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The Visualisation and Images as an Effective Tools in Science Communication and Science Education

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Introduction

The Visualisation and Images are the entities with which all thinking is considered to take place. Hence they are central to the process of learning and consequently to that of teaching. So, the role of visual images in intensive lectures will be introduced. In this essay, I consider how they can facilitate how chemistry students understand and learn through molecular visualisation. Indeed, I will present the role of visual representation in science communication. The extensive demand for effective scientific visualisation alongside rising sensitivity to popular considerations has created a reckless culture of image manipulation. Scientists, artists and illustrators take a wide licence as to how they manipulate images for their purposes, but a minority of viewers is conscious of or alerted to what has been changed. This paper will explain how the public understand and see the images of nanoscience and nanotechnology. In addition, the image typologies will bepresented.[1]

1. Importance of visual images in lectures

During recent years, the understanding and learning of the text of lectures has been intensivelyrealized. However, the fundamental drawbacks to lectures are the listlessness of students and the shortage of feedback with respect to the understanding of the lecture. Examination of the effectiveness of learning by visual images has been paidmuch less attention. On the other hand, many researchers have confirmed that our brains are more capableof retrieving and storing images than of memorizing the text.[2]
According to studies that were carried out as early as the 1970's, the brain has an extraordinary ability to remember and imprint images accurately. With regard to conception, images can be stored in the long-term memory of our brain, because the images excite a range of responses such as to texture, colour, visual rhythm, dimension and imagination. The extent of storage and retrieval of images has cannot be reduced.
Visual images have become a crucial tool to stimulate our imagination; they represent a large part of our learning process from our childhood, particularly by

students who are learningan unfamiliar subject. A number of researches throughout the 1990's demonstrated that the function of pictures as visual text is not only decorative but they also have a role in representation, transformation, interpretation and organisation. The combination of visual images and text isa crucial process in supporting the understanding of students.[1] [3]

Visual images can make a lecture more interesting and visually more stimulating; they can facilitate students to comprehend topics rather than simply memorise them. Moreover, images lead to opportunities for interaction with students in a lecture, which contributes to improving students learning.

Scientists frequently make visual images of phenomena that cannot be seen or sufficiently understood, whether the phenomena are real or abstract, from chemical reactions and molecules to universal truths. In parallel ways, the science educator may utilise the images that have been created by the scientists or those who concern themselves to enhance the interest of students and promote mutual understanding. In addition, cognitive psychologists investigate how researchers, educators, people and students alike comprehend facts with respect to visual images.[1]

2. Scientific visualisation in science education

Visualisation is a fantastic tool for shedding light on what was once unknown. Scientific visualisation concentrates on the utilising of computer graphics to create visual images that facilitate the understanding of the complexity and meaning of science. Scientists seek to provide clarification for natural phenomena to describe the causes which lead to those particular effects in which they are interested.

Visualisation can connect the science and what we see around us in our daily lives. For example medical scan may be seen in three dimensional images, which allow great insight into the functions of the human brain.

Furthermore, scientific visualisation can play a crucial role in displaying computer data in new and attractive ways.Visualisation facilitates researchers acquiring a deeper perspective on their data and they can see the evolution of their research more clearly. The main target of scientific visualisation is to create a kind of interface, which depends on the perspective of human intelligence.[4][5]

Figure (2) shows as an example of visual images which illustrate the three dimensional models of a complexprotein called GroEL. Scientists created this image by using visualisation as a tool to analyse and indicate the models dependence on experimental data. Because it was not enough to provide this image by only using technology, electron microscopy and X-ray crystallography were employed. X-ray crystallography was used to resolve detailed atomic-level information. However, the cryo- electron microscopy illustrates the relative orientation of one protein to another. The image was coloured, and the parts of the model were rendered visible. That helps us to distinguish between a varieties of components of the GroEL complex. For instance, the adjacent copies of GroEL protein were coloured differently to differentiate each copy from the other. These complex entities were visualised because it is critical to our understanding of their function and structure.

