ARTICLE

The allure, glamour and certainty with which forensic science is portrayed in film and television drama have done much to promote it as an exciting and worthwhile scientific career. In the first in a short series of articles, Susan Pearson looks at some recent advances.

Forensic science: the facts behind the fiction

In the world portrayed by television programmes such as *Silent Witness* and *CSI: Crime Scene Investigation*, the role of the forensic experts is depicted as exciting, adventurous, maybe even a bit dangerous. In real life, of course, this is several degrees away from the truth. However, as anyone who has attend a school careers evening recently can confirm, this glamorous media image is proving to be one of the primary inspirations for young people to seek out more information on forensic science from biomedical scientists attending such events.

Of course, forensic investigations are not the preserve of any one discipline; there are many overlaps between sciences. A forensic investigation will take in the work of the forensic pathologist, who carries out autopsies and takes laboratory specimens; and many other specialists, such as biochemists, neuropathologists, ophthalmologists, biochemists and computer experts, are likely to be consulted.

In terms of analysis, forensic science can be divided into four traditional areas: toxicology, drug science, DNA and blood spatter analysis, and the (chemical) analysis of marks on the body. A fifth area, forensic ecology, is now emerging, and this covers botanical profiling, environmental factors and forensic entomology (the incidence of insect life on corpses).

This short series of articles will delve into some of the methods and techniques utilised in forensic pathology and provide just a brief glimpse into the intriguing world of crime investigation.

New techniques in facial reconstruction

One of the latest techniques in forensic science comes from the fast-moving arena of computer graphics. When Dr Damian Schofield from Nottingham University and Dr Martin Evison from Sheffield University were given an unidentified Egyptian mummy to work with recently, they applied their innovative new approach to building facial reconstructions to create a three-dimensional (3D) model of a face that could be that of the famous Egyptian Queen, Nefertiti.

Traditionally, facial reconstructions of unidentified skulls have been built out of clay, using two established techniques. The first approach, known as the American method, uses certain key landmark sites around the skull where the depth of the original tissue can be estimated. Originally, this data was amassed mechanically by the Victorians to build up statistical averages according to ethnicity, sex, age, body mass and so on. However, modern reconstructions are often based on data generated from magnetic resonance imaging MRI scans. The second system, the Russian method, relies on the approximate reconstruction of the soft tissue elements of the face, such as the musculature.

While computer graphics have been used

The face that could belong to the legendary Egyptian Queen, Nefertiti. An artist's impression based on Schofield and Evison's facial reconstruction.

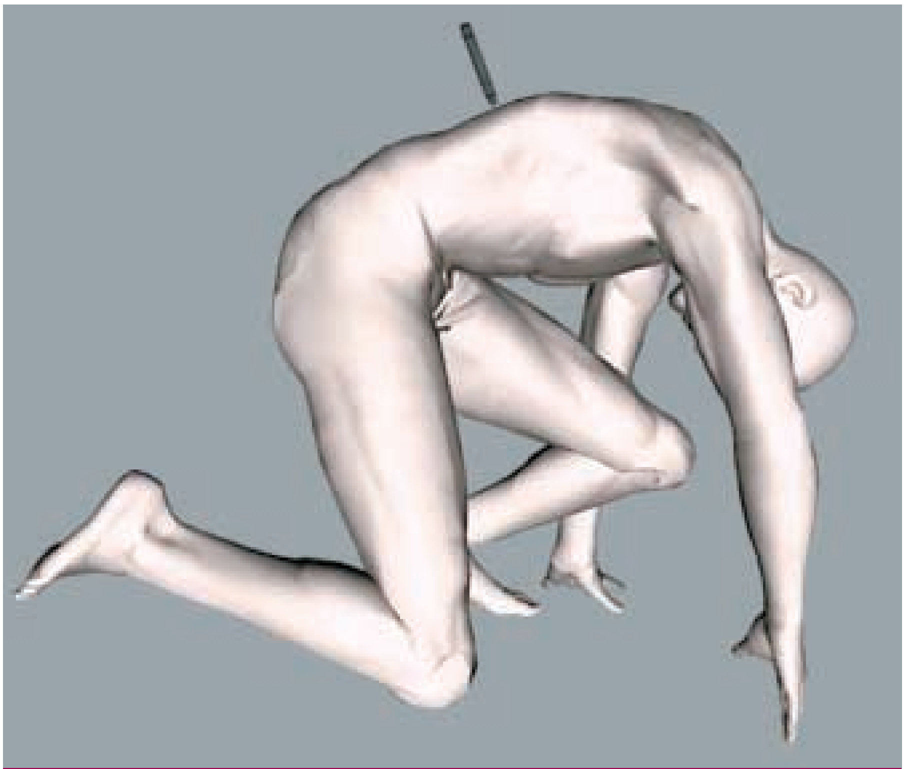
'Judgement of ancestry can be difficult as skull features common in Africans can be found in Europeans, and vice versa'

for facial reconstructions for some time now, they have generally been based on one or other of the systems and have tended to generate rather grotesque or mannequin-like faces. This is because mathematical approaches ignore the craniofacial soft tissue anatomy, generating distorted or over simplistic facial surfaces.

