

UMBERTO BOCCIONI

RECREATING THE LOST SCULPTURES

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Reconstructions and digital imagery
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Front cover: Reconstructed 3D models of Umberto Boccioni's *Synthesis of Human Dynamism*, *Speeding Muscles* and *Spiral Expansion of Muscles in Movement* together with the bronze version of *Unique Forms of Continuity in Space*.

Back cover: Photograph of *Synthesis of Human Dynamism* together with a 3D mesh of the reconstruction

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Photography of Boccioni's *Empty and Full Abstracts of a Head* merged with the 3D mesh of the reconstruction.

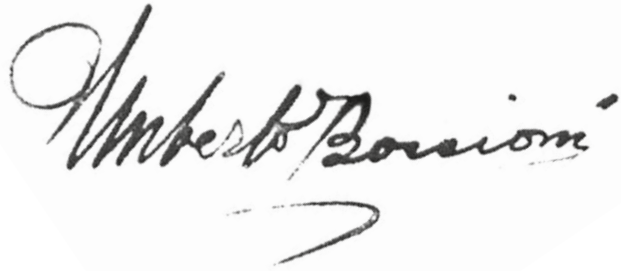




Umberto Boccioni
I Want to Fix Human Forms in Movement
(*Dynamic Deconstruction*), 1913
Milan: Civiche Raccolte d'Arte
Gabinetto dei Disegni, Castello Sforzesco

Recently, I am obsessed with sculpture! I believe I have seen the means of achieving a complete renewal of this mummified art.

Umberto Boccioni, 1912

A handwritten signature in black ink, reading "Umberto Boccioni". The signature is written in a cursive, flowing style with a large initial 'U' and a long, sweeping underline.

Umberto Boccioni Recreating the Lost Sculptures

The destruction, in 1927, of a number of plaster and mixed-media sculptures by the Futurist artist Umberto Boccioni (1882-1916) was a tragic loss for avant-garde art. Of the many groundbreaking sculptures he created between c. 1912 and 1915, only a handful remain in existence today. However, using a combination of vintage photographic material and cutting-edge 3D printing and milling techniques, digital artists Anders Rådén and Matt Smith have recreated four of Boccioni's destroyed works in full size: a volumetric study of a human face titled *Empty and Full Abstracts of a Head*, and three of the artist's iconic striding figures. They were exhibited at *Estorick Collection of Modern Italian Art* in London in September-December 2019, which allowed modern audiences to experience these lost masterpieces for the very first time.

Boccioni's interest in sculpture developed during the early part of 1912. On 15 March, he wrote to his friend Vico Baer from Paris: "Recently, I am obsessed with sculpture! I believe I have seen the means of achieving a complete renewal of this mummified art."¹

His best known three-dimensional work is undoubtedly *Unique Forms of Continuity in Space* (1913), the original plaster version of which belongs to the University of São Paulo's Museum of Contemporary Art (figure 1). One of the most instantly recognisable of all modernist sculptures, it represents an aerodynamic figure – part man, part machine – racing energetically towards the brave new world envisioned by the Futurist movement, a world 'multiplied' by technology, speed and industrialisation. It was in fact preceded by at least three sculptures on the same theme: *Synthesis of Human Dynamism*, *Speeding Muscles* and *Spiral Expansion of Muscles in Movement*. Until today, all that remained of these earlier works were a number of photographs taken in Boccioni's studio and at three exhibitions around the world between 1913 and 1917. Careful study and comparison of these images has enabled the creation of highly accurate 3D reconstructions of the original works. More clearly than ever before, they reveal the evolution of *Unique Forms of Continuity in Space*, enabling us to perceive the progressive refinement of Boccioni's ideas and the streamlining of his sculptural forms.

Biographical Notes

Boccioni is widely acknowledged to have been the most significant visual artist associated with Italian Futurism. Equally gifted as a writer, he was also one of the movement's most important theorists, and played a leading role in drafting a number of its key statements.



Figure 1. *Unique Forms of Continuity in Space* (1913 plaster original at MAC USP in São Paulo, Brazil)

¹ Zeno Birolli (ed.), U. Boccioni. *Tutti gli scritti editi e inediti* (Milan: Feltrinelli, 1971), pp. 349-51.



Figure 2. Giacomo Balla, Boccioni's mother Cecilia, an assistant and Boccioni himself standing next to *Synthesis of Human Dynamism*. On the left, *Spiral Expansion of Muscles in Movement*, May 1913.

Born in Calabria, Boccioni settled in Rome in 1899 where he met Gino Severini while attending classes at the Scuola Libera del Nudo. Like Severini, he was instructed in the Divisionist technique by Giacomo Balla, and became an accomplished exponent of the style, which was closely related to Neo-Impressionism. Symbolism and Expressionism also exerted important influences on his early work. In 1906 he travelled to Paris and Russia, settling in Milan on his return to Italy. Boccioni's restless nature and compulsion to create a "living art"² responded to the revolutionary spirit of F. T. Marinetti's Futurist movement, which he joined in 1910 along with Severini, Balla, Luigi Russolo and Carlo Carrà.

Boccioni continued to employ the Divisionist technique in his early Futurist works, which focused on urban scenes and sought to evoke psychological states, but toward the end of 1911 he encountered Cubism at first hand during a visit to Paris. Whilst this superficially 'modernised' Boccioni's imagery in the short term, it was to have little lasting impact on his artistic vision. This was largely due to his fascination with the philosophy of Henri Bergson (1859-1941), who argued that intuition and subjective experience – rather than rational analysis – offered the most authentic means of understanding reality. For Boccioni, the multiple perspectives of Cubist painting enabled the viewer to accumulate information about an object's physical properties, but had little to say about its essence or "interior force"³, as perceived by the true artist. On the same basis, he rejected a 'cinematographic' approach to the problem of depicting movement, seeking to convey a sense of the continuity of motion rather than to divide it into artificial, sequential stages (as Balla would do in his painting *Dynamism of a Dog on a Leash*, figure 4). Boccioni achieved this ambition most fully in his sculptural work, vividly expressing a sense of flux through the flowing, spiralling forms of his striding figures.

Although many of his three-dimensional works were destroyed, their incorporation of disparate and unconventional materials such as hair, glass and wire proved revolutionary. Two of the artist's sculptures were exhibited in 1913 as part of a group show in Rotterdam⁴; later that year a much larger selection was displayed at the Galerie La Boëtie in Paris in a solo exhibition⁵ which then travelled to Rome and Florence⁶. Smaller groups of sculptures were also shown in other cities during the artist's lifetime, including London⁷ and San Francisco.⁸

In 1914 Boccioni published his theoretical tract *Futurist Painting and Sculpture*, and later served with Marinetti and other Futurists in the First World War. He died in 1916 after falling from his horse during a training exercise.



Figure 3. Umberto Boccioni, c. 1914



Figure 4. G. Balla, *Dynamism of a Dog on a Leash* (1912).

² Umberto Boccioni, and others, 'Manifesto of the Futurist Painters' (1910), in Umbro Apollonio (ed.), *Futurist Manifestos* (Boston: MFA, 2001), p. 25.

³ Umberto Boccioni, and others, 'The Exhibitors to the Public' (1912), *ibid.*, p. 47.

⁴ Les peintres et les sculpteurs futuristes Italiens, *Rotterdamsche Kunstkring*, 18 May - 15 June 1913.

⁵ 1re Exposition de sculpture futuriste du peintre et sculpteur futuriste Boccioni, 20 June - 16 July 1913.

⁶ Esposizione di scultura futurista del pittore e scultore futurista Boccioni, *Galleria Futurista*, 6 December 1913 -15 January 1914; Esposizione di scultura futurista del pittore e scultore futurista U. Boccioni, *Galleria Gonnelli*, March - April 1914

⁷ Exhibition of the Works of the Italian Futurist Painters and Sculptors, Doré Galleries, April 1914.

⁸ Panama-Pacific International Exposition, summer 1915.



Figure 5. A. Archipenko, *Draped Woman* (1911). This is one of the sculptures that might have influenced Boccioni during his visit to Paris.

Boccioni's Approach to Sculpture

In early 1912, the Futurists mounted a major exhibition of their work in Paris which subsequently toured to a number of European cities. In his autobiography, Severini recalls how “on his way back to Milan after trips to Berlin and Brussels with our exhibits, Boccioni spent a few extra days in Paris, where he expressed a particular interest in sculpture. All day every day he would discuss the subject. To sate his appetite for exploring the problems of sculpture, I took him to visit Archipenko, Agero, Brancusi, and Duchamp-Villon, who were the most daring avant-garde sculptors of the moment.”⁹

Nevertheless, Boccioni remained convinced that contemporary sculpture was stubbornly resistant to modern aesthetics, and this perception seems to have provided the impetus he required to attempt a renewal of the discipline.

Unfortunately, we lack any firm knowledge of Boccioni's artistic practice since he never described it in his writings. However, he did publish two important documents detailing his views on sculpture: the *Technical Manifesto* of 1912¹⁰ and his preface to the catalogue of the aforementioned *First Exhibition of Futurist Sculpture*, held between June and July 1913 in Paris.

In the first of these texts, Boccioni called for the rejection of conventional materials such as marble and bronze, arguing that “even twenty different types of materials can be used in a single work of art”¹¹ – and went so far as to suggest the inclusion of kinetic elements and electric lights. Additionally, he insisted that a sculpture should not only represent the subject itself but also “those atmospheric planes which bind and intersect things”,¹² thereby developing ideas expressed in earlier works by Medardo Rosso, who was considered by Boccioni to be “the only great modern sculptor”.¹³ Early Futurist works such as *Fusion of a Head and a Window* and *Head + House + Light* reflected these ideas by incorporating found objects such as railings and window frames, and by the way in which Boccioni's figures were not self-contained forms but merged with, and were penetrated by, elements of their surrounding environments. Finally, Boccioni encouraged sculptors to focus their attention on “very modern and up-to-date subjects”,¹⁴ although his own works took no account of this recommendation.

