What opportunities and ethical challenges do emerging technologies present for display of digital facial depictions of ancient Egyptian mummies to public audiences?

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Overview

Digital technologies have advanced rapidly over recent decades and they can now afford new ways of interacting with depictions of people from the past. Such technologies allow for multi-modal, interactive and tactile experiences with digital and physical representations. These interactions and technical advances often facilitate the generation of new knowledge through interdisciplinary and sympathetic approaches (Roughley and Wilkinson, 2019).

In the computer game and movie industries we are seeing great advances in the production of digital humans that look, move and talk with convincing realism. Technologies and methods used by these industries are being adopted by facial reconstruction specialists to depict historic individuals from their skeletal remains, including Egyptian mummies. This allows the public to see and interact with a person from the past in unexpected ways.

However, these technologies and methods also pose a number of ethical questions. When working with ancient human remains, we must be aware of our contemporary biases surrounding these populations in terms of appearance and personality of the individual, especially where the archaeological or biological record do not provide such information (Wilkinson, 2020). Alongside making choices relating to skin, eye and hair appearance, caution must be taken when choosing to animate such depictions, where misrepresentation and dis-mediation could occur.

While these technologies provide opportunities for these digital humans to 'live' in current times and potentially forever; or as long as their computer files exist, this poster describes some of the current methods for presenting facial depictions of people from the past but also discusses the ethical challenges that must be considered.

Face Lab Facial Depiction Presentation Practices for Egyptian Mummies

Production of 3D digital facial depictions for presentation to public audiences may require the use of 3D surface scanning, haptic 3D modelling, 3D texturing, 3D printing and 3D animation technologies and methods. 3D facial depictions have a known shape accuracy (Wilkinson et al., 2006; Lee et al., 2015) but the most important objective of a facial depiction is to generate a life-like appearance (Claes et al., 2010). Selecting appropriate facial textures, such as eyes and hair, and wrinkles and skin colour to add to the skin layer output from the 3D facial depiction process requires careful consideration.

In forensic facial depiction scenarios, depictions are presented in black and white as not to infer textures that might hamper recognition (Frowd, et al. 2012). This process can also be applied to ancient individuals where evidence for textures might be limited. Figure 1 shows an example of a facial depiction of an Egyptian mummy presented in black and white as biographical information was finite, with less justifiable features, the hair in this instance, blurred and faded to black.

If there is archaeological, DNA or biographical information available, colour textures can be added carefully. Where there is further uncertainty, colourless outcomes might be more appropriate. Figure 2 shows depictions of the Egyptian mummy Ta-Kush. While Ta-Kush's cartonnage informed the colour textures for the depiction (right), a colourless 3D printed replica initially produced for haptic interaction by the visually impaired (left) might be the preferred choice for considered public display and interaction (Smith, et al. 2020).

Fig 1. Face Lab's facial depiction of the Cohen mummy stewarded by Johns Hopkins Archaeological Museum. Presented as a 2D image. Scan QR code for details.

Fig 2. Face Lab's facial depiction of Ta-Kush, a mummy stewarded by Maidstone Museum in Kent. Presented as a full-colour 3D model with 180 degree animation for screen display, as a full-colour 2D image for print and web display, and as a colourless 3D printed replica for haptic iteration. Scan QR code for details.

Public Display, Circulation and Potentially Problematic Re-presentation and Re-mediation

Fig 3. Face Lab's facial depiction of the Cohen & goucher mummies stewarded by Johns Hopkins Archaeological Museum, presented in an online blog by the museum. Scan the QR code for details.

