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REVIEW ARTICLE

Anatomy transformed

T. C. Lee,[1,2,3,4] Z. Molnár,[2,5] A. Stein,[3] M. O'Dea,[3] A. Kokaram[6] and C. K. Simms[1,4]

[1]*Department of Anatomy, Royal College of Surgeons in Ireland, Dublin, Ireland*
[2]*St John's College Oxford, Oxford, UK*
[3]*Royal Hibernian Academy of Arts, Dublin, Ireland*
[4]*Centre for Bioengineering & School of Engineering, Trinity College Dublin, Dublin, Ireland*
[5]*Department of Physiology, Anatomy& Genetics, University of Oxford, Oxford, UK*
[6]*Department of Electronic and Electrical Engineering, Trinity College Dublin, Dublin, Ireland*

Abstract

This paper arose from exhibitions in Oxford and Dublin and comprises three experiments which look at the relationship between anatomy and art. In the first experiment, a passport photograph, photographic portrait and portrait in oils, all of the same sitter, show how artistic input transforms anatomy from a mere likeness into works of art. In the second, the reverse is true, as computer techniques render idealized old master images anatomically accurate. The third experiment addresses the biomechanical consequences of anatomical variation and shows that vehicular design is based on mean body shapes, and so it is the average, rather than the idealized, form that is safer in a collision.

Key words: anatomical accuracy; art & anatomy; transformation.

Introduction

This paper arose from part of *The Art of Anatomy* exhibition in the Kendrew Barn, St John's College Oxford which was part of the Anatomical Society Summer Meeting, 23–25 July 2018 (https://www.youtube.com/watch?v=GY1YHiYwomw).

Together with an earlier film, *Anatomists, Engineers and Artists* (Morris et al. 2016; www.rcsi.ie/surfaceanatomy), these works were also exhibited as *Anatomy Transformed* in the Friends' Room of the Royal Hibernian Academy, Dublin, 7–23 September 2018. Here, we present our experience of considering aspects of the complex relationship between Art and Science.

Cecil Erskine wrote that 'in medicine anatomy is applied, in art it is transformed' (Erskine, 2001). Anatomy may be defined as the branch of biology concerned with the structure of organisms and their parts. Art is more elusive, but an experimental approach may be of benefit. We have undertaken three experiments to observe how art transforms anatomy and, in the process, to learn something of the nature of art.

Correspondence
C. K. Simms, Department of Mechanical and Manufacturing Engineering, Parsons Building, College Green, Dublin 2, Ireland.
E: csimms@tcd.ie

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The first experiment considers the transformation of real anatomy into artists' interpretations of it, by comparing images of the same sitter captured by a passport machine, a photographer and a painter. The machine image serves as a control, while the portraits should provide evidence of the artists' interactions with the sitter and their choices, skills and insights. Are the photographic portrait and the portrait in oils more than mere likenesses, but works of art?

The second experiment considers acknowledged works of art, where the painters have idealized anatomy through distortion. In both Botticelli's *The Birth of Venus* (*ca*. 1485) and Parmigianino's *Madonna with the Long Neck* (*ca*. 1534-40), the neck is approximately 10% longer than normal morphological data (Pheasant & Haslegrave, 2005). Ingres exaggerated the length of the spine in his *Bather* (1808), and added the equivalent of five extra lumbar vertebrae in *Grande Odalisque* (1814) (Maigne et al. 2004). Using computer techniques, these distortions can be reversed and the figures rendered so that they lie within the 95th percentile of real body measurements. When the original and remastered versions are compared, are the changes obvious and do they detract from the artistic merit of the works?

Having considered the real and the ideal, the third experiment addresses the biomechanical consequences of anatomical variations for injury risk in a collision (Hu et al. 2017). Are motor vehicles designed for the safety of some or of all? This is an active research topic in the injury biomechanics community: population diversity was the theme of the 2017 conference of the *International Research Council on the Biomechanics of Injury*. The

approach taken in this experiment was to create a short animated film addressing body shape and injury outcome. The concept was to use actual film footage together with a written narrative and cartoon representations of body shapes to emphasize the dramatic variations in body shape evident in the general population. In the process, this film underscores the practical importance of variations in body shape, well beyond artistic considerations.