In the second of Boccioni's theoretical texts, he noted that his initial mixed-media approach may have represented something of a dead end, noting that “the problem of dynamism in sculpture does not only depend on the variety of materials employed, but principally on the interpretation of form”.¹⁵ The sculptures recreated for this exhibition reflected these

⁹ Gino Severini, *The Life of a Painter* (Princeton: Princeton University Press, 1995), p. 110.

¹⁰ ‘Technical Manifesto of Futurist Sculpture’, in Umbro Apollonio (ed.), *Futurist Manifestos* (London: Thames and Hudson, 1973), pp. 51-65.

¹¹ *Ibid.*, p. 65.

¹² *Ibid.*, p. 52.

¹³ *Ibid.*, p. 61.

¹⁴ *Ibid.*, p. 65.

¹⁵ From the version of the text reproduced in *Esposizione di scultura futurista del pittore e scultore futurista Boccioni* (Rome: Galleria Futurista, 1913), pp. 3-9 (p. 4).



Figure 6-10. Boccioni's paintings and sculptures exhibited at *Galérie Boëtie*, Paris (June-July 1913).



Figure 11. Boccioni's *Speeding Muscles* in the Futurist room at the 1915 *Panama-Pacific International Exposition*, San Francisco.

Figure 12. Boccioni working on the plaster *Head + House + Light* in his studio, March 1913.





Figure 13. *Development of a Bottle in Space* (reconstructed c.1927)



Figure 14. *Antigraeful* (1912-13)

developing ideas, being made solely in plaster. The same essay also clarified important new directions in Boccioni's research, the artist explaining his ambition "to seek, in sculpture [...] not so much the construction of a body, but the construction of a *body's action*. To no longer explore the architecture of the pyramid [...] but that of the spiral. For me, a *body in movement* is not simply an immobile body set in motion, but a *truly mobile object*, which is an absolutely new and original living reality. In order to represent a body in motion, I do not render its trajectory – that is to say, its passage from one state of rest to another – but strive to capture the form that expresses its continuity in space."¹⁶

The Fate of Boccioni's Sculptures

Boccioni's family moved to Verona following his premature death. Since they were unable to take the artist's bulky plaster sculptures with them, Boccioni's sister Amelia entrusted them to a fellow Milanese sculptor named Piero da Verona (1888-1939). This would seem to have been intended as a temporary arrangement, yet the works remained with him in Milan until 1927, at which point he decided to get rid of them, and had his assistant dispose of them on a nearby rubbish dump. Having learned of this outrage Marco Bisi (the son of one of Boccioni's relatives) managed to salvage and reassemble one of the works – a painted version of the sculpture *Development of a Bottle in Space*, which today also exists in the form of bronze casts.

Other sculptures which escaped the fate of those left with da Verona include a vigorous portrait in plaster of the artist's mother titled *Antigraceful* (Galleria Nazionale d'Arte Moderna, Rome), and two delicate mixed-media constructions; *Dynamism of a Running Horse + Houses* (Peggy Guggenheim Collection, Venice) and *Essential Forms of a Footballer* (private collection)¹⁷. *Unique Forms of Continuity in Space* also survived, having been left with the Futurist painter and aviator Fedele Azari after Boccioni's death. In 1928, Azari sold the plaster original to F. T. Marinetti, who subsequently had the first bronze cast made of it. The original was eventually acquired by Brazilian collector Francisco Matarazzo Sobrinho in 1952, who relocated it to the Museu de Arte Contemporânea in São Paulo, where it can be seen today.

The remaining three striding figures reconstructed here, as well as *Empty and Full Abstracts of a Head*, *Fusion of a Head and a Window*, *Head + House + Light* and the still life *Forms-forces of a Bottle* were all lost, as was another sculpture titled *Human Forms in Movement* (see p. 15).

Toward the end of his life, Marinetti recalled the destruction of Boccioni's sculptures in his memoirs (which were written in a so-called 'aeropoetic' style, unburdened by punctuation of any kind). Despite its inaccuracies, his account of this episode reveals how profoundly he had been affected by their loss – and how keenly he continued to feel it many years later:

My ears drink in this tragic dawn at the telephone

¹⁶ Ibid., p. 5.

¹⁷ Maurizio Calvesi & Alberto Dambruoso, (eds.): *Umberto Boccioni: Catalogo generale delle opere*. (Turin: Allemandi, 2016), p. 472

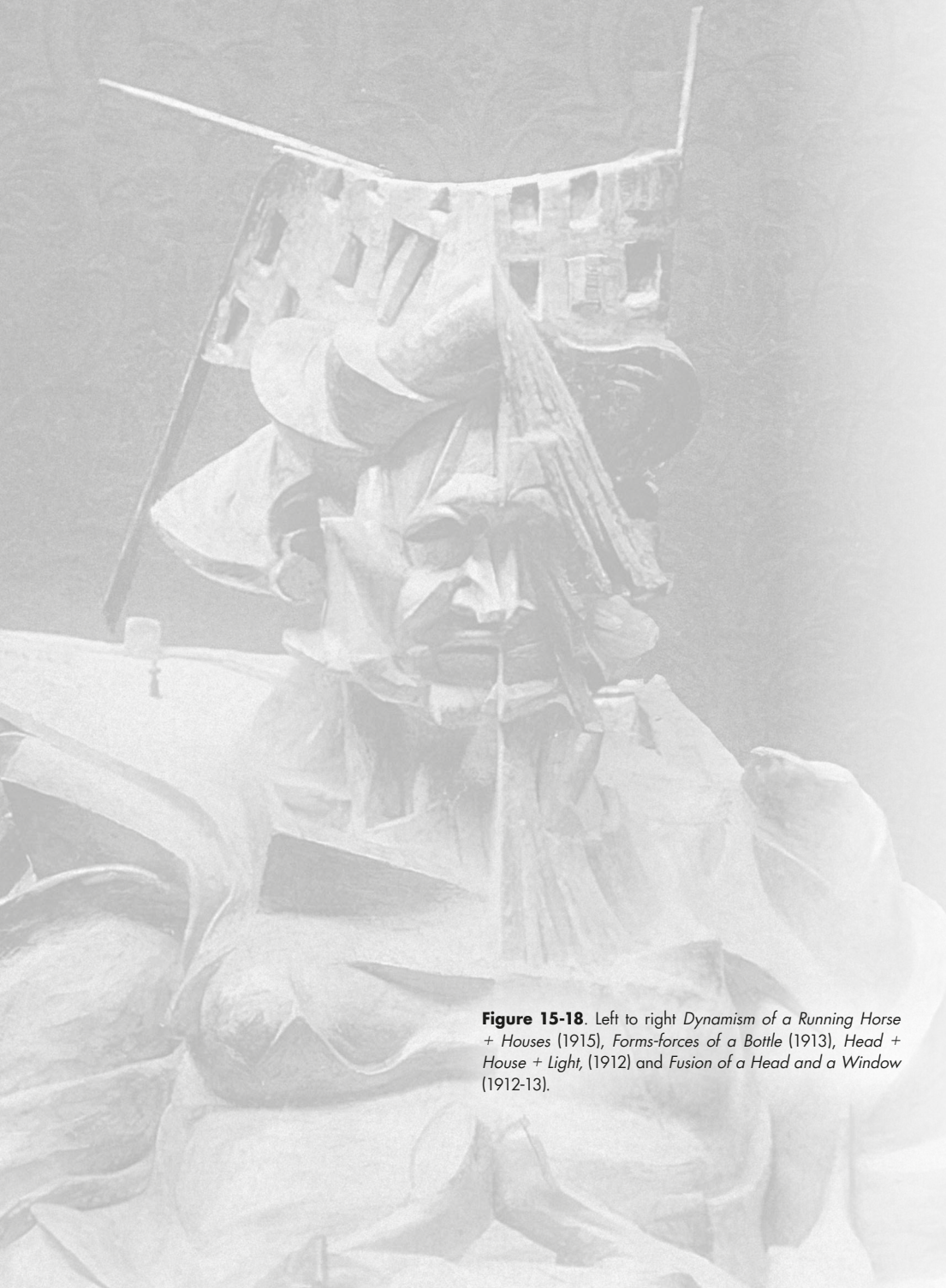


Figure 15-18. Left to right *Dynamism of a Running Horse + Houses* (1915), *Forms-forces of a Bottle* (1913), *Head + House + Light*, (1912) and *Fusion of a Head and a Window* (1912-13).

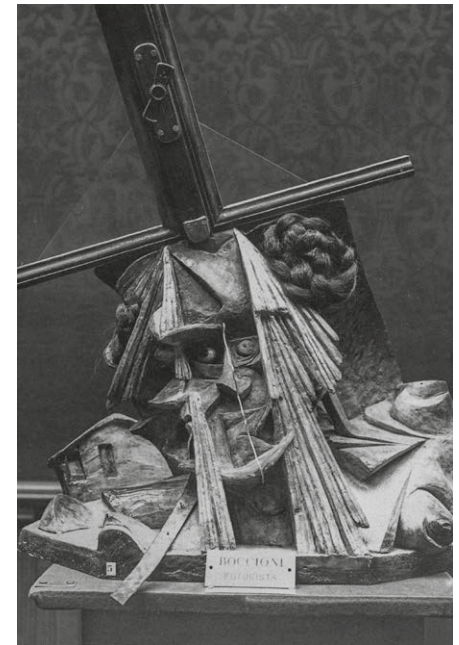
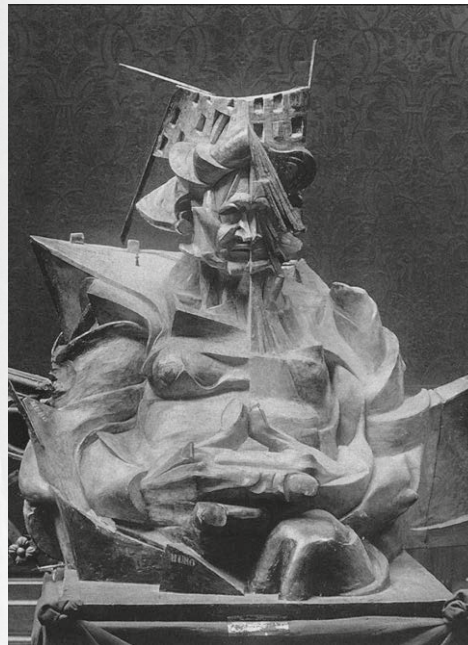




Figure 19. Boccioni photographed together with *Spiral Expansion of Muscles in Movement* in May 1913. To his left is possibly the unfinished *Human Forms in Movement*.

