Seminar Notes On ‘The Technology of Visualization and Visualizability in the New Economy’.

Abstract: The 'New Economy' is making businesses both more complex and more volatile. Financial statements are supposed to give a realistic picture of what a company is up to, but such auditing as an exercise in representation is often simplistic. We need to ask whether the complexity of some businesses is getting beyond the reach of our present representation technologies and how this might be improved. Arthur Miller explores the use of visual metaphors in science and suggests possibilities for business organizations. Max Boisot explores the I-space and its relevance to complex learning organizations.
(Note: Only the main presenters are identified by name - Ed)

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by Geoffrey J.C. Higgs 18/11/02

Arthur Miller

Aristotle says in the poetics that it is a great thing indeed to make proper use of the poetic forms, but the greatest thing by far is to be master of the metaphor. Ordinary words convey only what we know already. It is from metaphor that we can get hold of something fresh.

Visual representations in both science and the arts, and mathematical expressions are metaphors which play an important role in creativity. The cognitive processes are similar in searching for a new aesthetic, whether it be form in art or elegance in the simplicity of diagram or mathematical equation. In his perceptive book *Images of Organization*, Gareth Morgan writes: 'the challenge facing modern managers is to become accomplished in the art of using the metaphor'. He notes that existing metaphors for organizations often convey only mechanistic, cultural or self organizing attributes and viewing an organization through them can often lock people into an image that is undesirable. Organizations that are not managed so that they effectively interact with their environment will not thrive. Management, whether hierarchical or 'flattened,' needs vision and vision comes with the help of new metaphors.

Scientific data is often far removed from our commonsense perceptions of everyday phenomena, consisting of abstract patterns of figures. But the figures resulting from our measurements are often indicative of deeper relations which we represent as algebraic equations. Galileo once said that the book of nature is written in mathematics and we speak about representing phenomena either by visual representation leading to a code or vice versa. There is thus a subtle interplay between what we already know in science and how we interpret phenomena. The trail of bubbles in a bubble chamber, for example, is understood because of our theory of nuclear physics. The image and the diagrams on page 24, **(illustration 1.)**

below are representations both of the observed phenomena and what we believe is the underlying process.

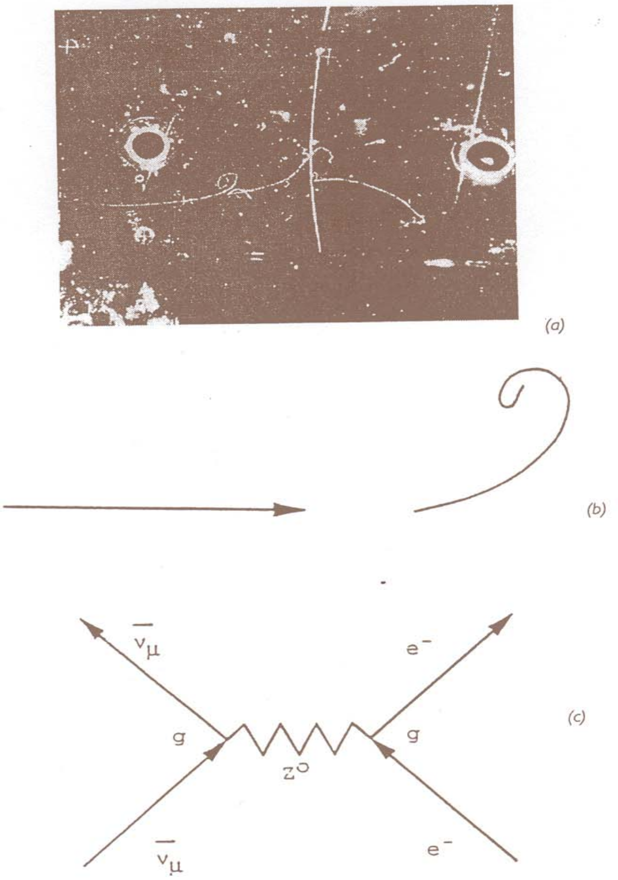

FIGURE 7.

(a). The first bubble chamber photograph of the scattering of a muon anti-neutrino ($\bar{\nu}_\mu$) from an electron (e^-). (b). We start to extract information from Figure 7(a) with Figure 7(b) which indicates that the muon anti-neutrino entered the bubble chamber from the left and struck an electron which moved in a trajectory that was curved by an externally imposed magnetic field. (c) The "deep structure" in Figures 7(a) and 7(b) according to the electroweak theory. Instead of two electrons interacting by exchanging a light quantum (Figure 8(b)), according to the electroweak theory an anti-neutrino ($\bar{\nu}_\mu$) and an electron (e^-) interact by exchanging a Z^0 particle, where g is the charge (coupling constant) for the electroweak force.

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The image from the bubble chamber (a) and the extracted line drawing (b), show the trajectory of an electron struck by an anti- neutrino in an externally imposed magnetic field. The theory (electro-weak) leads us to interpret what is happening as the diagram (c) in which the mathematics is the code which enables the Feynman diagram to be drawn.

We represent the world about us through a complex interplay between perception and cognition. There is no such thing as raw data or direct access to the world beyond the senses. We can get some idea of how we modify information about the world from the drawings that potentially depict two very different images at the same time (e.g.' duck'/'rabbit', 'young woman'/'old crone'). At any one moment we either see one or the other and though initially we may see the image as chaotic, once we see one or the other we do not see the image as chaotic again. Likewise our minds will often put things into an image in order to 'complete the picture' which on further close examination we realize are not there.

If we did have some infallible logic inside us we would not see such illusions, yet scientists have traditionally had a strong urge to think in visual images and many of the great discoveries in science have been made through visual representation. 'Seeing' in the philosophy of science in this respect can be regarded as 'seeing as', though the goal of science is 'seeing that' which may be understood as seeking the deep structure in systems and expressing the logic in mathematics. The 'educated eye' plays a great part in this recognition. Lots of people had seen the pendulum swinging before Galileo looked at it, but he saw the pendulum bob falling and rising and realized he could test his theory of 'free fall' in which all objects undergo the same acceleration under gravity. Scientific knowledge is like a lens through which the everyday world can be understood. If we do not know the science we do not understand the artefacts of scientific invention. A person from a non scientific culture seeing a cathode ray tube, for example, will not know what he or she is looking at. 'Seeing' carries knowledge with it and the more science we know the better we can interpret the world about us.

Eugene Tufte in *Visual Display of Quantitative Information* said that graphics are instruments for reasoning about quantitative information. If we have tables of data we need to know the best way of presenting what they mean and good graphics are more than mere summaries; they have an elegance of simplicity which may expose the deep structure underneath. In this respect we seek a minimalist representation for a maximalist amount of data. This is the aim of science and it holds in advertising too. In this respect we can see minimalism as a form of aesthetics and in science we have a firm notion of what that means. Good theories can be beautiful in a number of ways; mathematical equations can have maximal symmetry and can capture a system with as few variables as possible. Einstein, for example, initially discovered the theory of General Relativity by asking why we needed to have two kinds of mass (virtual mass and gravitational mass) when we could have one?

But perhaps a stunning example of what Tufte is talking about is provided by a drawing by M. Minard on page 24 (illustration 2.), which Tufte says rates as the greatest graphic ever done. Napoleon's terrible Russian campaign of 1812 could be described in two ways; as text with lots of words or as a two dimensional graphic in which a number of variables are taken into account. The width of the main track is the number of men remaining as the campaign proceeds. There is date, distance and temperature along with subsidiary battles that are fought. It shows the army's entry into Moscow with 100,000 men left and the long haul back under appallingly cold conditions. Napoleon's campaign was not just an appalling loss of men but a loss of money. Would it be possible we might ask, to illustrate the history of the giant energy company ENRON in a similar way so that ordinary people could learn something from it?

