National College of Art & Design

Fine Art Faculty

Painting

Dissecting The Visible Human Project;

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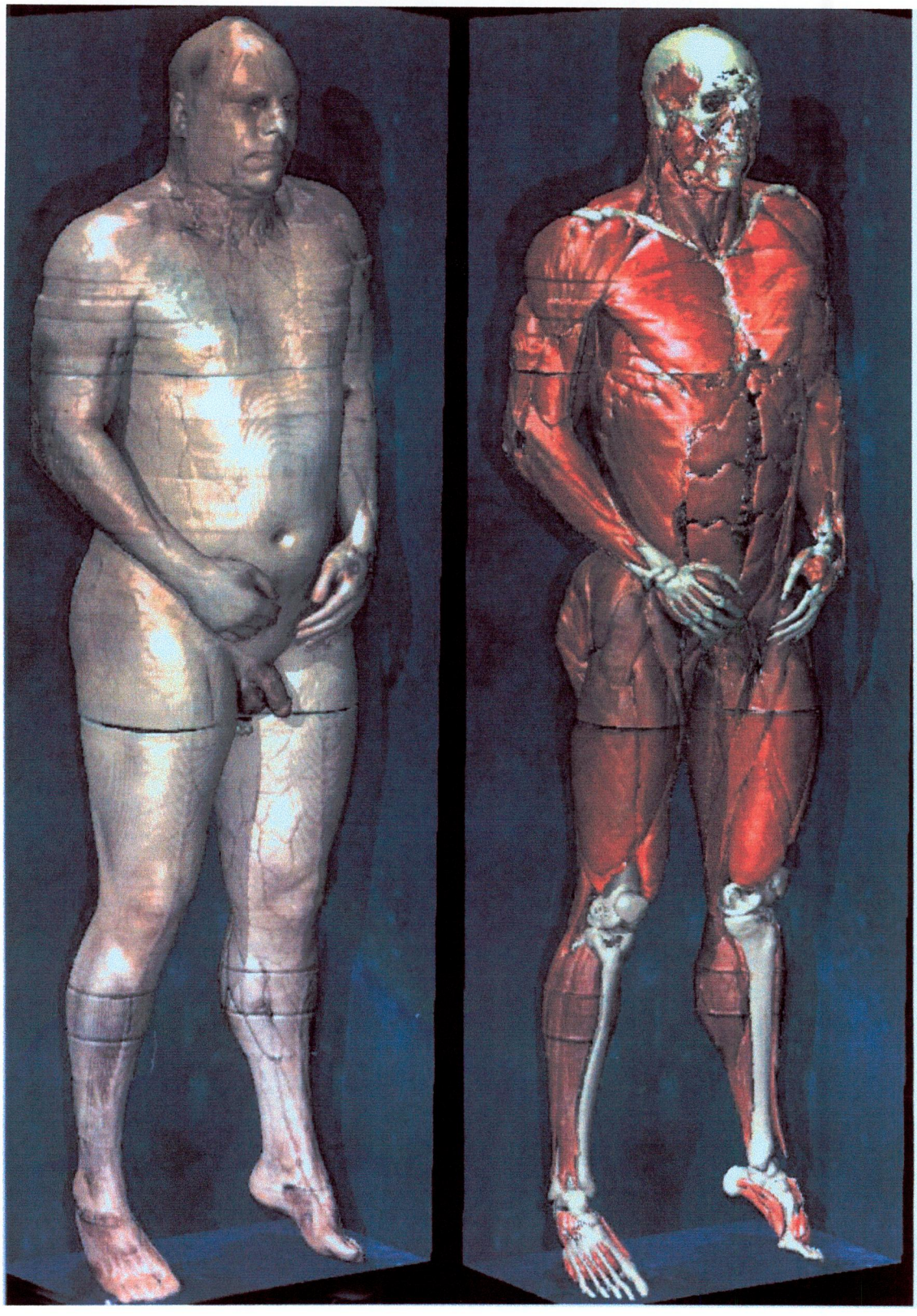
INTRODUCTION

This paper addresses itself to the medical representation of the body within anatomical atlases generally, and to the Visible Human Project (VHP) in particular.

The Visible Human Project has its roots in the National Library of Medicine in Bethesda, Maryland, USA. Because of the increasing role played by electronically represented images of the human body in clinical medicine and biomedical research, the NLM foresaw the time when its factual database would be complimented by a library of digital images. In 1989 the NLM began the first in a series of projects to build digital image libraries representing a "complete, normal adult male and female." (Ackerman, 1997, p.1)

The 'Visible Human Project' is the first anatomical atlas to visualize an entire human body using modern medical imaging technologies. It transforms real human cadavers into three-dimensional visual data, which can be dissected and animated on computer screens (Fig. 1). Because of the digital quality of the project, its method of distribution is through the World Wide Web (at http://www.nlm.nih.gov/visible human.html). Since the atlas went on line in August 1991, it has received a great deal of medical and public attention due to the nature of the procedure involved in obtaining the images,



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and the fascinating imagery that the project has produced.

Anatomical images are in themselves objects of curiosity. Despite their repulsiveness they can be quite spectacular, and have the power to simultaneously repel and attract. As such they become objects of fascination and 'spectacle,' and in some instances even 'fetishization.' One of the reactions to the imagery in the VHP is definitely a kind of 'fascinated horror' at the way it treats the body as meat, without even hiding the fact. What is interesting about the illustrations in any anatomical atlas, is that they simultaneously embody an ideology of the bodies they illustrate, as well as demonstrating the anatomy of the 'bodies' they represent. Since the introduction of anatomical atlases, the anatomical illustrations in them have recorded not only gains and changes in medical knowledge of the human body, but the moral and scientific transformations surrounding the dead and the living body.

The long-term objective of the VHP is to 'transparently' link static anatomical images of the body with the written knowledge of the physiology of the body. (Ackerman, 1997, p.2) It is proposed that the VHP will replace the tradition of using cadavers in medical schools to train doctors and surgeons. In this way, the VHP aims to set the standards and point the direction for a 'new' way of studying anatomy in the 'technological' future. The aim of this thesis is to question whether medicine's 'new' analogical vision constitutes a 'new' way of knowing the body.

The Visible Human Project is peculiar in that it has two rather distinct genealogies/histories. As an anatomical atlas the project is situated within medical and artistic traditions that can be traced back as far as the Renaissance, which marks the beginning of the science of anatomy. At this time artists such as Leonardo da Vinci, and anatomists such as Andrea Vesalius, started to change the way the body was represented and the way it was studied. This eventually led into the Enlightenment project, which precipitated a rational enquiry into the body, and gave us the Cartesian model of the body as a split between the mind that thinks and the body that is.

As a digital atlas the project is part of a 'technological revolution' which has taken place over the last twenty years. This aspect of the VHP can be directly linked to the mechanisation of vision that took place during the Englightenment project in the course of its search for objectivity in the sciences.

Both of these genealogies will be investigated in order to show that in spite of technological progress, when the Visible Human Project is placed within the historical and cultural context of anatomical atlases, most of the processes and ideologies contained within can be traced back to the Renaissance and Englightment projects.

The first chapter will discuss anatomical atlases, and the historical, anatomical representation of the body. In the second chapter I will look at mechanical and digital imaging techniques. The third chapter will discuss the Visible Human Project. The final chapter will consider the VHP as a form of 'post-natural' life.

Chapter 1 - ANATOMY AND THE RENAISSANCE

A simple and useful way of viewing anatomy is to consider it as two separate but connected practices, that of anatomy, and that of dissection; these have been described as "two parts in a single act." (Wilson, 1994, p.63) The science of anatomy is made up of a number of different processes; (similar to the body it studies), which together form a science. The paradox of anatomical science is that it studies the structure of living bodies through dissection of dead bodies.

Dissection can be seen as the splitting of something into smaller more organisable parts; and anatomy as the way these parts are reassembled to form a knowledge about the body. Anatomy and dissection go together like 'wax and a seal', and it is through the combination of these processes that a science of the body is formed. The body in Renaissance anatomy is represented as a system of parts, which are identified in dissection and reunited in anatomy.

During the Renaissance there was a change in the basic approach to scientific study and teaching. The body was central to Renaissance culture because the way the body was partitioned and analyzed in dissection served as the models for subsequent investigations into other organic matter. The body was used primarily as the object of 'visual demonstrations' which were deemed essential to learning.

Sawday, in 'The Body Emblazoned', regards the Renaissance as a "culture of dissection" and explores the way anatomy was used to organize the body in the early modern period. (Sawday, 1995, p.2) In this sense, dissection of the body not only led to a knowledge of the body, but also to the formation of 'bodies of knowledge', one of which was human anatomy. In the Renaissance period, the scientific practice of investigation which encouraged the partition and classification of the world and everything in it, was based on 'visual demonstration' practiced on the human body.

The examination and classification of 'the body' took place within the 'anatomy theatres' of Europe, and on this stage, through the anatomist's engagement with the cadaver, a 'knowledge' of the living body was formed. The anatomy theatres of Padua, Bologna, Leiden, Paris and Amsterdam were all seen as respected centers of learning and knowledge; for a city to have an anatomy theatre was of great importance. The anatomy theatre lifted anatomy out of the shadows and placed it centre stage as the basis for gaining 'knowledge' of the body. The process was sanctioned by the Popes in Italy, Kings and Queens in England and France, and by civic government in Holland.