“Marinetti Marinetti get up I’m Azari get up and get over here right away just think last night they massacred all of poor Boccioni’s plastic structures I beg you come right over so we can save them”

Absurdly entrusted to an envious passéist narrow-minded sculptor they were ripped apart by the workmen anxious to clear out a profitable part of the building and all is ended

The funereal courtyard is full of the moaning slaughter of the sublime plaster sculptures hacked into livid pieces that make me sob just to look at while Azari openly weeping picks up the pieces of a bottle and some force-lines and we leave with the pitiful white remains to paste them together and put them up again¹⁸

Chronology of the sculptures

It is very difficult to establish the chronology of Boccioni’s sculptures of striding figures since there is virtually no information concerning their creation. Some indications can be gleaned from photographs of the works taken in Boccioni’s studio and at exhibitions. However, based on stylistic similarities and evolving shapes, they were most likely created in the following order (figures 20-24):

1. *Synthesis of Human Dynamism*
2. *Speeding Muscles*
3. *Spiral Expansion of Muscles in Movement*
4. *Unique Forms of Continuity in Space*

Both *Synthesis of Human Dynamism* and *Speeding Muscles* are characterised by a sense of heaviness and complexity of form that renders their ‘movement’ far more staccato than that suggested by the fluid and streamlined shapes of *Spiral Expansion of Muscles in Movement* and *Unique Forms of Continuity in Space*. The latter two works also eliminate those extraneous details that featured in the earlier pieces, such as the hair, nipple and navel of *Synthesis of Human Dynamism*, and the architectural elements that encumber both it and its probable successor, *Speeding Muscles*. One can also perceive a progressive reduction of the length of the figures’ arms.

The evolution of certain sculptural features is sometimes so easy to follow that the tentative chronology is further corroborated: one such detail is the “spike” on the right foot which can be seen to evolve through all of the striding sculptures.

¹⁸ ‘Great Traditional and Futurist Milan’ (c. 1943), in F. T. Marinetti, *Let’s Murder the Moonshine: Selected Writings*, ed. by R. W. Flint (Los Angeles: Sun & Moon, 1991), pp. 171-222 (p. 214).



Figure 20-24. (left to right) *Synthesis of Human Dynamism, Speeding Muscles, Spiral Expansion of Muscles in Movement and Unique Forms of Continuity in Space.*

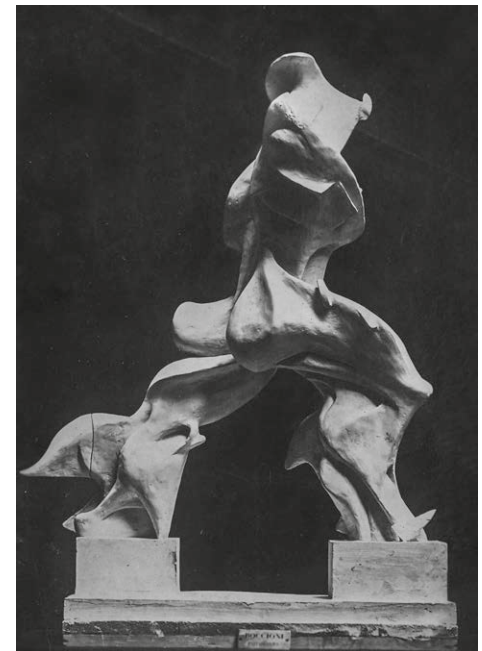




Figure 25. *Unique Forms of Continuity in Space* in Boccioni's apartment in 1915.

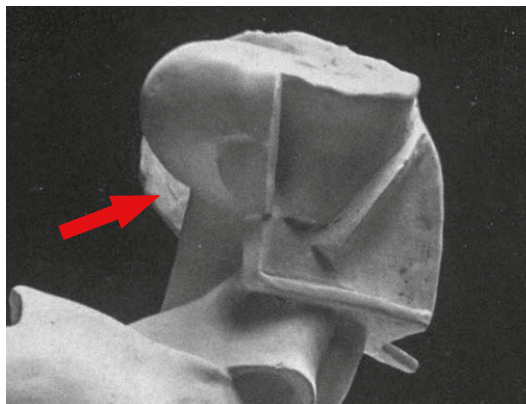


Figure 26. *Spiral Expansion of Muscles in Movement*, photograph (left) and the 3D reconstruction (right).

Yet another striding sculpture, *Human Forms in Movement* – the last major plaster Boccioni made¹⁹ – is listed in the exhibition catalogues of Galleria Sprovieri (Rome, Dec. 1913) and Galleria Gonnelli (Florence Mar.-Apr. 1914)²⁰. Unfortunately, no photographs exist of this work, although it is possible that it is partly visible in an unfinished state in a number of photographs taken in Boccioni's studio in April-May 1913 (figure 19)²¹. It is certainly plausible that Boccioni had started sculpting *Human Forms in Movement* but didn't have time to finish it in time for the Paris exhibition starting in June – since it does not appear in the catalogue. However, he may have managed to finish it in time for the Rome exhibition in December. Furthermore, the title of the work would also suggest that it is a striding form, and thus quite large in keeping with the other striding sculptures.

General Characteristics of the Striding Figures

One characteristic is recurring in all Boccioni's four striding sculptures, apart from the fact that they all begin their stride with the right leg: the right side of the sculptures is invariably more detailed than the left. This observation was already acknowledged in Boccioni's own time. A friend of his, Alberto Martini, writes to him in March 1914: "Allow me to tell you something I cannot keep silent about (I would admire your sculptures a thousand times more if they were conceived and modeled on one side only): I am sure that when you modeled one side of your statue, in shaping the opposite side you feel a little exhausted and tied to the outline of the first. You would be a thousand times more lyrical modeling only one part. I don't know if I can explain myself. Your drawings also confirm this".²²

Recent research²³ has revealed that the *Unique Forms of Continuity in Space* plaster contains internal metal scaffolding. X-ray images show metal pieces of varying dimensions forming a rough skeleton beneath the plaster. This suggests that the other striders most likely contained metal scaffolding as well. In figure 33, *Synthesis of Human Dynamism* is stabilised with ropes running from the top of the head to the ceiling. It is possible that these ropes are fastened to metal scaffolding that continues down through the body.

Reconstructing the Lost Works

Matt Smith and Anders Rådén independently discovered that the photographic documentation of the lost sculptures from 1913 to 1917 is quite extensive. They started putting the pieces of the story together, began to collaborate in 2018 and came to the

¹⁹ Laura Mattioli Rossi (ed.), *Boccioni's Materia: A Futurist Masterpiece and the Avant-garde in Milan and Paris* (New York: Guggenheim Museum Publications, 2004), p. 35

²⁰ Luigi Sansone, 'Die Gipsplastiken von Umberto Boccioni: Unveröffentlichte Geschichten und Dokumente', in Feierabend, V.W. (ed.), *Umberto Boccioni. La rivoluzione della scultura* (Milan: Silvana Editoriale, 2006), p. 27

²¹ Giovanna Ginex, 'Boccioni e la fotografia', in Laura Mattioli Rossi (ed.), *Boccioni Pittore scultore futurista* (Milan: Skira, 2006), p. 159

²² Mattioli Rossi, 2006, p. 67

²³ Ana Magalhães and Rosalind McKeever (eds.), 2018, *Boccioni and Unique Forms of Continuity in Space* (MAC USP, accessed 20 April 2020, http://www.mac.usp.br/mac/conteudo/academico/publicacoes/folderes/2018_boccioni_EN.pdf)

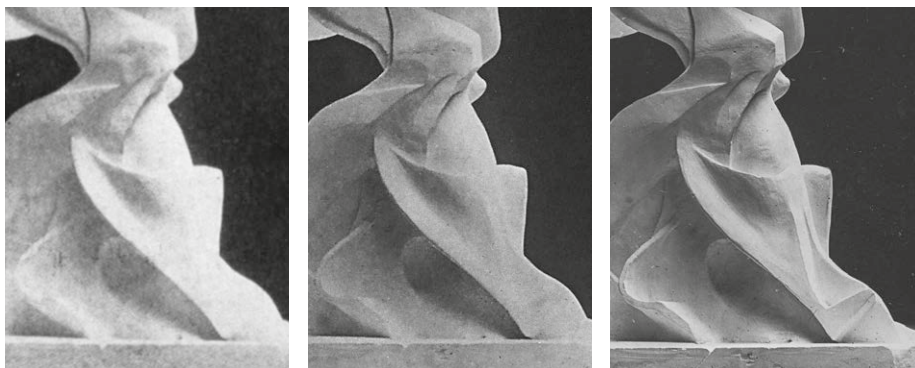


Figure 27. Differing image quality in photographs from three sources of *Spiral Expansion of Muscles in Movement*. Brightly lit areas progressively reveal greater detail.