Material and methods

Portraits of an anatomist

Passport machine

The passport machine required the sitter to sit in front of a light grey background, fit his head into the oval space on the screen, remove his glasses, keep his eyes open and avoid smiling (Irish Passport Office, 2018). Three flash photographs were taken, one of which was chosen by the sitter.

Photographic portrait

Photographs were naturally lit and taken with the sitter wearing either a black polo neck jumper against a black background, or his normal work clothes in his office. The photographer used a manual camera, medium format 6×6 cm^2, and traditional film. Images were captured at a shutter speed of 1/60th of a second. Each shoot lasted for approximately 1 h and 50 images were taken. Four were selected by the photographer for *post hoc* editing, of which two were chosen by the sitter.

Portrait in oils

Paintings were made in the artist's studio, naturally lit from a north-facing window, involving several sittings over 6 days. The sitter was dressed in his normal work clothes, seated on a chair, and asked to fix on a distant point and keep still. Preliminary sketches in pastel were used to acquaint painter and sitter, and then three portraits in oils were made. At the artist's request, a three-quarter length portrait was made with the subject wearing a white tee shirt while standing facing the artist. The painter's eyes flitted from sitter to canvas and the paint was applied. Minor changes were made by the artist after the sitter had left and, once satisfied, he signed and dated the work in the wet paint with the top of a brush.

Old masters remastered

Four paintings were chosen where anatomical features have been distorted for artistic effect. Their images were digitally altered to render them realistic, based on morphological data (Pheasant & Haslegrave, 2005). The human forms were mathematically warped along feasible skeletons using algorithms inspired by earlier work (Wolberg, 1990). Digital editing was used to fill in the gaps left in the background and to blend overlapping regions (Kokaram, 1998; Brinkman, 2008).

The biomechanics of beauty

This short narrative film mixed animation with high-speed camera footage of crash events and scientific data. The narrative first sets out the advances made in crash safety, largely through the process of testing with crash test dummies. The effects of car design were studied by a film showing a head-on collision between a 1959 Chevrolet Bel Air and a 2009 Chevrolet Malibu, in which the older vehicle showed a greatly reduced chance of survival for the occupants due to the large deformation of the vehicle. The narrative then illustrates how the wide range of real anthropometries is poorly represented by the existing crash test dummy 'family'. A consequence of this is that people with body shapes far from the mean are not as well protected in the event of a collision.

Results

Portraits of an anatomist

The machine printed four copies of the passport photograph at a cost of €8 (Fig. 1). At airports in both London and Dublin, computers have compared this passport photograph with a live image of the sitter, matched the biometric data, and permitted him to pass through immigration control.

Two photographs were chosen for exhibition, one with the sitter dressed in black against a black background (Fig. 2) and the other in his work clothes in his office. In the latter, the button-down Oxford shirt, college tie and tweed jacket, along with framed certificates and skulls in a glass

Fig. 1 Photo-Me, Anatomist (2018), Passport photograph, 14 × 10 cm.

Fig. 2 Amelia Stein RHA, Head (2018), Archival pigment print, 36 × 36 cm.

case in the background, provided significant clues to the academic role of the sitter.

The painter's preliminary sketches in pastel were left and right lateral views of the sitter. In two of the oils, the sitter was in three-quarter profile, looking up and to the left or right, while the third was a frontal view. The same work clothes were worn as in the photographic portraits, suggesting his academic role, but the artist positioned him eccentrically in all five paintings. For the largest portrait, he wore a white tee shirt, black long-sleeved undershirt and green trousers, which gave no indication of his profession, and faced the painter/viewer directly (Fig. 3).

Old Masters remastered

Figure 4 shows (in red) the axes along which the neck of Botticelli's *Venus* and spine of Ingres' *Grand Odalisque* were warped and (in blue) the lengths by which individual anatomical segments were altered. *Venus's* neck was reduced by 15% while the spine of the *Odalisque* was shortened by 10% to bring body proportions within the 95th percentile of the typical population. The before and after images of each are shown for comparison in Figs 5 and 6.

