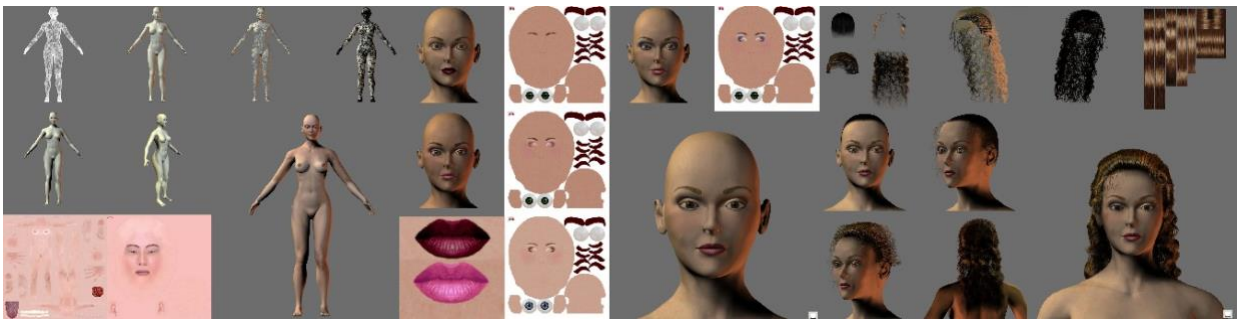

Figure 3: 3D modeling and texturing of Odabella. Rendering by Massimiliano Ciammaichella, 2024.

3. RECONSTRUCTIONS OF STAGE SUBJECTIVITIES

With a view to studying and enhancing the cultural heritage offered by Santuzza Calì's invaluable work, in the absence of tangible costumes, the research made use mainly of archival sources. Specifically, the stage photographs, now kept in the Historical Archives of the Teatro La Fenice in Venice[4], and the substantial bequest of sketches that the costume designer donated to the Institute for Theatre and Melodrama of the Giorgio Cini Foundation in Venice[5].

As for the drawings of the Attila opera, we are left with only photographic reproductions, because the originals were lost following the fire that destroyed the theatre in 1996.

These are eighteen plates on black cardboard, all numbered, made with mixed techniques and collage in the 350 x 500 mm format. They mark the actions performed in the prologue set in Aquileia and the Adriatic lagoons, which are followed by acts at the city of Rome in the mid-5th century.

Characters are portrayed frontally, and faces portrayed in profile, thus, special attention is paid to interpretation and verisimilitude representation, through three-dimensional models of costumes and stage relationships in relation to the kinematics of the subjects involved.

With today's digital representation tools, in fact, it is possible to reconstruct in a very short time the physiognomy of a human being, reproduce its movements within the scene, build the costume model, up to the creation of paper patterns and prototypes.

The digital reinterpretation of the entire staging of Attila, takes its first steps precisely from the reconstruction of the bodies of the actors, here modelled on the physical characteristics of Samuel Ramey and Linda Roark Strummer, respectively playing the King of the Huns and Odabella, daughter of the Lord of Aquileia.

The *Poser*[6] software is equipped with a library of 3D avatars who's physiognomic and body proportions can be modified, to adapt silhouettes to subsequent size proportioning, through intuitive tools that apply 3D morphing to parts of mesh surfaces, varying their vertex coordinates. The same system is articulated regarding more complex facial expressions that can be supplemented by photographs of faces, ensuring maximum correspondence with the people to be portrayed (Niiro and Kallmann 2020).

Once the digital twins of the actors' bodies had been generated, they were exported to *Cinema 4D*[7] software, where they completed the modeling of the hairstyles, which, in Odabella's case, involved layering multiple subdivision surfaces to be assembled into a long, wavy hair style with two locks gathered at the back.

The most complex part concerns the processing of the textures to be applied on the mesh surfaces (Fig. 3), once they have undergone useful unwrapping processes to match the coordinates of the numerical models with the U and W coordinates of the images. This phase requires a lot of skill when the meshes have a complex topology with mixed polygons, which must be parameterized again

[4] https://www.archiviostoricolafenice.org.
[5] https://archivi.cini.it/teatromelodramma/home.html.
[6] https://www.posersoftware.com.
[7] https://www.maxon.net/it/cinema-4d.

(Bernik et al. 2019). But the results achieved also optimize simulations of the effects of stage makeup, vaguely Brechtian, where contrasts between blacks and whites predominate, emphasizing the red tones of the mouth. Some recent studies have focused on the production of animated replicas of historical costumes acquired with digital photogrammetry techniques, demonstrating their effectiveness commensurate with the flexibility of exporting them to software such as *Marvelous Designer*[8], in which to experiment with rigging techniques useful for animating the movements of 3D avatars, only after subjecting them to the effects of inverse kinematic chains (Kubišta et al. 2024). However, as already anticipated, since we did not have the physical prototypes to digitize, we reconstructed the costumes based on the iconographic sources.

