Bio(r)Evolution?
On the Contemporary Military-Medical Complex

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„The 5th Dimensional Human"

This text is the result of my impressions while attending two international medical conferences in San Diego in January 1998. Certain aspects of the program were shared by both conferences. One could even say that one was the continuation of the other, namely, as an articulation, and even more as a condensation of the contemporary military-medical complex, which finds an important and varied center of research in the town of San Diego itself.

The importance of San Diego

In San Diego, this »complex« gains a special meaning. Tourist pamphlets emphasize its importance as a »Navy town« by offering various sightseeing tours inviting us, for example, to „Join Old Town Trolley Tours as we show you one of the largest military complexes in the world." The location of the conference seems to have been quite deliberately chosen with respect to this specific economic, political, geographical and social constellation. The Mexican border is nearby, in fact, it can be reached by town trolley. Restricted military areas abound within the town and around it, the monuments for fallen soldiers cannot be missed, the Navy dominates the architecture in the area with living quarters for the families of the enlisted and retired army personnel. There is a lot of overlapping with the civilian world, as for example in the academia. The UCSD (University of California San Diego) tends to inherit professors that have quit their posts in military institutions, especially if their area of research embraces the new media. Local bookstores demonstrate a gender-specific manifestation of the influence of the military complex. The »women«-section offers paperbacks on Lady Diana or fantasy novels. But there is also a special section for »men« which holds oversized picture documentaries on the military, books on military history or reports on the »Operation Desert Storm« and the operation in Bosnia. A further incident that comes to mind is the story of the amok-driver who found his fifteen minutes of fame and international press coverage in 1995 by stealing a tank and driving it over the highway, crushing several cars and houses along the way. The man had been trained as a tank-driver and then let go in the wake of the so-called downsizing of the military which involved budget-cuts and staff reductions.

Military Tour Information: „Join Old Town Trolley Tours as we show you one of the largest military complexes in the world.“

18-05-95: „This is war.“

These varied impressions are supported by the facts and figures documented in the Internet concerning the status of the military in San Diego. Despite a staggering reduction of the national defense expenditure since 1990, San Diego has retained its importance as a decisive center of activity.

> „The Navy accounts for nearly 20 percent of the local economy. (...) Close to 30,000 civilians rely on the military for their livelihood. More than 133,000 men and women in the military call San Diego their home. (...) There is a total of 241,000 Navy and Marine Corps family members in San Diego County. (...)There are approximately 53,500 retired military in San Diego. The Navy owns approximately 171,000 acres of land in San Diego County.“

One might add that the present annual expenditure of the department of defense for San Diego County amounts to 9,6 trillion dollars. The high average income throughout the region is furthered by the traditionally close connections of the industry, especially in flight and space technology, and the defense technology in the narrower and broader sense, ranging from the production of missiles to high-tech solutions in communication and navigation.

Still, the decisive measures of military downsizing have already brought about significant changes. Since 1990, California has experienced a rise in unemployment that is proportionally much higher than in the rest of the United States and still lies above average. The most drastic cuts concern the area of flight and space industry and affect the whole of the economy in California. Many highly-paid posts in the military high technology have been eliminated, and the turnover of the local industry working for them has also come to a standstill. The transition to civilian market potentials has already been made in many areas, especially with regard to information technology, such as high tech medicine. This development is in concert with the policies of the defense department. The »Dual-Use-Act« states the intentions of the DARPA of preferably financing research projects that can also be implemented into civilian health projects. This means a major transfer of technology: decades of military-technological knowledge will be poured into medical areas, also as a means of stabilizing the job-situation in the shaky military industry.

Another initiative is currently being supported by the government. The Trade and Commerce Agency of California offers, under the heading »Areas of Opportunities«, cheap openings for »venture capitalists« interested in profiting from the existing concentration of over 200 companies in the area of San Diego that concern themselves with a new technology. Biotechnology, defined as »techniques that use living organisms or their components to make products« is promoted as the technology of the future.

> „San Diego is host to more than 200 biomedical and biotechnology companies. The City of San Diego sells bonds to create incentives for biotechnology companies to build new facilities. The passing of NAFTA (North American Free Trade Agreement) has introduced new business opportunities along the US/Mexico border in San Diego and Imperial County. (...) NAFTA will allow companies to source materials in North America, produce in the border region and distribute throughout Canada, Mexico and the United States, without import duties."

The conferences

This special regional situation which already demonstrates an economic shift from military to civilian high technology, with a special emphasis on biomedicine, is not, however, subject of the conferences. No attempts were made, whether in the papers read or in the discussions that followed, at questioning the so-called »dual-use« in military and civilian matters, as for example in the dubious militarisation and technologisation of medicine, . On the contrary: the general attitude was global and optimistic. On the horizon, if not squarely at the center of many presentations stood not only the future of the American Healthcare System, but also the future of the earth and even of mankind itself. On the other hand, a large proportion of the speakers came from San Diego and California, working in research or as businessmen in the area of technology, and there was one military reference which popped up again and again: medical care on battlefields of the future . The question of who should attend these conferences was answered in both cases with an almost identical list of professions: „Physicians, Surgeons, Roboticists, Information Scientists, Medical Technologists, Biotech Entrepreneurs & Researchers, Biomedical Professionals, Medical Technologists, Venture Capitalists & Corporate Futurists (...), Anyone interested in the future of medicine and biotechnology". However, that in itself does not explain the many highly polished patent leather shoes that seem to belong to the staple wardrobe of the US-military and remained astonishingly motionless on the thick carpets of the lobby and the »ballroom« of the hotel that had been converted into a conference room.