The biomechanics of beauty

The benefits of modern car design, crumple zones, protective cabs and air bags were clear in the collisions between the 1959 and 2009 Chevrolets (www.linktovideo*). It was also evident that the test dummies used to represent our

Fig. 3 Mick O'Dea PRHA, Three-Quarter Length (2018), Oil on canvas, 100 × 85 cm.

bodies in crash tests assessing the safety of vehicles only reflect a small proportion of actual body shapes. If one deviates from the mean, is too tall and thin or short and large, injury risk is greater even in modern cars. A particular problem in many modern societies is obesity, which introduces substantial challenges for occupant protection. In future, such protection will need to be customised for each individual, similar to the concept of personalised medicine.

Discussion

The passport machine, the photographer and the painter all achieved the goal of depicting anatomical structures – the face, head and torso. A recognisable likeness of the sitter was evident in all the images, and the passport photograph proved itself machine-readable by satisfying passport controls in Great Britain and Ireland. When these works were exhibited, the passport photograph was considered to be of no artistic merit.

The interactions between artists and sitter resulted in portraits which are 'not only forms which we see, but also something more' (Bazant, 1991). This was achieved by the use of symbols and setting in one photograph and in five

*video link supplied separately.

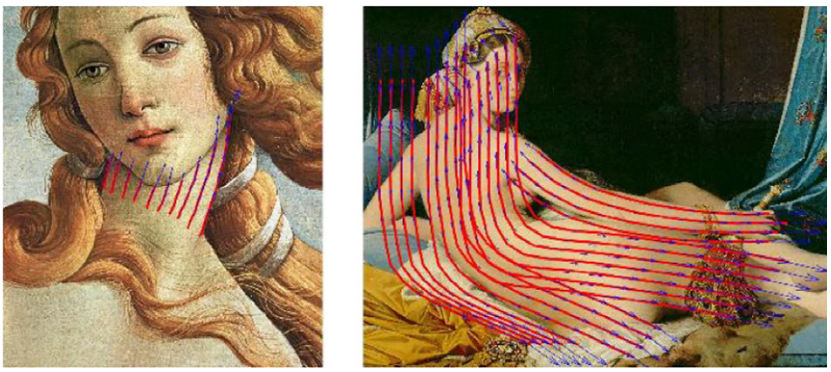

Fig. 4 Detail from digital prints showing the axes along which the form was warped (red) and the length by which different anatomical sections were changed (blue vectors).

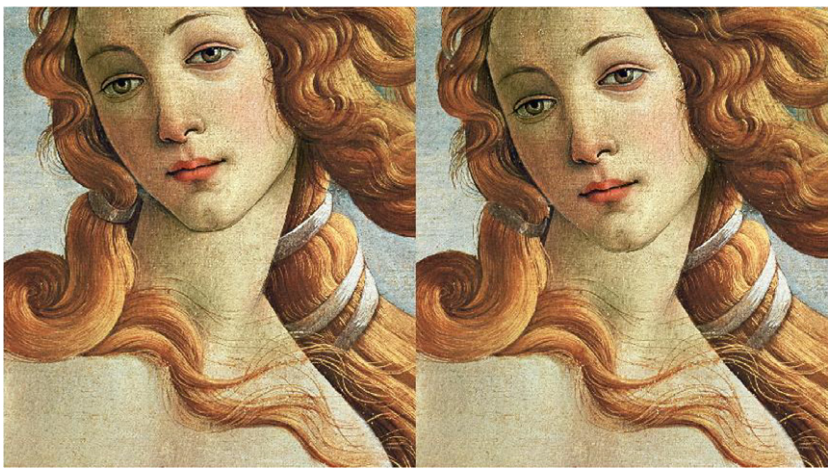

Fig. 5 Sandro Botticelli (left), The Birth of Venus–detail (*ca*. 1485), Tempera on canvas, digital print, 59 × 41 cm (Bridgeman Art Library) & Anil Kokaram (Right), The Birth of Venus Remastered–detail (2018), 59 × 41 cm.

of the six paintings. The depictions in his working clothes inform the viewer about the sitter's likely role as an academic. The cover of *Journal of Anatomy*, framed certificates and skulls in the background of the photographic portrait confirm him as an anatomist.