Fig 4. Face Lab's facial depiction of the Goucher mummy posted on Face Lab (left). The same image edited by a member of the public posted on Facebook (right). Scan the QR codes for details.
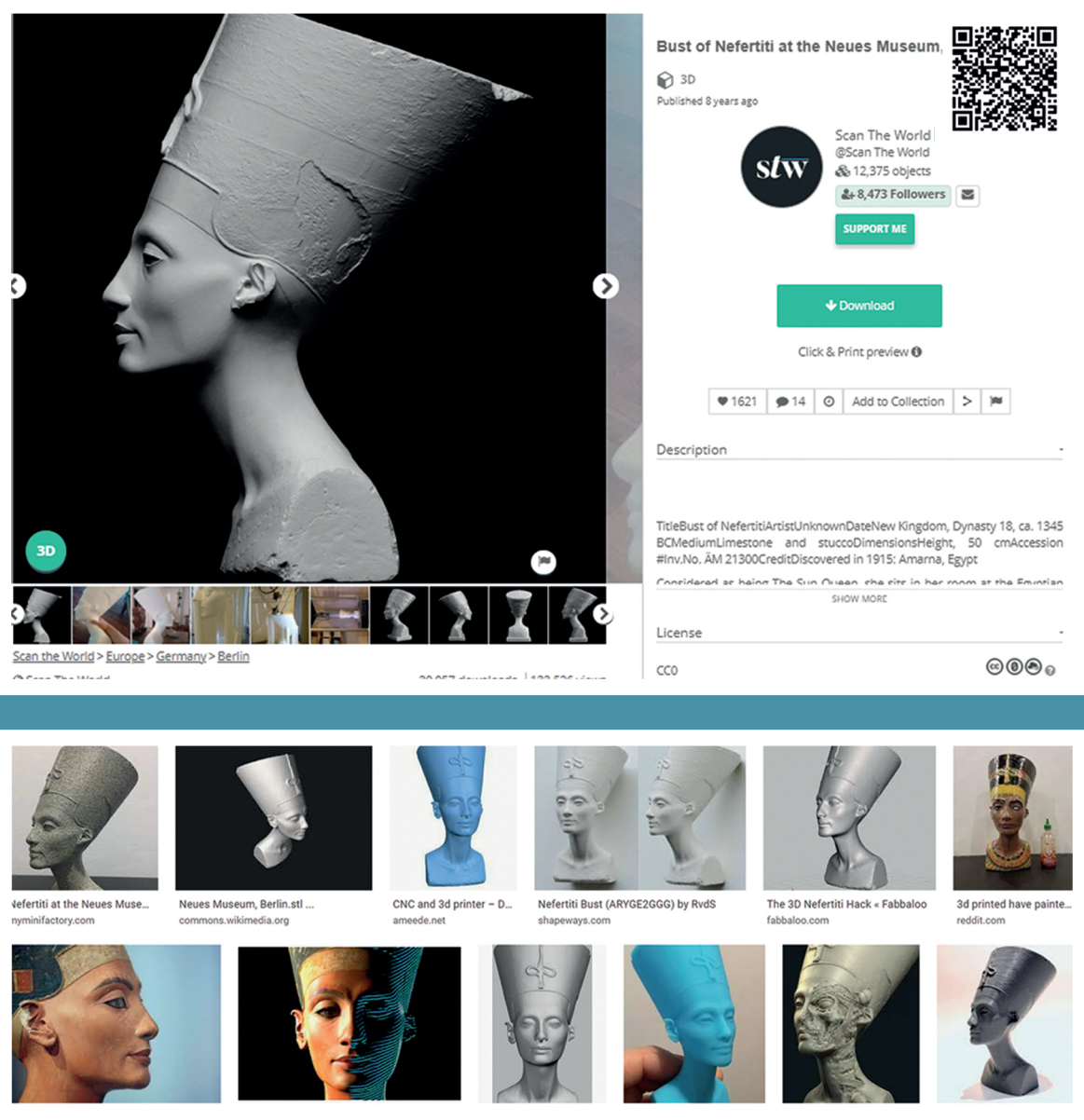

Fig 5. 3D scan of a bust of Nefertiti available for free download from Scan The World (top left), photos of 3D rendered, printed and painted replicas of the bust posted by the public online (bottom left), a Twitter post showing the bust after import into 'Metahuman' (animated and textured). Scan the QR codes for details and to watch the video.

3D digital facial depictions can be presented in a number of ways, including animations and 3D printed replicas (Roughley and Liu 2022), however, the most common presentation method is as a 2D image. These can be presented internationally on screen and in printed format. Most are posted online in news reports, blogs (figure 3), academic articles and on social media. The downside of this publication format is that these images can be screen-shot or downloaded by the public, then altered and recirculated.