Conference location: „Standing at 40 stories, the Hyatt Regency San Diego is the tallest waterfront building on the west coast.“

„Medicine is Art. Medicine is supported by Science. Medicine is enabled by Technology.“

I would now like to invite you on a quite subjective »guided tour« of a subject-matter that seemed to me to emerge as a »military-medical complex« during my attendance the conferences. The broad scope of this tour mirrors the broad concept of the conferences, which promised, under an enlisted trademark, nothing less than a definition of the future of mankind - a better, safer, healthier future.

Starting point of our tour will be the sixth annual conference on „Medicine Meets Virtual Reality?“ which labels itself as the first international forum for the interfacing of medical and interactive technologies as a guarantee for »creating the future of healthcare«. The self-description of the conference spares us no superlatives, its achievements are offered for consumption:

> „Approximately 800 professionals attend MMVR each year, one-fifth coming from outside the US, to hear papers presented by the world's leading researchers and developers, and to view exhibits and hands-on demos of the latest technological advances. (...) This is the conference where hype is left behind; ...“

The subject of this year's gathering was stated as: „Art, Science, Technology: Healthcare (R)evolution?". Slogans on posters and glossy pamphlets maintained that: „Medicine is art. Medicine is supported by science. Medicine is enabled by technology." The programming committee consisted of 33 renowned representatives from the government, universities and the economy.

The second conference, which was held for the first time and which inspired the title of this text, was named: „Bio(r)Evolution?, NextMed: The End of Healthcare? (Thought _ Health _ Immortality)". Responsible for the program was one man, Dr. Shaun B. Jones, who was also am member of the programming committee for the other conference. Shaun B. Jones is a member of the Defense Advanced Research Projects Agency. There, he functions as a "Program Manager for Unconventional Pathogen Countermeasures in the Biological Warfare Defense Program".

Titles and subtitles of the conferences set the pace for the phrasing of theses, queries and goals of the conferences. The protection of the titles by trademark is the first thing that catches one's eye. Obviously, words are viewed here as trademarks, part of a business transaction. »Medicine is Art« can be seen as the declaration of a program. And the prophecy is self-fulfilling in the sense that the art of product-marketing is an important element in its implementation.

The protection of labels by trademark, labels that contain a reference to the vocabulary of social visionaries, seems to suggest that the correct word at the right time is worth gold and can, for example, influence important decisions. And since the speeches all followed a similar tendency, it was possible, without exaggeration, to mentally attach a small »?« to every one of the words read from the papers. In this context, words seemed to convert themselves into instruments of a sale strategy, quite apart from the substantial costs of attendance, up to 630 Dollars per conference. Following the argumentation of the conferences, one could see them as »instruments of information«. In endless repetition, intros and closing speeches stated that »the future of healthcare is information.« Information, as we have seen, that sells and can be sold. The object was information technology and the preparation of the market, or, as the guiding principle of the conferences loftily maintained: »Information Heals«.

This Healthcare(R)evolution, the (R) in parentheses implying that the future positive development of the healthcare system in the US will evolve as naturally as the species, would like to diminish the exploding costs and inadequacies of the healthcare system by investing in a wide range of information technologies.

The meaning of the word »information« in healthcare varies in quality, ranging from self-help-groups that exchange their views through the internet, chip cards for the extensive electronic registration of patient's records, or progress in the deciphering of the human genome.

»Information« also stands for health education in the widest sense. Thus, the question mark in the title of the conference NextMed »The End of Healthcare?« does not point towards a critical evaluation of the possible collapse or financial ruin of healthcare in the US, but instead takes a positive stand concerning the future. The main idea, which was reiterated endlessly, proclaimed: A new concept of healthcare could reduce a large proportion of the costs in the healthcare system, for example through the reduction of direct contact with doctors. How can this vision be reconciled with the qualitative improvement in healthcare?

For clarification, statistics are cited that seem to prove the extreme inefficiency of the current system: 50 to 80 percent of all people that consult a doctor are in no need of medical help. 70 to 80 percent of all health problems can be fixed at home, if one knows what to do. Not a lot remains to be treated.

The remaining cases that require healthcare for recognized, more or less „objective" health problems would be, as several lectures demonstrated, be eliminated through the intervention of genetic engineering against, for example, aging or cancer. The ideal of everlasting health for all was held forth in all seriousness as the happy end of the development in „healthcare", genetic engineering defined as a thing of the near future with reference to promising animal experiments. „Thought _ Health _ Immortality". The conference program of NextMed phrases this perspective in the following way:

> „The End of Health Care? The ability to manipulate genetic code presents the possibility of ending worry about diseases and defects which burden humankind. Deliberate Manipulation of the genome for physical 'improvements' may be closer at hand. Perhaps lasting perfect health won't always be a dream. ...Further reaching than computers and way beyond hype about the Web, the intersection of medicine and biotechnology will be the future of life, itself. Physicians, researchers, entrepreneurs and investors can glimpse this future; with an exceptional group of minds thinking together, NextMed will be the looking glass."

