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Drawings, artifacts and anatomical preparations: the collections of the Senese Museums for teaching Anatomy yesterday as today

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Abstract. The scientific museology highlights the importance of the specialized museum collections of anatomy as tools for teaching and scientific communication. The cultural heritage, deriving from research and study activities, have been preserved over the centuries. They are not simple goods to be exhibited, but are dissemination means of scientific culture and specialized teaching at university level. In fact, anatomical tables, models and preparations of the Senese museums are still used for teaching anatomy, as well as for dissemination activities to a large non-specialized audiences. The anatomical collections and the musealization of new findings are proposed as active means of communication and teaching, of health education and research on the biological history of man. Through their collections, the universities museums of anatomy allow to carry out empirical studies of a historical nature. In addition, the evolution of technologies can help the knowledge of the human body. The historical re-reading of anatomy by means of the goods present in the museums of human anatomy, the study of the technical and practical knowledge at the base of such finds, the possibility of using them for educational purposes alongside the most up-to-date tools that technology allows us to have available, are producing a new interest in the discipline that, overcoming the limits of a specialized knowledge, can acquire the value of a form of historical communication of the human body that can also be communicated to an inexperienced audience, as well as to students of medical degree courses and health professions.

Keywords: anatomy, museums collections, heritage, teaching.

INTRODUCTION

Anatomical museums, often found in many ancient universities, can be considered as true three-dimensional works of anatomy, where the human body is displayed in its normal state or in the pathological aspects that can characterize it. In anatomical museums, through human remains, drawings, and models, the structures and morphologies of the human body can be studied as an expression of the concept of normality in relation to possible pathological evolutions and the “monstrosities” of the teratological collections that are often found in 19th-century museums.

In fact, we should not forget that some collections of anatomical preparations have had not only an important role in teaching but also a specific social function: through what Italo Calvino has defined as the “pedagogy of the macabre” (1), showing specific pathological conditions meant to warn the population of the consequences of reprehensible behaviors, which society had to eradicate in favor of a wise and morally accepted conduct. For this reason, as an educational warning, preparations and models were exhibited that represented the effects on the body caused by syphilis, alcoholism, and tuberculosis.

However, the assets preserved in anatomical museums are above all the result of research on the biological history of man, the educational tools, and means for historical-medical dissemination.

The recent scientific museology particularly highlights the importance of specialized anatomical museum collections for teaching and scientific communication, today as then.

In this sense, the cultural assets that derive from the research and study actions of universities, which have been preserved for centuries, cannot be longer considered as simple assets to be conserved, studied, and possibly exhibited, but they assume the value of means of dissemination of scientific culture and specialized teaching at university level, as well as instruments for outreach activities to a wide range of non-specialist audiences.

THE ROLE OF ANATOMICAL MUSEUMS IN HISTORY

Although the study of human anatomy began officially in the 14th century and then more widely in the Renaissance, some physicians had already begun to make anatomical preparations for teaching purposes, preserving them in private scientific cabinets. It was with the Enlightenment, however, that these collections took on value for civil society, thus giving rise to the idea of a museum as a public good.

The foundation of pathological anatomy was fundamental to the anatomical museums birth and evolution. This is the time and the reason why anatomy becomes essential for clinical practice, determining a new and stronger interest in the study of the human body.

Actually, the history of the objects found in these museums has more ancient roots. Indeed, they can be traced back to the Renaissance period, when “the disciplines of the natural sciences based on description and observation (zoology, botany, paleontology, physics for many aspects and, above all, anatomy) had a development directly correlated with the development of representation techniques” (2). And immediately afterwards, in an attempt to give a new impetus to university studies, they became part of a teaching method based on observation and practical demonstration.

