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## A Collaborative Color Laboratory: Using 3D Modelling, Texturization, and AR to Challenge White Supremacist Uses of Ancient Classical Sculptures

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### Abstract

Polychromy in ancient classical sculptures is a historical fact. However, for centuries, archeologists and museum curators have scrubbed away traces of color before their public display. Most do not reference the rich pigments that used to cover their surfaces, nor how they reflected the colorful variety of the ancient world. This omission has led to the incorrect idea of a Greco-Roman predilection for pure whiteness—and to the equation of white marble with beauty—with a tendency toward chromophobia, that may even verge into a system of chromoeugenics (Calvo-Quirós, 2013). Currently, white supremacist groups are using the purported aesthetics of classical white refinement for propaganda. The consequences of this use run deep, and an international rise in neo-fascism, entangled with a fear of difference, requires a re-examination of cultural heritage's connection to identity formation. In line with the idea that physical engagement and supporting the social setting are principles that interaction designers should consider (Petrelli et al., 2016), interactive technologies afford new opportunities to curbe classical sculpture's misuse.

This paper discusses the power of color in ancient sculptural polychromy and new models of civic education that tap into the power of new technological paradigms. The paper investigates lessons afforded by the humanities, with a focus on the meaning and power of interpretative processes of cultural artifacts, including the view of objects as social and affective-inducing beings and the power of the ludic in interaction design. This paper then presents ColorColab, a potential critical thinking tool, consisting of an online app and an Augmented Reality (AR) device. ColorColab—a collaborative lab on color—would allow users to look at ancient classical sculptures in their original or imagined colors, by inviting them to choose and create visualizations, customizable with the colors of their own skin, body, clothes, and surroundings. It would be multi-accessible, for users that can't visit the sculptures in person. ColorColab would function as a tool for museums, teachers, and public officials interested in using technology for historical education about past and modern diversity through informal education. The goal of the tool would be to develop the senses and awareness of its users, a process which pre-supposes change and transformation (Desvallées & Mairesse, 2010). Initial explorations about the technical development of such a tool are presented, and further directions are discussed.

### Ancient Polychromy

From the Archaic Classical period all the way to Hellenism, ancient classical art was polychromous. The Greek and Roman statues of antiquity—still popularly perceived in the collective consciousness as pure in their whiteness—were never meant to be white. Rather, they were painted, often blazingly and in great detail, with a variety of pigments. They were, in fact, sensuously animated by color. The fact of ancient sculptural polychromy has been proven beyond doubt. The evidence for ancient polychromy is copious and multifaceted—including a variety of pigments that have remained in sculptures' surfaces (Brinkmann et al, 2010; Hedegaard et al, 2019), mentions in ancient writings (Primavesi, 2007), as well as a variety of artifacts depicting artists painting statues (Marconi 2011) [see Figure 1].



Figure 1. Left: Artist painting a statue of Herakles. Terracotta column-krater ca. 360–350 B.C. Right: An artist at work, with likely a brush in his right hand. Roman Carnelian ring stone ca. 1st–3rd century A.D. Metropolitan Museum of Art.

The modern study of polychromy can be linked back to the earliest excavations of Mount Vesuvius in the Gulf of Naples in Italy, where in AD 79 the eruption buried the luxurious residential neighborhoods surrounding the volcano. The 1748 excavations yielded dozens of figures with unignorable remnants of bright color, which were placed in the royal private collections of the Bourbon king of Naples. Johann Joachim Winckelmann (1717–1768)—

founder of the discipline of Classical archaeology and champion of the Neoclassical vision of the “pure white” classical aesthetic—was among the earliest viewers of the collections. From the early 1800s on, when the first departments of art history and archaeology at European universities started to emerge, discoveries of traces of polychromy continued to appear and be published. By 1886, Ludvig Peter Fenger’s reconstruction of the polychromy of Augustus of Prima Porta had been published (Fenger 1886) [see Figure 2]. Ancient written sources were also studied in their frequent mentions of sculptural polychromy, and were first reviewed by Quatremère de Quincy (1815) and Winckelmann (1880).

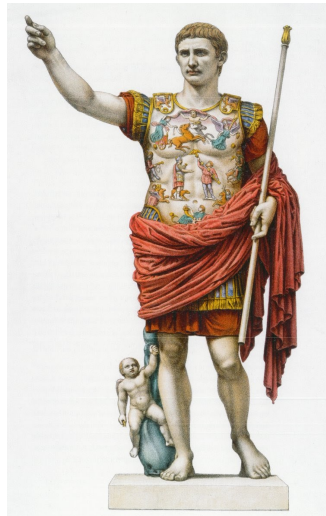


Figure 2. Left: Augustus of Prima Porta, currently displayed in the Braccio Nuovo (New Arm) of the Vatican Museums. Photo: Governorate of Vatican City State – Directorate of the Museums and Cultural Heritage. Right: Reconstruction by Ludvig Peter Fenger (Danish, 1833–1905) of the polychromy of Augustus of Prima Porta. Published in Fenger 1886.