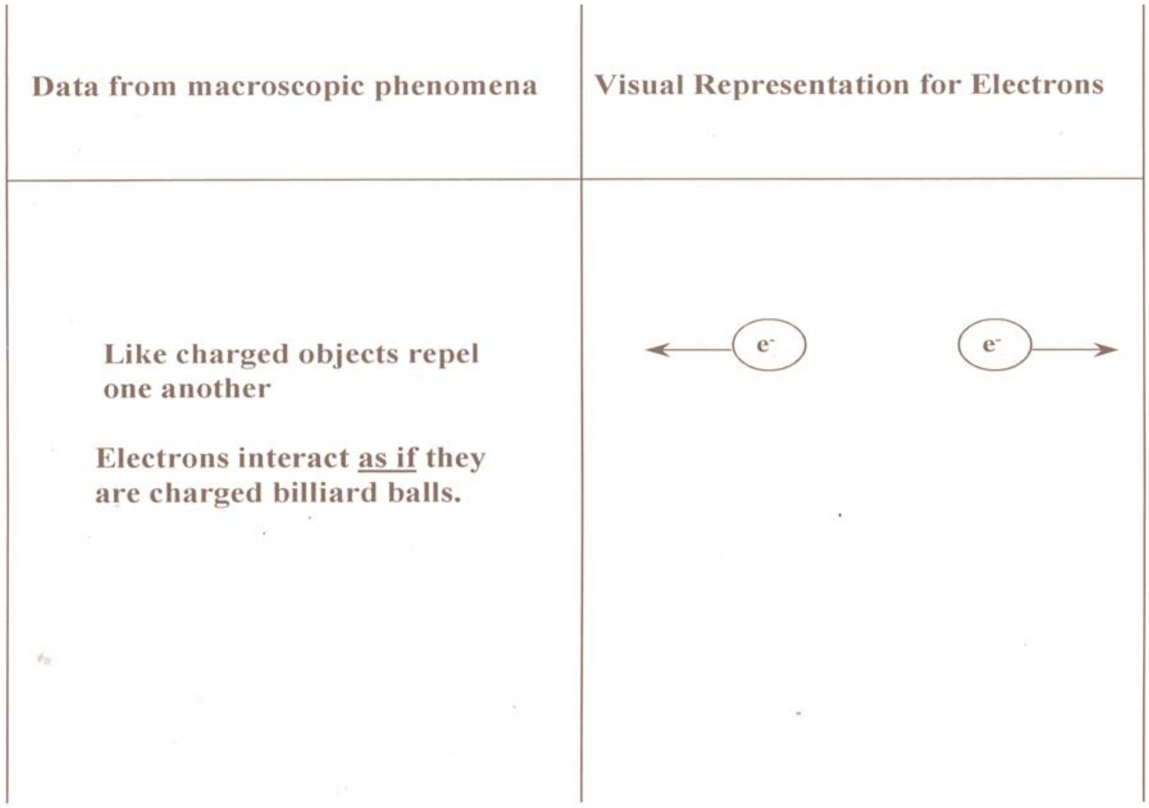
The visualizability of a situation is constrained by the science we have . The technology of armaments and in particular ballistics added an enormous impetus to the work of people like Galileo. After all if you fire a cannonball it's nice to know where it's going to land and since in the 17th century nobody could follow trajectories by eye, people relied on Aristotle's account. Aristotle's representation as shown in the illustration below shows the trajectory consisting of two parts: one is the 'unnatural' motion where the projectile is leaving the earth's surface and the other is the 'natural ' motion because the projectile is made of earth matter and seeks it natural place. Galileo's observations led him to conclude that the decomposition of the vertical and horizontal components would give a different curve and though the mathematics of the 16th and 17th century did not describe the parabola, Galileo 's drawings show that it was, and he went on to posit the unintuitive notion that all objects falling in a vacuum have the same acceleration regardless of their weight.

Illustration 2.Minard (p 24).

But we should give Aristotle his due. For roughly 2000 years much of his theory worked and though the Scholastics in the 13th century found fault with it, a Galileo did not arise because at that time science was words and logic rather than experiment. With the birth of Baconian science however, the graphic metaphor advanced science in leaps and bounds until the beginning of the 20th century when the ultimate nature of reality became much less accessible to visual description. Newtonian mechanics deals with the behaviour of objects or systems whose processes rely on the interaction of objective phenomena and so it deals with things which are either accessible to the senses or easily extrapolated from sense perceptions. In twentieth century science however, things became much less commonsensical.

When the electron was discovered in 1897 and for some time afterwards it was regarded as being like a small charged billiard ball. This was a useful metaphor and enabled people to probe something they knew little about in terms of something that they did know about. The diagram on page 25 (illustration 3) shows two electrons repelling each other as little charged balls. The model in the end failed, but for a while it worked out very well and since nothing succeeds like success physicists tried very hard to stay as much as possible with that kind of visualization.

Illustration 3.,Billiard balls.