Disease, the insinuation goes, is a thing of the past, conquered by information technology. But what can be the meaning of „healing through information"? A critical mind or a specific knowledge is equated with the genetic information of the body cells, as if it were all one and the same thing. The difference in possible meaning is neutralized by reducing all levels to one central formula, thus becoming a vehicle for beliefs that serve a certain self-interest when utilized through the texture of language: reaching as far as the belief in immortality, eternal health and a fulfilled life through the technological domination of this all-embracing »information«.

What are the linguistic and philosophical consequences of this simple and efficient maneuver? The goal seems to be nothing less than the elimination of that which has hitherto been seen in social, cultural and judicial traditions as the Subject. The I is seen as qualitatively equivalent to the information that can, for example, be interpreted as genetic individuality from a tuft of hair. The complex process of acquirement and criticism of knowledge, previously known as science and interpreted as cultural work, is being abolished by a concept of information that defines »information« as real, effective, successful information.

The prefix »Bio-« preceding the evolutionary revolution through »information« is relinquished as well in its function as the representation of resistance, for example in the diction of ecology or politics. »Bio-« represents the genetic information or medical data in simulated environments. Their »realization« for example through cloning is also seen as »information«. That is how the pompous slogans of the conference Medicine Meets Virtual Reality must be read: »Medicine is Art« - an assertion that gains its full significance through the fact that art and culture in the traditional sense of the word no longer exist. »Medicine is supported by Science« - an astonishing claim, since medicine itself used to be seen as a science. Here, however, medicine has surpassed science and become the regent over »information« and life. And pays its dues to the hardware that made this status of power over life and the world possible: »Medicine is enabled by technology«. Technology, it goes without saying, is based on computers.

I would now like to illuminate two projects or focuses of research as representative examples of the interaction and realization of such »information« in a non-lingual area that will also allow some definite conclusions. One concerns itself with the long-term attempts to introduce telepresence technology into the medicine of the future.

Telepresence systems stand for a certain concept of virtual reality. A robot instrument is directed from a distance and can be instructed to perform certain tasks. In order to know which commands can effectively be issued, it is important to transmit a representation of the environment that will be manipulated, if possible in real-time, to the site of the person issuing the commands. Traditional areas of research are the manipulation of dangerous substances from a safe distance, radioactive radiation or unmanned operations in space or surgical interventions over a large distance, as for example when supplying the far-off theaters of war.

Furthermore, I would like to introduce the largest attempt at visualizing medical data, the »Visible Human Project?« of the National Library of Medicine, US. The three-dimensional virtual representation of the body, that is here being concocted and defined as a »realistic« representation of the body will also offer a novel technological »model« of the human body for future medical telepresence operations. Both projects are conceptually and technically compatible - like a main-frame computer and its peripherals, like hardware and software.

Telepresence

Telepresence combines the Greek prefix »tele-«, remote, with presence, resulting in a »remote presence«, a novel, split form of existence. The term »telepresence« was coined 1969 at the Massachusetts Institute of Technology - by Marvin Minsky, Professor of Artificial Intelligence. His text »Towards a Remotely-Manned Energy and Production Economy« offers the following illustration of the concept:

> „A person wears a comfortable jakket lined with sensors and muscle-like motors. Each motion of arm, hand and finger is reproduced at another place by mobile mechanical hands. These hands are Light, dexterous and strong, those hands have their own sensors, through which the operator sees and feels what is happening. Using such an instrument, you can »work« in another room, another city or another country. Your remote »presence« can have the strength of a giant or the delicacy of a surgeon. Heat or pain is »translated« into informative, but tolerable sensation.“

What exactly is being described here? The motions of one's own arms, hands and fingers are reproduced at another place, outside the body. Is motion being transported into a distance? And what exactly is meant by »motion of hands«? A spatial event is being registered and transported through a temporal process - a three-dimensional curve in space that will follow a certain direction and velocity. Such motion, insofar as it is transferred into signals and transmitted elsewhere, can be executed in several places at the same time. The translations themselves contain further multiplication and variations on motion.

We do have one problem: how does one find an orientation while moving one's hands with the idea of transmitting this movement to another place? The sensors belonging to artificial hands that are mentioned in Minsky's text are the answer. These artificial hands can, for example »see« or »feel« by transmitting signals to the operator that must be technologically translated into sight and feelings. The artificial hands function as probes for remote, unreachable areas, enabling the operator remote sight and remote feeling that can be controlled through the signals of motion. Attached

to such a machine one could, for example, pick up a stone on the Mount Everest or stare a mountain climber into the eye, if these strange »seeing« and »feeling« hands happened to be there. If the telepresence hands were in the same room, one could also »look« at oneself and »feel« one's own body, in a kind of leap through time and space, in a dissociation of the »body«, even if the only thing that is transmitted are signals, not body parts.

This kind of artificial self-reference might lead to some confusion: Where is »here«, when is »now«? Having to find an answer to such questions may seem strange, but not stranger than another problem that inevitably crops up: Where does my or another's body end? What is the signification of the image data that is sent from the operating point in correlation to the spatial notation of motion?