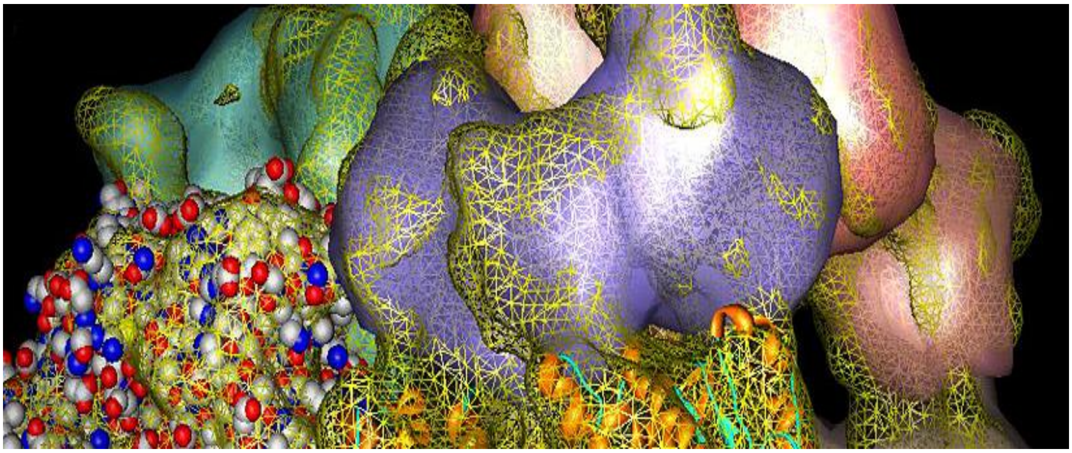


Fig (1)

2.1. Molecular visualisation in chemistry education

Nowadays, chemistry research is dramatically concentrated on phenomena which are communicated and understood by means of visual representations. Molecular visualisation is extremely important in chemistry. Picturing the three-dimensional structure of a molecule in our head has become possible, because we are able to see how these molecules interact with other molecules. Moreover, visualisation tools and high performance computing have the capacity to change the nature of chemical research. Indeed, they promise to transform chemistry instruction.On the other hand, the central images of chemistry research can present difficulties for the beginner chemistry student. Therefore, visualisation has been used in a central way in the introductory chemistry classroom. In order to investigate the usefulness of molecular visualisation tools in education, students must be able to clarify the images that are produced. [5][7]

Today, chemistry students can be exposed to a wide range of molecular visualisation, such as various dynamic three-dimensional computer-generated molecular models, structural formulas and images obtained by devices such as scanning tunnelling microscopes.

The benefits of visualisation to chemistry students' arebased on the knowledge of the concepts that they have been designed to represent. For instance, science students cannot understand space-filling models of molecules without the primitive concepts of molecule, carbon, atom and oxygen. Indeed, students must comprehend the mapping between the concepts and the models as well. Furthermore, as can be seen in fig. (1), the four small white spheres represent hydrogen atoms, the large gray sphere represents the carbon atom and the red sphere represents oxygen atom. The colours that are utilised in this figure are not the real colours.

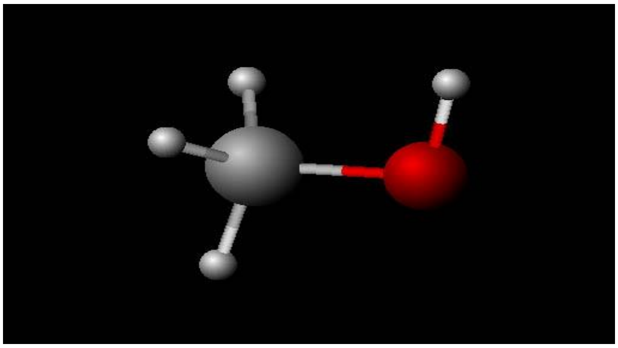


Figure (2)

Although the molecular visualisation might be challenging for students in learning because they could be complex, the utilisation of several molecular representations is crucial in comprehending the particular nature of matter.