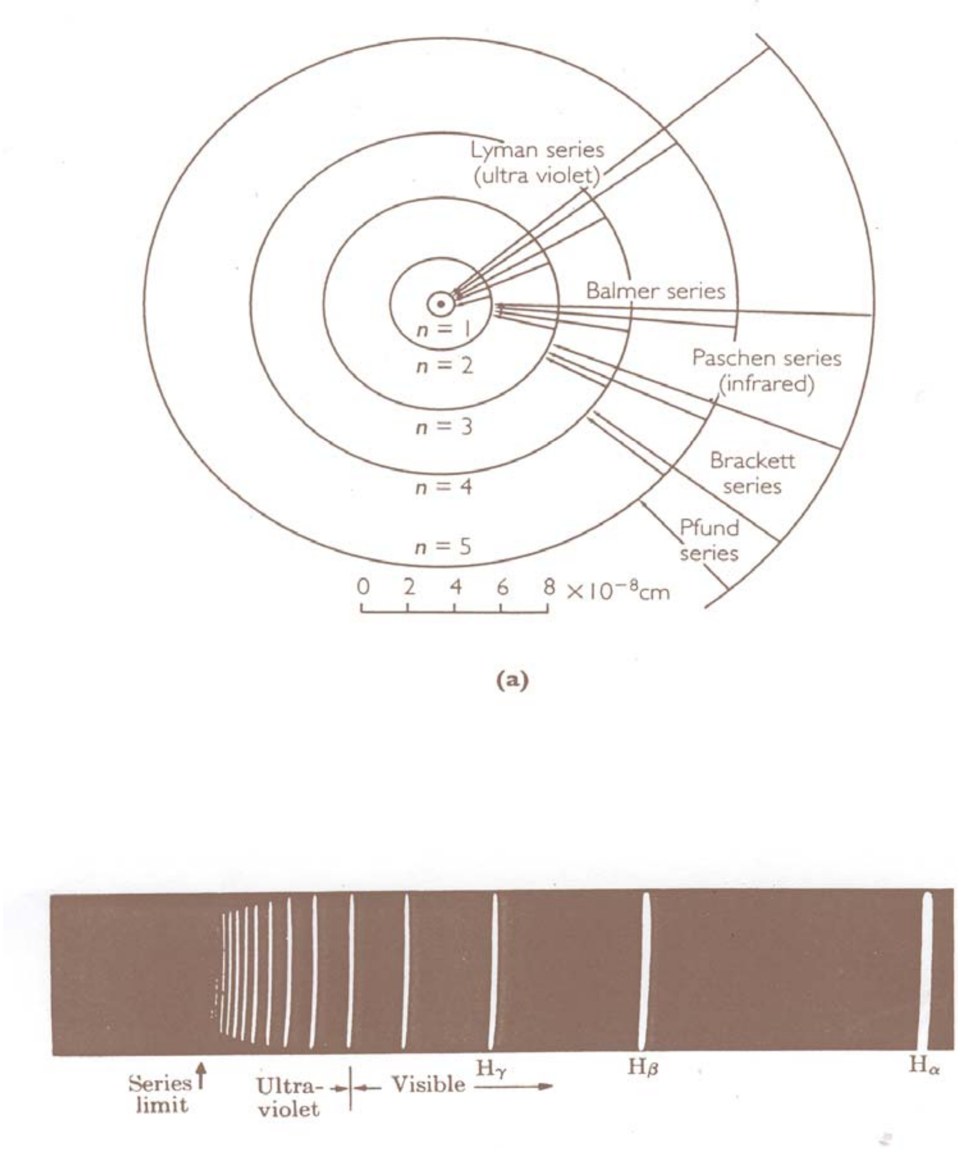


Data from macroscopic phenomena	Visual Representation for Electrons
Like charged objects repel one another **Electrons interact as if they are charged billiard balls.**	

At the beginning of the 20th century things began to diverge quite rapidly from Newtonian science, Relativity Theory went one way and Quantum Theory went another. Yet even then they were not considered to deal with things that were not accessible to common-sense. True space, was becoming non Euclidean but the theories were basically causal and could be handled by a sort of super-Newtonian equations and people could still draw pictures of what was going on.

This was not to be the case in later years. In 1909 to 1911 Ernest Rutherford discovered the nucleus of the atom by shooting alpha particles at very thin aluminium foils and when some of the alpha particles came back there had to be something very concentrated at the centre of the atom with a positive charge. Bohr produced his representation of a hydrogen atom in his atomic theory of 1913 and the conception of the atom as a miniature solar system was born (page 25 illustration 4) The positively charged nucleus was like the sun and the negatively charged electron ball was like a planet.

Illustration 4. Bohr atom (p 25).



(a)

(b)

It was a beautiful representation and when atoms of the other elements were made lots of things in chemistry then made sense (page26 illustration 5).
People could understand valencies and why the formula of water was H_2O etc. But soon conceptual problems arose with seeing the atom as a miniature solar system. For one thing electrons as particle-like planets going round the sun-like nucleus would accelerate and eventually fall into it and we know that's not the case because matter is stable. Then again it was found that the electron could only be in certain orbits and that the atom emits light when the electron drops from one energy level to another. Planets on the other hand do not have such specific energy levels and do not disappear and reappear like the Cheshire cat. Nevertheless the metaphor was very useful and such sober minds as Max Born in 1923 wrote: ' remarkable and alluring result that Bohr's atomic theory is a demonstration that the atom is a small planetary system. The thought that the laws of the microcosm reflect the terrestrial world obviously exercised a great magic on mankind's mind ... and its form is rooted in the superstition that is as old as the history of thought that the destiny of men could be read from the stars'.

Illustration 5. atomic representations

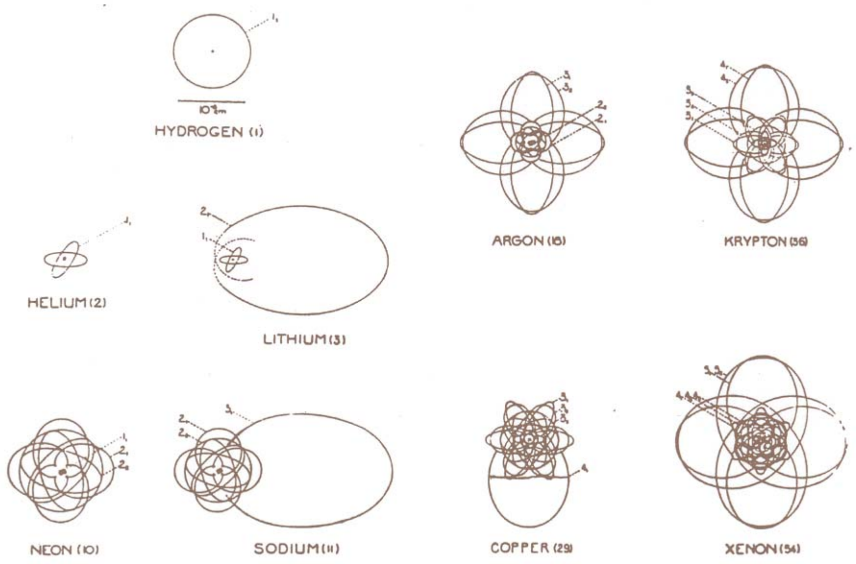


FIGURE 7
Representations of the atom according to Niels Bohr's 1913 atomic theory.

that the destiny of men could be read from the stars. The astrological mysticism has disappeared from science, but what remains is the endeavor toward the knowledge of the unity of the laws of the world.

being used as metaphors in order to understand the microscopic world. The theory of metaphor in the visual context and its importance in creativity was formulated by Max Black in the early 1960's. He said that metaphor creates similarity. If we have two things that may not be related before, the metaphor can relate them. He called his view 'the interaction view' and said: If something X acts as if it were Y with the instrument of the metaphor, the 'as if ' that relates the X and the Y, relates the primary subject that we wish to find something out about to a well-known secondary subject. The relations between the primary and the secondary subject may subsequently be found to hold but the greater the dissimilarity between the primary and the secondary subject the greater the tension between them, and so the greater is the creative potential of the metaphor.

In the case of the Bohr atom the instrument of the metaphor 'as if' signifies a mapping or transference from the secondary subject (solar system, classical celestial mechanics etc.) to the primary subject, (the thing called the atom). If we find that electrons don't behave exactly like planets then celestial mechanics might be suitably altered to allow for the fixed orbits. In probing the atom in this way the ontology remains fixed whilst theories change and as we make discoveries we have to modify the concept of the primary subject.

However the process of cognitive development is not just a smooth accumulation of knowledge and was described by the psychologist Jean Piaget, who started out as a mollusc investigator and went on to study children. The development of scientific intelligence takes place in stages much as a child develops an understanding of the world. There is a level of intelligence at T_1,and information is assimilated at that level until the emergence of a higher level T_2. In biology we have the process of 'homeostasis' in which systems maintain a stability at a certain level but are open and continually trying to catch up with the environment and what occurs is an upward spiral of stable levels tending to equilibrium (unless investigations force a radical paradigm change?)

When it was found that the electrons in the Bohr model atoms didn't respond to external stimuli as if they were miniature planets, another metaphor was formulated in which they were treated as harmonic oscillators (electrons on springs). The frequency of each of these oscillators is the frequency of possible transitions in an atom. However since there are an infinity of possible transitions in an atom it is not a graphically visualizable metaphor, but it was very useful and people won Noble prizes solving complicated problems by using the notion of systems on springs (e.g. 'superconductivity').