Throughout the nineteenth century, enthusiasts of the study and exposure of ancient polychromy to the public included architect Jacques Ignace Hittorff (French, b. Germany, 1792–1867), archeologist and dynamic museum director Georg Treu (German, b. Russia, 1943–1921) and curator and art authority Edward Robinson (American, 1858–1931). Under Robinson, an exhibition on the polychromy of ancient classical sculpture was presented to an astonished public in Boston and Chicago (1891–1892).

By the mid-1960s, the first scientific studies of bright colors left on original sculptures had begun. Eva-Maria Sczako and Christian Wolters at the Doerner Institut of the Staatsgemäldesammlungen in Munich optimized UV photography to capture past traces of polychromy in sculpture. With the aid of multi spectral photographic analysis, German classical archaeologist Volkmar von Graeve and Christof Wolters at the Goethe Universität in Frankfurt started examining multiple originals, including the famous Alexander Sarcophagus (Brinkmann et al. 2017, 20). Perhaps the most high-profile archaeologists and educators currently working on ancient polychromy, Vinzenz Brinkmann and Ulrike Koch-Brinkmann, are former students of von Graeve. They have, for decades, painstakingly examined classical works in search of traces of color at the great museums and collections of the West. They have worked at the Liebieghaus Sculpture Collection, Frankfurt, and have investigated pigments in antiquities in the collection of the Fine Arts Museums of San Francisco. Their research has established a new material basis (and expanded) our knowledge of ancient classical sculptural polychromy.

Nowadays, a variety of research projects surrounding ancient polychromy exist. The research is multidisciplinary by definition, as it now requires the examination of ancient artworks with new methods of digital imaging, microscopy and non-destructive materials analysis. Thus, it combines art history, archaeology, philology, conservation science, geology, geochemistry, chemistry, and physics. Multiple national and international organizations are dedicated to the study of color in Ancient Mediterranean art and architecture, including the Ancient Polychromy Network (APN) at the

University of Georgia and Tracking Colour: Polychromy of the Ancient World at the Ny Carlsberg Glyptotek. A crucial figure in the study of ancient polychromy is Jan Stubbe Østergaard and the Copenhagen Polychromy Network, whom systematically research and publish color reconstructions of the antiquities in the collections of the Ny Carlsberg Glyptotek (Østergaard 2012, Hedegaard et al. 2019).

## The Meaning and Function of Polychromy

The use of polychromy on ancient sculptures was not a simple, decorative act. Rather, as documented in Brinkmann et al.'s *Gods in Color: Polychromy in the Ancient World* (2017), the practice was a crucial aspect of the artistry behind ancient sculpture, to fulfill the greater purposes of creating sculptural art in the first place:

The Greeks and later the Romans did not simply paint their sculptures; rather, their use of color expanded the formal and narrative structure of the work of art. [...] the initial, pure form—as carved from stone or cast in metal—comprised just a first step in the production of an ancient sculpture. **It was only through the application of color that the artist achieved the desired vitality of his subject.** Ancient written sources leave no doubt that representations of life and fiction (myth) fashioned from inanimate material were intended to make the viewer marvel at (*thaumazein*) its potential for imitating reality (mimesis). (27, emphasis mine)

Sculptures were designed with color in mind, as color imbued the ancient sculptures with two main characteristics: legibility and vitality. By connecting form and content, color in ancient sculptures greatly increased the legibility of a figure (Brinkmann et al. 2017, 27-29). Color made it possible for the artist to communicate features and relationships that couldn't be conveyed through the three-dimensionality of the piece, such as boundaries of single figures or elements. For example, color was used to help clarify volumes of overlapping figures, and emphasize individual elements, such as different strands of hair. Further, color produced elements that are not visible without paint, such as pupils with irises, eyebrows, pubic hair, or decorative borders in dyed fabrics. As such, color helped clarify and imbue sculptures with content that could not be conveyed sculpturally. Perhaps more importantly, color imbued the sculptures with life-like vitality. As Bradley notes, color provided the finish that bridged the gap between art and reality and produced from sculptures “living images” on the ambiguous line between the real and the imaginary (2009, 440). By evoking reality, color imbued the figures with a mimetic force that was an intrinsic concern in the production of classical art. As early as the Archaic period, through the Classical and Hellenistic periods, the notion that a master sculptor could bring their subject literally to life was a familiar motif in the classical imagination. The goal to bring their artworks to life is captured by the long list of Greco-Roman stories of sculptures that seemed completely alive to viewers (Brinkmann et al. 2017, 209; Bradley 2009, 446).