Furthermore, figure (3) shows another example of visualisation. This is an image of a salt sample. This sample was collected by chemist Michael Zach of the University of Wisconsin, Stevens Point, on a trip to the deserts of the Death Valley National Park in California. In this image, he added water to the sample. the microbes in this sample, which were in dormant, came to life: the microbes can be seen squirming around in the background. The photograph was taken as the water evaporated; it captures the light as it is reflected off the growing crystals. The growth of the salt crystals is prevented by the secreting of chemical in the microbes, allowing them to survive in the salty ground.[7][9]

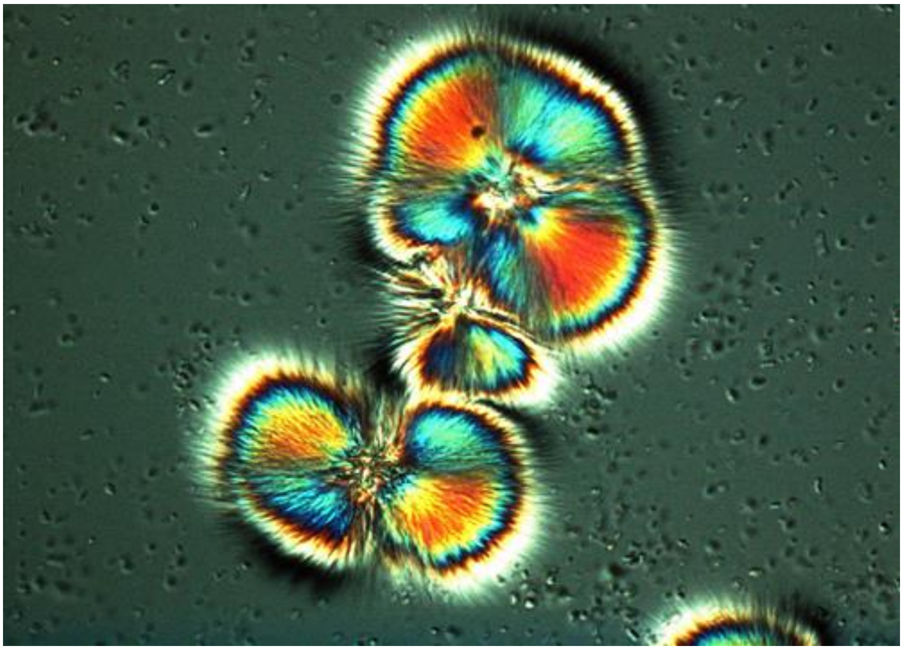


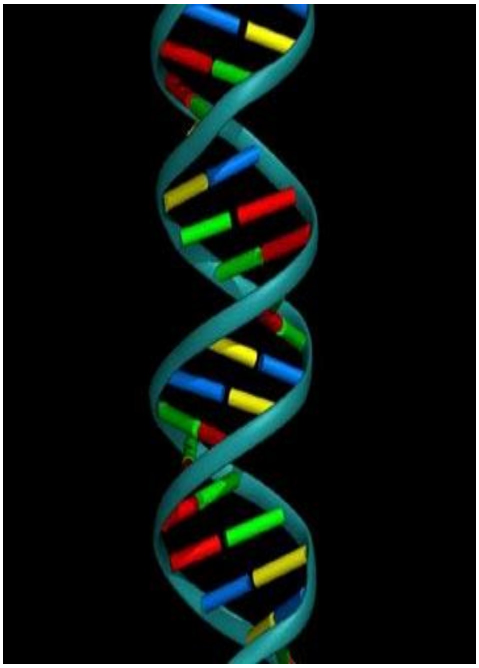
Fig (3): image of a salt sample

2.2. Visualising physical phenomena using interactive Media

Modern interactive media alone do not make research must becreated and brought together to develop a collective vision for the best use of these powerful tools and for advancement of science and education omprovement in and outside the classroom. Modern thecnologies and use of visualizations of physical phenomena are advancing much more rapidly than our knowledge of the basic and reference physical processes that they connect students attention. Better theories, methods and practices require long time interaction among disciplinary teachers, visualization practitionersand reserchers in vision science of education.