Figure 28. The increasing level of detail in the same photograph from different sources of *Speeding Muscles*. This is especially obvious when looking at the background paintings.

conclusion that high-quality reconstructions were indeed feasible. The vision was to experience the sculptures in three dimensions in a gallery setting just as the artist intended, and for a modern audience to experience these incredible forms for the first time in 100 years. In collaboration with the Estorick Collection it was possible in 2019 to finally print and exhibit the works.

“Why attempt to recreate long-lost works of art? Surely, only their creator could know how they looked” might be a possible objection to projects such as this. Ultimately, the success of reconstructed art depends to a large extent on the quality and quantity of the surviving visual documentation. In the case of Boccioni’s sculptures, sufficient high-quality photographic material certainly exist to make reconstruction feasible and worth pursuing. Art historian Roberto Longhi’s detailed essay of 1913 concerning the works also provided many important clues as to their appearance. It is crucial to note that the reconstruction process was not undertaken as a mere technical challenge; rather, it is hoped that the resulting pieces will offer new interpretative opportunities for both specialist art historians and the general public, providing fresh insights into Boccioni’s sculptural practice. In this particular instance, the project also represents a fusion of art and technology that would have doubtless appealed to the Futurists.



Figure 29. *Spiral Expansion of Muscles in Movement*. Areas in red take up 10% of the total area.



Figure 30. *Speeding Muscles*. Areas in red take up 19% of the total area.



Figure 31. *Synthesis of Human Dynamism*. Areas in red take up 9% of the total area.

How Accurate are the Reconstructions?

The intent of this project is using modern digital tools to reconstruct Boccioni's lost masterpieces as precisely as possible. Many of the historical photographs — when studied in high resolution — reveal more sculptural detail than previously recognised. Boccioni's works are marked by angular, sharply defined planes and contours, which cast dramatic shadows and highlights. These characteristics provide strong visual clues, even in areas hidden from direct view. With careful observation, the photographs allow for the recreation of volumes, connections, and transitions with surprising accuracy. Additionally, Boccioni's surviving sculptures and his theoretical writings on Futurist sculpture help inform areas where visual evidence is lacking. This significantly reduces the need for speculative interpretation.

A case in point is the head of *Spiral Expansion of Muscles in Movement* (figure 26): where the cranium meets the neck there is a white shape. Light shines from above, which means this must be a flat surface angled slightly upwards, with nothing to cast a shadow on it. Consequently, the head must have been divided into both flat and rounded forms, which aligns perfectly with art historian Roberto Longhi's 1913 description of the work as having “a halved cranium.”²⁴

One way of estimating the varying levels of accuracy is to add together those areas of the sculptures that are hidden from view in the corresponding photographs (marked in red on the pieces shown in figures 29–31) and divide them by the total surface area. Hidden areas constitute only 10% of *Spiral Expansion of Muscles in Movement*, meaning that an astonishing 90% of the work is visible in the photographs. *Synthesis of Human Dynamism* has even fewer hidden areas, since photographs of the sculpture exist from all sides. As mentioned before, many of these hidden areas are very easy to extrapolate based on the surrounding forms, thus leaving even smaller portions to conjectural guesswork.

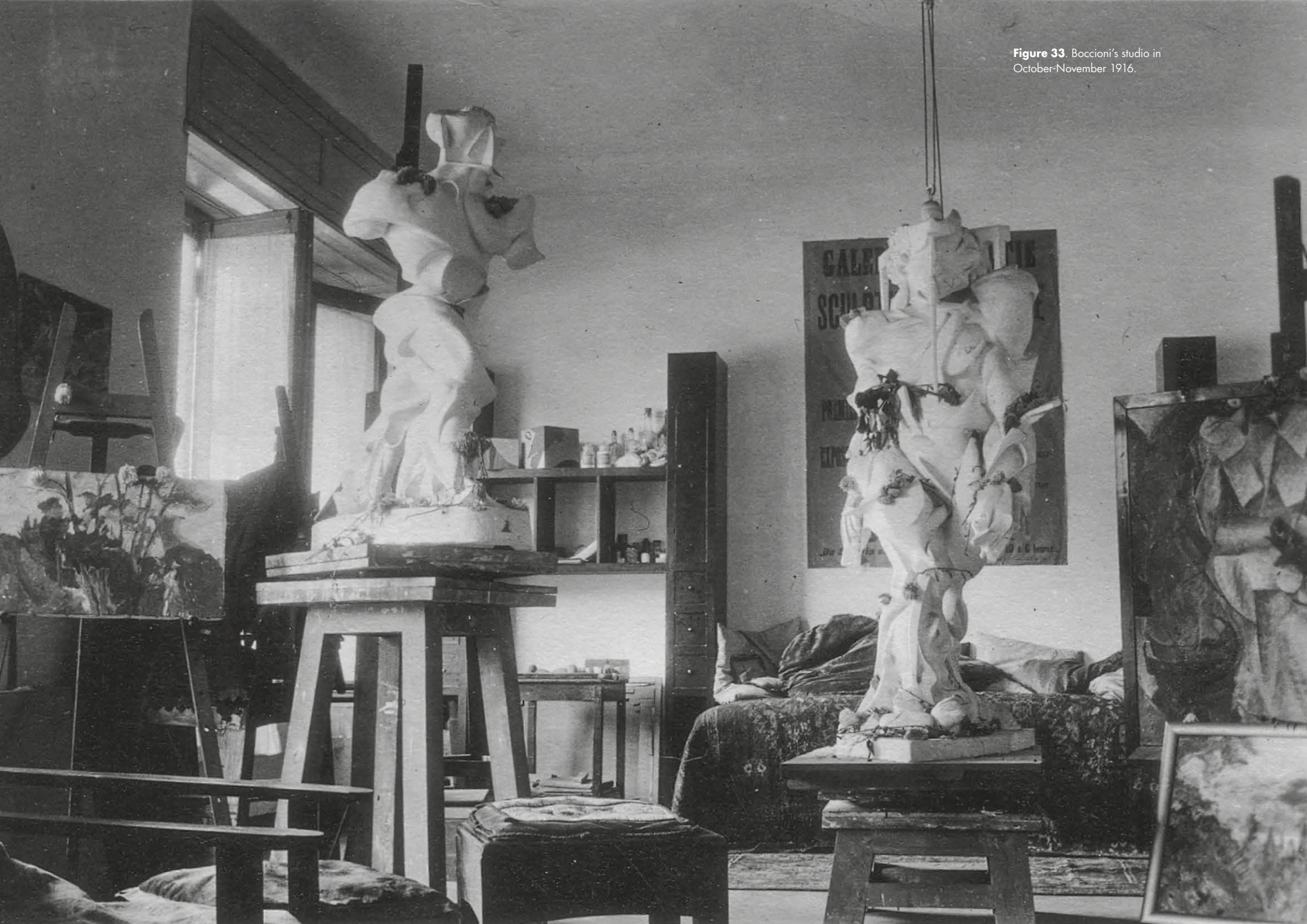
It should also be stressed that the work of reconstruction is in constant evolution, since the discovery of new or better photographs will always necessitate a rethinking of certain shapes (figures 27 and 28).

²⁴ Roberto Longhi, *Scultura futurista: Boccioni* (Florence: Libreria della Voce, 1914).

Figure 32. Boccioni posing with *Synthesis of Human Dynamism*. This is one of the last photos of Boccioni in his studio, Nov.-Dec. 1915.



Figure 33. Boccioni's studio in
October-November 1916.



Unique Forms of Continuity in Space – a special case

Unique Forms of Continuity in Space started out in 1913 as a plaster. There is no known record of Boccioni himself wanting to cast any of his plaster sculptures in metal during his lifetime, so the fact that *Unique Forms of Continuity in Space* is today almost universally represented as a metal sculpture is not according to his wishes. F.T. Marinetti was the first to cast the work in 1933. His aim was to better preserve it for posterity, since the plaster had already started to deteriorate. To date, 24 casts have been made, 17 of which are copies of already existing casts – so called surmoulages.

Boccioni's original plaster of *Unique Forms of Continuity in Space* still exists, and is housed at Museu de Arte Contemporânea da Universidade de São Paulo (MAC USP) in Brazil. Historical photographs show that the sculpture's appearance has changed over time, largely due to multiple restoration efforts in 1960, 1971, and 1986.¹ These interventions aimed to repair cracks and damage caused by handling, transport, and display, but they also altered the original form. The effects of these changes are visible in the plaster itself and are even more noticeable in various metal casts made from it (see figures 34-39). This can partly be attributed to the casting process; details are invariably slightly changed or even lost due to the metal shrinking as it cools.

In order to match *Unique Forms of Continuity in Space* more closely with the reconstructed striding sculptures, it was felt necessary to make a photogrammetric copy (essentially a 3D scan) of the metal version, then digitally “reverse engineer” it back to its original state with the help of photographs of the 1913 plaster.

The Tate Modern metal copy, cast in 1972, was digitised in high resolution and used as a starting point (see pages 30-33 for more details of the process). An in-depth analysis and careful comparison of the 1913 photographs with corresponding ones of the Tate Modern cast provided the information needed for making the necessary sculptural changes in the 3D software. Overall, the emerging 1913 *Unique Forms of Continuity in Space* is much tauter and has sharper defined features than the restored plaster, not to mention the casts.

A small 1:4 scale 3D print of this reconstruction was exhibited at Estorick Collection in 2019 (see page 33). It is currently the closest existing approximation to Boccioni's original conception of *Unique Forms of Continuity in Space*.

At least 13 historical photos exist of this work prior to the restorations; seven from the 1913 Paris exhibition in Paris, three from Boccioni's studio, two from the retrospective exhibition in Milan 1916-17, and one from the exhibition *Prima Mostra Nazionale d'Arte Futurista* in Rome 1933.