The kind of vitality that artists sought to imbue their sculptures with was a sensuous, life-like one. A good example of expressiveness channeled through color is the scientific reconstruction of a kouros, a Greek sculpture of the archaic period that depicted a naked youth. As reconstructed by the Gods in Color team, the figure becomes sensuous through details that become visible only on the painted surface: including lavishly arched eyebrows, elegantly stylized pubic hair, and ornamented nipples [see Figure 3].

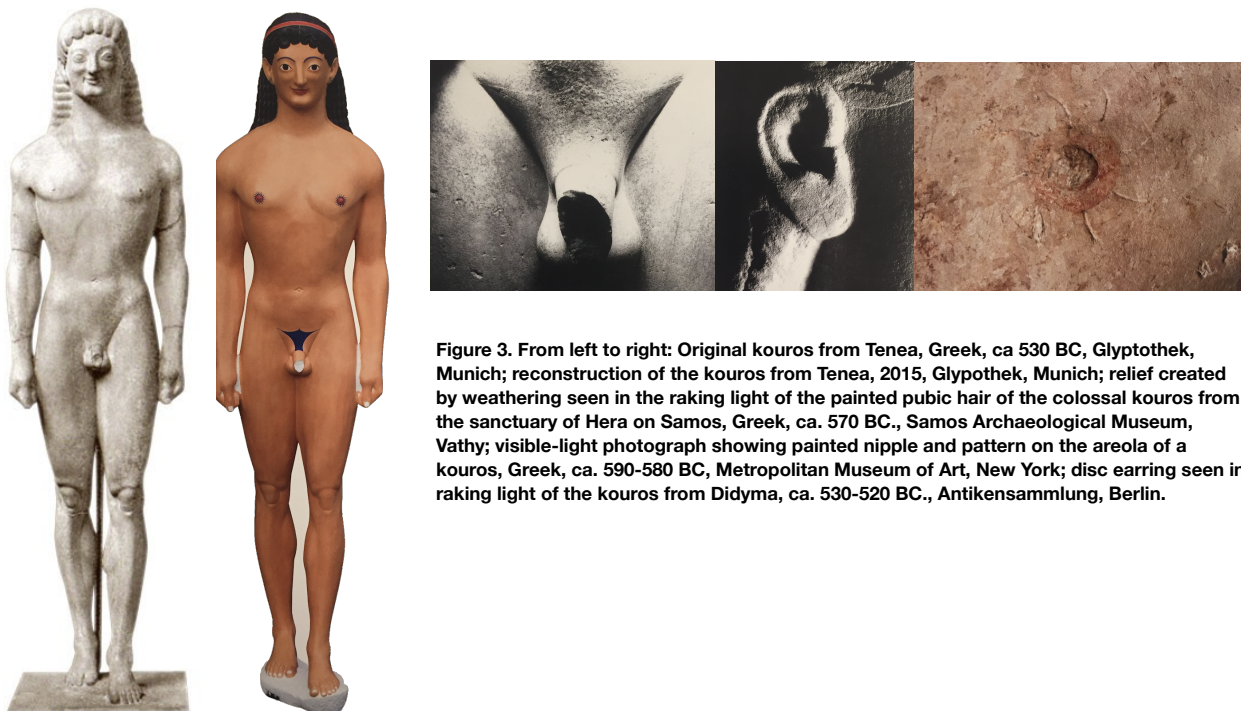


Figure 3. From left to right: Original kouros from Tenea, Greek, ca. 530 BC, Glyptothek, Munich; reconstruction of the kouros from Tenea, 2015, Glyptothek, Munich; relief created by weathering seen in the raking light of the painted pubic hair of the colossal kouros from the sanctuary of Hera on Samos, Greek, ca. 570 BC., Samos Archaeological Museum, Vathy; visible-light photograph showing painted nipple and pattern on the areola of a kouros, Greek, ca. 590-580 BC, Metropolitan Museum of Art, New York; disc earring seen in raking light of the kouros from Didyma, ca. 530-520 BC., Antikensammlung, Berlin.

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The use of color paint on classical sculptures included the use of pigments for coloring skin. And in some sculptures, the painted and treated skin color made the sculpture more naturalistic than any other element. For example, in the sculpture of Phrasikleia, the glossy paint of her skin is mixed from red Cypriot ochre, bright umber, and white lead; the white lead would have been compressed into a silky gloss like the one found in Egyptian mummy masks from the Middle and New Kingdom and the Late Period (Brinkmann et al. 2017, 34-35). Including color in historical contextualization or representations of ancient figures is powerful, as ancient sculptures in their polychromy reflected the variety of color in the society that created them. The varied palette of classical society included the skin color of people, with in fact, much of the Roman élite coming from diverse-looking stock—such as Berber, Arab, Transylvanian, Danubian, Spanish.

## Chromophobia and White Supremacy

*...Savage nations, uneducated people, and children have a great predilection for vivid colors.*  
Goethe, J. W. *Theory of Colors*, London, 1840.