Figure 4 shows a 2D image of a facial depiction of the Goucher mummy produced by Face Lab that was posted on Facebook by Face Lab. A Facebook user expressed dissatisfaction about the textural choices in the comments section and proceeded to download the image, edit it to how they believed the individual should be presented, and re uploaded it to Facebook. This image is now re-circulating online, potentially misrepresenting the ancient individual based on uninformed textural choices.

It is uncommon for 3D facial depiction files to be made available for public download and creative experimentation. However, artistic representations of historic individuals such as sculptures are being frequently digitised and made available to the public via Creative Commons (CC) licenses. This is the case of the bust of Nefertiti held by the Berlin Neues Museum. It is one of the most copied works of ancient Egyptian art (Bishara, 2019). The 3D scan of the bust is downloadable from multiple online locations such as Scan the World, and the CC license allows for remixing and sharing. These files can now be re-textured, 3D printed and animated by the general public (figure 5). While democratic, it is easy to misrepresent the individual. For example, animating a depiction in Epic Games''Metahuman' allows them to smile, move or even talk in that manner that they may not have in life.

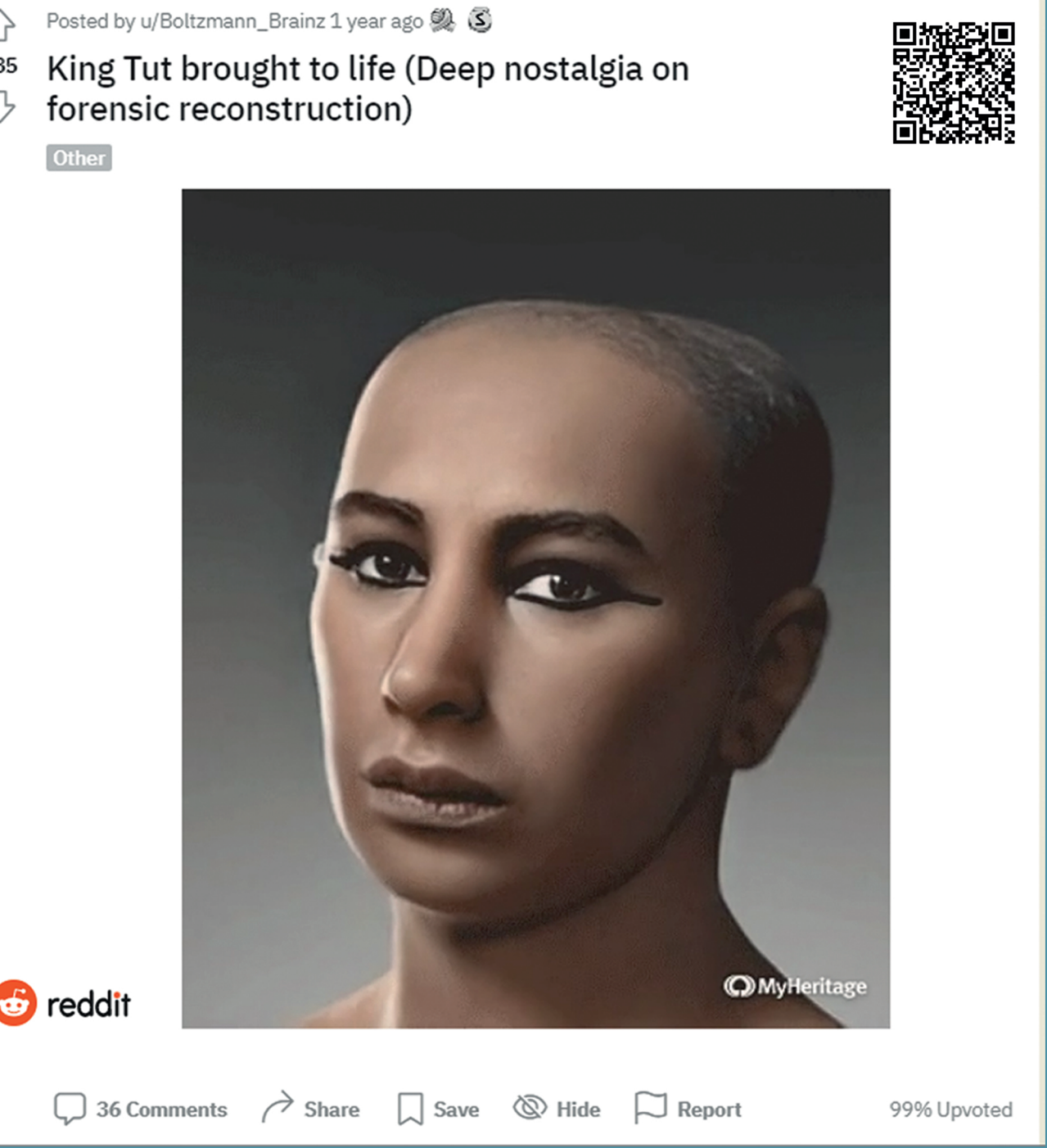## Emerging Technologies & Ethics - because we can, should we?