3. Visual science communication

Historically, images have been a fundamental part of science. On the other hand, the development of the capability to generate visual representation is attributed to the effect of computing and modern media technologies, alongside providing attractive new opportunities for participation in producing those images among or between scientists and the public. The visual representation of science functions in three overlapping fields, which are the scientist, science communication and the public. Members of each of these fields are able to be prospective producers and prospective consumers of scientific images. However, the scientific and visual literacy between scientists, science communication and the public might be completely different. The explanation of both the words and the images that are obtained by the scientist is the role of science communication. The purpose of those images is to make the message more willingly understood by a non-expert audience.The process ofvisual representation in its several shapes is an important portion of science communication. [2][5]
If DNA is taken as an example, the majority of us wander what it looks like. Many people have seen images of the double helix, which is a magnificent spiral strand of something. Certainly, they ask themselves many questions, such as what is its colour? Is DNA larger than a drop of water, an atom ora molecule? Does it actually form like a spiral? This vital, spiral- formed image fills the television screen, illustrating a report on cloning, what precisely are we seeing? This is a form knowledge for us, but is it only symbolic notion or a factual representation.[9]
Otherpopular DNA images are these in which laboratory technicians inject something into a vaguely gelatinous substance, whereas stories of gene sequencing abound in the background. Somehow, in this substance, DNA was made visible. The images of the double helix, DNA stand, and a gene map dominates the media, and the understanding of genetic by members of the public may attributed to these unlinked visual representations. (see figures (4) and (5)).
In figure (4) we may see what the DNA Double Helix (two DNA strands) looks like. Every DNA strand is consists of nucleotides. [7][8]



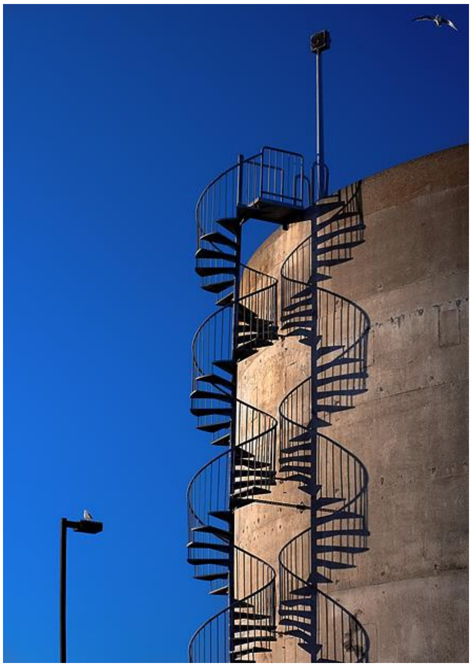


Figure (4): DNA Double Helix

Scientists have exposed their capability to use genomic analysis to identify a person's geographical genesis to within only a few hundred kilometres. In addition, they offer possibilities for the testing of genetic ancestry. The research could also have crucial implications for understanding the function of genes in complex diseases and other genomic-based health studies.

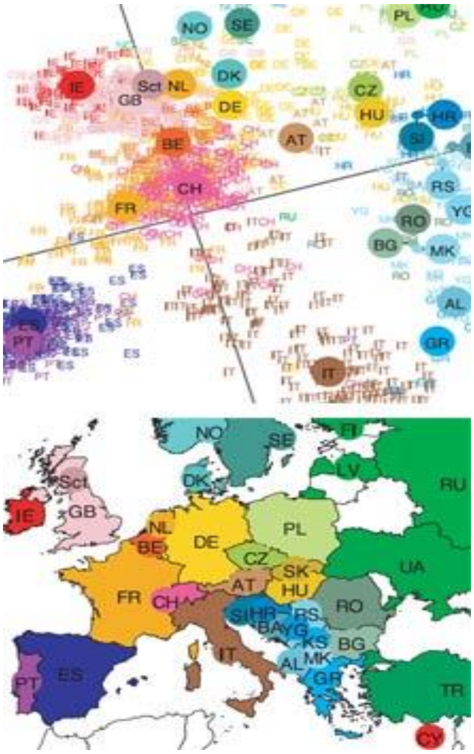


Figure (5)