The classical paradigm adopted by Renaissance and Neoclassical artists drew upon the “lost” colors of the ancient works, and prompted the idea that ancient statues were originally white. This purely white marble paradigm continued strongly until the late eighteenth century, when the earliest (1748) excavations of Mount Vesuvius took place. While historically cited as the logical propeller of the pure white classical idea, the natural fading of color produced dulled shades of the original hues, not stark-white surfaces, so some scholars have argued that the project lightening and whitening started as soon as the excavations did, with mounting expertise. This expertise included scrubbing away surface impurities, discrediting textual evidence of painted marble, and producing replica study casts using white plaster (McClintock 1995).

From the start, the emerging evidence of polychromy was met with scholarly resistance. One of the first to have access to the excavated objects from Mt. Vesuvius was Johann Joachim Winckelmann (1717-1768)—champion and father of the Neoclassical vision of the “pure white” classical aesthetic. Winckelmann knew and discussed ancient polychromy, as he personally handled the excavated objects and was familiar with the written evidence, even citing a well-known passage from Plato in which a passing reference is made to painting statues. Yet it was Winckelmann that established the idea that color was irrelevant when contemplating the beauty of ancient classical sculpture. *In Die Geschichte der Kunst des Altertums unter den Griechen* (The History of Ancient Art Among the Greeks), Winckelmann was interested in determining the most effective colors for embodying and displaying beauty. Winckelmann believed that color ought to be dismissed, as it was a distraction from the technical mastery of sculpture, which should instead be focused on spatial form. He argued that white was the most effective color for an appreciation of beauty, as it was a canvas that did not distract the viewer from form.

As argued by Jennifer Stager, the monochrome became a distancing and protective tool. The monochrome began its function as an insulator for the beholder both from sensuality and from seeing race. As thoroughly discussed by David Batchelor in his 2000 book *Chromophobia*, it is the plurality imbued by color that made (and still makes) it an internal threat to a “higher”, unified aesthetic system. When it comes to the unbearability of color related to ancient polychromy, “it is plurality itself that is feared, for it undermines white exceptionalism” (Stager 2018).

The steadfast neoclassical desire to define one standard of beauty—with whiteness as its center—can be situated within the historical forces of the eighteenth century. In his analysis of the neoclassical connections between Winckelmann, Goethe, Hegel and white beauty, Purdy analyzes Johann Wolfgang von Goethe’s (1749-1832) interpretation of Winckelmann’s work as a “discovery” of ancient classical art, and comparison to Columbus’ “discovery” of the Americas,

as the artifacts from Greece and the travel reports from the Americas presented a stark alternative to the cultural norms of early modern Europe. [...] Both discoveries placed Europe within a new cultural geography. On the one hand stood the living cultures of the Americas (threatened with conversion and extinction), on the other, a long-dead civilization sprung to life through Winckelmann’s aesthetic perception. (Purdy 2004, 85)

Color as bodily adornment became a universally transferable sign of backwardness and bad taste (Purdy 2004, 94). For Goethe, the use and admiration of “chaotic” colors indicated impulsiveness and lack of self command. It was only “men in a state of nature, uncivilized nations, and children” the ones who “have a great fondness for colours in their utmost brightness” (Goethe 1840, 327). But Goethe was not the only high-profile person to show just how much the West disdains its own relationship to color. Charles Blanc, the French Minister of Culture, expressed the



shared sentiment in 1848, arguing that "...colour is the peculiar characteristic of the lower forms of nature, while drawing becomes the medium of expression, more and more dominant, the higher we rise in the scale of being" (Blanch 1867). As the absence of artificial body decorations was correlated with the advancement of civilization, as the nineteenth century progressed, claims of cultural superiority became increasingly correlated to the absence of color. According to Purdy, "the absence of coloring was one of the features that separated the naked Greek warrior from the painted American savage, and thereby became a means for modern Europeans to redeploy the distinction between civilization and barbarians" (2004, 87).

These ideas heavily influenced European self-consciousness even within scholarly circles. By the nineteenth century, the white aesthetic had already become so ingrained in European consciousness that even among archaeologists that took the evidence for ancient polychromy earnestly, there was serious debate about the extent to which classical art was painted. For example, influential German architect Gottfried Semper (1803-1879) and German art historian and politician Franz Kugler (1808-1858) held views on opposite extremes. Semper thought all buildings and statues without exception were entirely covered with paint, so that the origin costly materials were not seen at all. On the other hand, Kugler saw Semper's view as exaggerated, and his alternative account was limited to two colors--red and blue--plus gliding. Kugler's model was not based on independent research, and rather reflected his notions of taste, which catered to the artistic preferences of his contemporaries. Recent studies confirm Semper's "total polychromy" view particularly with respect to the marble sculpture of all Greek antiquity, with even all white elements (like the white of the eyes) colored with white pigment (Brinkmann et al. 2017, 16).