Fig 6. A photograph of a facial depiction of Tutankhamun by Élisabeth Daynès, animated by a member of the public in My Heritage's 'Deep Nostalgia' AI, and posted on Reddit. Scan QR code to watch video.
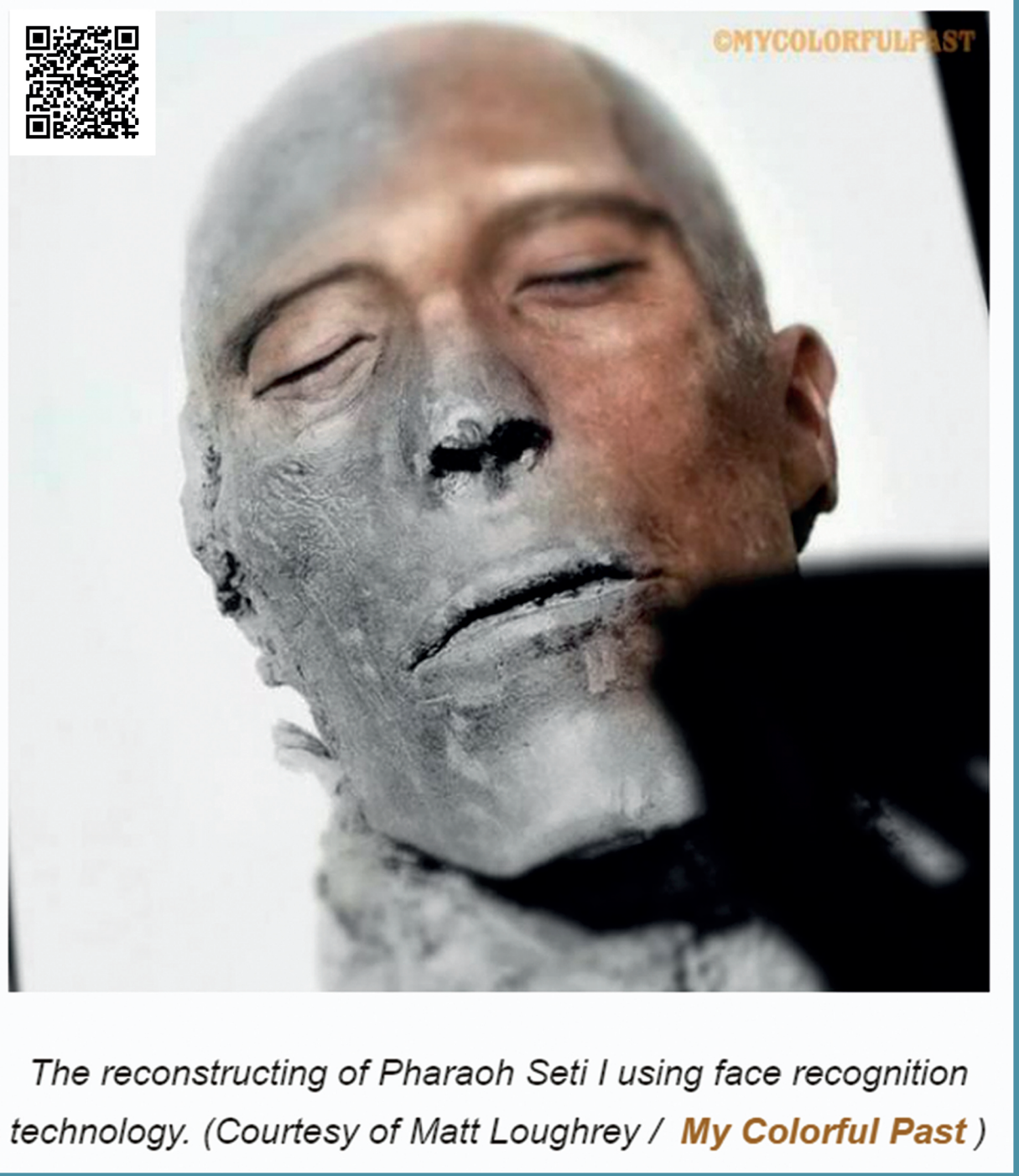

