BODY AND MIND: A 3D CGI ARTIST'S APPROACH TO MRI VISUALIZATION

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This paper discusses the author's practice-led approach and philosophical perspective to creating images that combine Magnetic Resonance Imaging (MRI) data with interpretative 3D CGI techniques. The paper concludes that more approaches to MRI data visualization could provide an aesthetic language that offers an alternative mode of interaction.

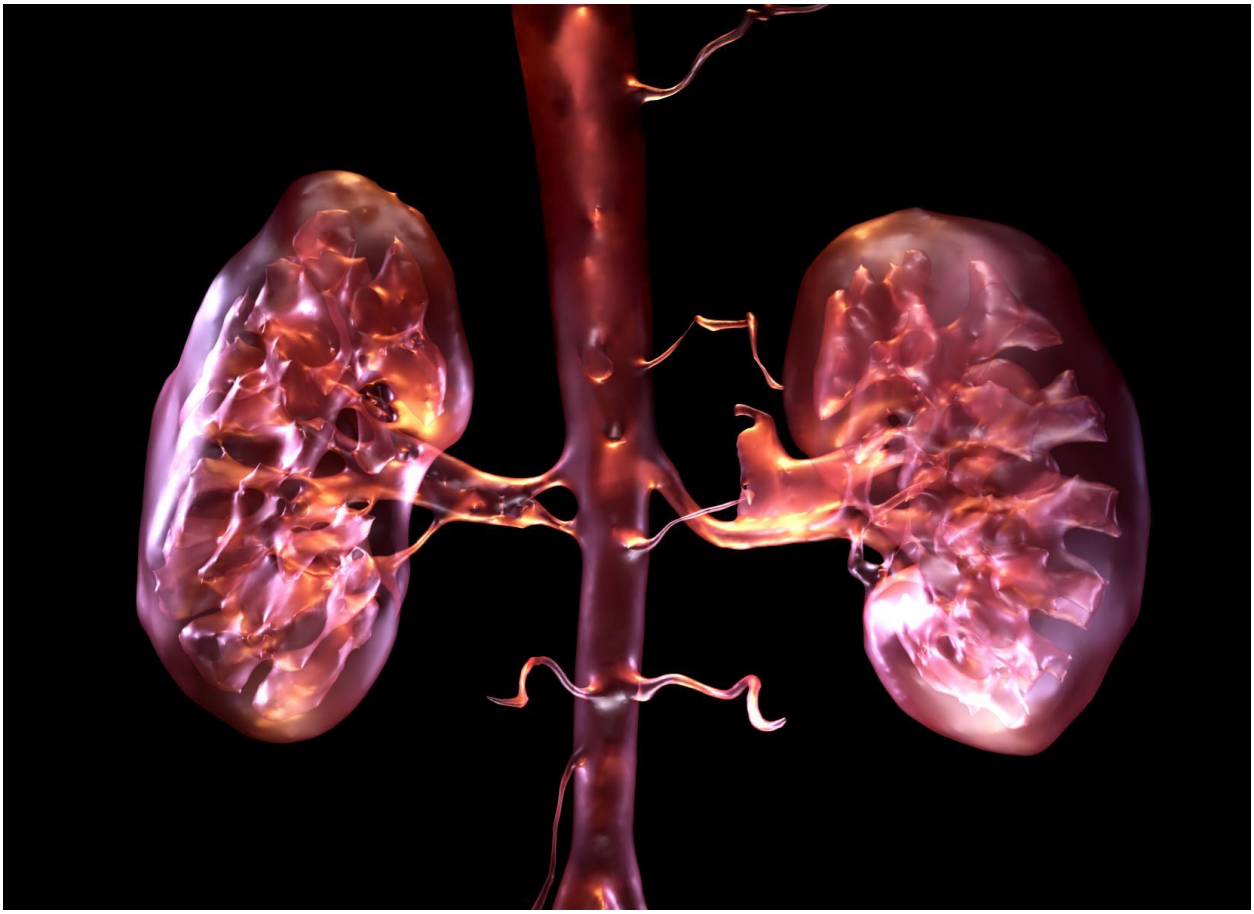

Fig 1. Kidneys. Copyright John McGhee.