The comparative light in which white beauty was defined--against an othered, colored plurality-- still holds today. As Dyer has noted, this oppositional position has migrated into the understanding of whiteness itself, a unique feature in the study of "race:" it is "as if only non-whiteness can give whiteness any substance. The reverse is not the case--studies of images of blacks, Native Americans, Jews, and other ethnic minorities do not need the comparative element that seems at this stage indispensable for the study of whites" (Dyer, 460).

It is thus not surprising that the (mis)understanding and (mis)use of classical sculptures based on their purported monochromy has not ceased. And it is not news that the modern "alt-right" loves the classics: in *Not All Dead White Men* (2018), Donna Zuckerberg shows that sections of the alt-Right, who see themselves as heirs to a purported European warrior masculinity, have promoted an agenda of the Greeks as paragons of whiteness. Currently, in the global north the idea and purported aesthetics of a Greco-Roman white refinement have been used for a search of identity, including by some white supremacist and fascist groups.

One of these groups is Identity Evropa. Based in the United States, Identity Evropa is a neo-nazi, alt-right group that is based in the United States, that has looked to antiquity as a way to legitimize their belief in white supremacy. It specifically builds name recognition by distributing flyers around college campuses printed with images of classical European statues and phrases like "Our Future Belongs to Us" and "Keep Your Diversity We Want Identity." Although now "retired" because of its facing a lawsuit related to their role in the deadly 2017 Charlottesville, Virginia, "Unite the Right" rally, its images continue to circulate internet forums and college campuses [see Figure 4].



Figure 4. Collection of Identity Evropa memes and images taken from various alt-right fora, these posters popped up on college campuses throughout 2017 and 2018.

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Today, even with cost-effective ways for museums to correctly educate their public (the easiest, and cheapest way of saying more about it in their labelling), this resistance persists in the minds of museum professionals and art historians (Combs 2012). Combs documents this resistance as present even in revered museums like the Metropolitan Museum of Art in New York, and the Museum of Fine Arts in Boston. For example, the Metropolitan Museum, with an extensive collection of Greek and Roman sculpture spans almost 800 years, provides no mention of polychromy in the two key sculpture galleries that contain the highlights, not even in the accompanying audio guide or gallery talks (Combs 2012, 37). Both museums create the dilemma that many visitors falsely associate ancient Greece and Rome with white marble. Combs finds that, by perpetuating an aesthetic established in the Renaissance without pursuing the issue of polychromy, many revered museums are at odds with their mission statements by negating an important aspect of history.

But the absence of the color aspect of ancient classical art pervades more than museums, and therefore needs more responses. University curricula also mostly omits it; for example, Germany's most widely distributed textbook on classical archaeology does not deal with the subject at all (Brinkmann et al 2017, 25). Even in the most innovative contemporary format of representation, online games, false constructions of the ancient past are used, with white monochrome statues filling the screen rather than the more accurate polychrome statues, thereby perpetuating a (mis)historical paradigm of beauty. The fact that more accurate depictions of Greek statues look odd and cartoonish to us compared to their whitewashed representations proves the power and influence of Western epistemology, as incredibly pervasive and ingrained (Kim 2019, 186-187).

Since 2017, when the conversation surrounding ancient polychromy became more mainstream, more violence has ensued. Between April of 2017 and November of 2018, a sleuth of articles appeared in major newspapers 'revealing' classical polychromy to the general public, both in print and electronic form. Two of them, in *Hyperallergic* and *Forbes*, were written by professor of Classics Sarah Bond: *Why We Need to Start Seeing the Classical World in Color*, and *Whitewashing Ancient Statues: Whiteness, Racism And Color In The Ancient World*. As the pieces were picked up by some conservative and far-right websites, Bond was met with threats of violence, calls for her termination, heckling, and harassment, including anti-Semitic references (Flaherty 2017). Bond, who understood that the subject of polychromy could cause a stir within the field, commented: "the hatred and invective I received from this post was more than anything I have ever received to date" (Bond 2017). Also in 2017, the well-known, and highly respected Cambridge classicist Mary Beard became the target of violent trolling and uninformed criticism, as she defended a BBC's children's cartoon that depicted a dark-skinned Roman father. The cartoon caused a commotion about diversity in the Roman Empire, with an uproar and intense debate about skin color in Roman Britannia (Zhang 2017).

## Lessons from the Humanities: Cultural Artifacts as Social Beings

Cultural heritage is about objects, traditions, and people—and how the relationships between them are active, fluid, and socially bound. To develop successful civic education projects surrounding cultural objects, it is necessary to understand such relationships. The humanities— with interpretation of cultural objects as one of its core functions— have much to offer in this endeavor.