Santuzza Calì hybridizes the fundamentals of Western sartorial pattern making, which, from the development of two-dimensional paper patterns makes the costumes, with the practices of moulage, in which the draping of fabrics wrapped and knotted to the human body determine the volumes.

In this practice, the paper pattern is easily derived and requires no pattern-making skills (Ciammaichella 2019).

Software such as *CLO 3D*[9], for example, equips itself with mannequins and dummies that can be imported from other software, on which to lay rectangular modules of fabric on which to draw cutting and sewing lines.

The intuitive sculptural approach to costume creation is assisted by the subsequent processing of patterns. But the most important aspect lies in the refinement of advanced cloth simulation algorithms designed to simulate the correct adherence of fabrics on the body, because in their geometric collisions the real physical characteristics, explicated by an updatable collection of materials, are considered. The realization of the virtual fitting (Fig. 4) also includes three-dimensional body modeling, parametric punching and stitching variations, in a user-friendly dynamic visualization (Huang and Huang 2022).

In accepting the costume designer's consideration, regarding the character construction project, who write this article instead steps into the shoes of the scholar of costume archaeology, therefore its drawing, here, cannot disregard the physicality of the actor.

From the study of Santuzza Calì's croquis, certain rhetorical clothing lines were identified, both for Odabella and for the warrior maidens of Aquileia. For the refinement of the rucked skirts, once the 3D models of the prototypes were generated, varying radial stresses – from 2 to 4 mm – were applied to the vertices of the surfaces.

In general, variations on the same theme are allowed in the widening of sleeves, the folds of skirts, and the length of capes. Yet, each costume appears different. The theme of iridescent weaving returns, of color that, like a paint, rests on the fabrics creating ever-changing textures.

[8] https://www.marvelousdesigner.com.
[9] http://www.clo3d.com.

Figure 4: 3D modeling and texturing of Odabella and Attila costumes. Rendering by Massimiliano Ciammaichella, 2024.

Figure 5: Photographs of the prologue: scene II and scene III. Photo by G. Arici and M. Smith. Courtesy by the Historical Archive of the Teatro La Fenice di Venezia. 3D modeling, rendering and photomontage with 3D avatar of Attila and Odabella by Massimiliano Ciammaichella, 2024.

After all, 3D modeling, rendering and animation software allows this, overlaying textures on the three-dimensional models of costumes and beyond. We can define the type of fabric, applying deformations, freely imprinted forces in particular surface regions, generating multiform wefts capable of reproducing the essence of individual workings.

Finally, we can develop the surfaces on the plane, deriving the pattern to be handed over to the tailoring to make the prototypes. In this synthesis lies the potential of a research activity that aims to enhance the artistic and cultural heritage inherited from knowledge, that combines the visual and performing arts with craft and industrial practices (Fig. 5).

Going back to the compositional and design logics of a disenchanted world, that of the association of Emanuele Luzzati with Santuzza Calì, implies the recognition of a game of life played by the theatre. In fact, precisely in the playful dimension of the drawing, which takes up the foundations of illustrations for childhood, lies the valor contribution of those who have dedicated an entire existence to experiencing dreams and visions open to the expectations of an audience as heterogeneous as possible, but conducted with the humility of an artisanal work that is confronted with the boundless greatness of art (Ursini Ursic and Rauch 1996).

4. CONCLUSIONS

The paper focused on a topic peculiar to the drawing discipline, here ascribed and circumscribed by that on-stage corporeality in dialogue with the field of theatrical costume design, about which little remains known, and much more will have to be write, to recognize knowledge and craftsmanship that are in danger of disappearing.

The research outcomes argued here, in fact, move on the axes of European strategies aimed at the enhancement and dissemination of cultural heritages, tangible and intangible, all to be rediscovered.

Digitization processes are useful in understanding them, offering possible development scenarios that could open to the reproduction of lost works and performances, to forms of revisitation and reenactment worthy of being staged.

However, the few accredited professionals continue to work in sporadic opera productions, while in prose, old costumes are rehashed to be reassembled to cut costs, in other cases actors customize their costumes by relying on the seamstress on duty. If the discourse is then extended to other genres of entertainment, such as dance, the corps de ballets of theatres can be counted on the fingers.

The culture of theatre deserves to be recognized, valued, and empowered because in ignorance no process of growth can be initiated, while in the 'Here and Now' the democratic relations of proximity of a directed action on restricted time, but it continues to manifest themselves and is always ready to welcome the criticism or ovation of an audience of spectators who in the performance find the reasons for being of a story of life lived or interpreted, desired or embodied.

