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Introduction Invisible Vision: Could Science learn from the Arts?

A different point of view is simply a view from a place you are not.[1]

We are not surprised anymore when, making our way to collect our baggage at Amsterdam's Schiphol Airport, we bump into a more-than-life-size ultrasound image of a foetus ('Because babies don't come in two dimensions') as part of Philips' 'Sense and Sensibility' marketing drive. Or when we look at the intriguing image of a Renaissance painting that looks as if it had been put under an x-ray device. Instead of showing the layers of paint, the skin and bone of the skeleton of the subject are revealed. This image accompanied the slogan 'Discover all that you don't usually see' in the advertising campaign introduced in 2005 for the Italian newsweekly *L'espresso*. Neither does the billboard on Barcelona's Plaça Catalunya shock us by displaying a green-coloured X-ray of a skull with the slogan 'Piensa verde!' – Think Green! – with a red dot purporting to show where the 'active drinking part' of the brain is located according to the Dutch brewers Heineken. And what to think of Esso's campaign on energy challenges – 'More energy and lower emissions: Only one kind of power can deliver them both' – being illustrated with a scan of a human brain? Medical images have released themselves from the isolation of the medical world to become part of our day-to-day life. Scientific imaging has gone public.

Visual Culture

The 21st century is the era of visual culture, and scientific imaging has gained a place in it.[2] As easily as we can fly virtually through the world with applications such as Google Earth, we can also travel the human body.[3] Many of us are already captivated by Google Earth's three-dimensional interface with the planet, which combines satellite images with topographic maps and Google Search on our desktops. We can tilt and rotate through the images to see the surface of the earth and mountains in three dimensions or look for our homes from the air, all behind our own computer screens.

The same kind of tour is possible through the body. At the end of 1994, the digital data set of the 'perfect male' was released online as the Visible Human Project by the US National Library of Medicine. The corpse of 39-year-old convict-

ed murderer Joseph Jernigan, who was executed by lethal injection in Texas in 1993, was imaged with magnetic resonance and computer tomography, and then frozen solid in a block of blue gelatine. Next, it was sliced from head to toe into more than 1,800 ultra-thin layers, and electronically scanned. The slices of this digital man can be downloaded and his 3-D body seen from every angle.[4]

Today's world is becoming steadily a more visually based society. The current generation is already growing up with the technology to communicate through computer screens, icons, sounds, and games. 'Homo Zapiens' has learned to be in control of information flows and deal with information overload in a world full of electronic devices (computers, game consoles, iPods and mobile phones).[5] This new trends cannot leave the more traditional and conservative worlds of science unaffected.

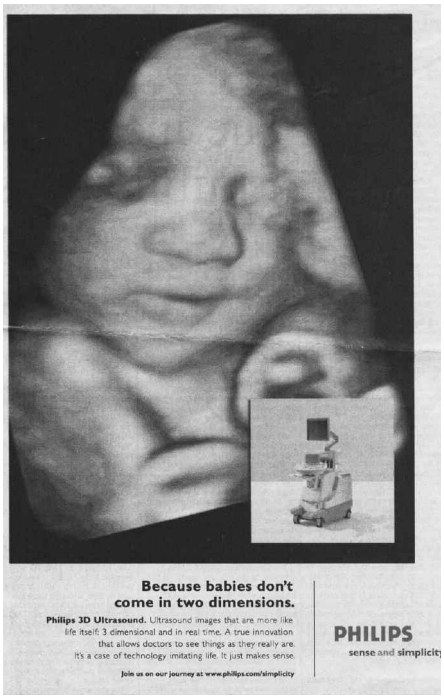
Our visual culture also shows an increasing use of scientific images in addition to, or in place of, words. Medical images cross our path in daily life at an ever-increasing rate, not only in a medical context but – perhaps even more often – in popular culture, through art, advertising, film productions and so on. In this book medical digital imaging is placed at the heart of present-day trends.