From the moment of their creation, ancient classical sculptures have had the ability to engage viewers affectively. This capacity of the sculptures, as objects, to engage with multiple dimensions of human beings has been investigated in various disciplines. In his anthropological theory of distributed agency, for example, Alfred Gell (1998) sees the relationship between objects and subjects as interactive and imbued in a network of material and social exchanges. Arguing that systems of knowledge and social relationships are determined more by circulation than by production of goods, Gell sees objects as instrumental, produced in order to influence the thoughts and actions of others. He sees objects as agents given their ability to produce effects such as happiness, fear, anger, or lust (Hoskins 2006).

Nowadays, colored replicas of the sculptures also raise emotional reactions on their viewers too, often by delivering a shock (see Chapter 3). Art historian Max Hollein, currently director of the Metropolitan Museum of Art, reflects on the element of shock that the *Gods in Color* exhibition created for some viewers, in the foreword to the exhibition catalogue: "Ancient classical art was originally animated by the application of vibrant pigments, and the notion of an unpainted sculpture might have been as surprising for a person living at that time as the bright colors on the reconstructions in this exhibition might seem to us today" (Brinkmann et al. 2017, 6). Rose-Greenland (2006) believes that the emotional aspect of this tension, "the sense of losing or gaining control over a cherished mental

image of a fetishized historical period,” merits further development, empirically and theoretically (99). The fact that these sculptures have since the beginning and all throughout their social lives raised emotions ability to raise emotion in viewers is clear, and can be exploited in the service of public and civic education.

How can emotional reactions be used for civic education? I argue that part of the answer to this question lies in participatory endeavors that engage people in a surprising, playful manner. Doris Sommer, Director of the Cultural Agents Initiative at Harvard University, has championed cultural agency to promote development through arts and humanities. In “Art and Accountability” (2005), Sommer argues for agency, as a “modest but relentless” call to creative action, she sees agency as enabling artists to “engage the existing social world, instead of discarding it or despairing altogether” (263). In this way, humanists can contribute to other agency by distilling general observations from a variety of particular events and effects, as the pause needed to distill is hardly affordable for others. Participatory culture denotes a culture in which private individuals (the public) do not act as consumers only, but also as contributors or producers. This idea has been used in several civic education projects, based on the understanding that creating a respectful, safe, and involved society is a difficult endeavor in which official avenues—law, fines, police and policy—often don’t work. Increasingly, interactive, participatory experiences inviting people to appropriate events in real time have been successfully used to engage people in emotive discoveries and (re)interpretations.

Furthermore, research on ancient polychromy shows that ancient cities were inhabited with lifelike statues, inviting passersby to tread the blurred line between art and reality. The oscillation between sculpture and living figure, as recounted by Talbot in conversation with archaeologist Mark Abbe, seems to have been incredibly playful. Play, a voluntary and absorptive practice, is ubiquitous in humans--it is not associated with any particular stage of civilization or view of the universe. In *Homo Ludens* (1950), Huizinga approaches play historically, and ascertains how far culture itself bears the character of play. By analyzing the relationship between play and law, war, art, culture, and Western civilization, he finds that play has a semantic value, as in play there is something “at play” which transcends the immediate needs of life and imparts meaning to action. Further, Huizinga finds that play functions as is bounded in space and time, such that it is “played out” within certain limits of time and place, containing its own course and meaning (9). Specifically, Huizinga sees play’s function as an intermezzo from ordinary life in both individual and collective ways:

an interlude in our daily lives.... it adorns life, amplifies it and is to that extent a necessity both for the individual—as a life function—and for society by reason of the meaning it contains, its significance, its expressive value, its spiritual and social association, in short, as a culture function. (9)

Because play invites understanding and knowledge acquisition through a process of intuition as opposed to painful intellect, it can play a crucial part in civil and informal education. Specifically, the ludic can be a weapon against negative values can be used in the case of ancient polychromy education. This is precisely where ludic pursuits--such as video games, coloring books, cartoons, and museum experiences--can step in and begin to shift the visual narrative (Bond 2017). In searching for new education projects for ancient polychromy, we can and should take advantage of the play drive, because it is one of the few things that can change strongly held opinions for education, art and civilization as a whole.

## **ColorColab: The Idea**

### *The Experience*

ColorColab is a proposed interactive art installation surrounding color and multiple ancient sculptures or their copies. The experience would allow users to choose one or various polychromatic visualizations of the sculptures through the use of an online tool or an augmented reality (AR) interface [see Figure 5]. A repertoire of pre-made palettes would be available to choose from, yet the user would also be able to dynamically design their own choice of a palette, including from the colors of their own skin, body, clothes, and surroundings. At the end, the user would be able capture a “screenshot” of their 3-D piece as a digitally shareable souvenir. The project would be multi-accessible: complemented by an online application to have a similar (albeit less tangible) experience remotely, for those that can’t visit the sculptures in person.