Then it is worth returning to the playful dimension of making, to bring younger generations closer to a practice not to be afraid of, experimenting with images and imagery that are always the fruit of study and improvisation, like the magic that Emanuele Luzzati and Santuzza Calì have shown they can make come true.

5. ACKNOWLEDGMENTS

This paper presents the results of a research work carried out over several years on the design, construction, and representation of identity, a process that inevitably engages with the performative palimpsests created when the self encounters otherness. Interpreting the Other always involves a degree of theatricality, and in this context the costume worn by the performer amplifies their personal contribution of meaning, functioning as a device that communicates the aesthetics of the community to which they belong.

This research would not have been possible without the constant support and invaluable collaboration of Maria Ida Biggi, Director of the Institute for Theatre and Melodrama at the Giorgio Cini Foundation in Venice, with whom I have shared reflections, drawings, and documents central to the themes explored here. I am equally grateful to Marina Dorigo, Head of the Historical Archives of the Teatro La Fenice in Venice, who, with great patience and dedication, assisted me in identifying the most significant iconographic sources needed to reconstruct the stage costumes for Attila.

Finally, I dedicate this important step in an ongoing line of research to Santuzza Calì and Emanuele Luzzati, whose work continues to inspire its development.

REFERENCES

Bérain, Jean. 1678. "Habit d'Hyver." *Le Mercure Galant* (October 1678): 373–378.

Bernik, Andrija, Damir Vusić, and Robert Geček. 2019. "Effectiveness of Ptex Method in the Field of Texture Mapping and Polygon Topology." In *Proceedings of the 23rd International Computer Science and Engineering Conference (ICSEC)*, 176–181. Phuket, Thailand. https://doi.org/10.1109/ICSEC47112.2019.8974768.

Biggi, Maria Ida. 2024. *Santuzza Calì. Arte fantasia colore.* Milano: Silvana Editoriale.

Biggi, Maria Ida, and Maria Teresa Muraro. 1998. *L'immagine e la scena. Giuseppe e Pietro Bertoja scenografi alla Fenice 1840–1902.* Venezia: Marsilio.

Ciammaichella, Massimiliano. 2011. *Disegno digitale per la moda. Dal figurino all'avatar.* Roma: Aracne.

———. 2019. "Fashion Wefts and Geometries of Design." *XY* 8: 78–89. https://doi.org/10.15168/xy.v4i8.164.

———. 2024. "Stage Space Maquette: Device of Illusion and Theatrical Practice." *diségno* 14: 239–250. https://doi.org/10.26375/disegno.14.2024.2.

Conte, Tonino, and Emanuele Luzzati. 2001. *Facciamo insieme teatro.* Roma–Bari: Laterza.

Huang, Shuxian, and Li Huang. 2022. "CLO3D-Based 3D Virtual Fitting Technology of Down Jacket and Simulation Research on Dynamic Effect of Cloth." *Wireless Communications and Mobile Computing* 2: 1–11. https://doi.org/10.1155/2022/5835026.

Kubišta, Jiří, Oldřich Linhart, David Sedláček, and Sven Ubik. 2024. "Workflow for Creating Animated Digital Replicas of Historical Clothing." *IEEE Access* 12: 83707–83718. https://doi.org/10.1109/ACCESS.2024.3413674.

Lampugnani, Agostino. 1648. *La carrozza da nolo overo del vestire et usanze alla moda.* Milano–Monza: Lodovico.

Laver, James. 1969. *Costume and Fashion. A Concise History.* London: Thames & Hudson.

Lo Sciuto, Paola. 2016. *La forma è l'essenza. Storia del costume per lo spettacolo. Cinema, teatro, danza: l'arte del costume e il mestiere del costumista*. Roma: PS Edizioni.
Luzzati, Emanuele, and Rita Cirio. 2000. *Dipingere il teatro. Intervista su sessant'anni di scene, costumi, incontri*. Roma–Bari: Laterza.
Niiro, Yusuke, and Marcelo Kallmann. 2020. "Assembling a Pipeline for 3D Face Interpolation." *arXiv* 2011.09657v1: 1–6. https://doi.org/10.48550/arXiv.2011.09657.
Solera, Temistocle. 1850. *Attila. Dramma lirico in un prologo e tre atti.* Milano: Francesco Lucca.
Ursini Ursic, Giorgio, and Andrea Rauch. 1996. *Emanuele Luzzati scenografo*. Genova: Tormena Editore.
Zannoni, Marianna. 2023. "«Un pagliaccetto tutto colorato». Santuzza Calì e la fortunata avventura del teatro." *Arti dello Spettacolo / Performing Arts* 9: 152–163.

Received June 2025; revised June 2025; accepted July 2025.