shows the gene map of Europe thatresearchers created by mapping genetic distinctions between Europeans. The above map represents a genetic map of Europe compared to its geographic equivalent show below.According to the country of origin of all four of their grandparents, this map indicates each of the 1,387 individuals, represented by a colour and a country.[10]

The form of DNA still leaves the science novice wondering. The strict visual representation for the scientist depends on scientific data; a basic part of research.Much of contemporary science cannot be communicated accurately in texts. The sequences of DNA models of medical molecular imaging scans, the simulation of flight towards terrain and simulated fluid flow;all of these phenomena need to be expressed visually. Furthermore, for scientists,the changes in these phenomena usually need to be expressed visually too.

A variety of images is created, as simulation depends on structural prognosis of operations which cannot be seen. These speculative images are referred to as scientific visualisation. Moreover, they are improved by utilising computing technologies. The representation of the images is based in part on fact and part on theory (see figure (6)).

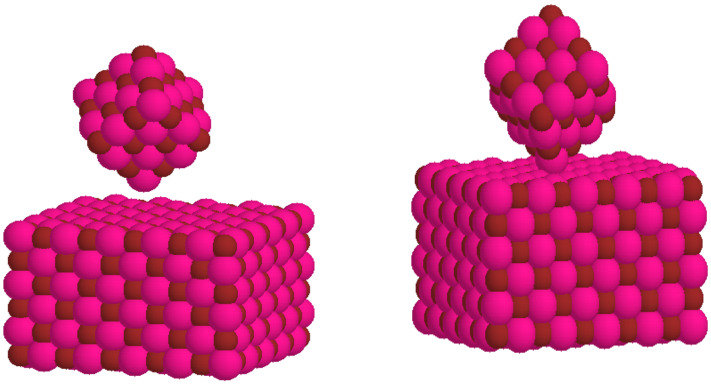


Figure (6) shows a photograph of a computer simulation reproducing the sliding motion of a tip on a surface on the atomic scale.

3.1. Public understanding of images in Nanoscience and Nanotechnology

Most people have heard of the nanoscience and nanotechnology; the majority of them comprehend that they are almost certain to produce far-reaching technological changes in the next twenty years. However, a minority of non-scientists are already familiar with what they are. The images of nanoscience and nanotechnology that come to the minds of most people include a tiny submarine navigating through the bloodstream of someone. These images are a constant source of science fiction and, because they have proved so enduring,it is often images of this kind that areutilised to provide stories about nanoscience and nanotechnology in magazines and newspapers. On the other hand, scientists who areinvolved in improving nanoscience and nanotechnology believe that, thesesorts of images are incredibly ambiguous. Indeed, the nanotechnologies that will be improved in the future will look absolutely different.

On the other hand, images are extremely influential. Scientists believe very strongly that the images that can be seen by the public to shownanoscience and nanotechnology are misleading or even incorrect; that meansthe images need to generated in some better form. These images need to be attractive and fascinating, so that editors will select them to use in newspapers and magazines and on television as well. Additionally, we need to make sure that these images do notprovideconfusing impressions of science.

Recently, modern scientists have felt obliged, often with reason, to interest a mostly uneducated public, in order to shape public understanding and to improve the willingness of decision makers, to maintaining an incessant flow of research dollars.

Modern technology has changed the approaches and tools of the way that we perceive it. A reckless culture of image manipulation has been created by the widespread demand for effective scientific visualisation, alongside a rising sensitivity to popular attention. Nowadays, images are playing a considerable role in the improvement of nanotechnology and nanoscience. Moreover, these images contribute to changing the means by which we comprehend seeing. Images are no longer a credible expansion of our eye and they are shaping a basic change, whether in the physiological or perceptual aspects of what it means to see (see figure (7)).