¹ M.B. Silva, *Chronology of the works Unique Forms of Continuity in Space and Development of a Bottle in Space by Umberto Boccioni* (MAC USP, accessed 20 April 2020, http://www.mac.usp.br/mac/conteudo/academico/publicacoes/boletins/escultura/pdfs/CRONO_BOCCIONI_ING.pdf)

Figure 34-39. (left to right) Details of the 1913 *Unique Forms of Continuity in Space* plaster compared to the metal cast at Museo del Novecento, Milan. The discrepancies are quite substantial.

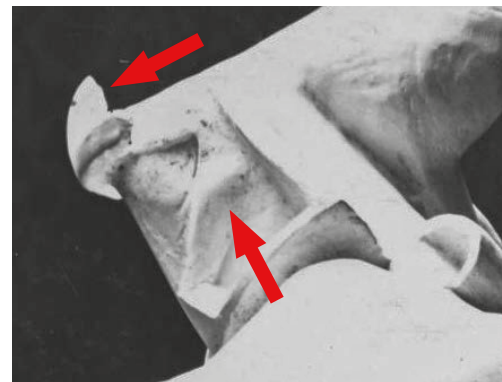
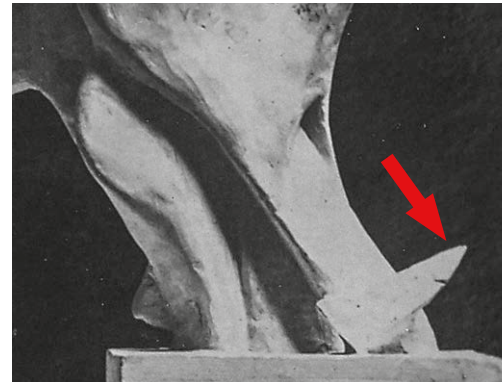




Figure 40-44. The *Unique Forms of Continuity in Space* plaster exhibited at *Galérie Boëtie*, Paris (June-July 1913). The photograph in the lower right is from *Prima Mostra Nazionale d'Arte Futurista* in Rome, 1933.

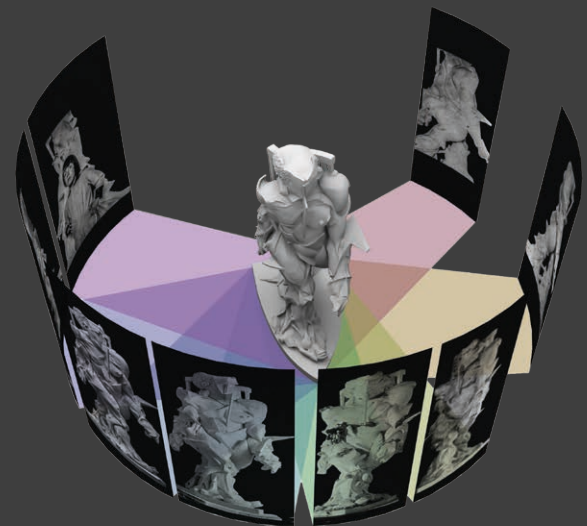


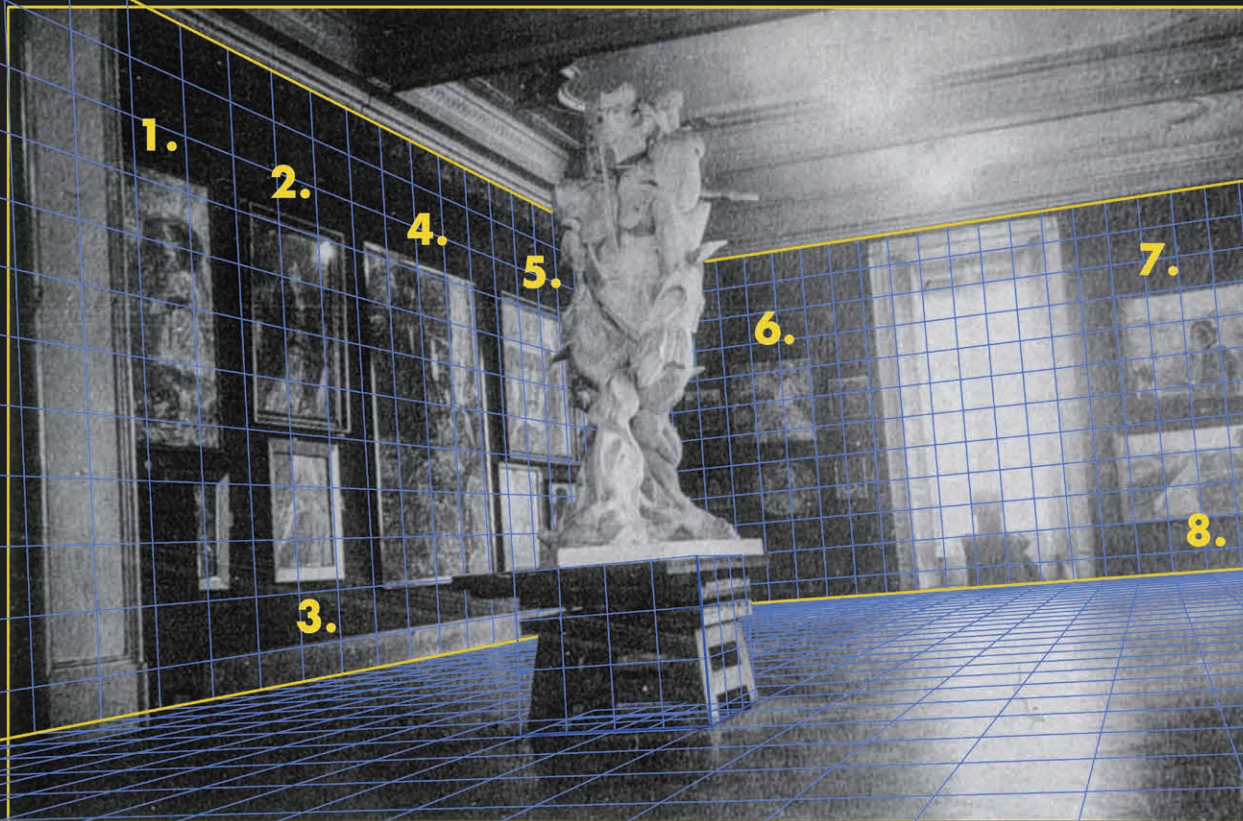
Synthesis of Human Dynamism

A total of 14 photographs of this work are known to survive, 11 of which were taken in Boccioni's studio, one at the 1913 exhibition in Paris, and two at the posthumous Milan show of 1916-17. The eight photographs used in the recreation process provide nearly complete 360-degree visual coverage.

Two rarely published photographs from the 1916-17 Boccioni retrospective in Milan were especially valuable, offering crucial visual information about the back and lower sections of the legs. Additionally, the way the sculpture integrates with and is penetrated by vertical and perpendicular elements of its surrounding framework — particularly in the upper body "scaffolding" — made spatial alignment in the 3D modeling process significantly more manageable.

The lighting in these photographs is natural except for image 6 which is lit by artificial lights in a gallery. The photograph from the back of the sculpture (upper left) was taken with a flash, which is evident from the way the shadows are cast.





Calculating the Sizes of the Sculptures

There is no documented information about the sizes of the lost sculptures, although quite accurate estimates can be made with the help of the surviving photographs. In three cases this can be achieved by comparing the sculptures with paintings of known dimensions that were displayed alongside them (yellow numbers in the photographs). Some of the paintings are lost or have been destroyed, which accounts for the lack of information about their dimensions.

Synthesis of Human Dynamism in the 1916-17 Milan exhibition

The paintings are: 1. *Bambina con cavallo* (1905). 132 x 104 cm; 2. *Ritratto della signora Meta Quarck* (1910), 106,5 x 130 cm; 3. *Controluce* (La

Madre) (1909), 62 x 55 cm; 4. *Le due amiche* (1916), 202 x 151,5 cm; 5. *Maestra di Scena* (*Ritratto della Signora Adalgisa Maffi*) (1909), 100 x 80 cm; 6. *La madre* (1911). 80 x 80 cm; 7. *Ritratto dello scultore Brocchi* (1907), 102 x 124 cm; 8. *Officine a Porta Romana* (1908), 75 x 145 cm.

Based on these dimensions *Synthesis of Human Dynamism* is 156 cm tall.

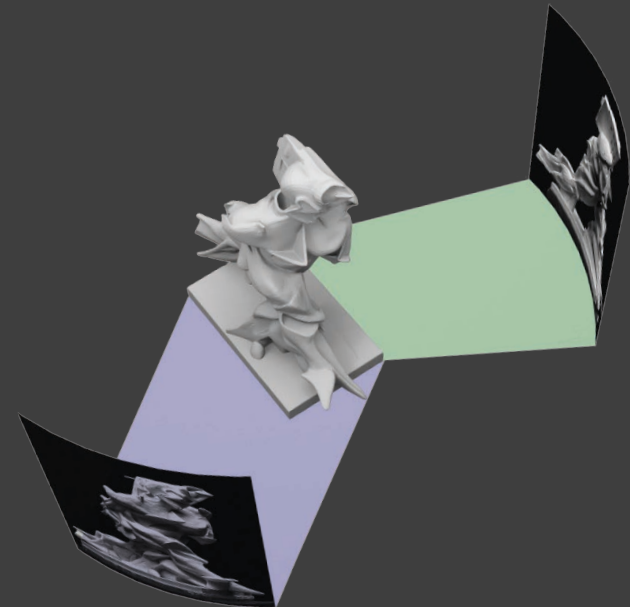
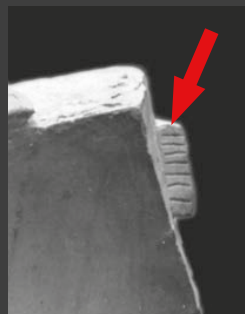
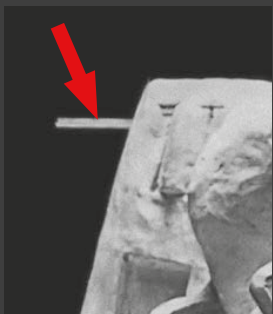