To witness the body inside out is an unmistakable way of grabbing the viewer's attention. Images made with the help of microscopy, X-rays, MRI, CT, PET, endoscopy, and echoscopy have become an inexhaustible source of inspiration. Images of the inside of the human body, and especially of the brain, have become icons in themselves. These 'transparent' body parts move between popular culture, scientific application, and artistic interpretation.[6] The transformation and translation of scientific images for such different contexts as the laboratory, publication in a scientific journal, online version, or as a work of art in a gallery will all change the meaning of the image. Could the arts be of added value in bringing this meaning forward?

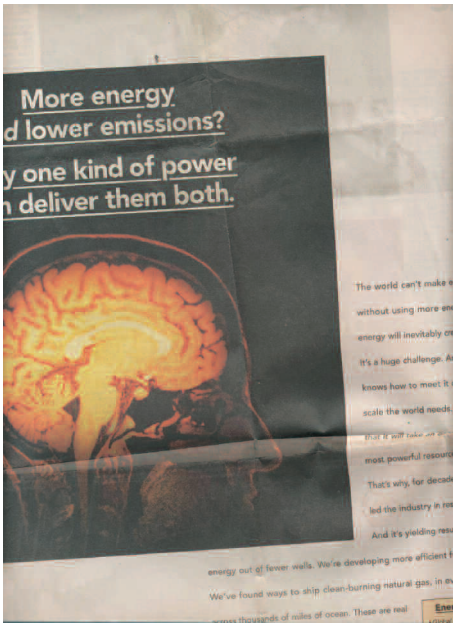
Inside Out

We are now so used to seeing the human inside out that it is hard to remember that it was only until the late-19th century that for the first time we could see inside the human body without having to open it. Before then, we were already capable of seeing particles too small to detect with the naked eye. The Dutch microscopist Anthonius van Leeuwenhoek (1632–1723) first gazed into the microscope to detect what were – for the human eye – invisible bacteria and semen.

If there had been a Nobel Prize in the 17th century, Van Leeuwenhoek's efforts would probably have been worthy of one. It would fit in the distinguished line of other laureates of fundamental research in the field of scientific imaging. Biomedical imaging techniques overall have played an important role in Nobel Prize decorations, and they form an important strand in the story of science, starting with Wilhelm Conrad Roentgen's accidental discovery in 1895 of skin-penetrating X-rays. Until then, anatomical knowledge was completely dependent on dissec-



[Full page with 4 illustrations: Because babies don't come in two dimensions/ Esso's campaign/Heineken's campaign/L'espresso by lowe pirella agency /Power of 10- Eames].



tion and visual exploration. Leonardo and his contemporaries observed and visualized the anatomy by physically dissecting the body and turning 'the inside out', from which understanding of the mechanisms of the human body followed.

Roentgen's discovery of this invisible vision was awarded with the Nobel Prize for Physics in 1901, followed in 1906 by the awarding of the prize for Physiology or Medicine to Ramón y Cajal and Camillo Golgi for their attempt to visualize the nerve cells of the brain by colouring them in silver nitrate. To add other significant discoveries to the list, the development of computer-assisted tomography should be mentioned by Godfrey N. Hounsfield and Allan M. Cormack, which ushered a new era in diagnostics and also gained a place in Nobel's gallery in 1979. Hounsfield is indisputably the key figure of the scanning device: he understood the drawbacks of X-ray, which could not distinguish between various soft tissues, and is a 'shadow play' that only shows structures in two dimensions. He developed a computerized imaging technique to overcome those shortcomings, and with his first clinically used scanner the inside of the head was visualized.

In addition to these developments, the fundamental work in electron optics should also be mentioned, as it resulted in the design of the first electron microscope and the scanning tunnelling microscope by Ernst Ruska, Gerd Binnig, and Heinrich Rohrer, who deserved the Nobel Prize in Physics they won for it in 1986. In 2003 the discoveries concerning magnetic resonance imaging by Paul C. Lauterbur and Sir Peter Mansfield were memorialized by the Nobel Prize for Physiology or Medicine. Nowadays, the different imaging techniques have become established procedures, and as a result, the invisible vision has become part of our culture.