Drawings, preparations, and models soon proved to be valid teaching tools, useful for showing and memorizing the details of the body’s structures. And if the preparations show the high professionalism of the technicians employed in the anatomical cabinets and institutes, the drawings and models, that represent the morphology of the bodies, are in substance artistic artifacts (3). After all, “science has always made use of the creativity and the art, which have allowed it to disseminate in a simple, spectacular, and fascinating way a knowledge that is often difficult to construct. In a strategic combination, art and science have aligned themselves over time to produce teaching aids that are in reality (also) very refined artworks, as faithful as possible to the scientific reality” (4). In this way, in the absence of organic material preserved as preparations, students could avail themselves of effective and faithful representations in wax, terracotta, or ceramic models, which replaced cadavers as teaching tools for learning anatomy or were shown as semiophors of the history of diseases in the anatomical-pathological collections.

To testify to the importance of the teaching function of the objects preserved in anatomical museums, we report the statement made by the anatomy professors of the University of Siena in 1882 on the occasion of the award at the X Congress of the Italian Medical Association for having exhibited “several macroscopic preparations referring more especially to the nervous system, and with various other microscopic preparations of embryology”. These preparations fully correspond to the purposes of the School of Anatomy in relation to “the needs of teaching and science” (5). In the collection of the Siennese Anatomical Museum - as can be read in the *Relazione sull’Università di Siena e sugli stabilimenti scientifici* for the academic year 1886-1887 - “every system of the human organism is represented and widely

and also according to age. About a thousand skulls, very many brains; admirable preparations of entire regions with their respective nerve systems and the relationships between the different nerves that take part in them. There are than a microscopic and an embryological collection” (6).

While the teaching and dissemination function of such collections is absolutely accepted for the past, according to several scholars the modern teaching systems, which make extensive use of technology, make the use and in some ways the preservation of anatomical specimens no longer essential for these purposes.

The experiences carried out in many anatomical museums, such as the Gordon Museum of Pathology in London (7), which is certainly a *best practice*, but also some university museums such as the Leonetto Comparini Anatomical Museum which is part of the Sieneze University Museum System, disprove this vision, reaffirming the strong and fundamental educational value of such cultural assets (8-10).

CULTURAL ASSETS AS TEACHING TOOLS IN THE SIENESE ANATOMICAL MUSEUMS

Anatomical museums are repositories of invaluable specimens that shed light on the intricacies of the human body. This has been their primary function for centuries, and it remains a cornerstone of education at the University of Siena.

Anatomical drawings and preparations derived to the practice of dissection for educational purposes. This approach, pioneered by Mondino de' Liuzzi (1275-1326) (11) in the early 14th century, revolutionized the transmission of knowledge within universities. The renewed emphasis on dissection led to the creation of teaching aids that could be utilized during periods when dissection was not possible. Anatomical tables, in particular, were deemed more effective than written texts, allowing individuals across different locations to observe what could otherwise only be seen through dissection. Similarly, preparations and models served as substitutes for direct observation of the cadaver (12).

This article highlights the crucial role of anatomy museums in preserving and disseminating knowledge about the human body. It emphasizes the value of anatomical drawings, preparations, and models as educational tools, both in the past and in the present. These specimens serve as invaluable resources for understanding the human form and its complexities, bridging the gap between theoretical knowledge and direct observation.

The models

Among the many fascinating anatomical specimens housed in the University of Siena's Anatomy Museum, one particularly stands out: a papier-mâché ear model, larger than life-size, dating back to 1877. This remarkable creation is attributed to the French anatomist and naturalist Louis Thomas Jérôme Auzoux (1797-1880), as indicated by the signature on the model itself: “*Auzoux Doct.re fecit anno 1877.*”

The model's brilliance lies in its intricate design, comprising nine meticulously crafted, detachable parts. This feature makes it an exceptional educational tool, allowing students to gain a comprehensive understanding of the human ear's anatomy. By carefully examining each component, they can visualize the intricate structures of the outer, middle, and inner ear, gaining a deeper appreciation for the complexities of this vital sensory organ.

In his search for more durable, affordable, and user-friendly anatomical models alternative to those made in wax, Louis Thomas Jérôme Auzoux (1797-1880) embarked on a revolutionary endeavor in the 1820s. He developed a novel technique, crafting models that were not only less fragile than their wax counterparts but also easily disassembled to reveal the intricate details of the human body.