What was introduced in 1969 as sensors that could be used for visual, audio and tactile feedback or as »hands« that can operate at a distance has since been implemented into many products and was presented at the conference in various examples. For example in a DARPA-project, developed by Spawar Systems Center, which demonstrated the so-called »Sensate Liner for Combat Casualty Care«, a computer in the guise of a T-shirt for soldiers, that contained a »Global Positioning Tracking System« which enabled the localization of its wearer within an area of three feet. Software that is woven into the shirt as electricity-conducing, encoded threads can calculate the path of a projectile and estimate which of the soldier's organs might be wounded. The optic sensors of the T-shirt can color-analyze the blood coming out of a wound and define its venal and arterial components. Audio sensors compute the data for a prognosis of the velocity and size of the intruding projectile. Data on breathing, blood pressure and pulse are transmitted, as well as physical data on movement or standstill and information on the environment, for example the temperature. Processor and transmitter are attached to the textile in the form of a small electronic package. If we compare this portable computer to Minsky's remote-operating »hands« from 1969, one could say that these hands have now turned into a T-shirt and gained the ability to differentiate remote perceptions that can be delivered to the supervising physicians in the form of images, sounds and diagrams.

This development primarily allows for a permanent connection of a soldier's body to the universalized concept of telepresence. Another project has set itself the goal of optimizing the telepresence operation of endoscopic instruments of surgery. In this example, the patient is already lying under the remote-controlled surgeon's »hands«. The »Computerized Endoscopic Surgical Grasper« from the University of Washington was conceived for the improvement of tactile feedback during remote surgeries. An automated function allows the grasper to independently analyze the mechanical attributes of certain tissues by applying different types of pressure, thus identifying the small intestine, lungs, spleen, liver, colon and stomach. Haptic differentiation of sick or healthy tissue is already being developed.

„Smart Shirts ...Might Just Save Your Life - In the wars of the new millennium, soldier's wounds will be digitally diagnosed."
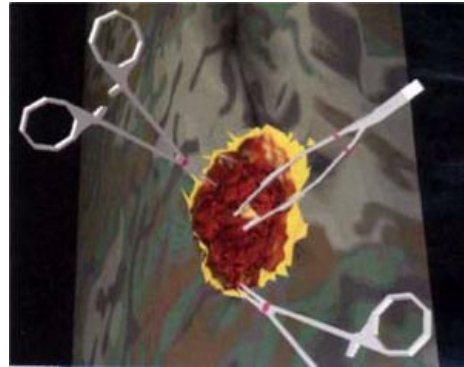

„Because surgery simulation is a nascent technology, the Uniformed Services University of the Health Sciences will initially function as a test bed to evaluate the performance of VR medical training systems."

An important part of a telepresence system is the visualization of the objects that the sensors »touch« and »see« at some remote location. This is most obvious in the three-dimensional simulations - visualizations shown in HeadMountedDisplays or different types of Shutter-Glasses that are getting smaller and lighter all the time. Even a laser ray that projects the image directly into the eye, on the retina, without using a display (»Virtual Retinal Display«) is seen as a realistic possibility. A pictorial »realism« of these visualizations in the sense of high-definition and photographic image quality is not the primary aim, since that would entail an immense delay for the computing involved. Even visualizations that may at first sight seem primitive, reminding one of gray shadows or multicolored tinkertoys, enable the actual execution of complex manipulations. The operators of these telepresence systems often describe this as a novel experience, connecting the impressions of reality with a feeling of »presence«. The decisive factor seems to be the changes in the three-dimensional pictorial world following the movements of head and hands. The motion of one's own hand (in a data glove or a mechanic manipulation system) leads to the same motion in the image of a hand. Turning your head means that the angle of the images shown changes as well, and if one lowers an instrument, its image in the artificial scene is also lowered. One thing remains obvious: the movement that is seen is different than the one that is enacted. What is perceived in a telepresence system does not correspond to what has been done, does not correspond to the execution of the remote units. Bluntly said: I cannot see what I do. However, each user feels the need to reconstruct himself as an operating subject from the synchronicity perceived through motion, and to interpret this temporal correlation as a guaranty of a temporarily and pragmatically donned identity.

With respect to the object operated on, telepresence surgery signifies that every operation is performed on an »image«, with, of course, in this case, life-defining consequences for the person portrayed. One cut into these novel »body-images« can be seen both as a computing process and as a cut into a living body.

„Using modern telemanipulator, control, and imaging capabilities, we have developed systems, that enable the full spectrum of surgical tasks - such as cutting, suturing, and dissecting - normally performed by surgeons."
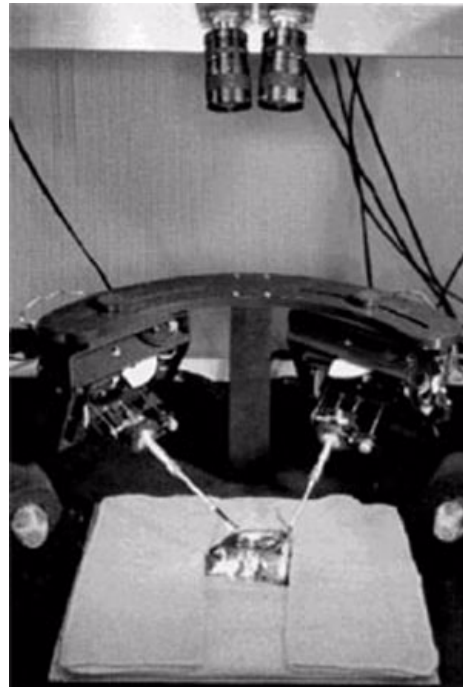
„Improvements to expand the interface to two hands and interaction with a more realistic tissue model are under way."