Making the Invisible Visible

While scientific images are made that are astonishing and aesthetically beautiful – and are sometimes even referred to as 'art' – the same images can also be the carrier of bad news. The scan that shows the amazing structure and function of the brain could also indicate the presence of a malignant tumour. These images each occupy a point on a spectrum that ranges from the beautification of scientific images – seen as representing the 'art' of medicine – at one end, to the raw data, consisting of numerous bits and bytes, at the other. These latter, complex, multivalue data sets need to be translated and 'functionally beautified' to be meaningful to the viewer. Yet, with each step in the visualization process, from the patient undergoing the scan to its analysis by a medical specialist, there is the risk that important information could be distorted or lost. Could medical imaging, in the process of visualizing science, perhaps gain new angles of incidence from the arts?

In the chapter 'Making the Invisible Visible' we will go through time to follow the human attempt to unravel, step by step, the mystery of the interior of our bodies, and realize the interaction between science and art. Could medical digital imaging learn from the arts in a way comparable to anatomists and artists in the Renaissance?

Science Visualization and Data Beautification

Since the birth of human anatomical study, the image of the human body has been built up (now literally) bit by bit, through (bio-)medical digital three-dimensional imaging techniques such as Computerized Axial Tomography (CT), Magnetic Resonance Imaging (MRI), and Positron Emission Tomography (PET). Medical imaging went through a golden age that saw the invention of the most prominent medical digital imaging techniques. However, the great increase in data causes an information overload in a way we have never experienced before. To use the information as accurately as possible, new ways need to be found to scroll through the data and present it.

Could conventions and skills from traditional scientific illustration and art be applied to medical imaging in order to translate the intrinsic digital information into a meaningful image? Could medical imaging learn from the arts in this respect?

From the 'Art' of Medicine to Art in Medicine

Why should a scientist actually spend time on something as frivolous as art? Could merging the two disciplines lead to new insights in both worlds? Those questions are often raised when analysing collaborations between artists and scientists. The process of interaction between science and art is studied in the chapter 'From the 'Art' of Medicine to Art in Medicine'.

The scientist and artist seek the interaction and dive into a real dialogue with each other, which could lead to new insights in both worlds based on 'visual intuition'.[7] Art and science are not the same thing, but they well up from the same inner necessity to gratify our systems of perception, cognition, and creation.

Even though the means and ends are quite distinct for a scientist and an artist, they potentially share a 'structural and visual intuition' – coined by art historian Martin Kemp –, which 'are the most potent tools we possess for feeling our way into the unknown'.[8] This synthesis results from the profound cooperation between scientists and artists, in which the scientist could 'learn' from the artist and vice versa during the process of interaction.

Imaging and Imagination of Science

Since the beginning of the 21st century the basic principles of medical visualization technology have not altered greatly. Yet, in the meantime the capacity of computing power has expanded enormously, and we are capable of producing more slices with every scan and ever more highly resolved data. Graphics cards in computers transforming digital data into images are also becoming more sophisticated, and screen resolution is increasing. The steady increase of working storage, processor speeds of computers and the growth of more powerful graphics cards are of added value to all fields of three-dimensional visualization.

Medical imaging was, and still is, an interdisciplinary speciality, which merges not only with traditional medical fields such as radiology, physics, and medical technology, but more recently with creative and artistic domains such as art, animation, digital games, virtual reality, scientific illustration, film, and photography. This leads to interesting, unexpected fields such as medicine serious games, virtual reality applications for medicine, the fusion of scientific illustration with 3-D modelling in volume illustration rendering, and data beautification. This chapter explores these new territories, in which scientific visualization has become commonplace.

In the chapters to come, medical imaging will be looked at from unconventional perspectives and angles. Bringing science and the arts together leads to different insights, a better public understanding of science through art, and cross-fertilization.