During the Renaissance, those who had transgressed society's rules were routinely sentenced by the courts to 'death and dissection.' Dissection was seen as the punishment of the body beyond death; a "prolongation of the suffering inflicted by the

executioner." (Lupton, 1993, P.45) Because of this view, most of the cadavers dissected were the bodies of criminals. Sawday has pointed out that "the entrance of the medical gaze into the interior of the body under the control of the judiciary, is the beginning of the surveillance of the body within regimes of judgement and punishment." (Sawday, 1995, p.) This is what Foucault has called the 'spectacle of punishment;' by making an example of an individual body, it was a way of controlling the larger population. (Foucault, 1977)

During the Renaissance the whole idea of dissection was surrounded by enormous contradictions. The body was considered to still house the soul after death, so on the one hand, dissection of the body was regarded as 'taboo.' On the other hand, because this process was thought to reveal the hidden secrets of the human body, and also because dissection was usually part of a criminal's punishment, its execution was a celebrated, almost theatrical, public event.

It was in the Renaissance anatomy theatres of Europe that the spectacle of dissections reached its peak (Fig.2). All sorts of people paid to go and observe the dissections; the audiences were made up of wealthy people from various backgrounds, not just the field of medicine.

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Dissections were carried out in the dead of night, in secrecy, by people such as Leonardo and Vesalius, because there was always a shortage of cadavers available through legitimate means. In the 1600's there was an 'economy of flesh'. The black-market trade in cadavers in Europe, where human flesh was sold by weight, built the first fortunes of modern medical science. (Hockenberry, 1996, p.45.) The practice of grave robbing was a frequent means of acquiring cadavers for study purposes. Vesalius himself confesses to stealing corpses from the gallows. (Harcourt, 1987, p.43).

There was never any danger that the bodies of kings and queens or popes would end up on the dissecting table. The taboo surrounding dissection ensured that only the bodies of those at the bottom rungs of society were used. In Britain for example the Anatomy Act of 1832 offered science the bodies of the poor and the destitute. This Act legalised the cutting up of any unclaimed bodies from public institutions such as workhouses, hospitals, asylums, and prisons. This act clearly distinguished which, political and social, bodies were deemed suitable for dissection.

ANATOMY AND THE DEAD BODY

Anatomy which produces knowledge about the living body's structure does so through the analysis of dead bodies. To gain knowledge about the living body, the dead body

must be opened up to vision. It is this process that took place within the Renaissance anatomy theatres.

The living body is resistant to us knowing it, in this sense it is uncontrollable. The living body operates as an organic totality that is resistant to reduction and dismemberment. (Wilson, 1987, p.62) Only a corpse can be treated as an uncomplicated object of logical dissection. In the anatomy theatre the corpse was the privileged object of the anatomical 'gaze', because it could be readily opened up and reduced to organs, limbs, and cells, to which importance could be ascribed. The corpse rather than the living body, is central to the production of the anatomical knowledge due to its use as a 'working object'.

A 'working object' is a simplified form of organic matter. It standardizes the organic matter that science seeks to study. Its function is to make the organic matter fit in with the scientific process "because unrefined natural objects are too quirkily particular to cooperate in generalization and comparison." (Daston and Galison, 1992, p.85). Anatomical atlases were produced as a standardized substitute for the living body.

VESALIUS AND THE FABRICA.

One of the best known examples of an anatomical atlas is the 'De Humani Corpus

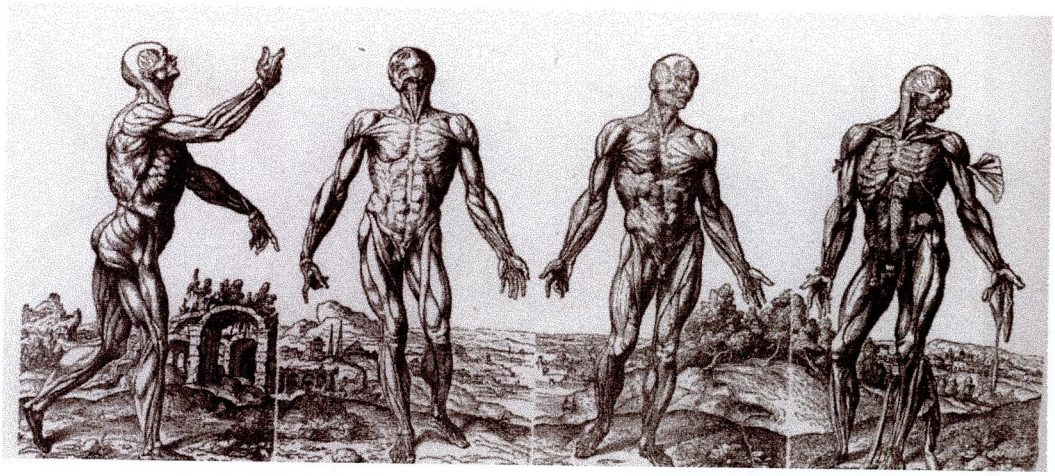
Fabrica' by Andrea Vesalius, published in 1543. Vesalius was a lecturer of anatomy in Padua who after finding that existing texts of the 'body' differed from what

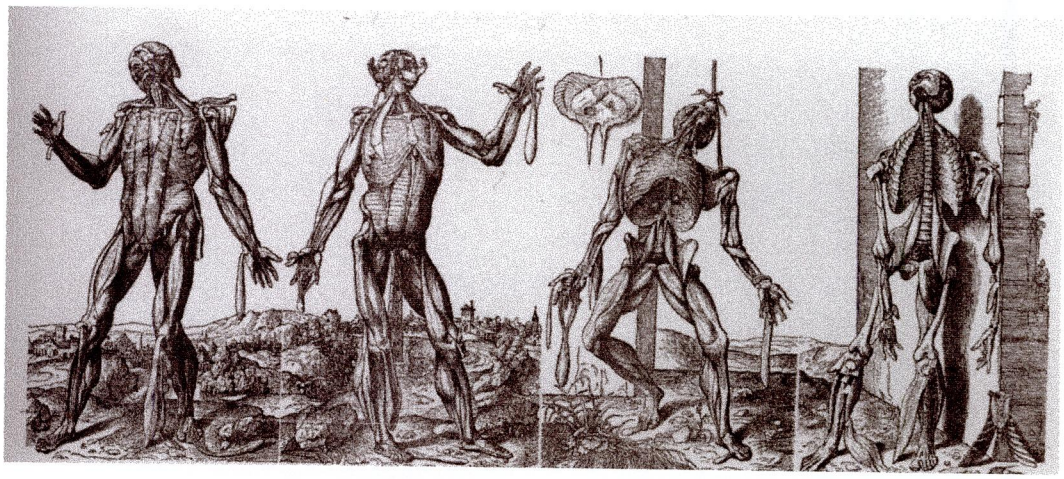
he saw in practical dissection, decided to produce his own textbook as a critique of the accuracy of existing texts.

The illustrations in the 'Fabrica' were to act as a 'substitute' for the human body, and the text provided detailed instruction in correct dissection and surgical techniques of a human body. (Simpson, 1991, p.10)

Vesalius's illustrations do not originate from one individual cadaver, but from a number of dissections over a period of time. As such, the illustrations claim to describe an 'average' human anatomy, which under ideal dissection conditions, could be shown to be accurate (Fig.3). Because Vesalius wanted to produce a normative description of human anatomy it was "desirable that the body employed for public dissection be as normal as possible according to its sex and of medium age, so you may compare other bodies to it,..." (Harcourt, 1987, p.42.) The 'Fabrica' establishes its norm by repeated observations made by Vesalius himself in the course of the many dissections he performed.

The representation of a 'normal' human anatomy in the "Fabrica" serves to distance





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itself from any particular individual body. Composed illustrations in the Fabrica represent an evasion of the unsavory process that 'real bodies' had to undergo in order to extract knowledge.

The publication of the 'Fabrica" in 1543, marks a major episode in the history of scientific anatomy, by its 'realistic' representation of the body. Many writers have suggested that Vesalius conducted the first scientific investigation of the body, (Singer, 1957; Harcourt, 1987; Sawday, 1995) however, through lack of cadavers and the subsequent use of animals in comparative anatomy, many of his observations concerning human anatomy were wrong. The 'Fabrica' shows bones that do not even exist in human anatomy. Never the less, there are numerous reasons why it is still considered important.

The Fabrica stands out in anatomical history as the first atlas to try and represent the whole of the human body. Direct observation played a huge part in the production of the illustrations, and Singer described the 'Fabrica' as "the first great original treatise involving a large amount of observation in any department of the sciences and also one of its first positivist achievements." (Singer, 1957, p.123).