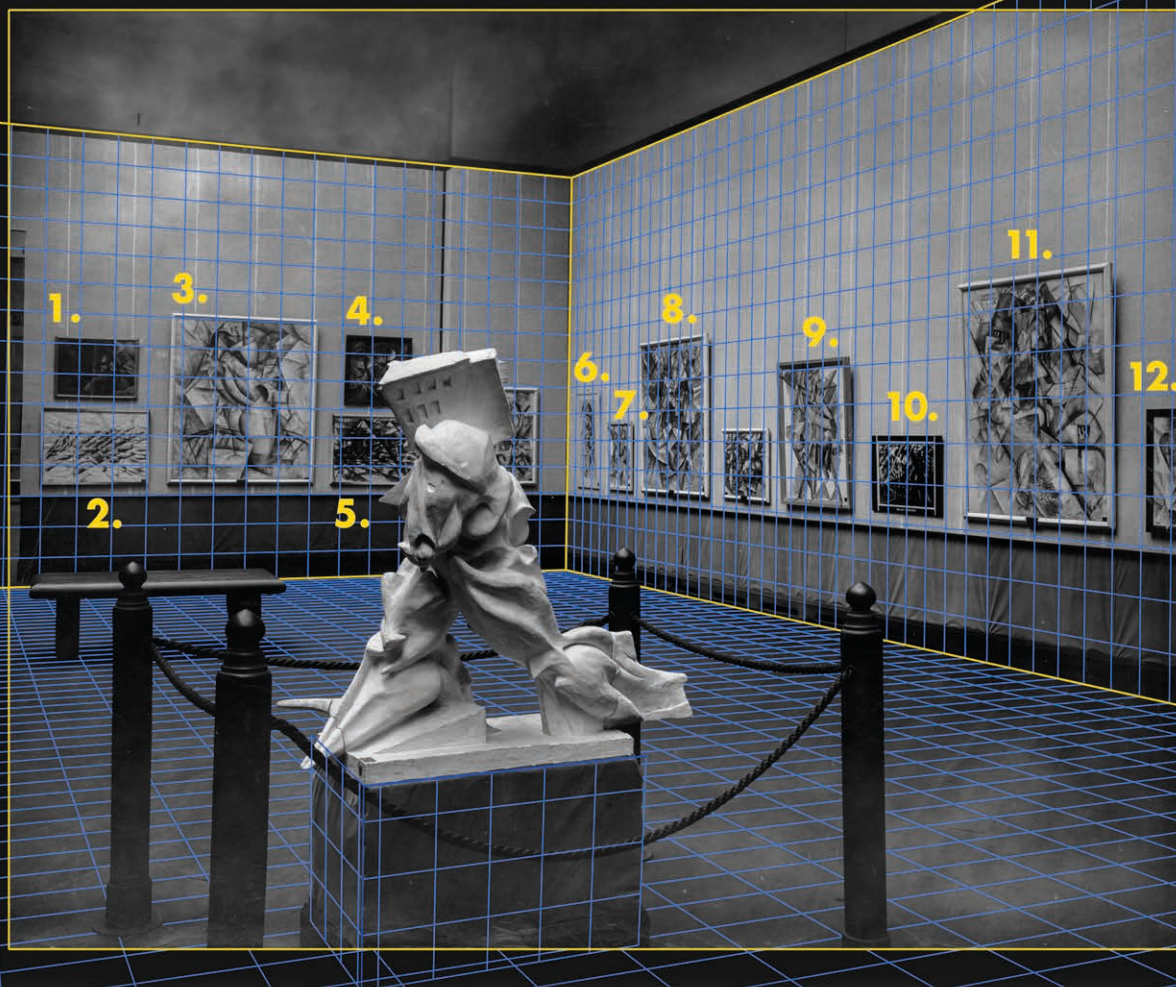
Speeding Muscles

This work is a rarity in historical documentation, appearing in only three known photographs. Two were taken at the 1913 exhibition in Paris — the second replicates the first, but in smaller scale — and a third at the 1915 *Panama-Pacific International Exposition* in San Francisco. Fortunately, these few images complement each other so well that the reconstruction of the sculpture involves remarkably little guesswork. The high resolution of the available photographs further supports detailed analysis.

The only notable difference between the Paris and San Francisco photographs is a small protrusion on the upper back of the head. In the 1915 San Francisco image, this feature appears to have been altered. The final reconstruction is based on this later version.

The surface of the plaster sculpture is significantly rougher than that of Boccioni's other striding figures, suggesting that the work progressed rapidly from concept to form.



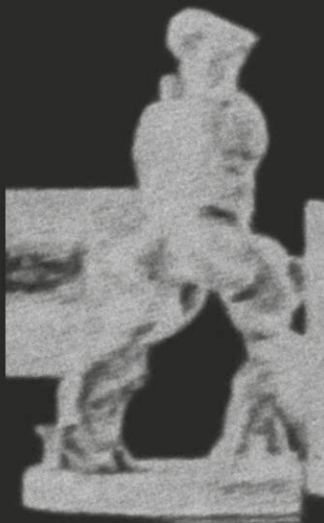


Speeding Muscles in the San Francisco exposition of 1915

The paintings are: 1. Luigi Russolo: *Volumi dinamici* (1913) 2. Giacomo Balla: *Disgregazione x Velocità, Penetrazioni dinamiche d'automobile* (1913), 67,6 x 96,2 cm; 3. Carlo Carrà: *Simultaneità, La donna al balcone* (1912), 147 x 133 cm; 4. L. Russolo: *Autoritratto* (1912); 5. G. Balla, *Velocità di automobile* (1913) 64,7 x 93,8 cm; 6. C. Carrà: *Studio di una donna nuda* (1912), 36,2 x 81,9 cm; 7. Gino Severini: unknown; 8. C. Carrà, *Trascendenze plastiche*

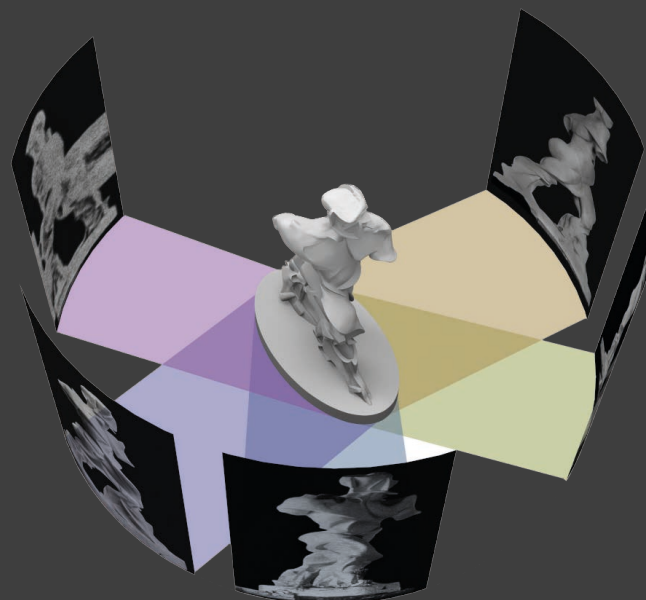
(1913); 9. G. Severini: *Tango argentino* (1913); 10. G. Balla: unknown; 11. C. Carrà: *Forze centrifughe* (1912); 12. G. Severini: *Espansione sferica della luce centrifuga* (1913-14) 60,9 x 49,5 cm.

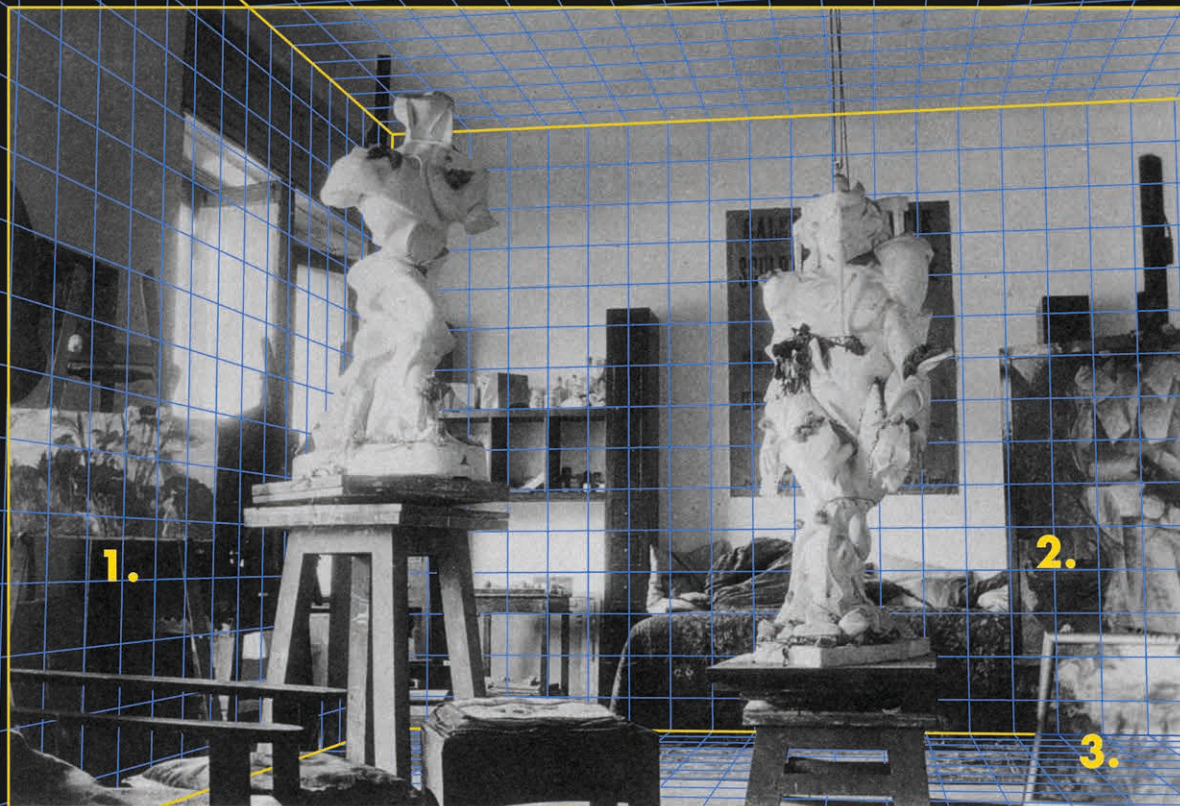
Based on these dimensions *Speeding Muscles* is 107 cm tall.