Fig (7) illustrates the inner ear hair cells, coloured by the scanning electron micrograph (SEM) of sensory hair cells from the cortex, in the cochlea of the inner ear. These cells are delimited by a liquid called the endolymph.

There are several nanoscale images which are colourless, but which are visually insipid versions of well-organized atoms or simple surface topologies, exhibiting the facility to arrange or manage our environment. Others take a wide licence in creating an image that is frequently more visually exciting than really informative. For instance, break-through images such as Don Eigler’s now famous company logo, ‘IBM’,conform to the capability to manipulate our world one atom at a time,even though very slowly and at very low temperature.[6][7]

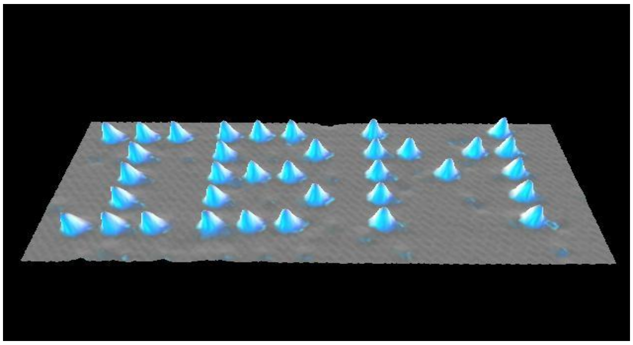


Fig (8)

That was rapidly followed by competition from 'Intel' and a change of subject to the representation of self in the 'Carbon Monoxide Man' as shown in figure (9). It is exciting to note the way inwhich the images seem to summarise the development of Western art in images of our environment, starting with marks, moving to representations of self, and lastly seeking more imaginative and visually attractive variations.

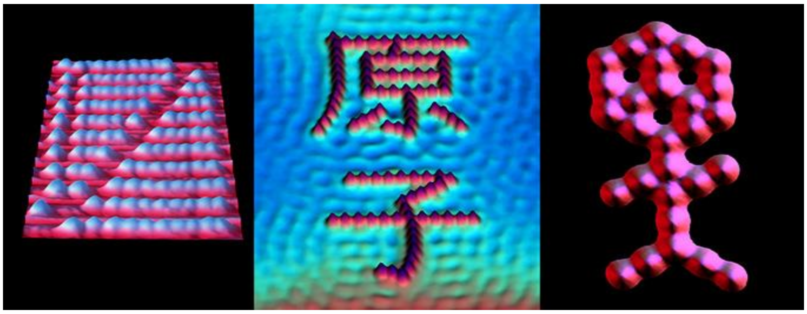


Fig (9): Carbon Monoxide Man

Although the majority of careful investigators believe that, this science and technology will affecteach aspect of our lives and be ahuge social leveller, the process of improvement is slow and the requirement for concreteconsequencesirresistible. This equilibrium between essential research and realistic application is aprogressively more contentious subject on university campuses as well as in company laboratories. Wishes for a " rags to riches"increasesimilarly to these of the digital manufacturing industry, beside the fear of inadvertent and probablyillegalutilisation, complicate the debate even more.[8]

3.2. Image typology

The images have a variety of typology that involves: schematics, documentation, fantasy, and Fine Art.

3.2.1. Schematics

Schematics represent an idealised version of an image through diagrams, graphs, stick and ball models and simulations. These are the development of traditional, guarded images of scientific visualisation with some visual drama. There are various examples thatinvolve line drawings and molecular models of the DNA spiral or a simulation of a excellent motion organizer, potentially utilised for future molecular manufacturing.[9][1]

Figure (10) presents a schematic representation of the structure of a molybdenum oxide cage (polyhedral) with encapsulated water and electrolytes by ball and stick models. A sodium ion (violet) is arranged by water (O yellow) and sulphate (S orange, O red) and molecules.