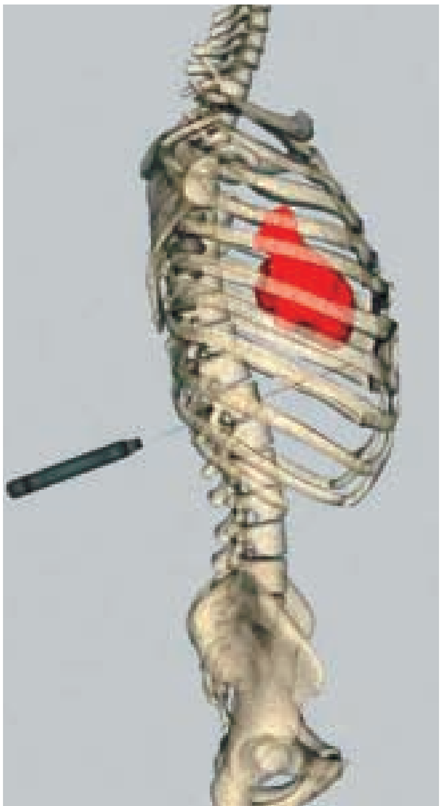
What is different about Evison and Schofield's system is that they use the latest industry-standard visualisation modelling techniques to work with a computational approach that incorporates both the American and Russian methods. They capture a 3D model of the skull, often created by laser scanning of the original, onto which the American landmark depths are located. The muscles and other anatomical features are modelled directly onto the skull in virtual reality and the skin and facial features can then be built up over the top.

In the case of the skull believed by a number of UK experts to be that of Nefertiti, digital X-rays gave Evison and Schofield an image of the skull inside the mummy. At this point they had no clues as to the mummy's possible identity but in order to build up the geometry of the face they next had to make a judgement as to the ancestry of the skull. This can be difficult as, for example, features common in Africans

Computer visualisation showing how the knife reaches the heart through the 11th thoracic vertebra when the victim's spine is flexed in this position.



Computer model showing the hypothetical position of the victim's limbs at the moment of the stabbing



Computer model showing the projection of the knife through the 11th thoracic vertebra when the murder victim's torso is in an upright (straight) position.

can be found in Europeans, and vice versa. However, the indication here was that this particular skull could be classified as Indo-European.
The appropriate landmark depths could then be assigned and the features put in place.

This is the system that Schofield and Evison have also applied to create images for several murder inquiry cases involving unidentified skeletal remains. The details of these are currently unavailable as the cases are *sub judice* but the researchers are confident that their reconstructions produce identifiable images. As Damian Schofield says of their work on Nefertiti: "This is the best facial shape we could get from the X-rays we were given. If I saw this image on *Crimewatch*, and Nefertiti was my daughter, I think I would recognise this face as hers."

Computer-aided visualisation of autopsy findings

There are other contexts in which computer graphics can play a part as forensic evidence. Among other projects, Schofield and Evison are carrying out research to improve the technology involved in computer-generated visualisations of autopsy findings, which can permit a better understanding of the information obtained from post-mortem examinations.

Evidence is generally presented in two formats: as illustrative evidence or as substantive evidence – which actually proves a point. In an illustrative example of a murder case in which a man died from one significant injury – a stab wound which pierced his heart – visualisation was able to bring significant clarity to the case.

The length of the wound and the angle at which the knife entered the man's back, cutting through the left half of the 11th thoracic vertebra, were quite clear. However, when the body was laid out on the mortuary table and the angle of the wound was projected through it, it was evident that the knife could not have reached the heart with the body in a straight posture. What was required was a visualisation that could show how the man might have been positioned in order to sustain the fatal wound.

Reconstructing the body on screen, the heart was positioned with the knife located where the wound had been inflicted. The flexion of the vertebrae was calculated with the help of a forensic pathologist and the spine then reconstructed so that both the 11th vertebra and the heart could be reached by the knife. This produced a bent posture. As the knife blow was strong enough to cut through the bone, a downward motion was suggested and the body was then modelled over the top, with the arms and legs in hypothetical positions for the position shown in the picture. The model could be presented in court either with or without the limbs.

According to Damian Schofield: "The defence will always try to question the admissibility (validity) of the evidence, which means that we must ensure that we have precise audit trails, that all our evidence is reproducible – which is difficult in pathology because it is hard to get totally accurate dimensions. For example, we wouldn't have the precise measurement of someone's heart."

Compared with the situation in the USA, development of forensic computer animation in the UK is still in its infancy. However, computer visualisation services are currently available from a number of companies, and visualisation models are now regularly accepted in UK courtrooms.

‘Computer-generated visualisations can permit a better understanding of the information obtained from post-mortem examinations’

‘Forensic investigations are not the preserve of any one discipline’