German literature of the 1910 - 1930's, including that of Einstein, Heisenberg,, Bohr and Schroedinger shows the emphasis in representation was shifting from image to mathematical code. This trend was given impetus in German scientific intellectual culture by the philosophy of Kant. Kant had done work in physics and astronomy and formulated his philosophical system in order to put Newtonian science on a proper cognitive basis. Newtonian science intuitively tapped into concepts of space and time which Kant worked on and which led to a philosophical lexicon that gave rise to relativity theory and modern atomic physics. The aim of Kant's great work of 1783 was to separate higher cognition from the processes of mere sensory perception and he introduced the notion of *anschaulichkeit* which is the immediately given and *anschauung* which is how we interpret the phenomena. This makes the distinction in perception between 'visualizability' or what the object itself may offer for interpretation and 'visualization', how we do actually interpret. The process of abstraction from disposition of iron filings on a piece of paper with a magnet underneath is shown on page 26 (illustration 6). The pattern of iron filings is the *anschaulichkeit* and the *anschauung* is the abstraction to 'magnetic lines of force' that pervade space.

Classical physics assumes that performing experiments on an object or making measurements can be carried out without altering the objects properties. This is the assumption in science that given a sufficient number of different investigations, an objective underlying structure of a system can be exposed. But in 20th century particle physics the distinction between *anschaulichkeit and anschauung* in particle physics was getting harder to distinguish. In some experiments electrons behaved like particles (page 27, illustration 7), but when a beam of electrons was passed through slits in a board, patterns of interference were seen as if the electrons were waves (page 27 illustration 8). Such patterns had previously been found with light and the water wave metaphor was first suggested by Thomas Young in 1804. In the 20th century the maxima and minima areas of light intensity could be calculated using wave equations and tested experimentally yet the particulate nature of electromagnetic radiation was also observed in experiments.

Illustration 6. – Magnet

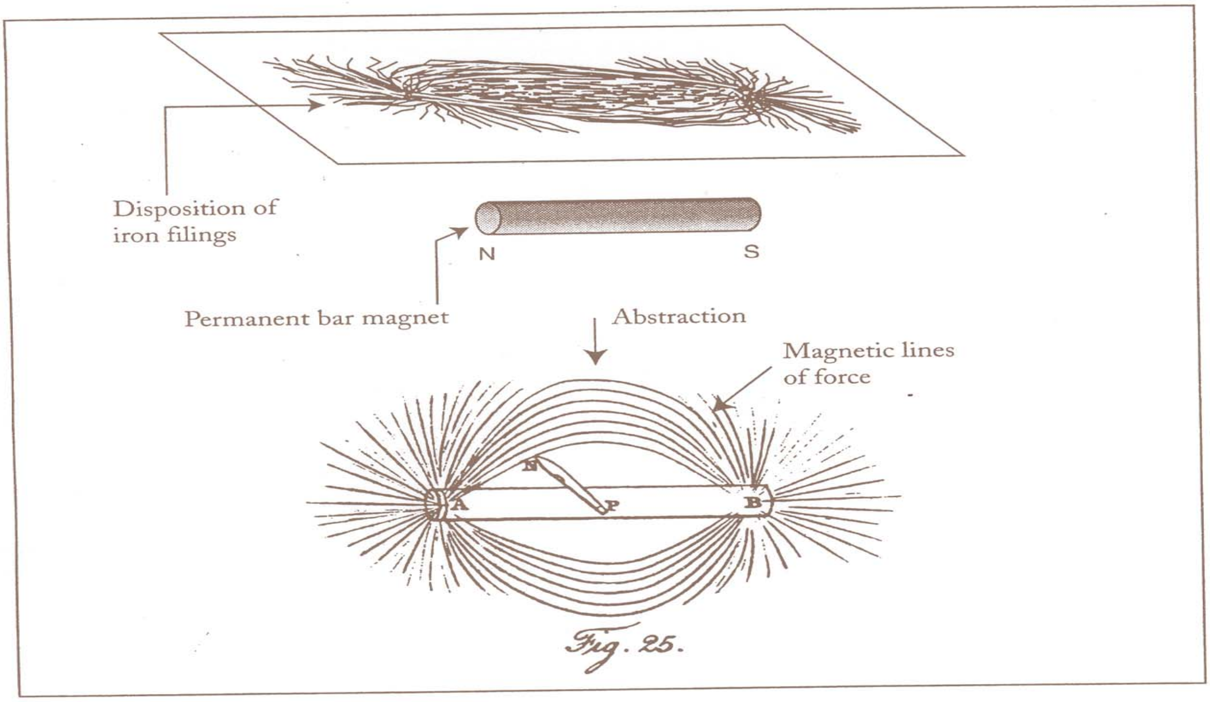


FIGURE 3.9 This illustrates the process of abstracting from phenomena that we have actually witnessed in the world of perceptions. In this case the disposition of iron filings on a piece of paper placed above a permanent bar magnet is abstracted to a visual image of magnetic lines of force that are assumed to permeate all of space. This representation is an *Anschauung*. The figure in the lower part was drawn by Michael Faraday in the course of his pioneering researches on the magnetic field in the 1830s (see Faraday 1965).

Illustration 7. – Slit experiment

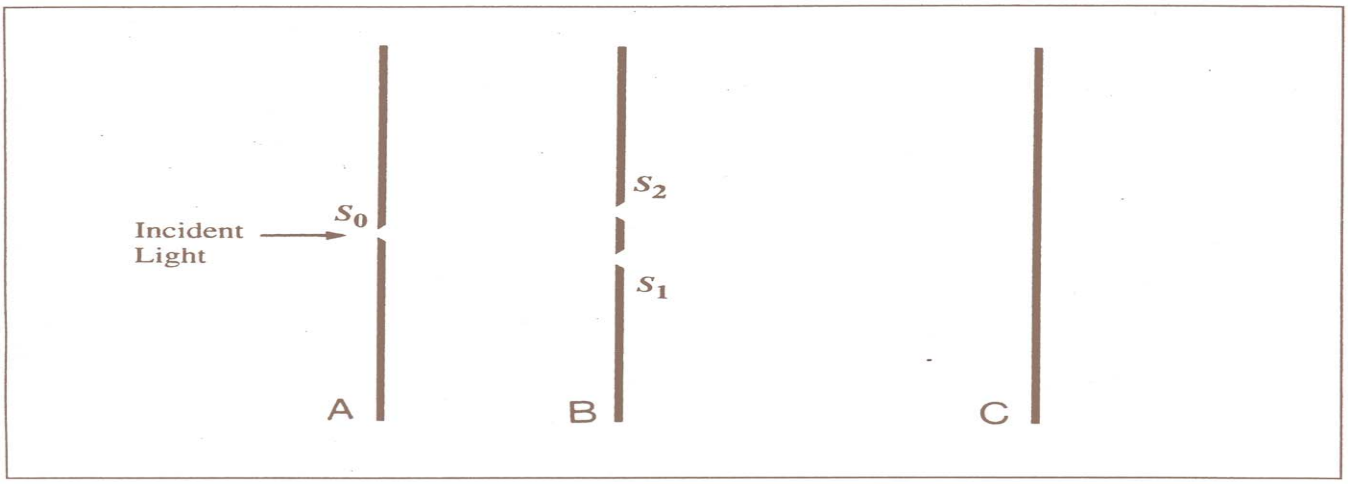


FIGURE 3.6 This shows the experimental arrangement in which light is incident on the slit S_0 on screen A. Another screen, B, with slits S_1 and S_2, is in front of screen C.