### *The Statues*

Color Colab’s initial prototype is being designed around four ancient sculptures found in Il Museo Ostiense inside the Parco Archeologico di Ostia Antica, 15km from Rome. The museum, housed on the ground floor of a building

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dating back to the 15th century, was created in 1865 by the archaeologist Pietro Ercole Visconti to expose the finds that were being discovered in the excavations. Ostia itself served as Rome's principal port and harbour throughout antiquity. The museum has particularly rich collections of Roman portraits, especially of Roman emperors and their wives. This makes it a particularly suited museum to later expand Color Colab to an even greater number of sculptures.



**Figure 5. ColorColab would allow its users to explore colorization of multiple sculptures with a variety of palettes that the user may choose from or create. The experience would thrive in museums which host sculptures, as users could explore their own colorizations on the real statues via AR.**

### *The Palettes*

A repertoire of premade palettes would be available in the lab for users to explore and play with. Some palettes would be based on scholarly archeological research on ancient pigments. A second category of premade palettes would be available based on iconic paintings and art history masterpieces. A third type of available palettes would be based on the top fabric patterns of the year and the most used colors and trends of the modern fashion world. Finally, a database of user-uploaded palettes would be available for any other use to get inspiration from. It would also be possible for the user to dynamically design their own palette, including from the colors of their own skin, body, clothes, and surroundings.

### *User Experience*

All in all, ColorColab is meant to be a highly interactive project. The user would be able to note which statues have a ColorColab stand next to them, and choose the statue of their choice to begin to enjoy their experience and move around how they want. Secondly, they would be able to directly contribute to the color palette database with their own color uploads from their own skin and clothes (as well as input some data they would like other users to know about the colors' origins). Additionally, users could upload their creations to the general database of "colorized" statues.

### *Audience*

ColorColab is being designed for users of all ages. Ease of utilization of the online application as well as the AR interface is a core design principle: the idea is that users will interact with the application in an intuitive way, and that the application will also have helpful notes throughout its design to aid in cases in which the user might be confused. Part of the design principle is that users' knowledge of day-to-day tech (ex., smartphones) offers an opportunity to tap into the power of focus and modes of interaction that they are already comfortable with. The application will be available in Italian and English (to become accessible to a more varied global audience). Depending on user evaluation and data, the project can later be translated into the most common languages of its users. In visitor studies, Eilean Hooper Greenhill identified target groups for museums that may include families, school parties, other organized educational groups, leisure learners, tourists, the elderly, and people with visual, auditory, mobility or learning disabilities (Hooper Greenhill, 1999: 86). ColorColab will work to make the project available, accessible and enjoyable to all these types of users by targeting, attracting, and entertaining these different groups.



## *Design and Narrative Concepts*

ColorColab is a multi-accessible experience—it would be accessible and enjoyable either through a mobile browser from any location, or both through a mobile browser and an AR interface in person at the Museum. ColorColab's digital application is meant to embody the concept of multi-accessibility, bringing users closer to the artifacts regardless of their physical location. Not only would there be a digital application, but the application itself would be responsive, and would thus be accessible from every device with an internet connection.

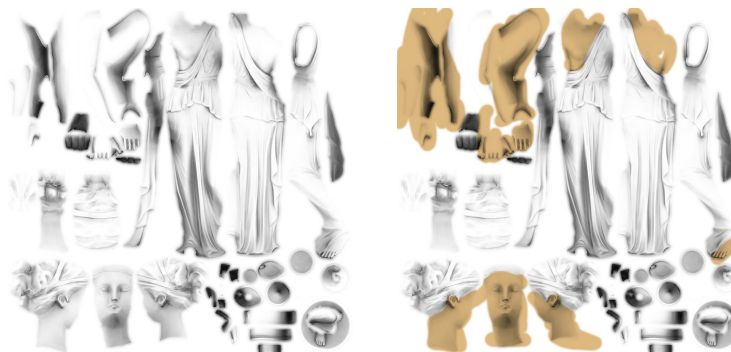
Gibbs and Tschritzis, when coining and giving a definition to the term 'Virtual Museum' (1991) focus on the fact that virtual realities in the cultural heritage tend to serve more as services rather than locations. As a matter of fact, this kind of service would aim to serve as a cultural mediator through the presentation of meaningful, historical data through 3D models, and through inviting users to become co-creators by editing them. In this way, the user has multiple ways to learn thanks to the many tools of different kinds that the virtual environment provides--it can evoke memories, feelings, and even past experiences through the means of an emotional approach.