In the absence of such overt clues, more subtle means were used. In the second photograph (Fig. 2), the sitter was asked to lean forward, tilt his head and smile. Natural light from the left illuminated that side of his face, while his features created shadows on the right side – *chiaroscuro*. The result was a bearded, bespectacled and friendly face, peering out to engage the viewer in a manner previously used by the artist to depict the playwright Frank McGuinness for the National Theatre Collection (Stein, 2018).

Unlike the photographs, the portraits in oils are not a record of one moment, but of many, with decisions made with each application of paint. Many of the initial marks were subsequently altered, or overpainted. In the largest portrait, the subject is standing, legs apart with arms by his side, looking directly at the painter/viewer. It is a confident stance, if not the 'power-stance' made infamous by politicians. The steady gaze, tanned face, and apparent mass of the torso and limbs, suggest the outdoors and the physical, and owe something to Sean Keating's painting *Men of the West* (Keating, 1915). The trimmed hair and beard, glasses and signet ring hint at some refinement. In the portraits, the artists included aspects of both the type and identity of the sitter (West, 2004).

Viewers found it difficult to differentiate between the original and the altered versions of the Botticelli and Parmigianino paintings. Elongated necks are common in paintings and used to celebrate femininity (Long, 2008). Raphael's *La Fornarina* (1518–1520) is another case in point, so subtle distortions may be seen as commonplace and be readily accepted (Kanz, 2008). Visitors to the exhibitions found it easier to identify the original and altered images by Ingres, with the *Grande Odalisque* the more obvious due to the addition of five lumbar vertebrae (Maigne et al. 2004). John Berger compared the *Grande Odalisque* with a pin-up photograph (Berger, 1972). In contrast, Carol Ockman noted that it was commissioned by a woman, Napoleon's sister Caroline Murat, as a gift for her husband Joachim, and she interpreted it as the act of a powerful woman (Ockman, 1995). The hyper-realistic details of the textiles, peacock feather and narghile contrast with the impossible anatomy combine to make it a fantasy composition, unreal and unattainable, according to Bryson (1984). However, once normal anatomy was restored, the result was a more conventional, and less inspiring, work.

The combination of narrative, animation and crash footage as a means to convey concepts of occupant crash protection appears to be novel. Viewers enjoyed the contrast