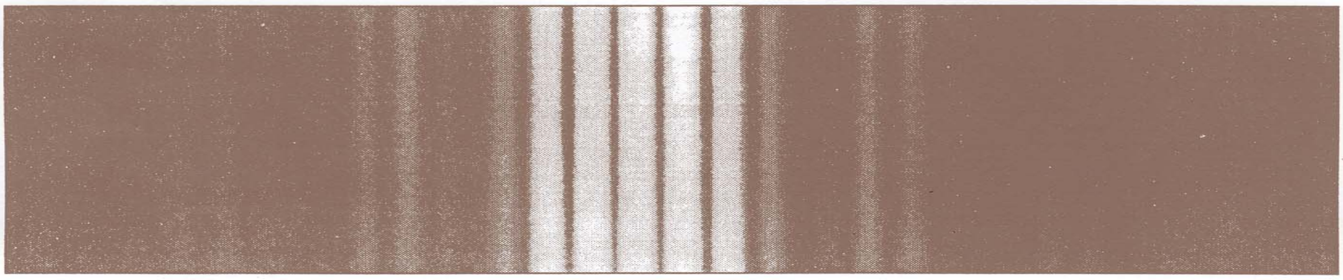
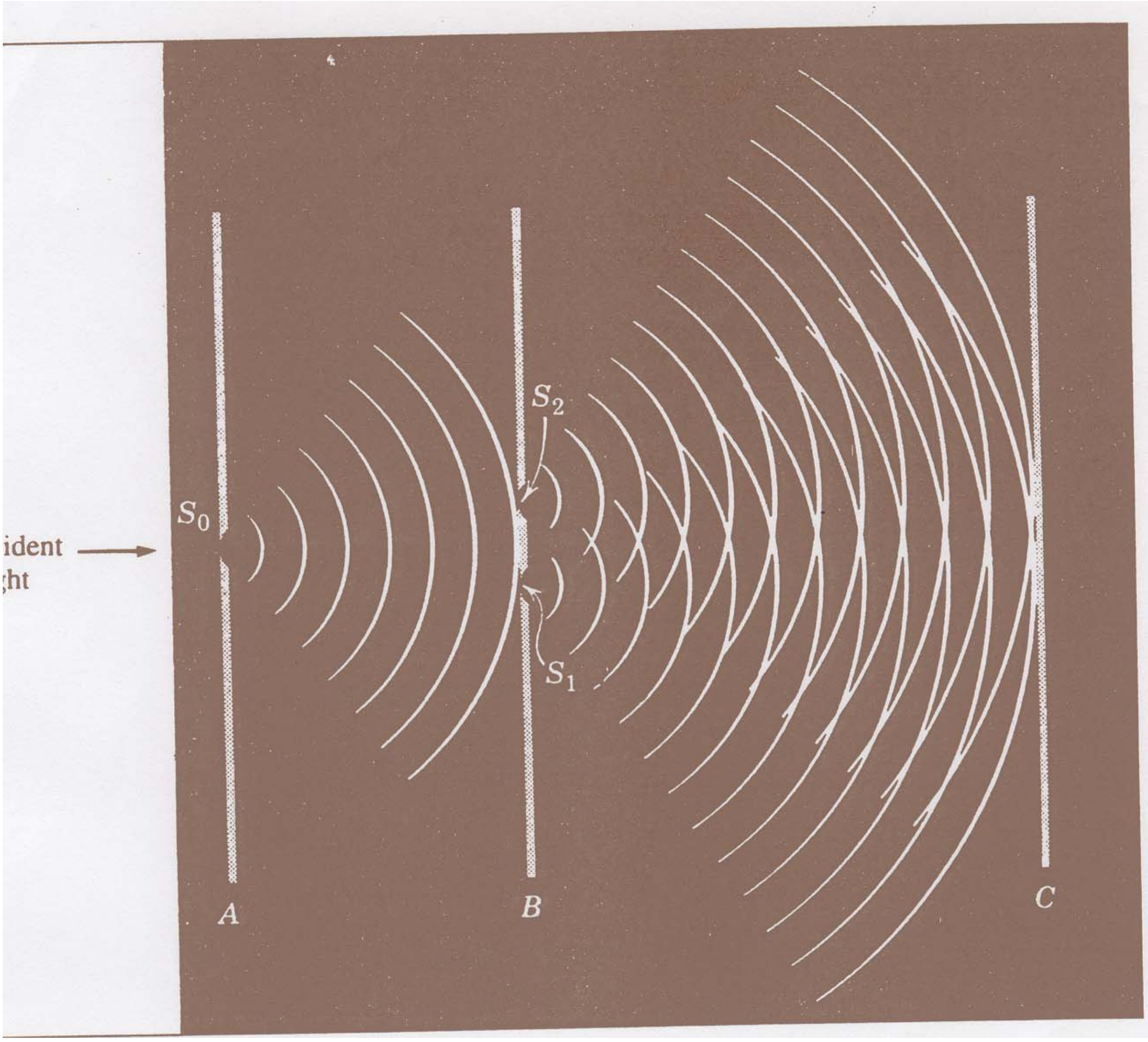


FIGURE 3.7 The data contained in the photograph of the effect on screen C from Figure 3.6 caused by light incident first on screen A and then on screen B.

llustration 8. - Interference

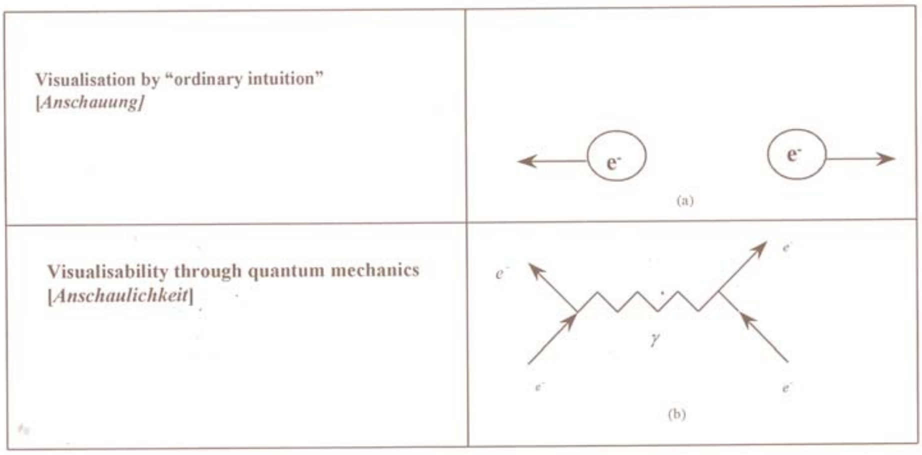


So were electrons particles or waves? Erwin Schroedinger was repelled by the inability to come up with a graphic image and suggested that an atomic electron could be represented as a charged vibrating string imposed on the orbits of the Bohr atom. It was however a metaphor of limited scope and although the mathematics worked fine it was not really understood what was going on.

The problem it was suggested was really a linguistic one and Heisenberg wrote to the great physicist Wolfgang Pauli saying: 'what the words 'wave' and 'particle' mean we know not anymore'. Talk of 'energy' and 'momentum' were already suspect when quantum theory began to be formulated. How could localized things like energy and momentum be related to non-localized things like frequency and wavelength? In 1927 Heisenberg produced his classic paper on the uncertainty principle, which restricted understanding of the terms 'position' and 'momentum' in the atomic domain and concluded that mathematics must be the guide to redefining terms. It is henceforth the mathematics which defines how we are to understand the theory intuitively and this is separate from visualization of atomic processes. Bohr proposed the 'complementarity' principle in which all elementary particles are the sum total of their wave and particle properties. In experiment however, such entities would only exhibit one characteristic or the other.