There is a tendency to view the 'Fabrica' as a piece of Renaissance art rather than a

scientific text. This is understandable as the representation of the body plays a significant part in making up the cannon of Renaissance art, as understood today. But in the Renaissance, art and science were considered the same. It is the representation of the body through visual means that marks anatomy as a descriptive science. (Harcourt, 1987, p.29)

Anatomical atlases performed a number of different functions. Firstly, they served as publicity for the scientific community; they are also useful as a visual tool to aid the memory of students and doctors; finally, they are "incorruptible evidence" of 'truth' of the body.(Daston & Galison, 1992, p.86)

ANATOMICAL ATLASES AND OBJECTIVITY.

Once Vesalius had based the study of anatomy on direct observation it presented a problem of representation for atlas makers that was never really resolved. This is the dilemma of whether the atlas maker should depict a particular body, with all its idiosyncrasies, or whether, like Vesalius, the illustrations should represent a synthesis of knowledge based on evidence derived from many sources. The problem became one of 'objectivity.'

In questioning the production of images of the human skeleton, as represented in

anatomical atlases in the 19th century, Daston and Galison indicate the extent to which anatomical images are produced as 'ideal types.' (Daston and Galison, 1992, p.87).

Not only does Daston and Galison's study of anatomical atlases show how 'ideals' were used in a sexist and racist way, but they also argue that the search for 'working objects' was bound up in epistemological concerns of representation and objectivity. The purpose of anatomical representation has been to 'standardize' the body. By using an 'ideal' as a standard, and ignoring individual idiosyncrasies, the images were able to circulate as being 'representative' of the body. The need for standardization to produce 'working objects' then raises the question of deciding what is 'ideal.'

Daston and Galison suggest that the 'ideal' is one of two variants within the range of the 'typical' variations of the fleshy body; the other is the 'characteristic.'

> Briefly put, the 'ideal' image purports to render not merely the typical but the perfect, while the 'characteristic' image locates the 'typical' in the individual. Both standardize the phenomena, and the fabricators of both insisted upon pictorial accuracy. (Daston and Galison, 1992, p.88)

Both of these variants, which become representative of 'normal,' show how different decisions concerning the same, supposedly objective, science of anatomy were made. These decisions still pose problems for present day atlas makers.

ANATOMICAL ATLASES AND THE SOCIAL BODY.

The material in most anatomical atlases is not organised as one might expect, by tracing the procedure of dissection in the anatomy theatre. Instead, the way the body was represented in atlases betrays a belief system relating too philosophical and socio-medico discourse about the body at the time of its production. (Petherbridge, 1997, p.63)

For example, the male body is the preferred object of illustration in anatomical atlases. Parts of women's bodies were represented, but the exclusion of 'complete' women's bodies from atlases, and the concentration on their reproductive organs highlights both a concern with 'origins,' and the homo-centricity of anatomical discourse.

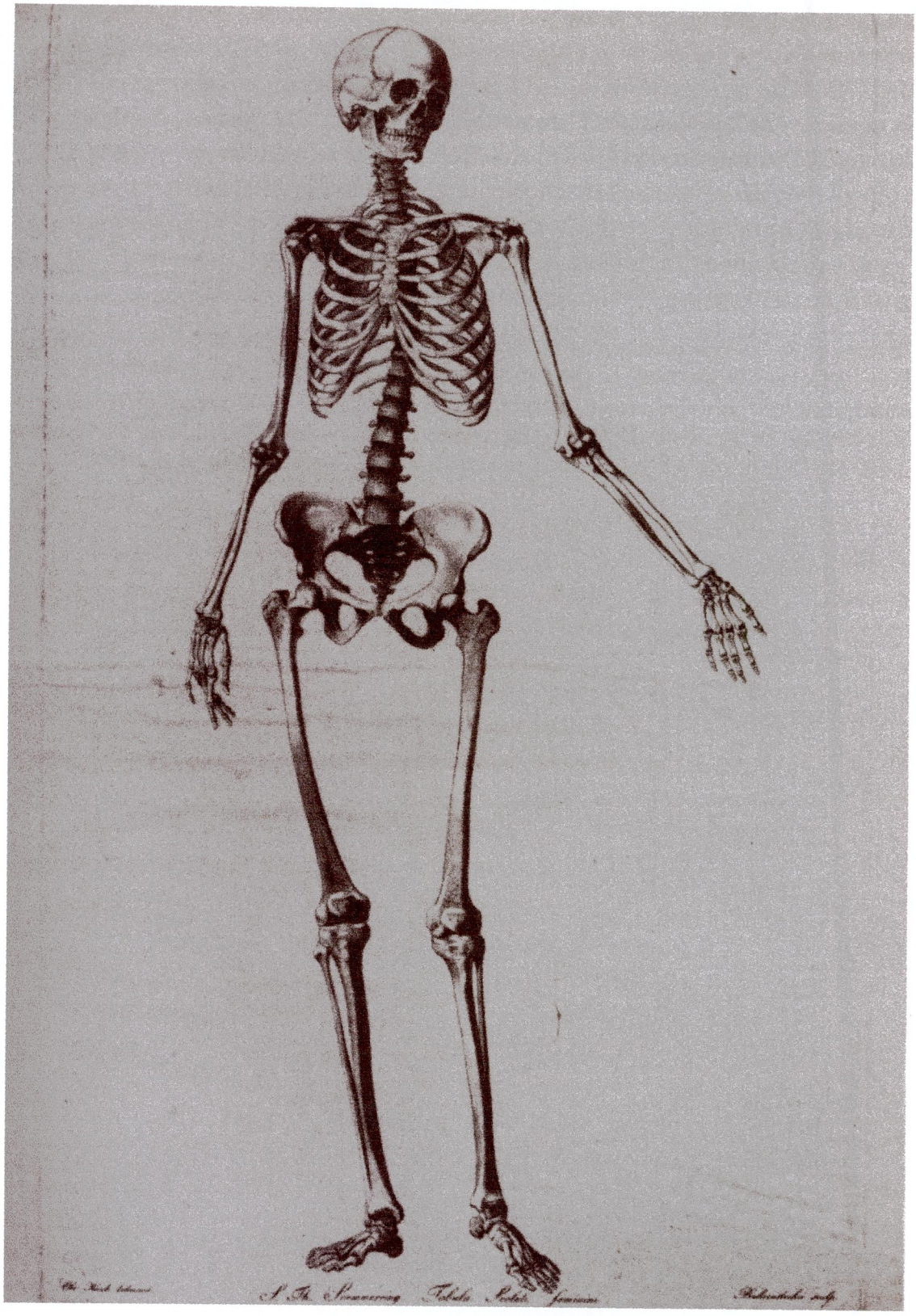
Consideration of the way in which women's bodies have been represented throughout the history of anatomy will show that anatomy is not a 'neutral' scientific practice.

Londa Schiebinger has described how representations of the skeleton have played an important part in the debates concerning the role of women in social and political life. Through examination of the 'first' representation of a female skeleton, in an atlas

published by Samuel von Soemmerring in 1796, she shows how the representation of the female skeleton was based in an ideology that saw women as inferior to men, and ascribed them specific social roles. (Schiebinger, 1986, p.42)(Fig.4). In the late 18th century, the question of the size of the woman's skull became the focus of a debate concerning the intellectual deficiencies of women. The size of the skull, and the brain it contained was used to discriminate against women entering education and public life. The size of the hips inscribed the role of motherhood, which was promoted due to the "mercantilist interest in population growth," onto the skeleton. (Schiebinger, 1986, p.53) The skeleton had long been seen as the foundation of the body. As a result, sexual difference in the skeleton formed the basis of sexual difference everywhere else. The anatomical investigation of 'woman' in this context highlights a paradox of scientific practice that still effects women today.

What has been made clear in this chapter is that after Vesalius published the "Fabrica," illustrations based on direct observation became the most important aspect of anatomical atlases, which were judged good or bad by the illustrations they contained.

However, the complexity of Vesalius's project of illustrating the form and function of the entire body, was unsustainable through artist's representations. (Harcourt, 1987, p.50)



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Chapter 2 - MODERN IMAGING TECHNIQUES.

The aim of this chapter is to examine the role of photo-mechanical and electronic imaging in the search for an 'objective' anatomical representation of the body.

All the illustrations in Renaissance anatomical atlases had one thing in common the hand of the artist, which was guided by the eyes, and as every artist and scientist knew was capable of making mistakes. The ideal behind anatomical illustration was exactitude and the potential for human error had to be eliminated if anatomy was to become an objective science. The only way to rid science of the subjectivity of the artist was to 'control the representational process itself by automatic means...In the age of science, mechanisation could and would triumph over art'. (Daston and Galison, 1992, p.100)

Anatomical science has always been quick to seize any new technique that helps with the visualization of the body. It has moved from the hand illustrations of the artist and anatomist to the supposedly more 'objective' technologies of the 'camera obscura' and the camera in a search for objectivity.

MECHANICAL OBJECTIVITY

Mechanical objectivity, in the form of the photographic image, became a symbol for non-interventionist objectivity. This was because it eliminated human agency. However the concern over objectivity was not settled by photography. Photography merely entered the debate along with other attempts at denying subjectivity.

The x-ray is a potent example of the failure of mechanical representation to achieve the standard of objectivity that science sought for itself. By the 1900s x-ray atlases were widespread in Europe. One of the most famous x-ray atlases was produced by Rudolf Grashey who at the beginning of his atlas stated his aversion to the 'artistic.'