These innovative models, properly named “anatomies clastiques” (clastic anatomies), drew inspiration from the Greek word “*klastos*” meaning “broken in pieces.” This model has in itself the very characteristic of the definition: the ability to be dismantled, allowing



Figure 1. Thomas Jérôme Auzoux, *Ear Model*, 1877 (Leonetto Comparini Anatomical Museum - University Museum System of Siena).

students to acquire a complete understanding of the anatomical structures represented, from the epidermis to the bones, from the blood vessels to the nerves (13).

Auzoux's ingenious method involved a unique blend of paper pulp, glue, and cork dust, carefully pressed into paper-lined molds. For simpler components, he employed plaster molds coated with layers of colored paper, meticulously soaked in glue. For articulated models, Auzoux devised a specialized paste that, upon drying, transformed into a robust material capable of supporting fasteners, hinges, or even metal frames for larger models.

The ear model, crafted with meticulous attention to detail, showcases the versatility of Auzoux's modeling techniques. Its larger components are meticulously constructed using the traditional papier-mâché method, involving layers of paper pulp carefully pressed into molds (13). This technique lends the model its durability and lifelike appearance.

For the finer details, Auzoux employed a range of materials, each selected for its unique properties and ability to accurately represent the intricate structures of the ear. The facial cranial nerve, a critical component of the auditory system, is crafted from a combination of wood and plaster, ensuring its sturdiness and intricate details. The tympanic membrane, the delicate barrier separating the outer and middle ear, is meticulously recreated using a double layer of gelatinous material. Its translucent quality mimics the membrane's delicate nature, allowing students to visualize its role in sound transmission. The larger arteries, essential for transporting blood to and from the ear, are constructed using a unique technique. Straw cords are carefully wound around a central metal core, providing a sturdy foundation. This structure is then coated with a layer of paper, creating a realistic representation of the arteries' appearance and texture. Each element is carefully chosen and meticulously crafted to ensure an accurate and visually appealing representation of the ear's anatomy.

This innovative approach revolutionized anatomical modeling, offering a multitude of advantages over traditional wax models. The "anatomies plastiques" were not only more durable and economical but also far more versatile, allowing for a deeper exploration of the human body's sophisticated structures.

In 2018, Auzoux's exquisite ear model embarked on a meticulous restoration, guided by the skilled hands of experienced conservators. The model, having endured years of careful study and admiration, bore the marks of time: a layer of grime obscuring its original vibrant hues. With utmost care, the conservators undertook their task, meticulously cleaning each component, gently removing the accumulated dust that had dimmed

the model's splendor. Their attention to detail ensured that the original painted surfaces remained intact, preserving the integrity of Auzoux's art. Once the cleansing process was complete, the conservators turned their focus to reinforcing the areas that had suffered from the passage of time. They carefully consolidated areas where the paint film had lifted, stabilizing these delicate structures and preventing further damage. Additionally, they addressed areas exhibiting surface craquelure, fine cracks that threatened to ruin the model's beauty. With the structural integrity restored, the conservators embarked on the final phase of the restoration: the retouching process. They employed the delicate technique of watercolor pointillism, meticulously applying tiny dots of color to match the original colors. This approach allowed them to subtly blend the retouched areas with the remaining original paint, ensuring that the model's authenticity remained intact.

The meticulous restoration of Auzoux's ear model extended beyond aesthetic considerations, addressing the fundamental need to preserve a cultural treasure while ensuring its continued use for educational purposes. With extreme care, the model has been reintroduced into the ambit of teaching, serving as an invaluable tool in the Otorhinolaryngology specialization school, in addition to captivating audiences at various public events.

This remarkable restoration exemplifies the delicate balance between safeguarding cultural heritage and ensuring its relevance in the present day. The ear model, once again a testament to Auzoux's artistry and the conservators' expertise, stands ready to inspire and educate future generations of medical professionals and the general public alike.