But in mathematics things could be reconciled. Quantum theory involves the principle introduced by Max Planck in 1900 that certain physical quantities can only assume discrete values. He dismissed the idea that an oscillator can gain or lose energy continuously and suggested it could only do so by discrete amounts which he called quanta. This unit of energy is given by *hv* where *v* is the frequency and *h* is a constant. Planck related momentum to wavelength, and energy to frequency and although his *h* is small it's not zero. It seems that in our ordinary macro perceptions, however, we are not aware of the kind of restrictions on momentum and position that occur in particle physics. And Heisenberg's work in mathematics would eventually prove to be a great help to Richard Feynman in constructing his 'Feynman' diagrams (page 28 illustration 9). These were a visual representation of the mathematics or code of the quantum mechanics.

Illustration 9. Feynman



Two electrons react according to our ordinary intuition of what is going on (*anschauung)*, but the Feynmann diagram gives us the way they really interact by exchanging a light quantum (*anschaulichkeit*). We would not have known how to draw this diagram without having the code before us. The changes in use of visual imagery in science can be set out along a spectrum from the seventeenth century up to the present (page 28 illustration 10). Up until about 1925 visual imagery was heuristic in formulating physical theory. During the intermediary period between 1925 and 1949 mathematics was the predominant format and then from 1949 to the present the coding itself generates visual image.

Illustration 10. Spectrum

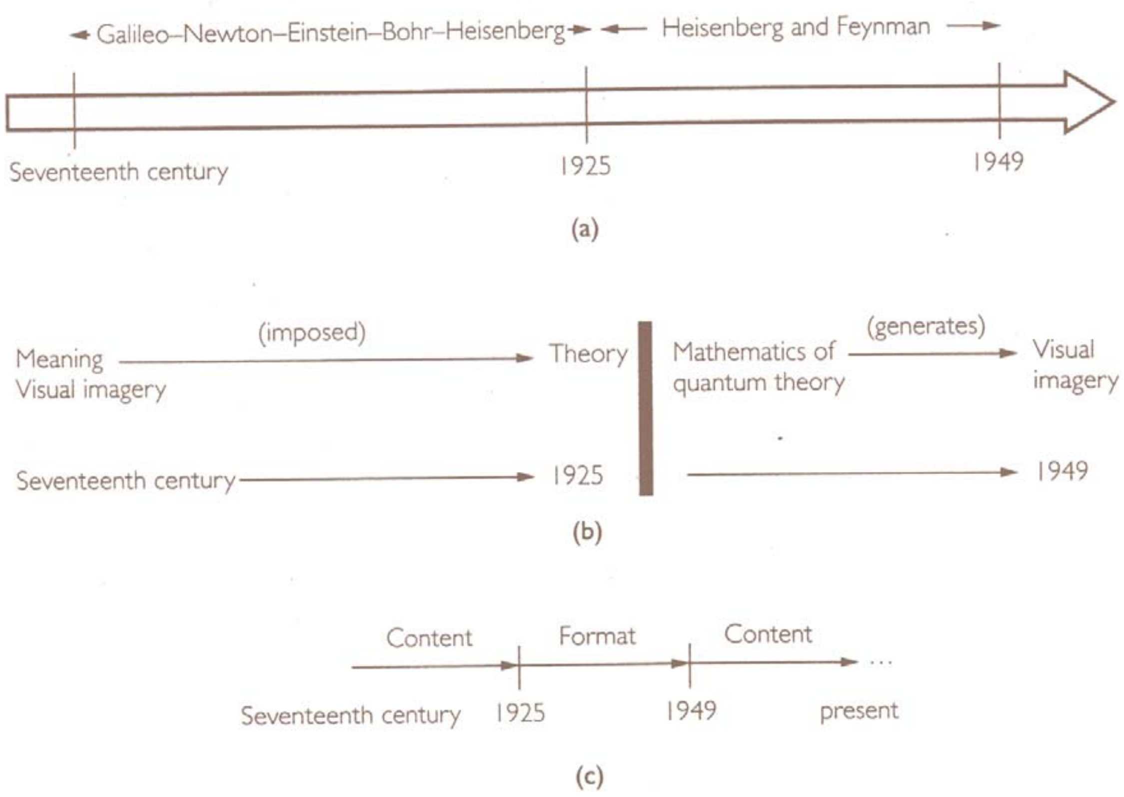
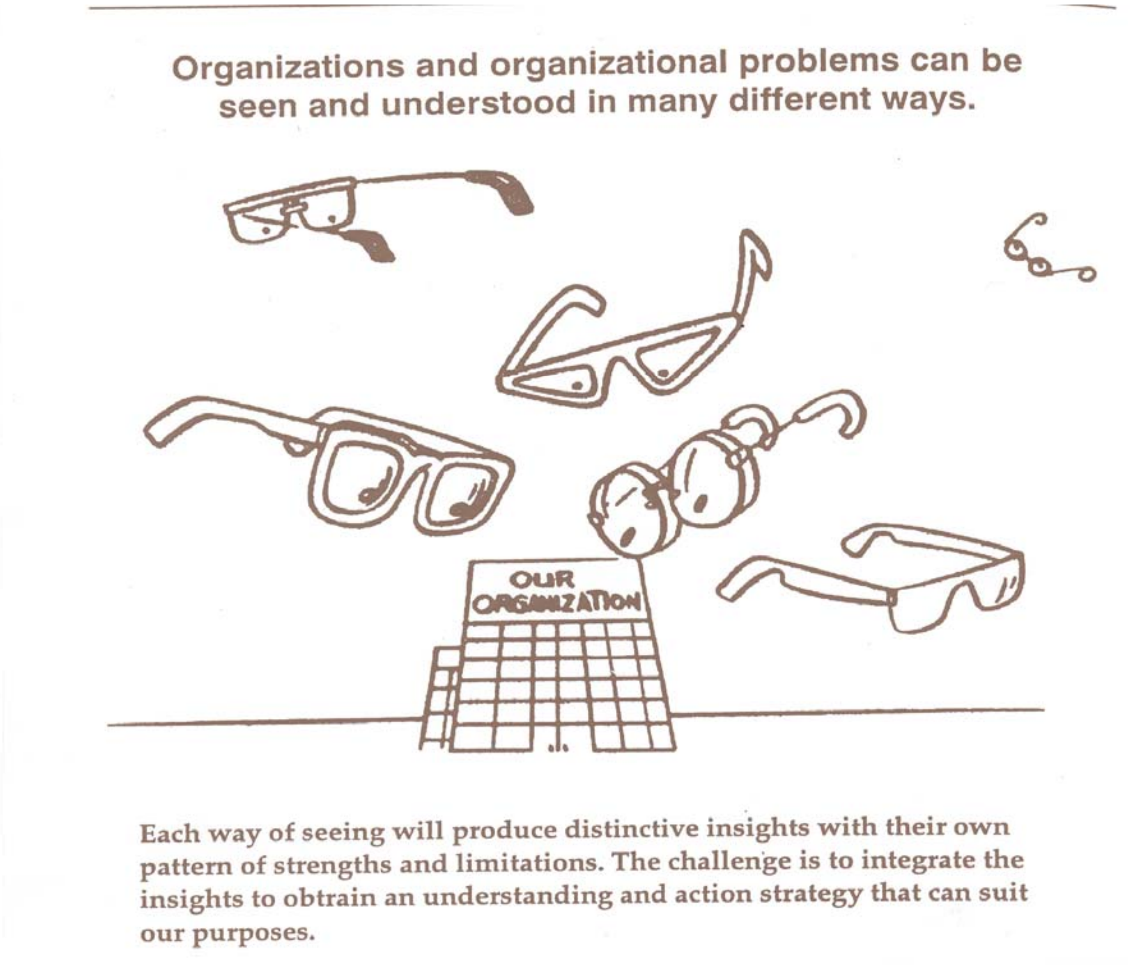


FIGURE 22.