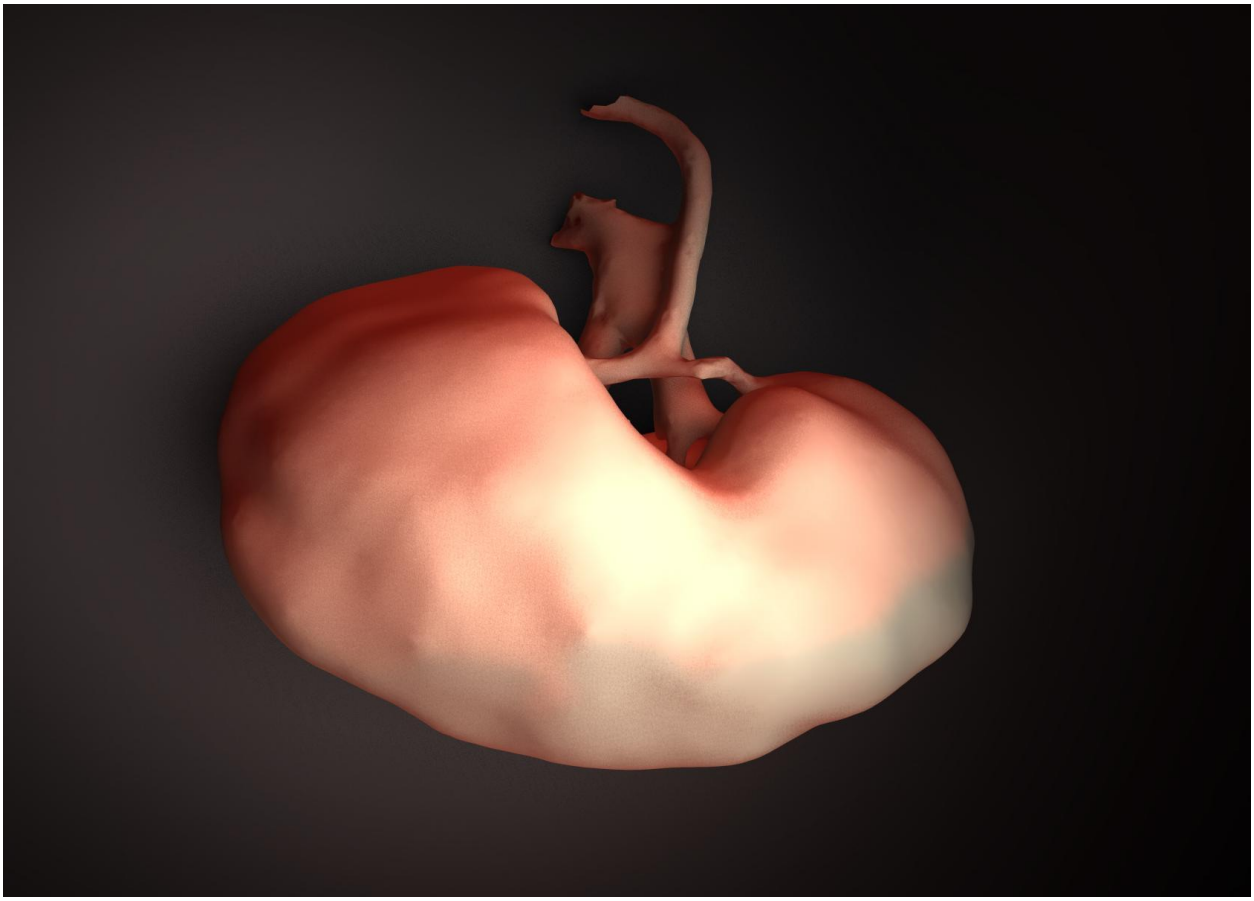

Fig 2. Isolation. Copyright John McGhee.

Introduction

Clinical imaging modalities such as Magnetic Resonance Imaging (MRI) allow the healthcare professional to explore, research and visualize our internal body structure. However the raw image data can be difficult to understand and interpret by the lay viewer. 3D CGI artists and researchers have the toolkit to widen accessibility to this type of image data.