Also produced by Auzoux, deriving from the collections of what was once called Physiological Anatomy, a model of eye in painted papier-mâché, jute, metal and glass, is preserved in the Museum of Medical Instrumentation, other reality of the Museum System of the University of Siena (Figure 2).

In the same Museum, nine educational obstetric pottery testify to the important attempt made in Siena, in the second half of the 18th century, to offer basic education to women who were or would have been midwives. These pieces, commissioned by Jacopo Bartolommei (1708-1782), the master of parts and lecturer of Obstetrics at the University of Siena, based on the model of those made in Bologna by Giovanni Antonio Galli (1708-1782). Originally the models were 40, of which 8 were life-size, 19 "half the natural size", four of about a quarter (8). They illustrate the various presentations and fetal situations, both from the physiological and pathological point of view (14). Skilfully restored, they are still

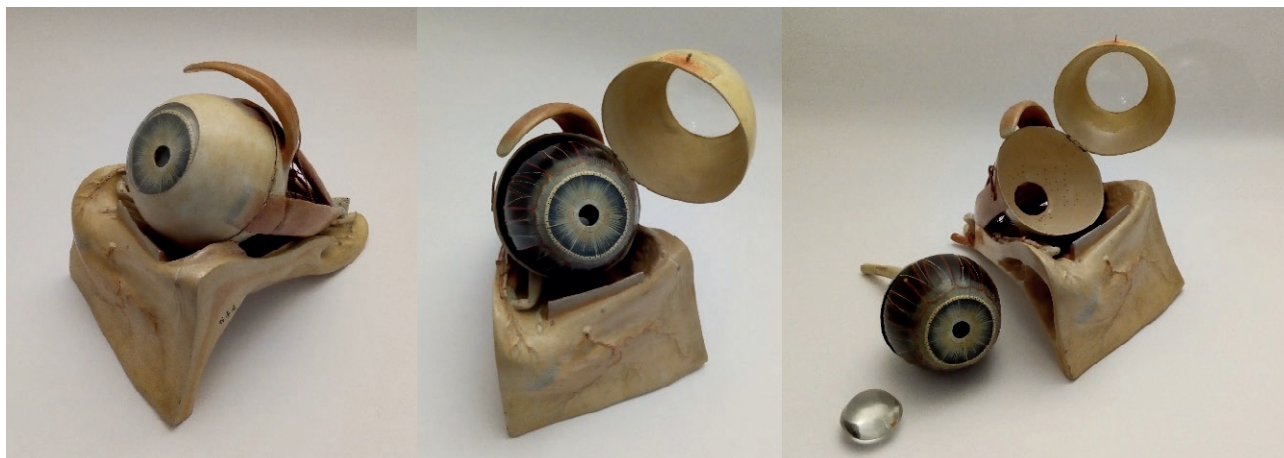


Figure 2 a, b, c. Thomas Jérôme Auzoux, *Model of eye*, second half of 19th century (Museum of Medical Instrumentation, at the Museum System of the University of Siena).



Figure 3. Educational obstetric pottery, second half of the 18th century (Museum of Medical Instrumentation, at the Museum System of the University of Siena).

used today to explain the history of birth and the evolution of obstetric practice in internships dedicated to medical students (Figure 3).

The anatomical drawings

The contribution of anatomical tables to the teaching of anatomy is still considered fundamental. Every student joins the study on the book to the vision of the tables on the anatomical atlas. It was in Siena that the revolutionary idea of an anatomical atlas with life-size figures was born. The scholar who had this idea and realized it was Paolo Mascagni (1755-1815) (15).

In his work entitled *Anatomia universa* (16-19) extraordinary in conception and commitment, Mascagni

create detailed anatomical tables reproducing the human body in real size, and in extremely detailed way. A universe of vessels, muscles, bones, organs, whole and dissected dedicated to medical students. The attention to the real proportions testifies how much Mascagni distanced himself from the scholars who had preceded him, while knowing and respecting their work (16-19).

The *Anatomia Universa* by Paolo Mascagni is still today, 200 years after its publication, a perennial proof of his ability as a scholar and teacher and his desire to contribute to the formation of a new medical class.