Grashey's atlas was made up of X-Ray images taken from a complete cadaver. After he finished imaging the body with X-rays he dissected the cadaver to verify the accuracy of the images. Grashey found that the images of the body that the X-rays produced were inaccurate. There were parts of the X-ray image that did not correspond to what was found when the cadaver was dissected. (Daston and Galison, 1992, P.106)

This led to a situation where the physician had to interpret the 'systematic deviations' in the X-ray image. Grashey also found it difficult to differentiate the 'normal' from the 'pathological' in individual images. To combat this he made images of "the most striking and rare deviations," (Daston and Galison, 1992, P.107) to illustrate the difference between the 'normal' and the 'pathological' X-Ray image, which without training would not be obvious to the viewer. As Foucault commented "the only pathological fact is a comparative fact." (Foucault, 1975, p.130) The eye of the observer had to be trained to interpret the new images that X-ray photography produced. This mechanisation of vision in medicine entailed a shift in the burden of representation away from the image-maker and onto the observer; "mistrusting themselves, they assuaged their fear of subjectivity by transferring the necessity of judgement to the audience." (Daston and Galison, 1992, P.109)

In the 20th century, scientific imaging of the body has progressed dramatically, allowing the body to be observed in even smaller parts. The development in scanning techniques allows medicine to see and record physiological processes as well as anatomical structures. Medical imaging technologies produce new representations of the body, which are much different to the hand drawn illustrations that preceded them. These images present doctors with problems of interpreting the highly technical and abstract images produced by medical imaging technologies. People with no medical training could understand something of the body's structure by looking at hand-produced illustrations of the body. The new images produced by digital means on the

other hand appear totally inaccessible to those who have not been trained to interpret them. (Cartwright, 1995a, p.220)

Most of these technologies produce images that appear in black and white format. To make the images user friendly the adding of colour has become standard in most imaging techniques. Colour makes the images user friendly by clarifying and differentiating the various parts of the body under study. Colouring also gives the images an aesthetic quality that is quite 'surreal.' In fact to look at most of them you would hardly recognise that the images represent parts of the body at all. Cartwright notes that within imaging technologies it is not the physician but the computer graphic artist who is the real authority behind the images. It is the artist who knows "how to build, and interpret the systems and images it produces." (Cartwright, 1995a, p.222)

The interpretation of images which have been created by the new technologies has led to a great deal of confusion among the medical profession, as there is no single, technique or procedure for the 'standardisation' of the images produced by all the different technologies.

"Image" is a program distributed by the NIH in an attempt to bring order to the 'unstandardised' world of image technologies. The NIH distributed the program

through the Internet and "Image" provided a system of "standardized colorization and spatial encoding systems, data analysis technique, and display modalities." (Cartwright, 1995a, p.231)

Each medical imaging technology has a specific clinical use, but can only be understood and produced through extensive technical mediation. The drawback of these image technologies is that they simply cannot image/'see' the body's interior in a 'naturalistic' way. This presents users of the technology with multiple problems of interpretation before they can be applied to particular human bodies.

The search for better, and more objective ways of seeing the body in medicine seems to have turned back on itself. Objectivity and the 'truth' of what we see in the image are even more difficult to perceive today. Jonathan Crary

explains that this is because images no longer have any reference to an observer in a 'real,' optically perceived world. Human vision in the field of scientific is being supplanted by digital machines. (Crary, 1990, p.2)

The supplanting of human vision by digital vision means that we are able to make more images than ever before but are less able to understand them. Sarah Kember argues that because of this, the performance of the observer has come under scrutiny,

and the once sovereign clinical eye is incorporated into the machine as a design fault. (Kember, 1995, p.109)

TOUCHING BY LOOKING

X-Rays are an important example of showing the way that changes in medical technology affect and alter the body so that it can be visualized. In "Screening the Body" Lisa Cartwright points our attention to the way that the living body, when used as 'test object' by science is altered to suit the purpose of the study. She uses the case of Clarence Daly and X-rays, to show the dangers involved in the altering the body in an attempt to visualise it. Daly was Thomas Eddison's assistant in his investigation of the X-ray, and used his hand as a 'test object' for the equipment. As a result Daly's body became afflicted with cancer, which started in the hand, and progressed through his body. To combat the cancer Daly underwent numerous amputations of his limbs "joint by joint" to stop the cancer spreading. In 1904 he died from X-ray induced carcinoma after many amputations. (Cartwright, 1995b, p.110)

This case highlights the potential for violence within technologies of medical vision, and the impossibility of a mechanical, non-interventionist mode of vision. As Evelyn Fox-Keller puts it, "it is the impossibility, even in the physical domain, of looking without touching: the very light we shine disturbs the object at which we gaze."(Fox-

Keller, 1996, p.117) Even for state of the art imaging technologies, this remains a problem.

New technologies, especially imaging technologies, are marketed as being of major benefit to medicine, but in pursuing this end, they alter, even damage the body in some way. The example I have given is perhaps an extreme example but 'non-invasive' modes of medical vision must alter the body in some way in order to see its workings. As Cartwright showed with x-rays each require processes of standardization to make them safe and involve risks to human subjects.

Medical imaging technologies occupy a peculiarly ambiguous place within the history of medicine. They are strangely intimate, in that, our own bodies are the material on which they operate; but on entering the apparatus of medical technologies, our bodies are reduced to the status of an object under investigation, no different to any other type of matter. Unlike with other technical domains, it is difficult to sustain a sense that 'we' are masters of medical technology when 'we' are also its material objects.

POWER OF VISION

This argument is taken up by Sarah Kember in her essay "Medicine's New Vision," wherein she argues that the Foucauldian reading of photography as a panoptic instrument of surveillance is also applicable to digital technologies, and the body is still subject to the same operations of power and knowledge. Foucault identifies the 'panoptic' as "a machine to carry experiments, to alter behaviour to train or correct individuals."(Foucault, 1977, p.203)

Kember outlines the major role played by photography, in the 19th century surveillance and classification of the masses, through disciplines such as physiognomy and phrenology. "Control was articulated and inscribed on the body by subjecting the isolated individual to minute and detailed forms of visual textual and statistical surveillance and

classification"(Kember, 1995, p.96) Kember argues that it was not the mechanical process of representation which gave photography the power of 'truth,' but the 'institutions' whose purposes it served.

It is for this reason that medical technologies can never be understood as a simple

medical tool. Rather, medical technologies are better encompassed by Foucault's term 'technologies of power,' (Foucault, 1977) According to Kember an effect of 'technologies of power' is the organization and exploitation of the materiality of the body in the interest of both social order and the generation of a certain kind of 'knowledge.' As an example, she points out the particular implications for women and 'reproduction technologies.' (Kember, 1995, p.108)

With the invention of Computer Tomography in 1973, the three-dimensional imaging of any part of the body became a reality. Since then computers have contributed significantly to the evolution of medical imagery.

One of the technologies used in the VHP is 'Magnetic Resonance Imaging,' which is based on the behavior of the nuclei of the hydrogen atom (in the subjects body), when they are placed in an intensive magnetic field. This results in all the atoms temporarily orienting themselves in the same direction (in normal conditions they are all oriented in different directions). When a pulse of radio waves is directed at this field, the atoms are knocked out of alignment and reflect the waves back at the scanner. A computer interprets the data and produces a monochrome image on a video monitor, which can then be coloured.

Another technology utilized by the VHP is 'computed tomography,' which is an X-ray technique in which low doses of rays, each lasting fractions of a second, are passed through the body at different angles, producing an image of a cross-sectional slice of the body.

Chapter 3 - THE VISIBLE HUMAN PROJECT

OUTLINE

At present the Visible Human Project consists of two databases which make up two images of the human body, one for the male, and the other a female. The databases contain data taken from computerized tomography, digital magnetic resonance images, and digitized photographic images of the two cadavers. The male has received more attention than the female as he was the first cadaver to be processed, and is in fact the body of one Joseph Jernigan, a criminal who's life was ended by lethal injection in a Texas prison on August 5th, 1993, aged 38. The female cadaver is the body of an anonymous 56-year-old woman who died of a heart attack.