A film-scenario produced by the US defense department in 1994 already shows how wounded soldiers are found and diagnosed electronically, then transported by their fellow soldiers to the surgery container where a nurse arranges them under the surgery robot in such a way that a specialist can operate the robot from a safe distance in order to extract the projectile and stitch up the wound. The lasting impression is one of precise, neat work done on a sort of construction kit which is, in this case, the body of the soldier. Taking into consideration that a satellite transmits the hand-motions of the surgeon as encoded data to the instruments working on the body of the wounded - doesn't this scenario seem to integrate space, earth and the body of the soldier into one virtual and actual battlefield? A battlefield which is itself transformed into a new, immeasurable »body« made out of bones, flesh and data, which can no longer be visually represented. Computerized image-production thus also touches on established categories such as fiction or documentaries, the previously fixed distinction between the visible and the invisible or between life and death.

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„The system is engineered so that the surgeon actually feels as if the surgery were being performed directly in front of him, when in reality the remote site (and patient) could be yards, miles, or even hundreds of miles away."
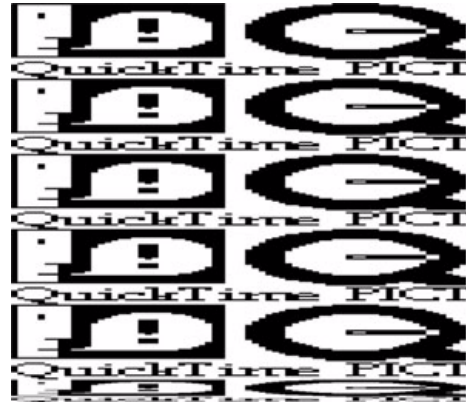
„Because the system was designed to mimic open surgery, there will be essentially no training required."

As is usually the case, the qualitative transformation and extension of the possibilities of image-production also serves to fuel an old desire which can be circumscribed as the »belief in the image«. It is the belief that the domination of an image entails an access to its reference in real life. This belief is certainly one inspiration for the non-differential use of the term of »information« at the conferences. The assertion that the transformation of the image-potential allows for a deeper penetration into the »Gewebe der Gegebenheit« than ever before shall now be further demonstrated through the example of the »Visible Human« project. Many of the lectures at both conferences contained references to this project.
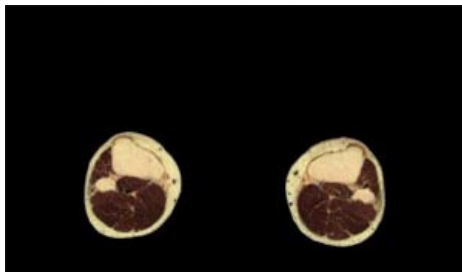
The „Visible Human Project?"

The »Visible Human Project« has gained prominence in many respects. Its portrayal in newspapers, magazines, television documentaries, online-sites on the Internet as well as scientific conferences defines it as the most advanced and enhanced attempt at visualizing medical data. Astonishingly enough, the main interest of popular as well as scientific reports seem to be the endlessly repeated idea of a transition: from a living organism to an oddly »iving picture«. The choice of words reminds one of the one-time belief in the potential of cinematography. Among the early definitions of the cinematographic technology we find terms such as »bioscope«, »biograph«, »living photographs« and »living images«. I would like to follow this misinterpretation of visualized »life« in the current example of the »Visible Human«.

The »Visible Human« was conceived by the US National Library of Medicine. An essential aim of this organization is the establishment of medical image data bases that can be accessed through high-tech computer-nets. The long-term goal is the establishment of an extensive »digital library« connecting medical image- and text-information, prepared as a knowledge base and structured as a Hyper-media. This entails the evaluation of visual information data that has been segmented by

experts. Segmented - as in the recognition and marking of the outlines of bones, muscles and organs in the images of computerized tomography, in order to be able to organize the anatomic specification of each identifiable image, according to the text-markings, as »visual knowledge«.

The first project on the long walk to the »Digital Image Library« was the »Visible Human«, commissioned in 1986. This digital library of a visible human necessitated the registration of the data volume of a »complete, normal adult male and female« through digitized photographic images for cyrosectioning, digital images derived from computerized tomography and digital magnetic resonance images of cadavers. This data was acquired during the last five years by the computer scientist Victor Spitzer and the anatomist David Whitlock at the Health Sciences Center of the University of Colorado. The data set of the male cadaver was completed first and named »Adam«.
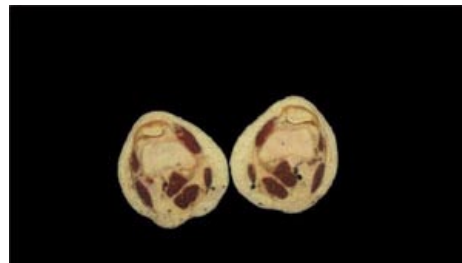
„Adam"   „Adam" „Eva"

Heralded as the »first digital description of an entire human being«, the »Visible Human male« not only stands for one male cadaver, but is quite casually also seen as a novel definition of the »entire human being«. The aim of representing a complete »human being« in a digital image library may seem astonishing and is, of course, theoretically impossible, since the values tend towards the infinite. The practical aim is of course a high degree of technological precision and completeness in the registration of images, with a data set that is as large as possible in order to guaranty a high optical image resolution.