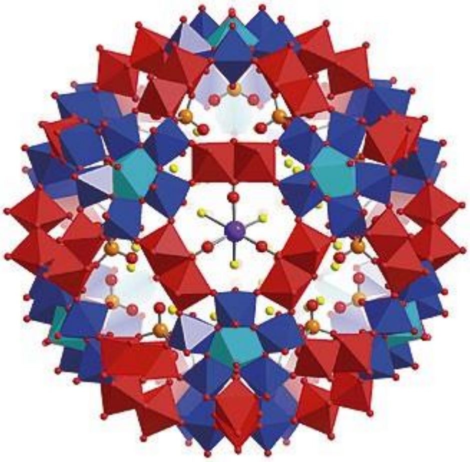


Fig (10): structure of a molybdenum oxide cage (polyhedral) with encapsulated water

The unique insight into the characterisations of hydrogen bonds was provided by the study of imidazolium hydrogen maleate (IHM).In principle; IHM contains the shortest hydrogen bond that has not beendiscovered yet. The oxygen to oxygen distance in the OH·· O hydrogen bond is an exciting 2.408 Angstroms. As can be seen in figure (11), IHM has a unique structure that contributes to study through INS spectroscopy. IHM can be deuterated in various combinations to present information about particularvibration modes. Moreover, the fact that IHM crystallises into inaccessible tetramers accelerates theoretical modelling.[7]

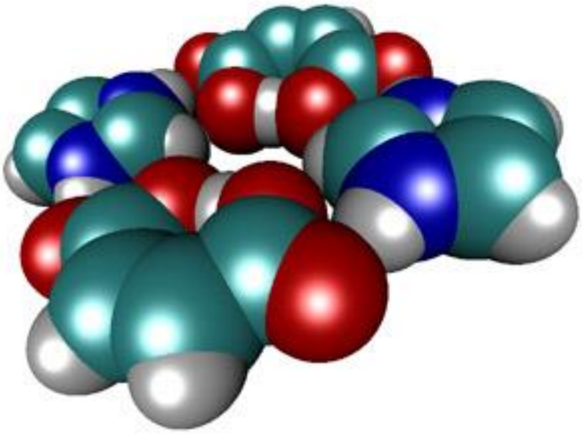


Figure (11) shows the space-filling model of imidazolium hydrogen maleate.

3.2.2. Documentation

Documentation meansefforts to characterise the image and involves photography, microscopy, indications, and animation. Examples are inseries from anextensive variety of nanolithography to Eigler's 'Electron Corrals'. The extreme nature of these topographies allows for fly-through animations, another wonderful, post-modernappearance that is yet unsure. A variety of these animations appear to be achievedeasily because we know how to produce them and because they look 'cool', rather than because they present any further insight or illumination.[6][7]

Figure (12) indicates the quantum mirage. A mirage of the atom appeared at the one centre while scientists positioned an atom at anothercentre of a stadium quantum corral.Even though the atom was just present at one focus, the same electronic properties were present in the electrons neighbouring both foci. The electron cloud about the other focus is called the quantum mirage, a phenomenon scientists wish to createin atomic-scale processors in the future.