In previous research work, the author established a pipeline in Mimics software to combine clinical MRI datasets with 3D Animation software Autodesk Maya (McGhee, 2010). Mimics is a package that facilitates the thresholding, segmentation and 3D meshing required for making MRI or CT into a surface <http://www.materialise.com/mimics/main_ENG.html>. The initial purpose of creating this hybrid approach was to develop 3D vascular images to improve patient understanding and comprehension of their vascular disease. This raises a series of philosophical questions and choices for 3D CGI artists; what is our role in creating these hybrid images? Do we act as a translator? Or should we mediate the data? In this paper the author argues that artists operating in this domain should provide new perspectives on

the data and not solely act as a conduit for scientific image dissemination. This, the author also argues is particularly relevant when stimulating dialogue between patients and health professionals.

1.0 The context

The role of the artist as scientific illustrator prevails in western medicine and has done for many centuries, whereby the artist is commissioned to illustrate for his or her scientific patron. This historical progression can be studied in germane research such as; 'Human Anatomy: Depicting the Body from the Renaissance to Today' (Rifkin et al., 2006). This type of medical anthology identifies the significant historical landmarks in medical illustration, highlighting the evolving role of the medical illustrator and placing the author's practice and research within an historical context.

Contemporary 3D computer-based animation in the field of biomedicine is a continuation of this historical timeline, providing screen-based tools to illustrate the internal body. According to Dijck (Dijck, 2005), computer 3D animation and visualization has provided artists with the apparatus to 'mediate' the human body with imagery. This 'mediated' perception as described by Dijck, has advanced into the digital age with both science and medical illustration using computer tools to virtually recreate and visualize the body. In the article 'Picture this' in the journal 'Nature' (Gewin, 2005), the medical writer Virginia Gewin identifies computer animation in biomedical science as a 'New-wave' niche. While this notion of 'niche' could be partly true, there is evidence to suggest 3D computer animation and visualization by medical artists is fairly widespread.

In Mike De La Flor's 'The digital biomedical illustration handbook' (De La Flor, 2004) several biomedical areas are cited where 3D computer graphics are applied. These include: 'surgical explanation, medical-legal, veterinary, patient education and cellular illustration'. In 'The Guild Handbook for Scientific Illustration' (Hodges, 2003), we also see evidence of the trend to move from traditional 2D methods of illustration to 3D computer animation, with an article by Mathews and Winkleman (Hodges, 2003) setting out a list of tools, materials and techniques for the 3D computer based illustration of science.

The medical animation firm Hybrid Medical Animation (Hybrid, 2010) demonstrates this emerging style. This model of production involves computer animators and artists being hired to construct a narrative to communicate a complex medical condition, a surgical procedure or the latest drug therapy. Further examples of commercial companies adopting this model include Biodigital Systems, Primal Pictures, Eyemaginations, Random42, Nucleusinc and Zygote to name but a few. However, these commercial examples often utilise edutainment as a mechanism of imparting complex biomedical information to the viewer. Edutainment mostly offers a stylised version of human anatomy and disease.

2.0 Clinical imaging aesthetic

In contrast to the 3D computer animation approaches discussed, clinical imaging refers to the acquisition of medical data, gathered from Computed Tomography (CT), MRI, Ultrasound and Positron Emission Tomography (PET) equipment. These modalities of contemporary clinical imaging apply a non-visible spectrum (radio waves and X-rays) to capture cross-sectional image slices of the human body. The term 3D medical visualization is a reference to the post-processing of this medical data acquired during scan procedure.

Medical interpretation of the body is but one stream of visualization, representing the body using a set of protocols and attributes embedded in science e.g. MRI. Radiological instrumentation describes disease in the language of science; abstract, specialist and separated from the body. In effect these images are encoded for interpretation by clinical radiologists only.

In this research the artist worked with cross-sectional MRI data of the human aorta, renal arteries and kidneys. The imagery captured by scientific instrumentation was a representation of inner body space. It is not truly a rendering of anatomy, but a translation of the body by the reactions of the tissues to the magnetic field of the scanner.

These types of radiological imagery attempt to break the body into pieces thus reducing it to understandable components, in the spirit of true reductionism. Empirical science sees the 'body as machine' a concept put forward by Descartes and Bacon and which still underpins the dominant reductive paradigm in medicine. Rosen argues: '…science is currently locked in the grip of a Cartesian tradition that asserts that organism is machine' (Rosen, 2000 p.297).