(a) The major figures in the conceptual transition in theorizing, from the seventeenth century until 1925, and then from 1925 to 1949. (b) The major change from visual imagery and its meaning being imposed on physical theories (seventeenth century through 1925) to the mathematics of quantum physics generating the relevant physical imagery with its meaning. (c) This is the transition from content to format to content.

What we have been discussing are the kind of metaphors which have been used in science in attempts to grasp the reality of systems that are not immediately accessible to our ordinary intuitions. Gareth Morgan in his book *Images of Organization* uses his ‘glasses’ metaphor to suggest that organizations and organizational problems can be seen and understood in many different ways each producing distinctive insights (page 29 illustration 11.)

Illustration 11. – Glasses

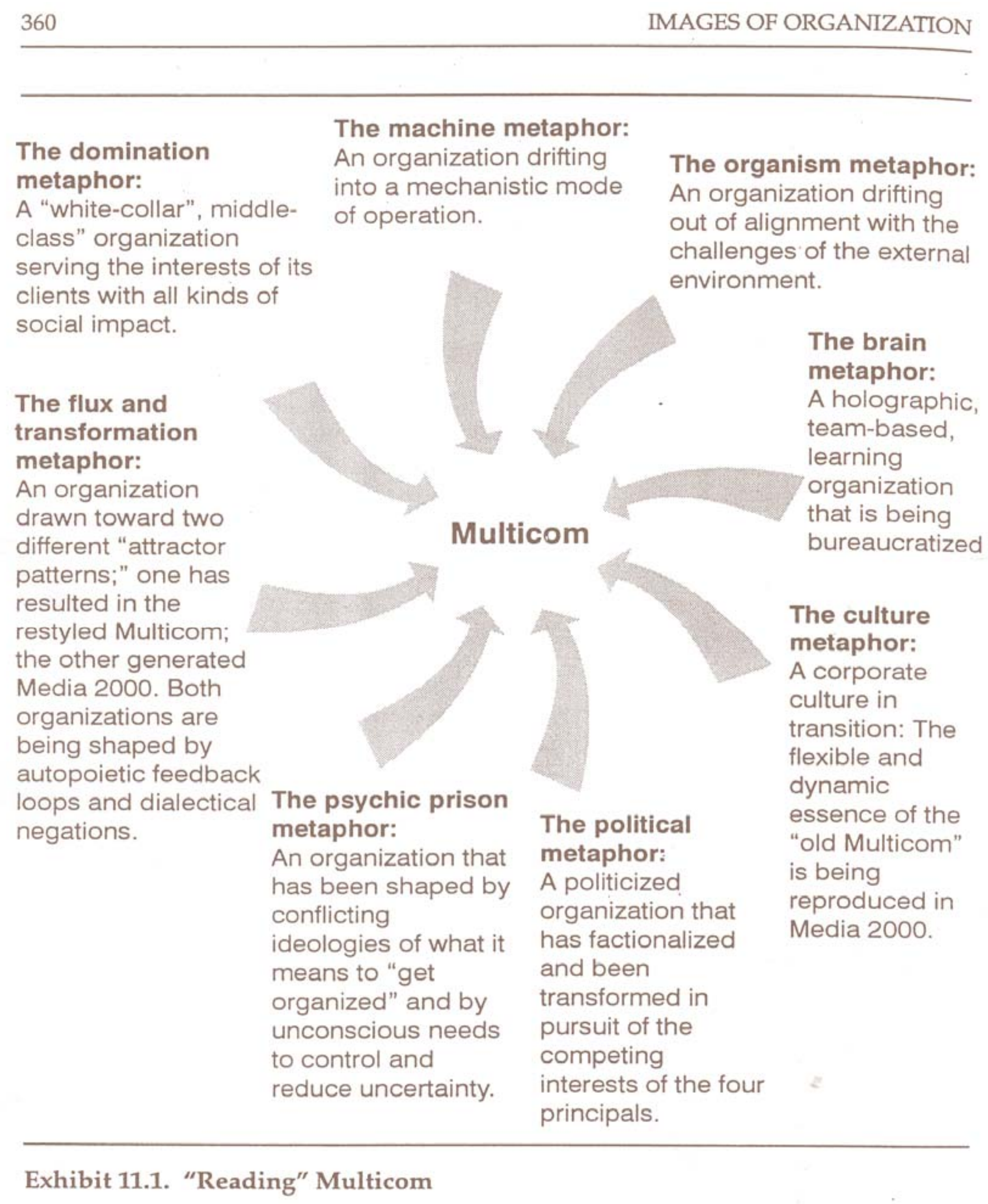


Organizations and organizational problems can be seen and understood in many different ways.

Each way of seeing will produce distinctive insights with their own pattern of strengths and limitations. The challenge is to integrate the insights to obtrain an understanding and action strategy that can suit our purposes.

But metaphor can both be enlightening and restricting as can be seen from the various ways in which we might view the hypothetical company Multicom (page 29 illustration 12).

Illustration 12 - Multicom.



360 IMAGES OF ORGANIZATION

The domination metaphor:
A "white-collar", middle-class" organization serving the interests of its clients with all kinds of social impact.

The machine metaphor:
An organization drifting into a mechanistic mode of operation.

The organism metaphor:
An organization drifting out of alignment with the challenges of the external environment.

The brain metaphor:
A holographic, team-based, learning organization that is being bureaucratized

The flux and transformation metaphor:
An organization drawn toward two different "attractor patterns;" one has resulted in the restyled Multicom; the other generated Media 2000. Both organizations are being shaped by autopoietic feedback loops and dialectical negations.

Multicom

The culture metaphor:
A corporate culture in transition: The flexible and dynamic essence of the "old Multicom" is being reproduced in Media 2000.

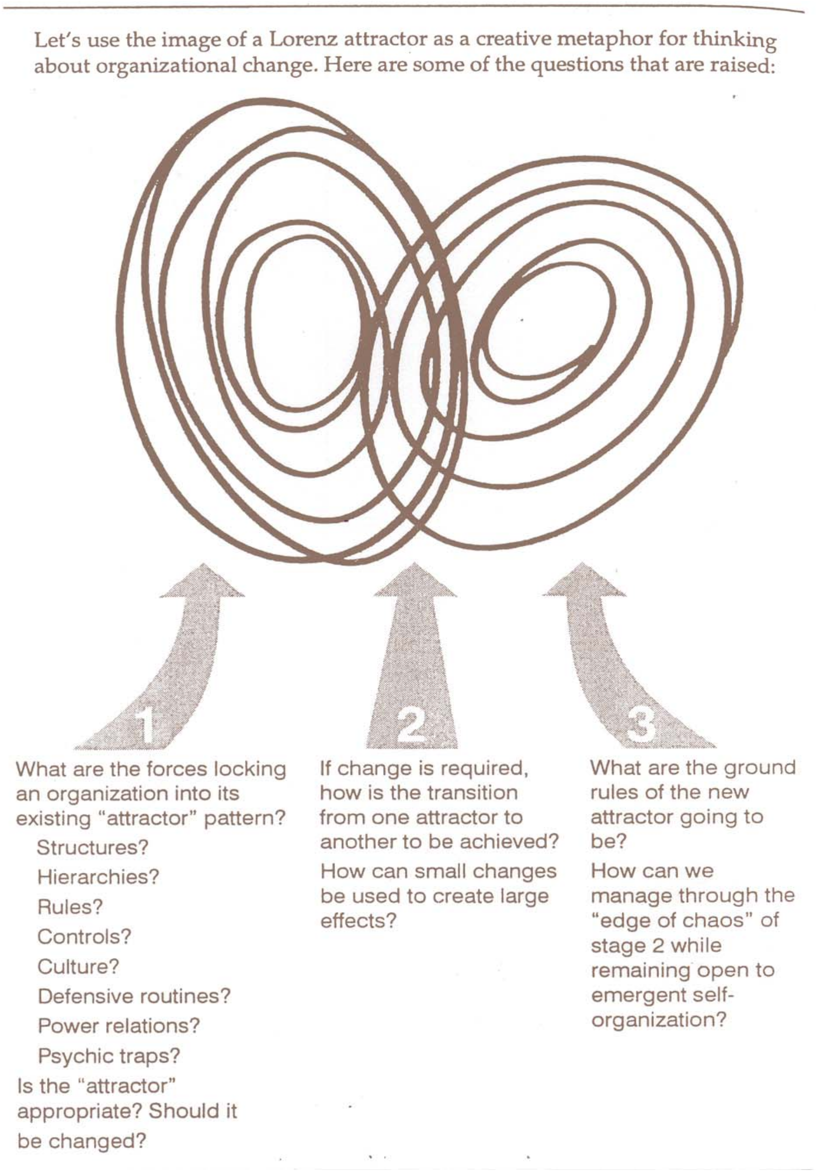
The psychic prison metaphor:
An organization that has been shaped by conflicting ideologies of what it means to "get organized" and by unconscious needs to control and reduce uncertainty.