However, the amount of data was not what made the project »Visible Human« famous. The images of the cadavers were represented in print media and television reports as something quite different, namely, as the »fantastic creation of the first (real) digital human being.« The supposed »life« of this data made headlines. The data set »Adam« was described in an biblical sense as a kind of repetition of creation, as the resurrection of dead matter. Newspapers and Television defined the whole project as a revitalization, the electronic »resurrection« of a dead body. As if a person might be able to »live on« in the form of complete, extensive and identical data in the computer. The quest for completeness in the registration of image data is transformed into the belief in the complete identity of the image and the portrayed, as if one were the identical double of the other. Images are thus seen as clones.

During the last years, scientists have been working on the data to produce more and more »realistic« simulations that enable many three-dimensional visualizations, the so-called »Virtual Human«, from the cyrosectioning photographic images. Future applications of the data set »Adam« include the implementation of »virtual« motions, in order to attain the active and passive simulation of motion.

„Teaching applications will range from identifying anatomical structures on the cross sections to visualizing full motion of the human form. It is this kind of interactive total body control and simulation (including simultaneous modeling of all the synergistic and antagonistic muscle motions) that will challenge today's best supercomputing facilities.“

Victor Spitzer himself outlined the planned animation of the data in a television interview, the formation of muscle movements, the addition of the motions of a beating heart, the simulation of the whole blood circulation - as if he were talking about a scientific usage of special effects programs that movies employ for the digital modulation of synthetic figures - and of course, Hollywood is as dependent on a realistic impression of motion as the field of medicine. Victor Spitzer, however, also mentioned further ideals in the »realistic« revitalization of the virtual body. Not only will the playing and modification of prepared sequences of motion be made possible, but also the implementation of programs with mathematically unpredictable processes - such as those from the area of »artificial life« - on the virtual »human being«. In this way, for example, aging processes with their implications on soft tissue and other physiological consequences could be simulated as well as the development of diseases, such as the emergence of a tumor at a certain location in the brain.

The further manipulation of the data set »Adam« has the long-term goal of offering environments of Virtual Reality that allow a visual and a tactile feedback and can be used for the simulation of surgery on the virtual human being. The high level of realism striven for would allow the simulation of the changing of shapes in the three-dimensional renderings as well as a feeling for the mechanical resistance of different tissues while applying a virtual scalpel. This in part already existing hard- and software-design of the »Visible Human« will be used in surgical training for the simulation of operations. The virtual »human« can be dissected and interactively manipulated at will, and in the end its original form can always be perfectly reconstructed. The real cuts are »healed« through the programs of visualization, they disappear as the regular structure of volume-elements in the new virtual image tissue. The imagery is open to all gazes or virtual instruments, from any spatial point, it can be turned around or opened or even, as a complete baring of the visual, entered like a tunnel. The imagery that is thus produced turns the »data body« inside out.

IMDM Uni-Hamburg
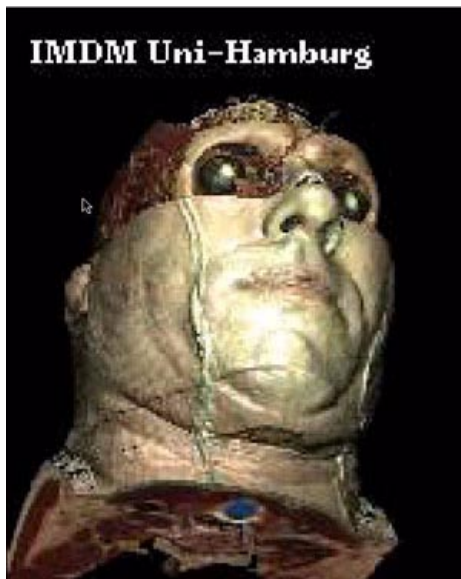
„The real challenge is, however, the construction of a volume model of the Visible Human, which allows the interactive exploration and the derivation of labeled pictures and animations with realistic visualization. The VOXEL-MAN environment is ready for this."
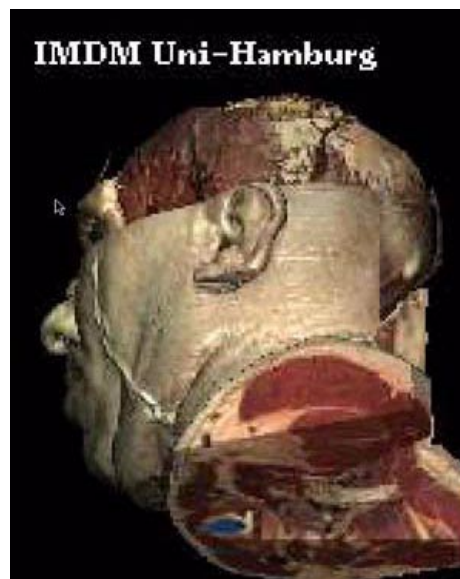
„Any visible object in an intelligent movie can be selected by a simple mouse click and related media like text, images, schemes, www-sites, or net-wide queries can be invoked locally or via internet."