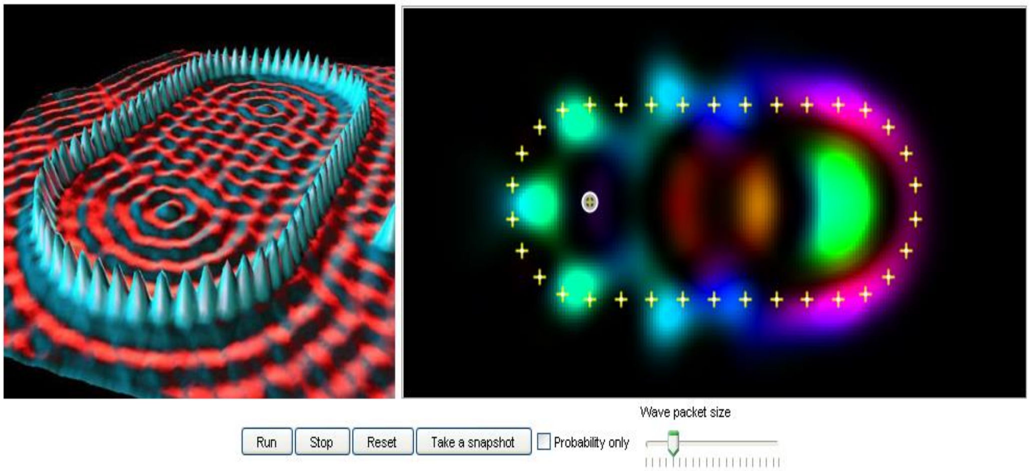


Fig (12): quantum mirage

3.2.3. Fantasy

This typology involves anextensive range of descriptive speculation that does not essentially depend on difficult science and captivates to the danger of becomingmisleading. In this case, we discover a wild compilation of metamorphosis-like mechanical instruments, often exposed in veins and arteries, producingcholesterol and attacking plaque. An award-winning transparent ‘nanolouse’ utilises pinchers and a needle, which issimilar to a probe, to grab and sample a red blood cell. In figure (13), a red blood cell isreceivingan injection from a nanorobot; one of the nanometers has a diameter roughly 10,000 times smaller than a human hair. In manufacturing, anample range of high tech products, such as DNA classification andnanoprocessing technologies, is utilised. [6][14]

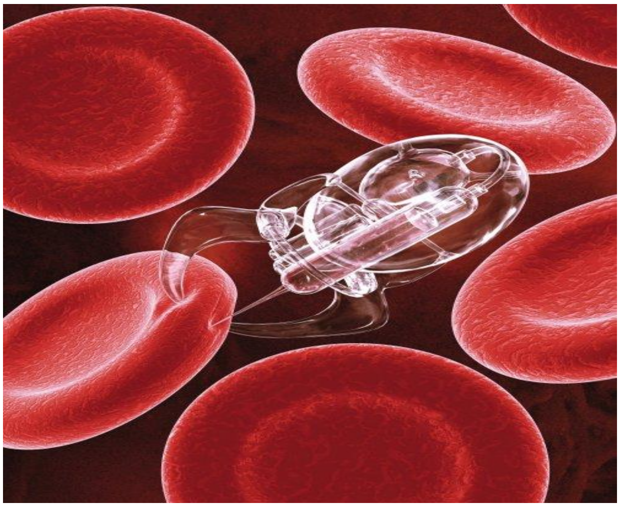


Fig (13) shows the award-winning computer-generated image of a nanolouse, whichoriginally looks realistic but close assessmentexposes an element of 'artistic licence'.

Several images show two humans havepracticalorganizational abilitiesabove the use of human-like nanobots. The depressing irony in this message is that there is aslight or no obviousassociation between the situation of the human drivers and the machines they apparently control. These images are popular, exciting and fascinating; however they are not very educational and are riskilyambiguous.

3.2.4. Fine Art

In the final category, nanoscience seeks to quantify and to shape important and enduring influence on culture. It is, nevertheless, roughly fictional, and leaves anabundance of chancesforaspiring young artists, who are determined to enter this complicatedomain. Some well-known modernartists, such as Gerhard Richter, have used microscopy images from nanoscalework in art and technology; installation and conceptual art presentefficient modelsfor meaningful artistic evolution and improvement.The general public is mostly ignorant of this quicklyimproving technology; the art world possiblyyetmore so, properly affected by a dread of what technology portends for them and a reactive willingness to seek the warmth and confidence of the hand-made.[4][13]

Conclusion

Theeffectiveness of learning by visual images was examined.Visualimages facilitate the understanding of the complexity and meaning of science. The advantages of visualisation to chemistry students were considered. Visual representation was in its various forms an essential segment of science communication. Thevisual representations provide opportunities for participation between scientist and public in understanding those images.The imageshave beenclassifiedinto the variety of typologies that includeschematics, documentation, fantasy and Fine Art, and that were described.

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