Next to the tables of *Anatomia Universa*, now exhibited in the Natural History Museum of the Accademia dei Fisiocritici of Siena, the University preserves and makes available to students and visitors of the Ana-

tomical Museum the superb tables of the *Vasorum lymphaticorum historia et ichnographia* (20), published by Mascagni in 1787. For the first time in the history of Medicine lymphatic system are described and presented in special drawings.

In addition of Mascagni's works, teatrise by another great scholar of anatomy, Antonio Scarpa (1752-1832), and about 600 more modern anatomical tables, some of the late nineteenth and other twentieth century are conserved in the Museum of Siena. Made on commission of teachers by designers and technicians who over the centuries have assisted the anatomy professor during dissections and lectures, represent a valuable collection of drawings, watercolors and lithographs that faithfully reproduce the apparatuses of the human body and that are still fundamental for teaching.

The anatomical preparations

The last category of didactic tools for the study of anatomy, which more than others suffers from the close relationship with dissection, is that of anatomical preparations. Absolutely preferred by students and those who want study of the human body, they offer a three-dimensional vision of the organ or section of the body that they represent.

In this case, the skill and professionalism of the preparators were extraordinary in creating specimens that can withstand the test of time, using various methods such as drying or formalin preservation.

The intricate craftsmanship and enduring value of anatomical specimens make them irreplaceable treasures in the realm of medical history and education. However, their preservation and restoration pose a complex challenge for museums, demanding a delicate balance between safeguarding these artifacts and ensuring their accessibility to the public. Open dialogue and informed decision-making are crucial to develop strategies that respect the historical significance of these specimens while upholding ethical considerations.

The exhibition of *human remains* demands a heightened level of sensitivity and ethical consideration. The emotional impact on visitors must be carefully weighed and addressed in the design of any display, whether temporary or permanent. Clear communication of the exhibition's purpose is paramount to ensure a respectful and meaningful experience for all.

The work of Gunther von Hagens (21, 22), the inventor of plastination (23, 24), has sparked intense debate in recent years. His exhibitions, showcasing meticulously preserved human bodies, have been lauded by some as innovative approaches to evidence-based teaching while

simultaneously criticized by others as commercial spectacles that disregard the sanctity of the bodies displayed.

Also Damien Hirst's artworks, particularly his iconic series of animals suspended in formaldehyde, have garnered both acclaim and controversy. The stark juxtaposition of life and death, the preservation of once-living creatures in a sterile medium, has been interpreted as a profound commentary on mortality, challenging viewers to confront their own fears and perceptions of death (25).

In addition, Bill Viola's video installations (26), often featuring slow-motion sequences of human bodies in water or other immersive environments, have captivated audiences with their ethereal beauty and profound exploration of human existence. Viola's work delves into themes of birth, death, transformation, and the spiritual realm, inviting viewers to contemplate the ephemeral nature of life and the possibility of transcendence.

Anatomical museums, in showcasing their collections of anatomical specimens composed of *human remains*, must be acutely aware that they are handling "culturally sensitive materials" according to ICOM's ethical guidelines (27). This necessitates a thorough and nuanced approach to ethical considerations in the display and interpretation of these specimens.

With the aforementioned ethical considerations firmly in mind, it is important to recognize that anatomical specimens, due to the transformative effects of time and human intervention, no longer fall under the legal definition of cadavers and do not evoke the same sentiments of piety towards the deceased. Nonetheless, these specimens retain their fundamental importance in anatomical education (28).

The Anatomical Museum of the University of Siena preserves and exhibits many preparations. Of particular interest are some preserved in formalin: in ancient glass containers are present fetuses at different stages of maturation, sometimes accompanied by placenta and amniotic sac and various organs including hearts, lungs and encephalia. Interesting a preparation of spinal cord wrapped by the meninges with the emergence of spinal nerves that in the last stretch gather to form the so-called "cauda equina".