Practice is then possible on the individual. The data set of the »Visible Human« can be linked to the specific data of a patient, thus enabling the simulation of a patient's body. This kind of computing, called »matching« is important since it allows a kind of representation that undermines the traditional distinction between a »model« and an »individual case«. The »Visible Human, male« is, simultaneously, an individual body and a structured knowledge base, and in the same way, every male patient can be linked to the analyzed structure of this one virtual human and rendered according to his specifications. In the surgical rooms of the future, the operation will be applied to the living patient with the same motions practiced in simulation. The condition is the telepresence transmission of surgery on the simulated body of the patient to a robot surgeon in the actual operating theater. Several plans for future surgery envision this kind of telepresence transmission into an actual environment as a normal procedure during surgery.

In this light, the image definition of the »Visible Human« project can be seen as a decoding and interpretation of information on human beings that was previously hidden in technical body-images. But not only the structure of a digitized image can now be analyzed and manipulated. The decoding of the image is itself seen as the blueprint of the object, of the human being, that can thus be diagnosed and manipulated. The surgery performed on this novel »body image« is situated on an diffuse border between life and death, between the matter of a new imagery and the matter of the human body, namely within the concept of »information« - which now arrives at its technically precise meaning as a reference to a type of border.
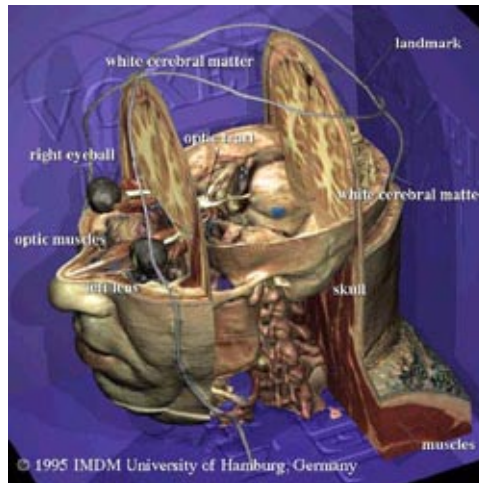
„The surgery performed on this novel 'body image' is situated on an diffuse border between life and death, between the matter of a new imagery and the matter of the human body, namely within the concept of 'information'."
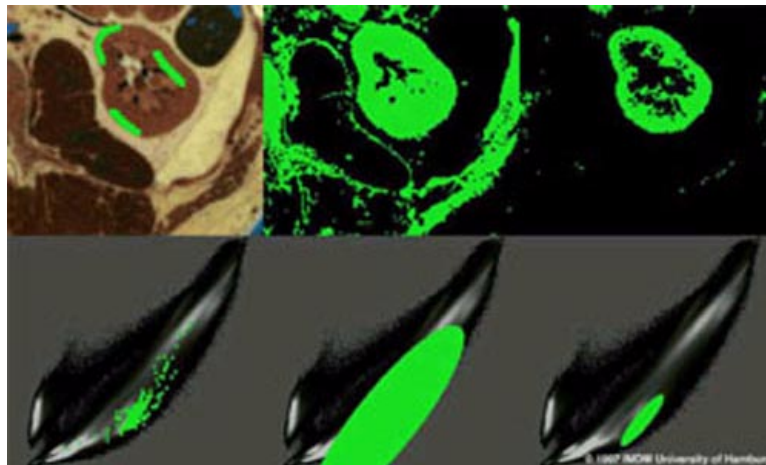
„Interactive classification in RGB-space for the left kidney: The user first outlines some typical areas of the kidney (left column). A preliminary result is obtained when all marked triples are used (middle). By restriction to the 'substantial' triples, the final sharp classification is computed (right)."

„The 5th Dimensional Human"

These observations are intimately connected to the issues of one main lecture of both conferences, held by Colonel Richard M. Satava, one of the most renowned protagonists of tele-medicine and the implementation of virtual reality in medicine. In San Diego, he was introduced as the spiritual father of virtual medicine and of the conferences themselves. According to his biography, he now holds tenure as a professor of surgery at Yale University after many years as a project manager at the Defense Advanced Research Projects Agency.

„During 20 Years of military surgery he has been an active flight surgeon, an Army astronaut candidate, MASH surgeon for the Grenada invasion, and a hospital commander during Desert Storm, all the while continuing a full time clinical surgical practice. While striving to practice the complete discipline of surgery, he is aggressively pursuing the leading edge of advanced technologies to formulate the architecture for the next generation of Medicine: Medicine 2001." The phrasing of the aims and responsibilities of Satava's former working place, the DARPA, published in the World Wide Web, seem to be the model for these biographical notes:

> „DARPA's primary responsibility is to help maintain US technological superiority and guard against unforeseen technological advances by potential adversaries. Consequently, the DARPA's mission is to develop imaginative, innovative and often high risk research ideas offering a significant technological impact ..."

The financing of research that serves as a creative pool for the free-floating development of visionary ideas by talented computer scientists and engineers (but could of course also be utilized by the military) is exactly what Richard Satava has been advocating for years.