The political metaphor:
A politicized organization that has factionalized and been transformed in pursuit of the competing interests of the four principals.

Exhibit 11.1. "Reading" Multicom

We can think of metaphors in which a primary subject is illuminated by a secondary subject as a creative process in which shifting metaphors cause certain tensions which are then resolved. But another way in which we can use metaphor is to expose the negative aspects of an organization. If for example we have a rigid mechanism that we know we have to change we can introduce a fluid dynamic from which new properties or ways of operation will emerge. It might even show the strange oscillation patterns of the Lorenz attractor shown on page 30 ,(illustration 13)

Illustration 13.



Let's use the image of a Lorenz attractor as a creative metaphor for thinking about organizational change. Here are some of the questions that are raised:

What are the forces locking an organization into its existing "attractor" pattern?

- Structures?
- Hierarchies?
- Rules?
- Controls?
- Culture?
- Defensive routines?
- Power relations?
- Psychic traps?

Is the "attractor" appropriate? Should it be changed?

If change is required, how is the transition from one attractor to another to be achieved?

How can small changes be used to create large effects?

What are the ground rules of the new attractor going to be?

How can we manage through the "edge of chaos" of stage 2 while remaining open to emergent self-organization?

What we do know is that to learn and change, organizations have to be prepared to challenge themselves and change the basic rules of the game at strategic and operational levels. Looking at business organizations as if they were organisms constantly interacting with their environments is the predominant perspective in modern organizational analysis and in scientific research this is paralleled by the effect of constant feedback from experimentation on theory which at times may require a radical shift in perspective.

Question 1.:
It was suggested that visual metaphor may not be the only metaphor that can be employed. Tchaikovsky's 1812 overture as a representation of Napoleons retreat might be useful or perhaps some version of Hess's *Glass Bead Game*.

Arthur:

Scientific reasoning, however, has fairly rigidly codification procedures and whilst metaphor in other senses such as hearing or touch may be possible, sight remains predominant. But certainly Einstein found great inspiration in Mozart's music, plucking theories of the universe as he would perhaps notes from the air, but by and large, music may be inspirational for getting a person in the mood but it is not, as far as we know, amenable to mathematical equations.

Question 2:
Perhaps the desperate need for reconciliation between the particle/wave incoherence was because the great minds of the early 20th century were prisoners of their own assumptions. It's a bit like the nine point puzzle where you ask people to link up nine points by four uninterrupted lines and the only way you can solve it is by going outside and they were staying inside the nine points. And what I think *anschauung* and *anschaulichkeit* mean in the German language pertains to physical perception and what these people seemed to be looking for was a physical perception of objective physical characteristics in the things they were looking at. They wanted to see *anschauung* and make it *anschaulichkeit*. However I thought that physics had grown out of that debate and that they had discovered in the 1930's that there was no physical objective reality. That you cannot see an objective reality out there because, as Heisenberg said, the objective reality changes as the position of the observer changes. The people who inspire me are Piaget and Varella who say that for any perception, 70% is internally generated and you said yourself that the more you know about physics the more your understanding colours that reality.

The second thing that I was taught was that there are two very basic types of reasoning: one is causal reasoning and the other is teleological and in the case of the latter which are things that have a goal, if you kick them the outcome is unpredictable because the goal gets in the way of the causal effect of the kick. When nature started to combine atoms to give complicated molecules certain of these started to behave teleologically.

Arthur :
Well, as to the second part. Molecular reactions of that kind are not that well understood. Whether coherence occurs for molecules that are big enough to be seen by a microscope but small enough to be affected by quantum laws is not clear. Things which are teleologically determined tend towards equilibrium at the quantum level because the laws of quantum theory are causal laws, not in the Newtonian sense, but in their own peculiar way.

To answer question one: In terms of physical reality Bohr tended towards instrumentalism but Heisenberg was a Platonist and was looking for a representation that was not visually perceptual. A*nschauung* here refers to the old visual imagery and *anschaulichkeit* the new visual imagery (the thing in itself). Heisenberg only used the term *anschaulichkeit* to connote the imagery that came from mathematics of the quantum theory and the basis of the Feynmann Diagram began to emerge around 1932. In fact in 1925 you didn't talk about seeing atomic processes but about measuring them and that began to move towards instrumentalism, but if someone had asked Heisenberg and Pauli 'what is an electron?' they would have said that, 'term in the equation is an electron'. How these things interact is non-intuitive in the sense of Galilean and Newtonian intuition but in the new intuition of quantum theory it is tempered by the uncertainty relationship. At the macro level we don't have much wave particle duality as we're pretty much localized. So to us the terms 'position' and 'momentum' and 'mass' and 'particle' are okay, but not on the quantum level where particles can interfere with one another. You get this quantum weirdness where particle 'feel' each other’s presence. So it's wrong to use the term perception in the old sense. Einstein showed us how physical theory leads us away from the path of ordinary perception. Theories enable us to look beyond our sense perception to worlds of reality beyond the senses.

Question 3 :
I was taken by your notion that Feynman Diagrams couldn't have been generated without the code of quantum mechanics. Different groups represent what they do in different ways. Physics has arrived at one mode when gets a handle on the kind of complexity they're looking at. Management researchers like Gareth Morgan struggle to represent organizations with musical metaphors like jazz. We are faced with a crisis in representing what managers do in the New Economy. We have a crisis in representation for companies like ENRON and DOTCOMS in general. Maybe management researchers struggling to find code to represent what goes on in organizations can learn from physics.

Arthur 3:
There's an example of classical management theory in Morgan's book along the lines of time and motion studies. It's a mechanistic metaphor, essentially a military operation. We have a pyramidal hierarchy and devolved responsibility and there's no room for innovation in the business. The business will fail because it's not in tune with its environment and it's very difficult to make it evolve. We cannot produce a mechanistic flow diagram for an ENRON or an IBM but perhaps its dynamics can be represented in some other way. The metaphor of a living organism may be somewhere to start.