Particularly rich is the collection of dried preparations, obtained by injection of sclerosing substances, subsequent staining and sometimes insufflation: these are mainly segments of upper and lower limbs, organs of the digestive, respiratory, cardiocirculatory and urogenital systems (Figure 4).

A peculiarity of the Museum are the craniological collections, prepared directly in the Institute of Normal Human Anatomy. Of the skulls that make up these collections some appear selected on the basis of the theory



Figure 4. Arteries of the stomach, preparation, second half of the nineteenth century (Leonetto Comparini Anatomical Museum - University Museum System of Siena).

of the “criminal by birth” of Cesare Lombroso (1835-1909), others come from the former psychiatric hospital of Siena. Of great interest is an osteological collection of over 300 skulls of fetuses and newborns dating back to the nineteenth century.

The skulls from the San Niccolò Mental Hospital of Siena are recorded in a Register, kept in the Museum, started in December 1862 by Carlo Livi (1823-1877) who was director of the psychiatric facility from 1858 to 1873 (29). The collection started from a pre-existing nucleus of eight skulls or parts of them, coming from the anatomical collections of the University of Siena.

The craniological collection preserved today at the Anatomical Museum is definitely linked to a research project resulting from an idea presented by Livi and other psychiatrists on September 28, 1862 in Modena at the tenth Congress of Italian Scientists. In this context it was proposed to promulgate a law on mental hospital and to extend the study of psychiatry. Thus, this collection of skulls is part of the Livi’s project: to study the bone and endocranial pathologies of the patients of the mental hospital, with the aim of confronting in a new and experimental way with mental pathology. The

recording of the skulls was carried out by Livi’s students and in particular by Paolo Funaioli (1848-1911) who, starting from 1881, recovered the Register attempting to fully understand the mechanisms of anatomy-pathological and physiological underlying mental pathology. A total of 284 skulls (174 belonging to males, 110 to females) were recorded in the Register.

The collection of the Register is configured for Livi and Funaioli as a tool for studying and enriching psycho-pathological, neurological and anatomo-pathological studies, to meet the needs of new knowledge useful to really affect the care of patients admitted, and therefore on their living conditions.

The Register collection, designed for Livi and Funaioli, serves as a vital tool for research and advancement in the fields of psychopathology, neurology, and anatomo-pathology. The aim is to leverage new knowledge gleaned from these studies to directly improve patient care for those admitted to the facility. Ultimately, this translates to a positive impact on their quality of life.

CONCLUSIONS

The importance of the collections in the museums of anatomy in the teaching of anatomy is evident. Methods and technologies have evolved over the centuries, but the study and understanding of anatomy is always based on direct observation of the human body mediated by tools such as drawings, preparations and models.

Anatomical museums, with their treasure troves of preserved specimens, are not merely repositories of the past; they are dynamic hubs that can rekindle interest in the study of anatomy. By delving into the historical context of these specimens, exploring the technical and practical knowledge behind their preparation, and utilizing them for educational purposes alongside modern technological tools, these museums can transcend the boundaries of specialized knowledge and engage a broader audience.

Anatomical museums are not merely static repositories of the past; they are also dynamic hubs of scientific exploration. The advent of new research methodologies, coupled with the wealth of information contained within these collections, allows researchers to delve deeper into the mysteries of the human body, uncovering hidden secrets and advancing our knowledge of anatomy and physiology.

Despite some criticisms, through innovative exhibitions, interactive displays, and engaging educational programs, these museums are making the wonders of the human body accessible to a wider public, turning

on a sense of curiosity and appreciation for the intricate workings of our anatomy.

The result is the need for a reflection from a museological point of view on the exhibition of anatomical collections and on the musealization of new finds: these collections must increasingly be proposed as active tools of communication and teaching, health education and research on the biological history of man, taking into account also the new sensitivity of the public towards human remains that are a fundamental part of the museums of anatomy.

Finally, anatomical museums with their rich collections, educational potential, and capacity for scientific discovery, play a vital role in the future of anatomy. They serve as bridges between past, present, and future, connecting us to our anatomical heritage while illuminating the path forward in our quest to understand the intricacies of the human body.

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