Spiral Expansion of Muscles in Movement

A total of 14 photographs exist of this work; 12 images taken in Boccioni's studio, one at his 1913 solo exhibition in Paris and one published in the newspaper *Il Secolo Illustrato* in January 1917 (bottom right). We believe that the latter is a new discovery, and is being published here for the first time. This means that five different angles are covered and two of these include the full sculpture.





Spiral Expansion of Muscles in Movement (together with Synthesis of Human Dynamism) in Boccioni's Milan studio in 1916.

The paintings are: 1. *Paesaggio montuoso* (1916), 33 x 55 cm; 2. *Costruzione spirale* (1914), 95 x 95 cm; 3. *Paesaggio (con montagne e lago)* (1916), 49,5 x 68,5 cm.

Based on these dimensions, and also taking into account the size of *Synthesis of Human Dynamism*, *Spiral Expansion of Muscles in Movement* is 117 cm tall.

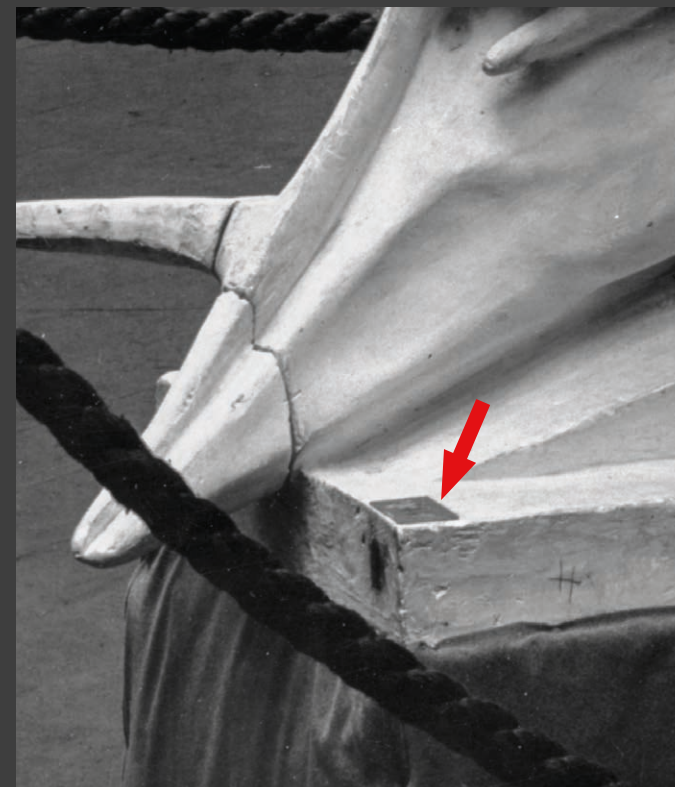


Empty and Full Abstracts of a Head

This work appears in seven photographs, four of which were taken at the 1913 Paris exhibition, and three in Boccioni's studio. This is the only sculpture by Boccioni that the artist included in one of his paintings, (*The Two Friends*, 1914, lower left), in which the figure's left ear can be seen. One can just about make out what would appear to be the right ear on a photograph taken at the 1913 exhibition (top right).

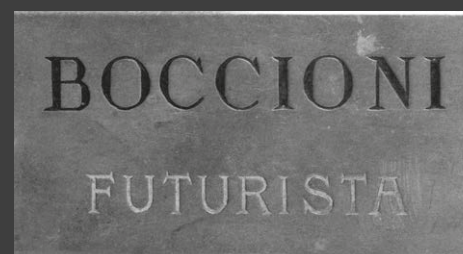
To our knowledge the top middle photograph has not previously been associated with this sculpture. The Head appears to have been painted or varnished, as was also done with *Antigrazioso* and *Development of a Bottle in Space Through Colour*. The photograph was taken in May 1913 — about a month before the Paris exhibition — where the Head is seen in white. It is possible that Boccioni initially painted or varnished the piece, but later decided to return it to its original white surface prior to the exhibition.





Empty and Full Abstracts of a Head in the Paris exhibition of 1913

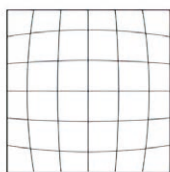
There is a plaque attached to the base of the sculpture with Boccioni's name. This plaque is visible in several other photographs, for example at the base of *Unique Forms* (middle) and *Speeding Muscles* (middle right) (see also pages 11-12). The known size of the plaster original of *Unique Forms* makes it possible to estimate the size of the plaque, and ultimately the head as 42.5 cm x 32.5 cm.



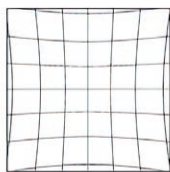
The Reconstruction Challenges

The photographs of Boccioni's sculptures — both in galleries and in his studio — have been printed and reprinted countless times. The original negatives have not been found and are probably lost. There are around 150 extant prints in private collections, institutions, and museums around the world.¹² There are most likely additional photographs that have not yet surfaced, especially those taken during various exhibitions. For now, however, we have had to make do with what is currently available.

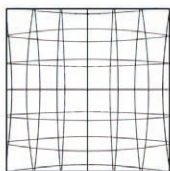
Very little is known about how many copies were made from the same negative. However, in many cases, when the same photograph from different sources is superimposed, the images do not match. This indicates that distortions must have been introduced during the copying process — either when the photograph was re-copied with a camera or during the development of the negative. These distortions manifest in various ways, exaggerated here for clarity.



A. If the camera is too close to the photograph the apparent effect will be that of an image which has been mapped around a sphere.



B. If the camera is far away, the visible effect is that lines that do not go through the centre of the image are bowed inwards, towards the centre of the image, like a pincushion.



C. When both of the above photos are superimposed, the differences become clear.

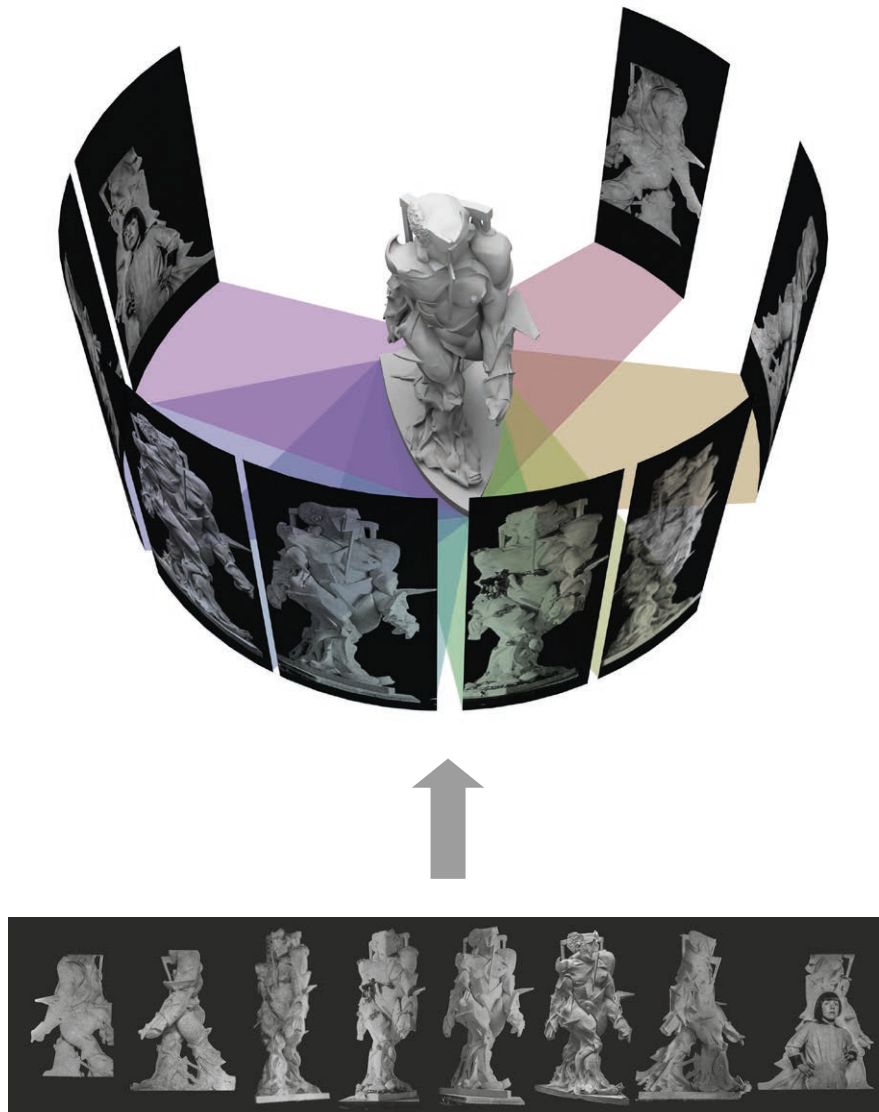
There is no information on which type of cameras were used in creating these images. Consequently, there is no information about the lenses that were used. A wide-angle lens produces photographs that look slightly different from those taken with a normal lens (nearby objects appear larger, while distant objects appear smaller).