Established 3D clinical visualization in medicine is designed as a tool to support medical professionals in diagnosis, planning and training. It is a machine-based reductive form of instrumentation that is controlled, with interpretation minimised. This type of MRI imagery is absent of style, is based on reductive values and automated scientific protocols. The 3D visualization of data has some interpretation applied but is an automated and measured process, designed to minimise human intervention.

While the acquisition and visualization of MRI data generates an image that is difficult to understand for the lay viewer, it collects unsurpassed detail of internal body tissue. The medical gaze of MRI sees deep

into the body, exposing what would be 'invisible' to the visible spectrum. This clarity of vision and verifying of data, while encoded, could potentially inform and take the lay viewer to places previously unseen and unexplored. In comparison to the more interpretative approaches seen in 3D CGI biomedical animation, clinical imaging modalities offer the scientific clarity and detail that is difficult for the 3D CGI artist to achieve on his or her own.

3.0 Arts-based interpretation of clinical (radiological) data

There are individual artists who do not conform to the artist-as-illustrator of science model, and represent an alternative perspective. These visual practitioners go beyond the current notions of visualization and representation of MRI data, albeit using predominantly physical media. These individual artists are not necessarily concerned with communicating functional aspects of the inner body. The work they produce is not intended for clinical or diagnostic purposes, but for providing an alternative way of viewing the inner body for exposition. Sian Ede, the author of 'Science and Art' describes this approach as beyond the didactic: 'Artists don't 'do' prettification, product or propaganda for public understanding of science. But they can engage with it and create images, which suggest alternative ways of seeing' (Ede, 2005 p.3)

Ede discusses this reflective and experiential aspect of artistic thinking: 'If art is 'about' anything, it is a reflection of human experience in complexity and it emanates from an inventive individual with an unusual and sideways view on things, communicating with vigorous, visual acuity and daring, its intellectual content.' (Ede, 2005 p.3). The role of the artist as described by Ede cannot just be about producing imagery for 'product or propaganda for [the] public understanding of science'. Ede suggests that artists have a responsibility to produce images and artefacts that present an alternative way of seeing the world.

In the work of individual international artists such as Justine Cooper, Angela Palmer, Susan Aldworth and Jane Prophet we see an interpretative approach to describing the inner body. These artists use medical scan data to challenge and explore our perceptions of the body, as exposed by clinical imaging. While these individual artists offer 'alternative ways of seeing' their respective approaches are often more about their own personal statements and creative agendas.

In a clinical context, this artist-centric approach could be seen as inappropriate, with the space for self-expression and ambiguity being redundant in diagnosis. However, to merely produce imagery that serves science would contribute little to the field and inevitably dilute the artist's contribution.

There is evidence to suggest that purely scientific didatic approaches to disease explanation may not be the best suited approach in patient communication. Cecil Helman in his book 'Culture, Health and Illness' (Helman, 2001), describes the communication problems that currently exist in the field of doctor-patient interaction. In particular, the notion of mind and body separation is significant, as it situates disease in the context of mechanics, separate from the mind. Illness is defined by 'objectively demonstrable physical changes in the body's structure or function which can be quantified by reference to 'normal' physiological measurements.' (Helman, 2001 p.80). Medicine concerns itself only with abnormalities of the body, viewing 'physical abnormalities' as opposed to a 'patient's symptoms, their psychological state, or cultural background' (Helman, 2001 p.81). If we are to connect with patients more holistically, I would argue that utilising new visual approaches and creating images that reconnect body and mind are advantageous.

4.0 The author's visual practice: the hybrid approach

The various pathways discussed in this paper all have merit as a means of engaging differing types of audiences using screen-based media. The author proposes that the blending and combining of these modes of visualization can result in an alternative pathway for visualising medical scan data. By mixing the strengths of clinical data and 3D CGI arts based interpretation, a series of 3D CGI artefacts emerge that could facilitate a new mode of interaction. This paper briefly discusses some examples of the author's approach.

I) THE KIDNEYS - WIREFRAME EXPLORATION

Once the data is extracted from the MRI dataset, the artist is left with a 3D model of the anatomy, containing none of the colour and lighting present within real life photographic situations. This provides a mechanism for interaction, displaying a digital model in real-time. In these wire-frame renderings, I can tumble through, around and inside the 3D mesh. This familiarisation process provides me with a means of exploring the complexity of the anatomical form, as well as stimulating ideas for visual narrative and aesthetic.