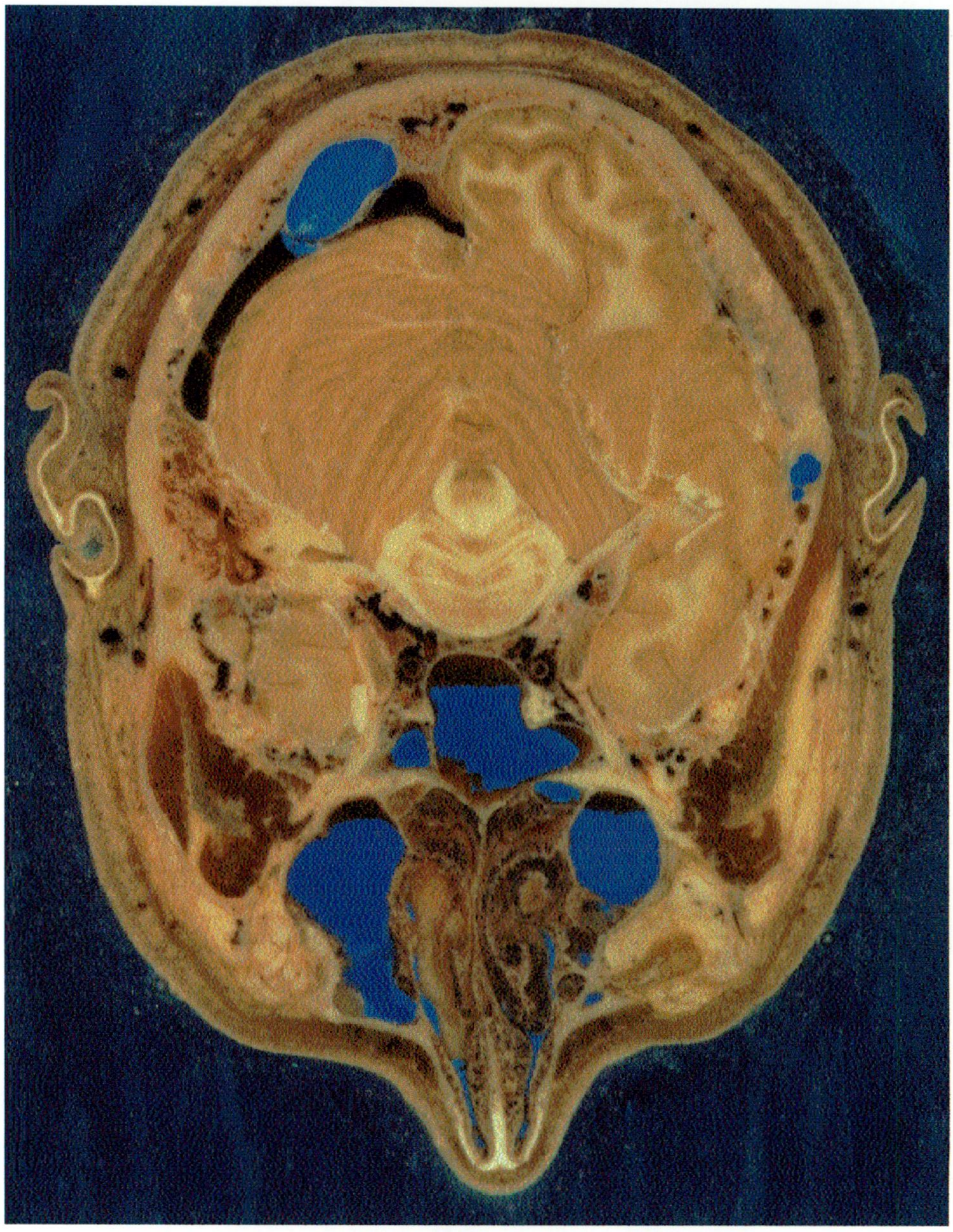
PROCESSING THE CADAVER IN THE VHP.

The cadavers were processed by first of all taking CT, and MRI images of the representative male and female cadavers at an average of one-millimeter intervals. After that, the cadavers were frozen in a special gel at -70C, and then with the use of an instrument called a 'cryromatrome', very fine slices of the body are taken from the head to the toes at 1mm intervals for the male, and .33mm for the female. Each

'cryrosection' is then digitally photographed and stored as a separate file in a computer (Fig 5,6). The data of each file is registered to the file above and below it. With modern supercomputers and complex three-dimensional modeling programs the cadavers can be reconfigured on computer screens as three-dimensional representations of the human body.

Because of their digital qualities, the information gained from the cadavers can be distributed via the World Wide Web or can be reproduced many times on digital tape with no loss of reproduction quality. Public funding of 1.4 million dollars by the NLM means that the datasets are available free from the National Library of Medicine in the USA. However, one of the disadvantages of the project is that the data-bases are so large, it takes many days to download, and needs supercomputers with at least 50 gigabytes of storage capacity to be able to use both data-bases. As a result, CD Roms and digital tapes of the project are also available to the public on payment of a fee to cover the cost of reproduction.

The anatomical text/data of the Visible Human Project is being put to use by the Center for Human Simulation at the University of Colorado who promote the use of the VHP in clinical research, practice, and teaching. Using the data from the VHP, the center electronically models normal and pathological changes in human anatomy. (Pelster, 1996, p.1)



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The center envisages the training of a new type of 'anatomist/computer imaging specialist' for the 21st century. Due to the development of more abstract radiological imaging techniques, the anatomical representations being produced are increasingly sophisticated. Virtual-reality models are being developed to help teach complex clinical and emergency procedures which can be repeated by students rather like a pilot learns to fly on a simulator (Fig, 7). (Pelster, 1996, p.2)

THE VHP AS ATLAS

The VHP is the only digital atlas of an entire male and female body. It is what is known as a "cross sectional" atlas. Since the introduction of powerful clinical imaging systems which work by imaging very this slices of the body,

notably CT scanning and MR imaging, several atlases devoted to cross-sectional human anatomy have been created. However, the cross-sectional planes shown in these atlases, come from different cadavers and do not match up properly. The VHP is an improvement on these atlases because all the cross-sections come from one source, Jernigan, and so "match seamlessly."(Ackerman, 1996, p.129) Another advantage is that the VHP allows inspection of anatomical structure at the level of resolution that modern image technologies work at.

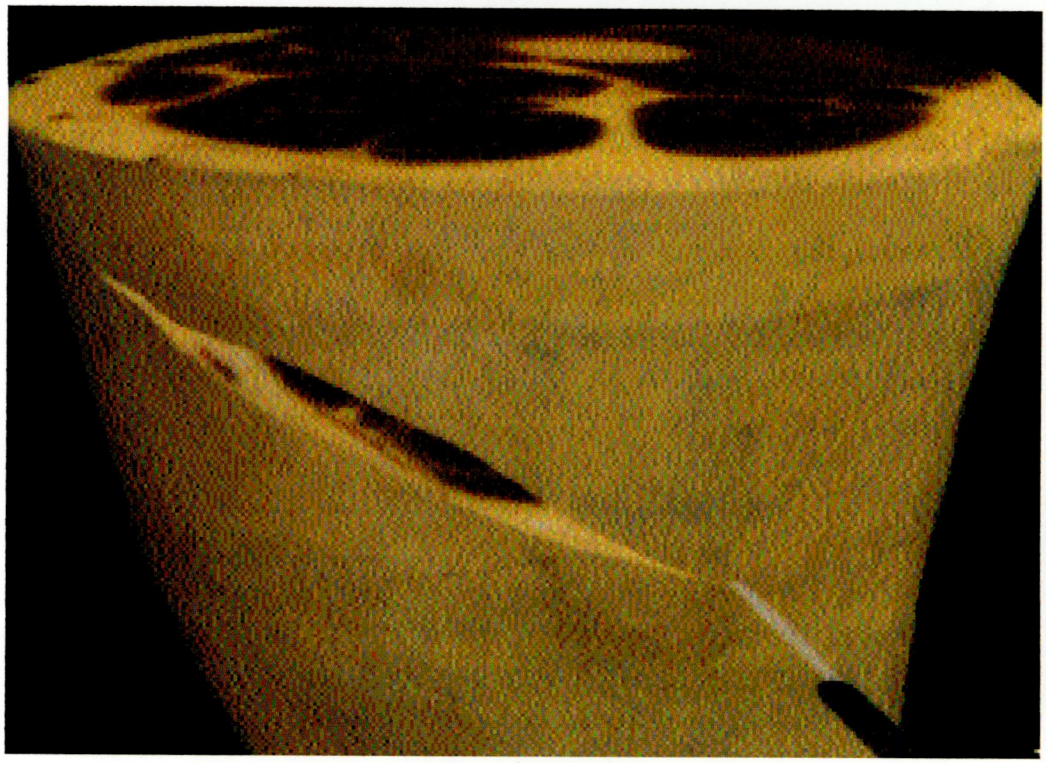


plate 7

However the authority of the VHP is, in many ways questionable, due to the many paradoxes inherent in the project. The VHP shares some problems common to less technically produced anatomical atlases. The problem of choosing 'who' to be represented as a 'normal' human anatomy posed a problem similar to ones faced by previous generations of atlas makers.

The involvement of the anatomy boards of three U.S. states, and the penal system, underline the power systems at work in the project. Jernigan was selected out of approximately 3000 cadavers, all of whom went through a rigorous screening process. The choice of 'type' of cadaver for the project was to be of 'normal' variation. The 'normal' in the project took on 'ideal' notions of health.

The medical records of the cadavers were checked because the body had to be disease free. The physical condition of the cadaver was also taken into consideration surgery; or any other condition that might have altered the subjects anatomy rendered it unsuitable. Size and shape played a part in determining the 'ideal' and any obese or emancipated cadavers were eliminated; even scars were taken into consideration. What is clear from all of these conditions is the state of this 'norm' is so idealised, that they are looking for a 'healthy' corpse.