Fig 7. An article showing the results of a grayscale photograph re-colouring AI that adds photo-relaistic textures to ancient Egyptian mummies. Scan QR code for details.
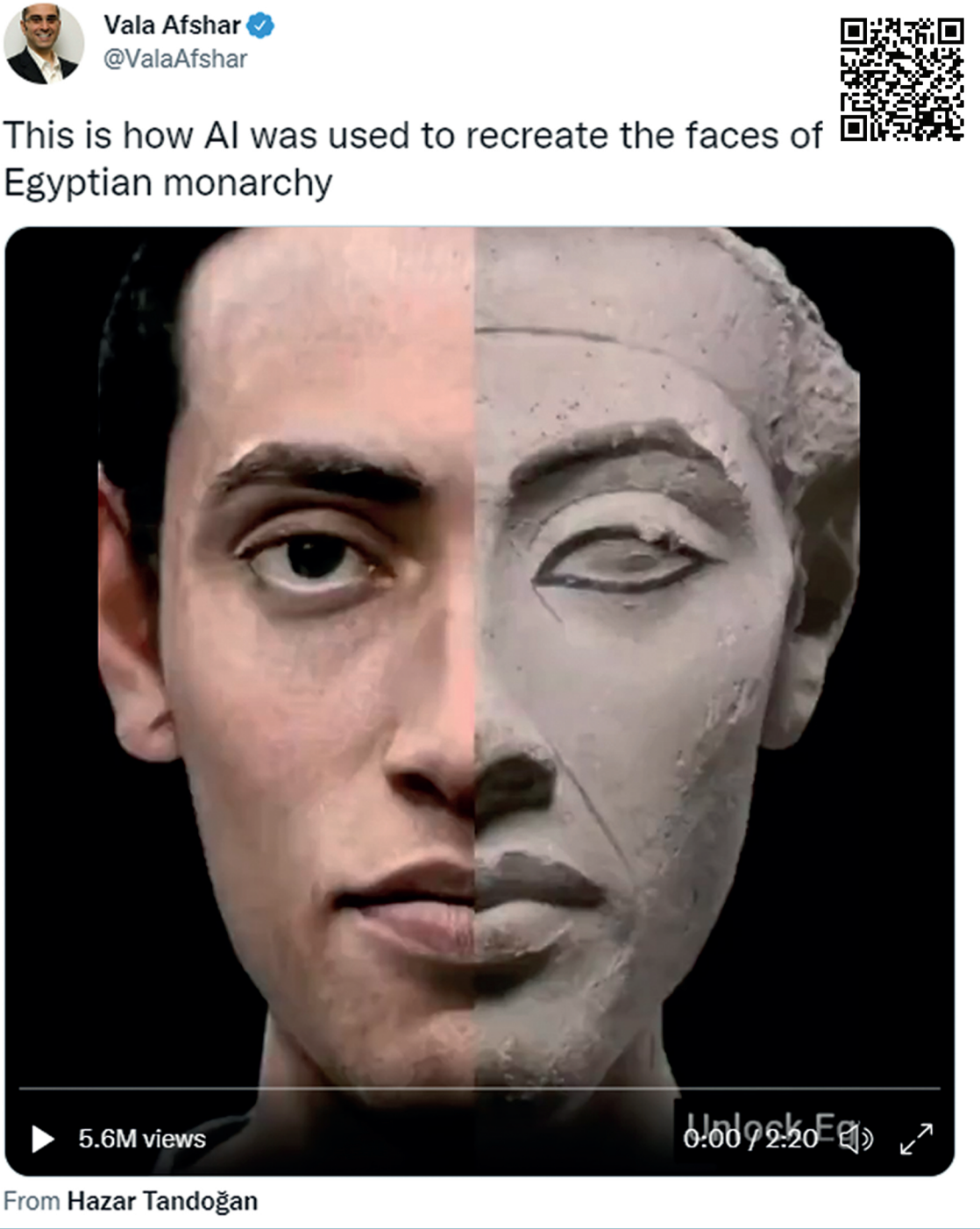