This type of image is not meant as a fully rendered final shot, but provides a digital sketchbook for exploring form and composition. The image files provide me with a window into the body, although not necessarily an understanding of the body.

II) THE KIDNEYS

The intention of adding digital lighting and colour to the wire-frame model is not to inform the viewer of the mechanical processes involved in blood filtration, but to start to develop an aesthetic language for communication. Using CGI lighting, a visual quality is applied that renders the image more like glass than soft organic tissue (Figure 1 - Kidneys). The transparency used in the render of this image provides a simulated optical effect that shows a structure within a structure. This aesthetic style translates the human kidneys into a screen based digital artefact with an alternative approach to the reductive.

In a separate piece of work a virtual camera was placed inside the aorta. A cave-like interior starts to emerge from the data, as the model is rotated and digitally surveyed. This suggests a feeling of isolation within a very large passageway or tunnel that winds its way through the human body. This stepping inside the aorta enabled me to explore yet another engaging structure, within an overarching complex form. By placing the viewer inside the structure, a sense of audience participation is introduced, challenging the viewer to explore this vast space further.

III) ISOLATION

The inner human body is completely devoid of daylight. It is a space that functions in constant darkness, only ever illuminated by the non-visible spectrum of MRI and X-rays.

Building on further exploration from the same dataset, a single kidney was isolated from the rest of the form. The kidney was rendered using a more diffuse and scattered lighting technique (Figure 2 - Isolation). The form takes on an almost foetal like position with a warmth to the surface. The essence of this image is to convey the sculptural form of the human kidney, isolated from the body.

5.0 Concluding remarks

This paper puts forward the idea that 3D CGI artists can combine clinical MRI data with a more arts-based approach. The goal of this combined approach is to develop a new visual aesthetic. The application of this type of work transcends the gallery space, offering digital imagery that could stimulate dialogue between health professionals and patients; an impartment of information beyond the purely functional.

It could be argued that this is not a new approach. The early anatomists saw this philosophical stance as the norm. The Renaissance humanist and Professor of Anatomy at University of Padua, Andreas Vesalius

(1514-64) published seminal work, entitled 'De Humani Corporis Fabrica Libri Septem' (The Fabric of the Human Body in Seven Books) (Versalius, 1543). This provided the first detailed published anatomy book in western medicine. Vesalius believed in the humanist notion that images embody an idea and offer meaning beyond words. This work revisits this approach, in developing a contemporary visual language for potentially improved patient interaction and communication.

References and Notes:

DE LA FLOR, M. 2004. The digital biomedical illustration handbook, Hingham, Mass. : Charles River Media, Inc.

DIJCK, J. V. 2005. The Transparent Body: A Cultural analysis of medical imaging, University of Washington Press.

EDE, S. 2005. Science & Art, I.B.Tauris & Co Ltd.

GEWIN, V. 2005. Picture this. Nature, 435, 1132.

HELMAN, C. G. 2001. Culture, health and illness, Arnold.

HODGES, E. R. S. 2003. The Guild Handbook of Scientific Illustration, Wiley.

HYBRID. 2010. Hybrid Medical Animation <http://www.hybridmedicalanimation.com> [Accessed 11/12/10] [Online].

MCGHEE, J. 2010. 3-D visualization and animation technology in anatomical imaging. Journal of Anatomy, 216, 278.

OSIRIX. 2008. Osirix <http://www.osirix-viewer.com/> [Accessed on the 24/08/08] [Online].

RIFKIN, B. A., ACKERMAN, M. J. & FOLKENBERG, J. 2006. Human Anatomy: Depicting the Body from the Renaissance to Today Thames & Hudson.

ROSEN, R. 2000. Essays on Life - Complexity in Ecological Systems, Columbia University Press.

VASALIUS, A. 1543. De Humani Corporis Fabrica, Venice, Senensem Germanum.

Acknowledgements

This paper would not have been possible without support from the following staff: Professor Graeme Houston, Professor Nigel Johnson, Dr Louise Valentine and the clinical team in Radiology, Ninewells Hospital, Dundee, NHS Tayside. Scotland.