With such a range of criteria to fill it comes as no surprise that the body chosen was that of an executed criminal. Jernigan also fitted in perfectly in another respect; the institutional nature of his execution meant a smooth organisable timetable that could be planned in advance. One and a half-hours after his execution he was being put on a plane to be prepared for processing. The 'norm' in the VHP then, is one of health, even in death.

Jernigan was chosen because at his time of death he was in peak condition as he worked out every day in the gym. (Hall, 1996, p.40) Jernigan stands for the 'normal' against which the 'pathological' and all other deviancies in physical structure will be compared. It also happens that the first representation of 'normal' human anatomy is a 'white,' middle-aged, man. Even though he died of lethal injection the traces of which must still be in his blood, he stands as a representation a healthy body.

In future race, age, and gender may even become issues of determining the 'norm,' but for the time being, the 'male body' is the standard against which the different female body is compared. This is almost a tradition in anatomical atlases which shows the hierarchy of what bodies best represent 'mankind.' Robert Ackerman notes that there does need to be a premenopausal woman in the VHP, and if he could kind the woman he would have no problem getting the money. (Ackerman, 1998)

The VHP is now faced with a problem; the drawbacks of the project become visible in an obvious way; how can one man be everyman? Although he has been joined by a woman, with such limited examples of human anatomy, how can the project be useful?

The next stage of the project is to expand upon the original 'normal' structure "to encompass specialized image collections such as Embryological development, normal and abnormal variations, and disease related images."(Ackerman, 1998) One way of getting round the problem of extending the data-base of 'normal' human variation without cutting up more bodies, is to use the data already within the VHP, and with anthropologists and scientists and mathematicians use statistics to 'morph' on demand, an individual anywhere along the entire range of 'normal' human variation.

The "Visible Human Embryo" has already been funded by the National Institute for Child Health and Developement; however 'social questions' have almost stopped the project.

While it might seem to be stretching a point to form links between Renaissance anatomical atlases and the latest, most technically advanced anatomical atlas, the point I believe is this: the VHP wants to be to the future of anatomical science, what the

'Fabrica' was to the Renaissance.

Robert Ackerman, head of the project at the National Library of Medicine, states that "the long term goal of the Visible Human Project is to produce a system of knowledge structures, which will transparently link visual knowledge forms to symbolic knowledge formats."(Ackerman, 1997, p.2)

I would contend that it was a change such as this that took place in the Renaissance anatomy theatres. With the linking of visual enquiry of the body, to the skills of the artist, a new model was created to aid the sciences of observation and representation, which eventually became the Enlightenment project. Today, it is hoped that the way in which the bodies in the VHP are organised within computer systems, will change the way vision and text are used, and form a new kind of 'knowledge.' (Ackerman, 1997, p.2)

The VHP is the most detailed attempt to render the human body visible in its entirety. It realises the dream of Vesalius and other anatomists since the Renaissance of undenied visual access to the body's interior and of its 'perfect naturalistic' representation.

The VHP brings to modern anatomy its shady past history of using the bodies of executed criminals as cadavers. We have seen in chapter one how the bodies of executed criminals have served as the raw material for the production of anatomical knowledge in the Renaissance. The first cadaver used, as mentioned previously, was that of an executed criminal, Joseph Jernigan, who became the latest, of many criminals to be dissected in the search for anatomical knowledge.

One of the aims of the VHP is the "identification of all structures of the body that appear on each cross-section and the identification of the extent of that structure". (Ackerman, 1998b) This process, which takes place within the VHP, is itself a trace of the Renaissance culture. For Harcourt the strength of Vesalius's illustrations as scientific knowledge, lies in the presentation "of the number, site, shape, [and] size of each part of each body and, to a certain extent, their connections to other parts." (Harcourt, 1987, p.44)

However the VHP achieves what Vesalius failed to do, in the "Fabrica." Vesalius tried to provide a visualization of both structure and function of the living body at the same time, through representation, but that attempt failed to attain a completely convincing 'visual embodiment' of these two qualities working together. It is precisely, here, in the animation of the cadaver by sophisticated computer programs, that the VHP advances anatomical illustration; it finally illustrates what moving mussel or leg would look

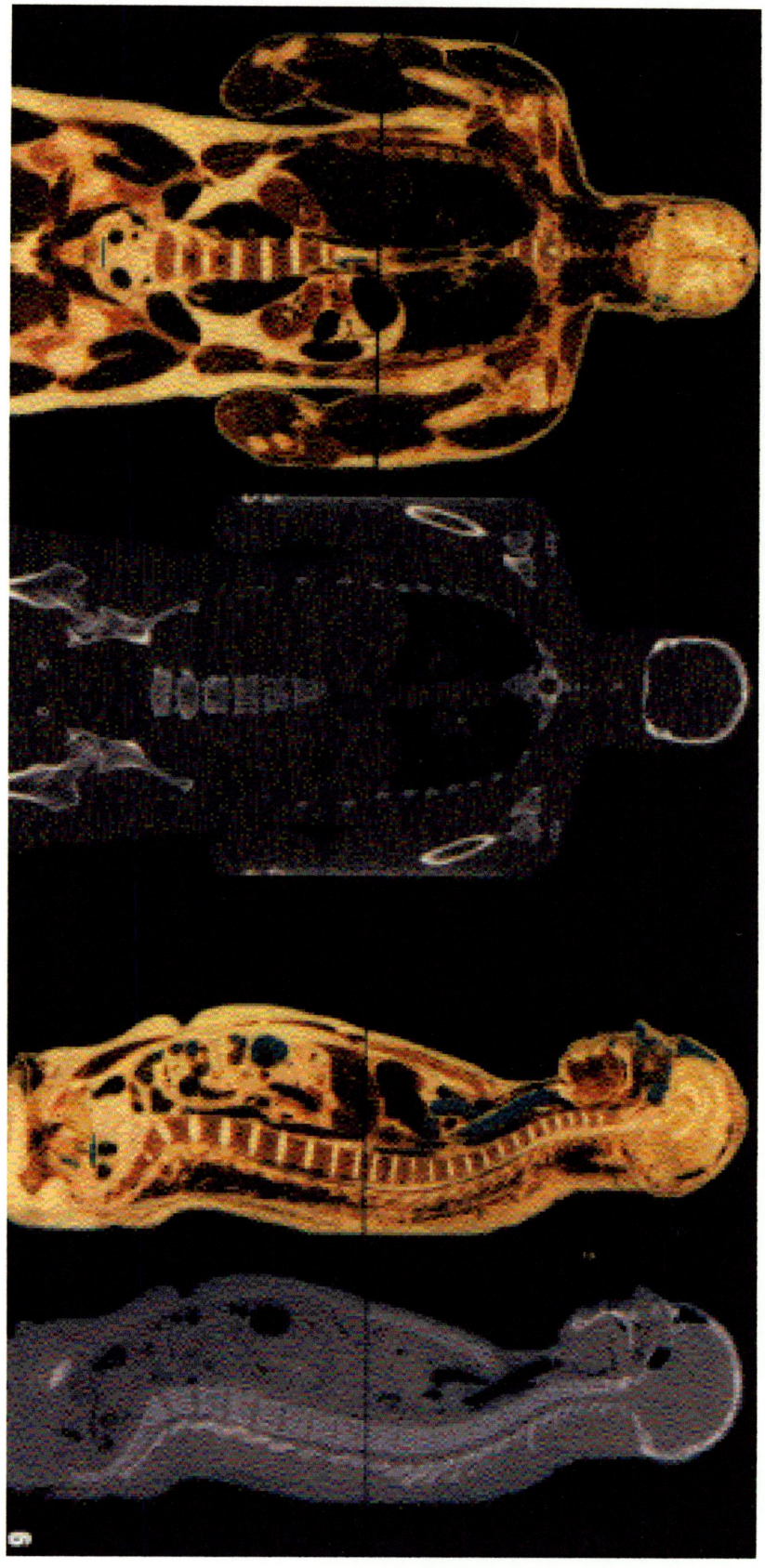
like.

VHP AND IMAGING TECHNOLOGIES

The VHP uses just two of the many new medical-imaging techniques. These are 'Computer Tomography,' and 'Magnetic Resonance Imaging.'(Fig, 8). As discussed earlier, these imaging systems visualize the whole of the body and record the information as a screened image resulting from the data gained from the scans. Through the imaging processes of the VHP the body's unknown volume is transformed into a three-dimensional topography. However it does not make it visible in a 'realistic' way. To do this the 'test object', in this case Jernigan, must be open up in order for the 'technological anatomical gaze' to record the body.

The opening up of the cadaver in the VHP is done to allow the cross-sections to be digitally photographed and the flesh recorded in digital format. This is then used to create the realistic effect of flesh throughout the entire VHP. By doing this, Jernigans body, while being visualized by the VHP, is literally being turned into sawdust. One of the advantages that imaging technologies brought to medicine was the preservation of the bodies' flesh by lessening invasive surgery. (Wyke, 1996, p.254)

The VHP is produced through a massive act of violence, (the same as all dissections),



Jernigan is both executed, and then subjected to 'cyrosection,' but the visual text produced has left no trace of violence; he has been recomposed in 'Virtual Space.'