Fig 8. A video showing the results of an AI adding photo-realistic textures to sculptural depictions of ancient Egyptians. Scan QR code to watch video.

Emerging technologies are exciting and present many new options for depicting the dead. However, like forensic DNA phenotyping, which presents a spectrum of possibilities for eye, hair and skin colour, use of these technologies should be approached with caution.

Although the facial reconstruction process is rooted in scientific knowledge, subjective material is often added during the depiction process, especially when the facts prove insufficient for a realistic appearance. This subjectivity is conditioned by confirmation bias and any accepted knowledge/beliefs (Wilkinson, 2020). The facial depiction practitioner should be aware of their own cognitive biases when applying textures to facial depictions, especially for forensic purposes whereby application of incorrect colour textures can affect recognition.

However, the desire for hyper-realistic and interactive depictions of ancient humans, particularly for museum display, sometimes outweighs available evidence for justification of texture choices and movement. Figures 6-8 show emerging technologies used to animate, re-colour and re-texture facial depictions of ancient Egyptian mummies using Artificial Intelligence. With 'Deep Nostalgia' it uses pre-recorded videos of facial movements and the AI identifies which ones work best for each photo, depending on the subject's pose. This is not necessarily representative of the individual in life and could imply a particular character.

Re-colouring of grayscale photos and re-texturing of photos of sculptures using AI relies heavily on the subjectivities of the humans training the AI. While these technologies may be useful additions to the facial depiction process, care must be taken to avoid biases and not be swayed by the 'cool factor'.

References:
- Bishra, H. (2019). *Official 3D Scans of Nefertiti Bust Are Released After Three-Year Battle.* Hyperallergic. Available at: https://hyperallergic.com/530400/official-3d-scans-of-nefertiti-bust-are-released-after-three-year-battle/ [Accessed: 21/08/22]
- Frowd, C.D., Skelton, F., Atherton, C., Pitchford, M., Hepton, G., Holden, L., McIntyre, A.H. and Hancock, P.J. (2012). Recovering faces from memory: The distracting influence of external facial features. *Journal of Experimental Psychology: Applied, 18(2)*
- Lee, W.J., Wilkinson, C.M. and Hwang, H.S. (2012). An accuracy assessment of forensic computerized facial reconstruction employing cone-beam computed tomography from live subjects. *Journal of forensic sciences, 57(2)*
- Roughley, M. and Liu, C-Y.J. (2022). Digital 2D, 2.5D and 3D methods for adding photo-realistic textures to 3D facial depictions of people from the past. In: Rea P. *Biomedical Visualisation 11.* pp.45-280
- Roughley, M. and Wilkinson, C. (2019). The affordances of 3D and 4D digital technologies for computerized facial identification. In: Rea P. (eds) *Biomedical Visualisation 2.* pp. 87-101
- Smith, K., Roughley, M., Harris, S., Wilkinson, C. and Palmer, E. (2020). From Ta-Kesh to Ta-Kush: the affordances of digital, haptic visualisation for heritage accessibility. *Digital Applications in Archaeology and Cultural Heritage, 19.*
- Wilkinson, C., Rynn, C., Peters, H., Taister, M., Kau, C.H. and Richmond, S. (2006). A blind accuracy assessment of computer-modeled forensic facial reconstruction using computed tomography data from live subjects. *Forensic science, medicine, and pathology, 2(3)*, pp.179-187.
- Wilkinson, C. (2020). Cognitive Bias and Facial Depiction from Skeletal Remains. *Bioarchaeology International, 4(1)*, pp.1-14.