Figure 45. Boccioni's camera has not been preserved. However, from the characteristics of the original prints, it is clear that it was a portable camera with roll films, a type contained in leather cases with shoulder straps: just like the one visible on Boccioni's sofa (above).

¹² Laura Mattioli Rossi, 2006, pp. 137-155 [p. 152]. Almost all of the photographs are found in four private Italian collections, with a few also in the Getty Research Institute in Los Angeles, the Bisi Crotti archive at the Museo del Novecento, Fondazione Longhi in Milan and the Victoria and Albert Museum in London.

Figure 46. The digital model of *Synthesis of Human Dynamism* and the eight extant photographs in their corresponding places. For illustrative purposes the photographs are not positioned in Y space here, only X and Z.

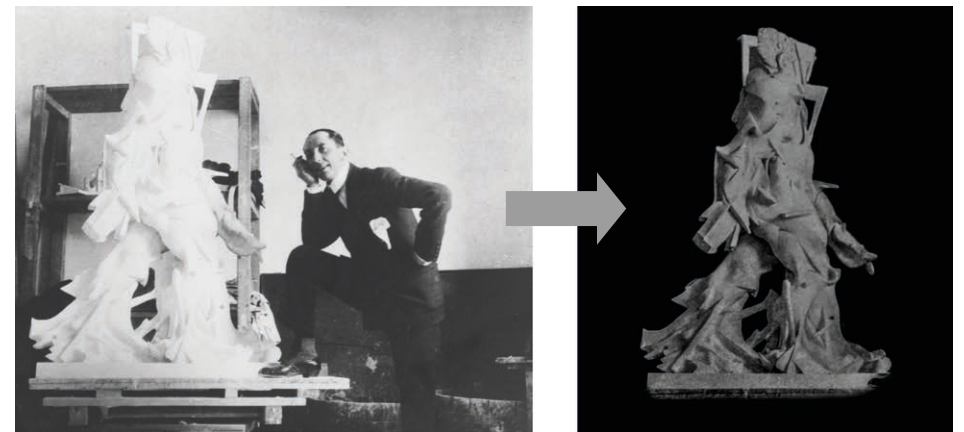


All these factors were important to keep in mind during the recreation process. A balanced judgement had to be made whenever it was evident that photographs taken from different angles did not match as expected. These are also some of the reasons why photogrammetry techniques were not applicable. Furthermore, due to the limited number of photographs, their varying quality, and the interpretive decisions required, AI or machine-learning approaches were not an option for this project.

The Reconstruction Procedure

The recreation process is here described in detail, using *Synthesis of Human Dynamism* as an example.

1. The best available photographs of Boccioni's sculptures were scanned from books and/or if possible, acquired from art museums, publishers and institutions.
2. The contrast of the images was adjusted, and shadowed area were lightened in order to bring out as much detail from the photograph as possible. Where necessary, resolution was artificially enhanced by up-scaling the photograph with machine learning algorithms.



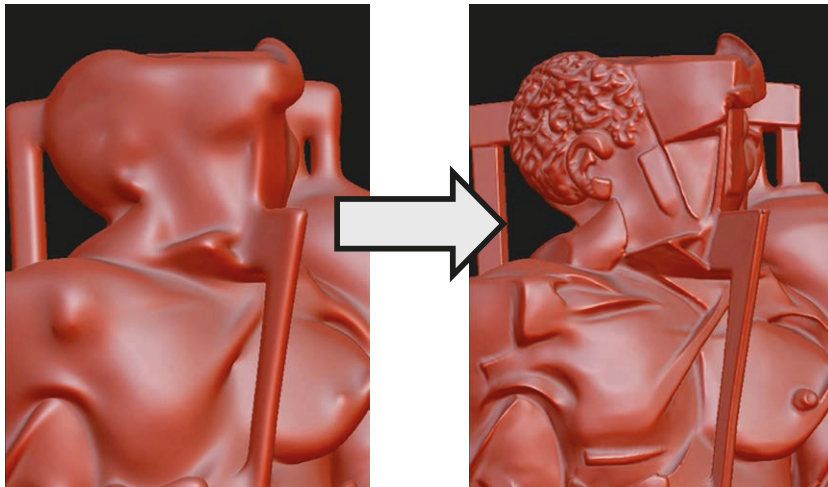
3. Each of the sculptures was extracted from its surrounding space to make evaluation easier. In the case of *Synthesis of Human Dynamism* this yielded 'cut-outs' from eight different angles. As seen in figure 46, the eight images cover almost every angle of the sculpture, with the caveat that some of the images only show part of the sculpture.

4. Using 3D sculpting software, these cut-outs were loaded into interconnected image planes that were adjusted in 3D space until they aligned with each other perfectly.

5. The initial step was to create a 3D armature that was superimposed onto the frontal view, and adjusted until all the limbs were in their approximate places (figure 47b). The limbs were adjusted in a similar manner in the remaining seven interconnected images. This created a 3D foundation for the continued sculpting.

6. An adaptive skin or mesh was then created based on the dimensions of the armature. This layer was flexed and stretched into position in 3D space, thus matching the sculpture contours of all the image plane photographs (figure 47c). All of these adjustments resulted in a basic mesh with X, Y and Z axis dimensions that correspond to those of the actual sculpture.

7. Finer and finer details were sculpted into the mesh, tracing the features of each underlying photograph. The transparency of the mesh can be controlled incrementally which made it easier to judge the accuracy of the sculpting. The digital moulding tools mimic their real world counterparts and allow easy shaping of the digital 'clay'.



8. For further refining, the resulting mesh was put on a digital stage that mimics the lighting in the photographs, making it possible to use cast shadows as an additional parameter when adjusting the shapes (figure 48).

9. Once completed, the digital sculptures were exported to a 3D print file format and printed with Fused Deposition Modelling technology (FDM, using white thermoplastic filament) and Computer Numerical Control Milling (CNC, using dense white polystyrene).

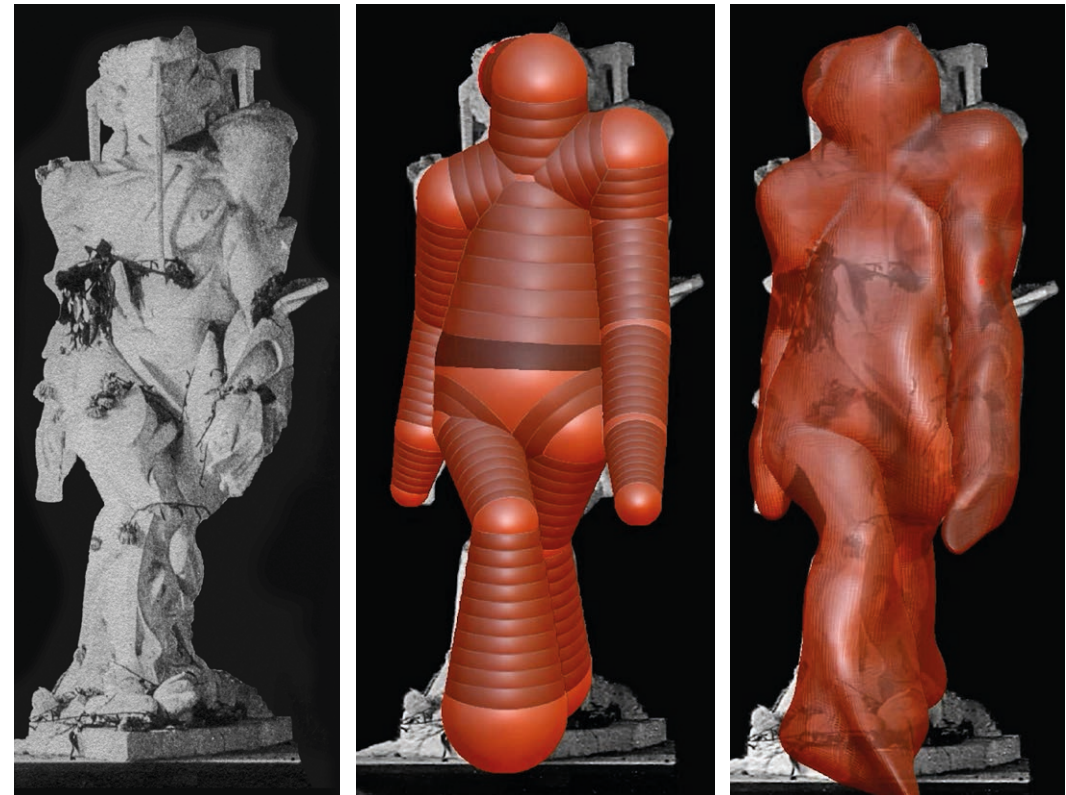


Figure 47a, b, c. To the left, the original photograph. A 3D armature was adjusted until it roughly traced the underlying image in all connected 3D planes (b). An adaptive skin was then added and stretched to match the contours of the image. This was repeated for all image planes (c).

Figure 48. The finished digital 3D model of *Synthesis of Human Dynamism* compared to the actual sculpture.



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The Artists

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The Estorick exhibition 2019

The following selection of photographs are from the resulting exhibition at the *Estorick Collection of Modern Italian Art* in London, 25 September - 22 December 2019. The sculptures were printed in full scale and 1:4 scale. Thermoplastic filament was used for all sculptures except *Speeding Muscles*, which was milled from dense polystyrene.







Figure 47. Photograph from the posthumous Boccioni exhibition in Milan, arranged by F.T. Marinetti in 1916-17. To the left is *Forms-Forces of a Bottle* and at the centre is *Unique Forms of Continuity in Space*.



Umberto Boccioni
Muscular Dynamism, 1913
New York: The Museum of
Modern Art