As a direct result of the violence, the images produced by the VHP seem unmediated. They have the realism of color anatomical photography as opposed to purely conventional colour-coding found in CT-Scans, (color that is only put there to aid the eye). These images look like the real thing, the way a body would look if sliced cross sectionally. The look of the whole Visibly Human body is opaque and whole like a real body, but it can be opened at will (Fig, 9).

The VHP is a good example of the way in which bodies are prepared and used so as to fit in with the limits of the technology used to embody the object, rather than the other way around; a type of "technical prothesization" of the body as Cartwright puts it. (Cartwright, 1995b, p.100) The material body of the 'test object,' a human here, is altered so as to conform to the requirements of the experimental apparatus. In the VHP Jernigans body is cut into four segments in order to fit it into a box that holds it while it is cryosected.

'Cryrosection' also demonstrates this quality of 'prothesization.' Because the method of storing the information in the VHP happens to be on computer the dissection is made

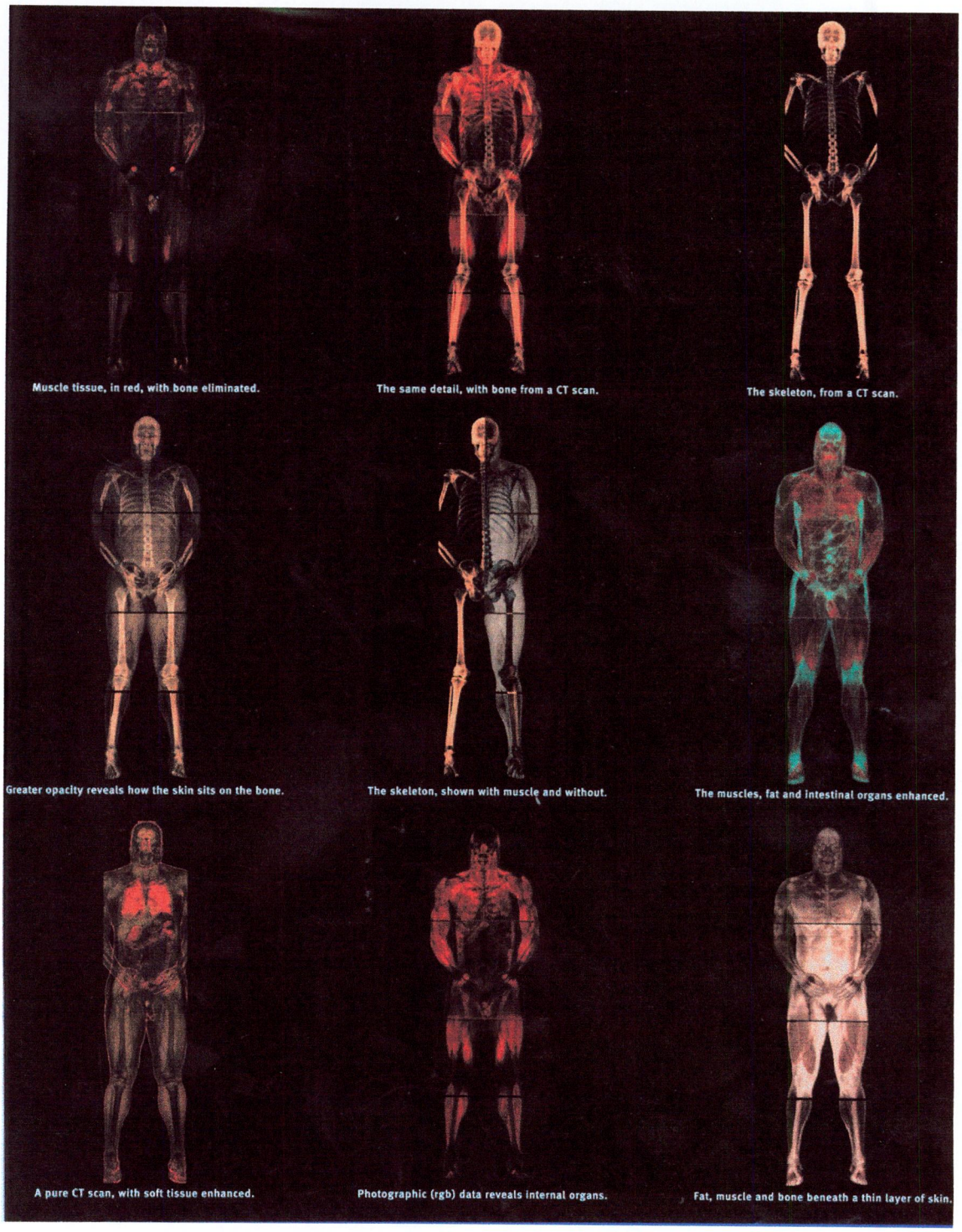
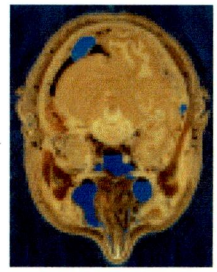
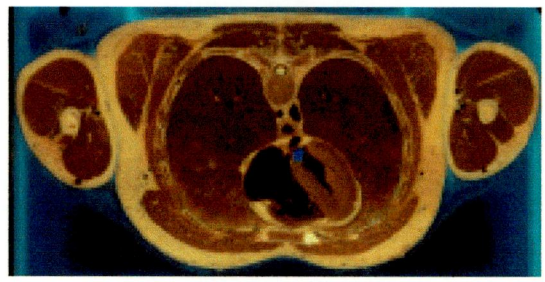

Muscle tissue, in red, with bone eliminated.
The same detail, with bone from a CT scan.
The skeleton, from a CT scan.
Greater opacity reveals how the skin sits on the bone.
The skeleton, shown with muscle and without.
The muscles, fat and intestinal organs enhanced.
A pure CT scan, with soft tissue enhanced.
Photographic (rgb) data reveals internal organs.
Fat, muscle and bone beneath a thin layer of skin.

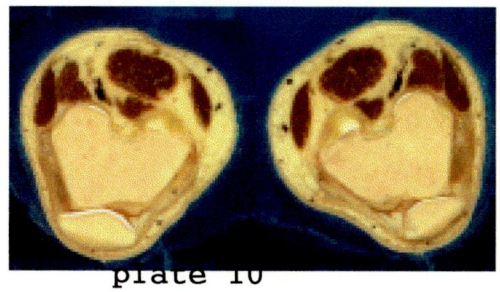
plate 9

conform to computer storage format. A 'normal' dissection would not happen through 'cryosection' because no useful information would be gained from the process; a traditional anatomical dissection would not be logical enough to be able to be stored and reassembled by computer. By slicing the body into very thin slices, which can be numbered and stored on computer in a series of files in its memory bank, each file can then be retrieved individually depending on what cross-section to be viewed; or all at once to see the whole body (fig, 10).

This process of storing an image of the body in digital format is not new. CAT scans and similar technologies employ the same process. But the VHP is the first attempt to store a complete human body in this way. In doing so it transforms a real body not into a similar representation, but into quantifiable mathematical data. As such it forms a new way of conceptualising the body. This is similar to the 'Genome Project' where DNA, the 'building blocks of life' are being recorded in data and stored on supercomputers. The Visible Human Project therefore, can be seen as one of many attempts by science to control not just the body but 'life.'







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Chapter 4 - SPECTACLE OF THE VISIBLE HUMAN PROJECT

The removal of human agency as bodily presence, and signifiers of pain from the image field in the VHP is relevant to the work of Foucault. In Discipline and Punish he writes that at the beginning of the nineteenth century "the great spectacle of physical punishment disappeared; the tortured body was avoided; the theatrical representation of pain was excluded from punishment"(Foucault, 1977, p.14) Here in the closing decade of the twentieth century we see a curious mutation of the repressed spectacle of public execution with the representation of an executed criminal put on display for all to see.

This display is carried out through a ritual of medical and technical apparatus. Medical knowledge is put to use in the execution in the form of lethal injection, as a humane way of punishment. The execution is followed by dissection, which in the case of Jernigan, is transformed into a spectacle of medical, technical and juridical power. As Catherine Waldby has pointed out "his punishment has extended beyond execution to perpetual anatomization and mastery by others." (Waldby, 1997,p13).

Foucault describes a docile body as one "that may be subjected, used, transformed and improved" (Foucault, 1977, p.136) The body in the VHP can be manipulated in ways that the fleshy body cannot be, because of the method of its dissection, i.e. sliced and

filed, it can be viewed from all angles and dismembered and remembered in seconds. Individual sections or organs can be viewed separately. The body produced by the VHP is a "docile' body.

Jernigans donation of his body to science is a subtle form of control. Power and discipline acts not only through punishment but through gratification. According to Foucault power is everywhere enforced just as much by indivuals' unconscience self-surveillance as by authority. Here I suggest that people who donate blood or organs to family, or as in Jernigans case, the body to science after death, are rewarded with the 'gratification' of being seen as good people due to the positive response they receive in the medical world and the popular press. (Lupton, 1993, p.47) In Jernigans case, offering his body to science can be seen as a recompense for the deeds he has done in life, for which he must pay the ultimate price.