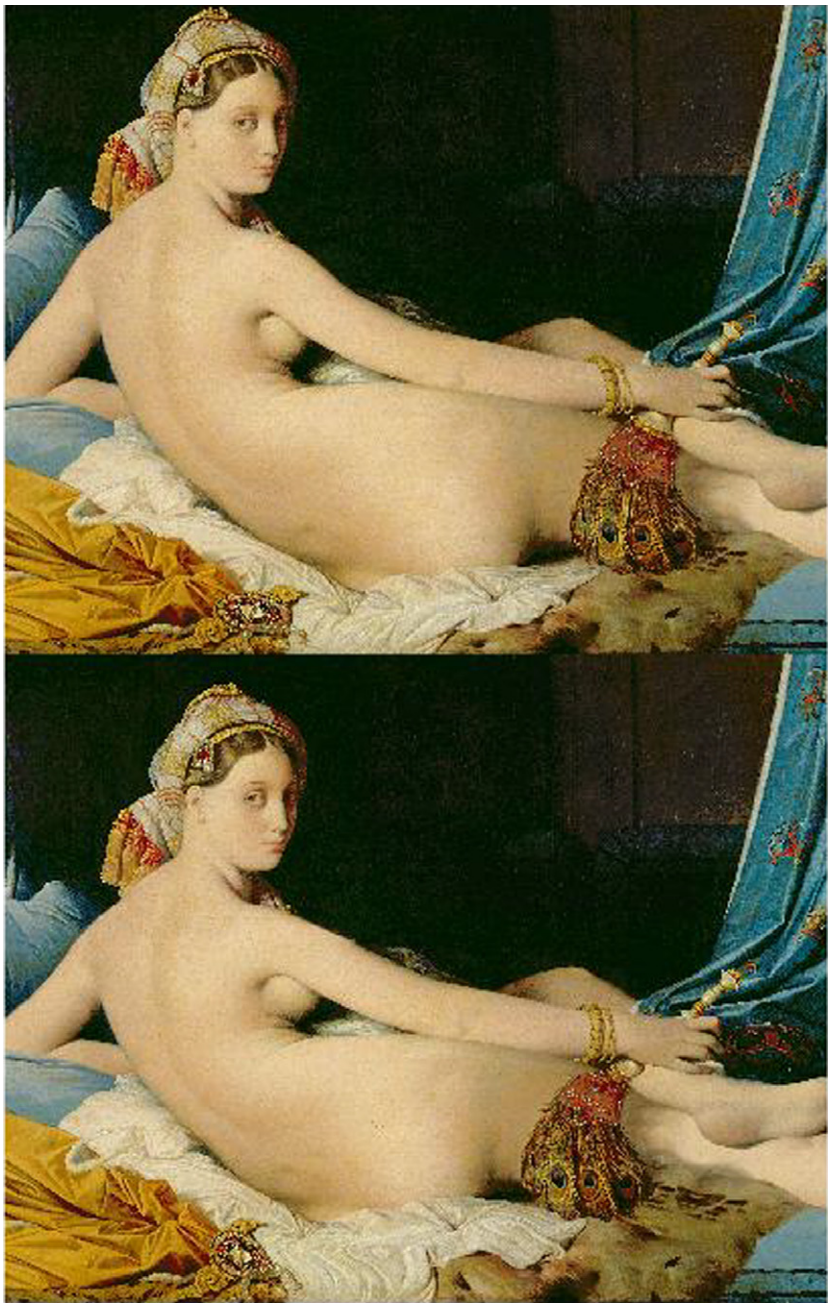

Fig. 6 Jean Auguste Dominique Ingres (Top), Grande Odalisque–detail (1814), Oil on canvas, Digital Print, 48 × 86 cm (Bridgeman Art Library) & Anil Kokaram (Bottom), Grande Odalisque Remastered–detail (2018), 48 × 86 cm.

between the visceral reaction to watching high-speed camera film footage of staged collisions and the experience of watching the colourful animations exaggerating body shape and highlighting the differences between existing crash test dummies and many people's anatomies. The narrative is an assessment of an on-going issue with crash safety. Addressing this challenge remains the major goal of the science of injury biomechanics. While significant advances have been achieved in crash safety, scientists and designers are now focusing on individual anatomies to provide personalised protection.

Conclusion

The photographic and painted portraits of the anatomist offer more than the mere likeness of the passport photograph (Kanz, 2008). The artists drew from their interactions with the sitter to edit the image, adding character by including or exaggerating aspects of the face before them. In addition, as Oscar Wilde observed, 'every portrait that is painted with feeling is a portrait of the artist, not of the sitter' (Wilde, 1891). If the passport photograph is the control, the photographer and painter included much of themselves

and their experiences within the portraits, which resonate with the viewer and become works of art.

The use of anatomical distortion can aid in creating a work of art. Swan-like necks add grace to paintings, and may go undetected by the casual viewer. Marked distortions can add to the fantasy element, or idealisation, in a painting. When normal anatomy is applied, this is lost, and what remains is a mediocre academy nude, rather than great art.

Car safety has radically improved in recent years by the inclusion of features based on 'average' body shapes. However, this is a one-size-fits-all approach. For those of us who are outliers, a bespoke approach is required to improve car safety.

In art, anatomy may be transformed in the creation of a great work of art, and its accurate restoration can reverse the process. However, where safety is paramount, such accuracy is essential in both biomechanics and medicine.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Video S1. The Biomechanics of Beauty.