## *Virtual Museum Categorization*

In 'Designing a taxonomy for virtual museums for the use of AVICOM professionals' (2015), Simona Caraceni sets forward a taxonomy for the categorization of virtual museums. Under it, ColorColab would partly fall under Category 'C': Virtual museum enhancing museum EXHIBITIONS with OPEN INTERACTION in a CLOSED SPACE showing SELECTED OBJECTS from the museum collection, NOT allowing visitor CONTRIBUTIONS. One aspect of Category 'C' definition that makes it a particularly accurate description of ColorColab is its focus on unique gesture-based interaction. Specifically, Caraceni notes that "this virtual museum model includes all exhibitions using onsite gesture based technology or the use of Augmented Reality gesture and device based technology". That is, this type of virtual experience centers around an interaction with the objects and/or information that is gesture based—involving the visitor's body taken as a whole or an action to be taken by visitor. In the case of ColorColab, the AR experience requires the visitor to physically explore the sculptures through the magnifying glass—an action that requires the physical movement and displacement of the visitor's body around the sculpture and throughout the allotted space. Nevertheless, it is crucial to note that this category misclassifies ColorColab in one critical aspect: ColorColab not only allows, but rather encourages visitor contributions. Indeed, ColorColab motivates users to contribute both in the form of content (through the uploading of users' skin and clothes colors, their own palettes, and their finished colorizations) and through comments and notes attached to that content.

## **ColorColab: Technical Experiments**

The most basic needed data underlying the ColorColab is be a series of image-based 3d models of sculptures, most likely all gathered through photogrammetric methods, and an additional layer of applicable texture that is customizable. For the latter, a series of initial experiments were conducted using Blender software. Specifically, different approaches to texturizing a 3D model were investigated. Experimenting with UV mapping, the 3D modeling process of projecting a 2D image to a 3D model's surface for texture mapping, was the core of the investigation. Specifically, in an attempt to be able to texture only the skin of a 3D statue in one click, the sections corresponding to skin in a UV map of a 3D sculpture were color-tagged [see Figure 6].



**Figure 6. Left: Original UV Map for the *Hebe* 3D statue. Right: the same UV map with skin sections tagged with color.**

[DRAFT]

Through this experiment it became clear that more fine-grained region distinction was needed, as with this simplistic, binary (skin/non-skin) separation, eyes, nails, hair, and more, were not customizable. As such, a new experiment was developed in order to tag different parts of a statue (skin, clothes, nails, hair, etc.) independently. The way this was done was by creating five different binary (black/white) masks, that detailedly tagged specific parts of the statue that ought to have their own texture applied to them [see Figure 7]. This allowed for the underlying statue to be textured with the skin color, and additional masks of textures for other details to be applied on top. With this approach, a more detailed map of texture nodes was employed, in a way that allowed for different textures to be applied independently. The approach is promising, as it allowed for easily changeable (one-click) customizations of the statue that co-exist [see Figure 8].



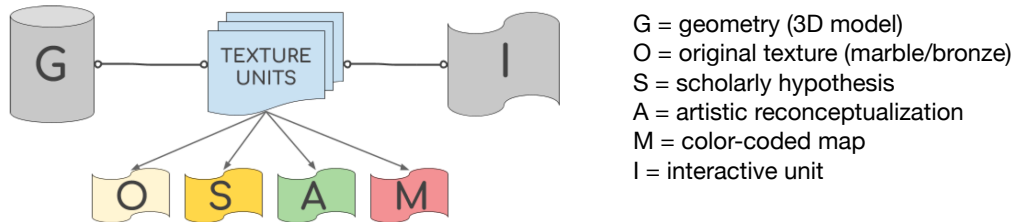
Figure 7. Five different masks, developed to independently tag sections of clothes, hair (including eyebrows), eyes, nails, and non-person objects.



Figure 8. Multiple texturizations for the same statue of Hebe. Each region (hair, nails, clothes, skin, eyes) is textured independently.

## Further directions

The main purpose behind ColorColab is to use embodied interaction with historical artifacts as a critical tool for rethinking and strengthening the social fabric. The previously discussed initial explorations do not yet account for the critical component of interaction. More work is needed to allow for an interactive component, and as such we are currently working on developing a model based on three meta-layers: a 3D-geometry layer, a layer of texture units, and an interactive application layer. The middle, texture unit layer itself will include 4 textures: 1. original texture based on modern look (eg., marble or bronze texturization), 2. scholarly hypothesis based on archeological data, 3. artist reconceptualization texture, and 4. color-coded map allowing for interactive texturization [see Figure 9].



**Figure 9. A proposal of model to underlie ColorColab's interactive data component.**

While much work is still necessary to make ColorColab a real application available on the web and in museums, the initial explorations provide promising results. Further research is needed to implement the proposed model and to translate the findings into an interactive application online and in person. For the in person module, further work is needed to be able to connect the web application to an Augmented Reality device.

Overall, with the goal of creating an experience in which each person can assimilate cultural knowledge in a ludic way, ColorColab could function as an experience that confirms users' humanity and place in society. In this way, ColorColab will allow for the contextualization and re-appropriation of cultural heritage in a social fabric whose details and complexities are only revealed in color.

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