"Part of the undeniable fascination of the reconstructed man is that he is not simple an animated anatomy lesson, but a disturbing curiosity."(Hall, 1996, p.40) This feature of the VHP is taken up by Waldby in her essay on the VHP. In it she argues that the 'reconstructed man' cannot be reduced simple to the technical status of an anatomical atlas within the culture of medicine. Instead the body created by the VHP is an 'uncanny' form of digital existence, what she terms 'postnatural' life, which exists in the virtual world of the computer screen.

Waldby argues her point very eloquently and views the VHP from a 'technological' perspective, she sees the fascination that people have with the project as part of a 'technological interest. 'She offers early cinema as an example of how people were interested in the technology even though the same images were reproduced continuously. It was the way that cinema altered the representation of the body that interested them and not the image. (Waldby, 1997, p.3). Secondly the newness of the virtual space that the body inhabits "has unprecedented imaginative possibilities, philosophical implications and ontological consequences..." (Waldby, 1997, p.4)

By moving the bodies from the real world into the computer screen she argues the bodies take on the force of the 'uncanny' due to the 'double register' that visual technologies such as photography work in. Photography alters the distinction between 'life' and 'death' by its power of resurrection. She argues that if this is the case, then digital visualization multiplies this by 'several orders.' Digital representations are three-dimensional simulacra which appropriate a visual cloning of the fleshy body; a mapping of cells to pixels which Waldby believes collapses the distinction between what is 'real' and what is not. (Waldby, 1997, p.6)

Waldby takes the view that through 'simulation' and 'animation,' the VHP is somehow 'copying' or 'cloning' life. Her views on this animation of the body in the VHP as a

form of life is similar to the position that Luke Wilson takes on the body of the cadaver in the Renaissance anatomy theatre.

Wilson charts the transformation of the corporeal body in the Renaissance anatomy theatre from the dead body into the 'body of knowledge' that gave the practice of anatomy its legitimacy. This transformation of the dead body of the corpse into the 'living body of knowledge' by the performance of the anatomists is he states, "one of the first victories of modern science over death." (Wilson, 1987 p.89)

At a certain point in dissecting the body, he tells us, we realise the unbearable truth that the body is corruptible flesh. The magical feat is to restore order to the living body, through the cadaver and the anatomist, by searching the body of the dead. The transformation of Jernigan into a animated corpse in the anatomy theatre of virtual reality is as Wilson says "anatomy as romance; its trope is the reanimation of the dead."(Wilson, 1987, p.89)

The process of reanimation of the cadaver by the use of computer animation does not simulate actual life. To believe so would be a leap in faith between what we really see and what science and the VHP creators would like us to see.

The allegedly animated postnatural 'visible human' body that exists in the VHP as

described by Waldby, is a fantasy. It is a fantasy that tries to reverse both the execution and the dissection that were performed on Jernigan and the anonymous woman. It tries to deny the violence that has been done to the bodies. She claims that "these are dead bodies which have nevertheless been preserved from dissolution, corpses which are nevertheless animated,"(Waldby, 1997, p.6).

What is new in the VHP is the transformation of the body into mathematical data. This means that the body can be measured, analysed and classified more than ever before. Technology we are told is bringing new life to anatomy. I believe the opposite, anatomy and with it the human body is bringing new life to technology.

As mentioned earlier the VHP is to be the cadaver of the 21st Century in medical schools through surgical simulation, and the data sets used as teaching aids. Enquires I have made at the National College of Surgeons here in Dublin do not seem to fulfill the VHP ambition. Eric Clarke sees this prospect as very unlikely. The teaching of anatomy, from what I saw that day is a hands on practice. No amount of exploration on an electronic cadever would be an equal substitute for real flesh. The medical department at UCD will not use any images or data from the VHP on ethical grounds, namely that Jernigan was an executed murderer. However, the choice of this particular body by the VHP team could be a simple publicity stunt, or perhaps it was a tactic to have the project more widely accepted.

Conclusion.

This has been an investigation of the VHP through two main areas, the domain of anatomical atlases and image technologies. Through anatomical atlases I have show how the production of the VHP like all other atlases has ideologies which are influenced just as much by culture as by objective science. Beauty, health and reproductiveness are all factors in deciding the 'norm,' from Sommering and his 'wide hips,' to the VHP and the need for a slim 'premenopausal women.'

Through the technological domain, I have mapped the changing role of human vision in the search for 'objectivity' in human anatomy and in medicine generally. The potential violence of the primacy of vision is shown through the altering effects that these technologies of vision have on the body 'just by looking.' This is heightened in the VHP as the body is put on display as a 'spectacle' of medical knowledge and juridical punishment after technology has had its way with it.

The VHP is the most spectacular visual and technologically advanced anatomical atlas to date, but it bares a remarkable resemblance to the Renaissance anatomical project of Vesalius's "Fabrica." The idea however of Jernigan's digital representation containing a quality of 'life' and a desire to cross back through the interface as Waldby puts it, is a

fantasy. Dead is dead is dead (Fig 11). We must not confuse representation in the form of simulation, with 'reality,' just as we would not believe that the illustrations in the "Fabrica" are alive or the cadaver is going to stand up and walk out of the anatomy theatre. Simulation may or may not help us understand the 'real' living organic body better, the jury is still out on this, but we must never confuse with the "real" body.

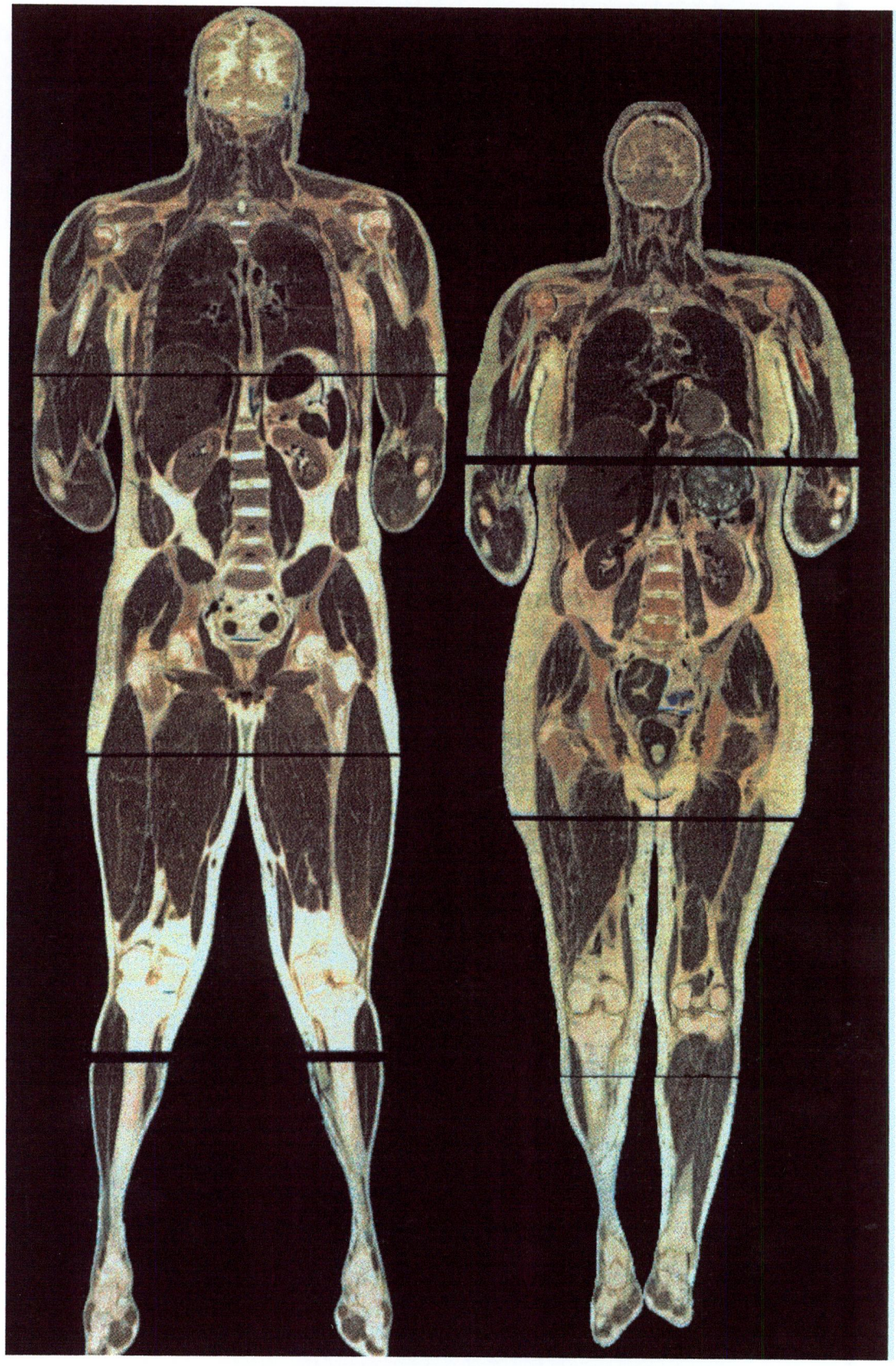

plate 11

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