His lecture at the conference »NextMed« was called: „The 5th Dimensional Human: Integrating Physical, Biochemical and Informational Worlds". What is meant by this surprising introduction of a fifth dimension? Supplementing the three dimensions of geometrical space and the fourth dimension, time, Satava introduced a fifth dimension, namely: »Information«.

> „It took a long time to get the right title here. (...) What's the fifth dimension? I was struggling to understand what the information age is all about. And as I looked around, there were 4 dimensions, the dimensions of space and time. And as we started building new information-based technologies, as I will show you, it became apparent to me that information, whatever information is, is actually a dimension. What do I mean by that? A dimension is something that you can to a certain extent measure, but when you work with it, it can make a difference in the real world. I can kind of measure time, but I can't feel it. To be in time or not makes a difference in the real world. As we start building a record on a medical avatar, there has to be another dimension. (...) That is, the information is contained within. In my case it is within the human being. That is what we are calling the properties that make us people."

Here we find an model illustration of what the superseding of »human beings« through »information« might mean. An »avatar« is the image representation of a user in a virtual environment. An »avatar« can, for example, be nothing more than the symbol of a hand that is used to navigate through the scenery portrayed, but it can also represent the user in the form of a complete, often quite fantastic figure. The »medical avatar« that Satava refers to will origin from the data structure of the »Visible Human«. The idea is not just the generation of a model for the »human being«, nor simply the reconstruction of the data of individuals. Instead, Satava is chasing a for more ambitious dream:

> „The Visible Human is one of the cornerstones of a one million percent revolution in medicine." (...) ?If everyone develops their simulators from the Visible Human, then these things will be interoperable. All you do is replace the Visible Human with your patient's data." (...) „It's no longer blood and guts, it's bits and bytes. It's like sending a letter or E-mail - with one you sent the physical object, the atoms; the other, you sent

the bits. You get the same information." (...) „You will carry a little credit card that you put in a reader, and a hologram of your body will come up, replacing all of your medical records. The technology exists now."

Is this really the case? Is this »information« really the same? Is the medical avatar identical to the patient it refers to? Satava ends his lecture on the »5th-dimensional human being« with the declaration that many powers are working together towards the ultimate goal of creating a different world, a world consisting of »information« that will coexist with our real world and »enable us to do things we have never been able to do before«.

What is envisioned here is a continual, immeasurable, complete registration of data that will be passed on to a control station. Data currents like those from the battlefields of the future will also flow from the everyday-life of all those that are connected to this healthcare-system, always contributing to the final completion of the construction of this »world of information«:

„You can build all these sensors into the bathroom and give everybody a physical examination every day. This data is about you, and it feeds back into your avatar, your own personal Visible Human."

The automatic check-up in the bathroom of the future will be set into motion through sensors in the lavatory (analyzing excrement), in the mirror (diagnosing the eyes) or in the handle of your toothbrush (for measuring pulse and blood-pressure). Referring to a video-show that demonstrated the body image computed from the data set of the »Visible Human«, Satava explained:

„What you are looking at here is bits and bytes. Zeros and ones. But it's also a living, breathing, caring human being. This may well be a way to introduce the future to you, this may be your medical record." »This is what you will look like« would be the logical consequence of this line of thought. In its euphoric gesture, this use of language has crossed a border. The world of »information« and the »real« world have been identified with each other. At this point at the latest, the lecturer has forgotten that the data of the »Visible Human« originated from a death-row candidate. »Adam« was conceived from the corpse of a convicted murderer. Obviously, the person who offered this data can no longer be alive. The idea of presenting all this as an image of »life«, the advocacy of a world of the future that controls information from »living« as well as from dead persons can only be interpreted as a Freudian slip - a slip which is augmented in a touching sort of way in his commentary of the video-show. Satava appealed to his listeners while motioning towards images of the three-dimensional reconstruction of the hand of the »Visible Human«:

> „Look here. Perhaps this is the hand of a surgeon. Look a bit closer. Perhaps you see the skill that went into that hand, when you go under the skin. All this must be embedded in the 5th dimensional human. The challenge is clear: Take these technologies and build the future for our children."

This slip that I would like to perceive as pertaining to the military-medical complex culminates in the comparison of the hand of a murderer with the hand of a surgeon - perhaps even with Satava's own hand. This cannot have happened consciously, it must be an accident, an unconscious mistake. And yet, the terrifying message remains the same. The universal term of »information« crosses the border between life and death, representation and the represented, avatar and patient - in an absurd gesture that would like to eliminate this border itself. In Satava's slip of tongue, even the border between healing and killing is surpassed. In the coming world of »information« it will no longer be of any consequence. Not only is the idea of the »human being« as it is, perhaps, today

»still« conceivable, sacrificed, but also the possibility of envisioning what the »human being« might signify in the context of this medicine-technologically changed future. »Bio(r)Evolution« would consist in the following promise for the future of »our children« - the death of Difference in the name of »living information«. This, in essence, is the blatant lie paraded about by the military-medical complex at the conferences.

„What you are looking at here is bits and bytes. Zeros and ones. But it's also a living, breathing, caring human being. This may well be a way to introduce the future to you..."

„While striving to practice the complete discipline of surgery, he is aggressively pursuing the leading edge of advanced technologies to formulate the architecture for the next generation of Medicine - Medicine: 2001."

Translation: Brigitte Helbling