RAPID FRAME UPDATING AND COORDINATE, CORRESPONDING SEAMLESS PERCEPTION

[1]DR K N PRASANNA KUMAR, [2]PROF B S KIRANAGI AND [3] PROF C S BAGEWADI

Abstract. : Any discussion of psychedelic hallucination is an equivalent to the discussion of the spontaneous emergence of perceptual information within human consciousness. Human perception is limited by the capacity of sense organs; or rather the **functionality of human perception is limited by sense organs**, **functionality of the human perception is limited bybyte speed and architecture of the neural network; functionality of human perception is limited by and the number of distinct perceptions the brain can analyze at any one time**. Despite functional limitations, human consciousness is seamless, meaning that each perception and behavior flows smoothly from one to the next. **When consciousness is equivalent to stable perception and behavior and stable perception are is seamlessly integrated, when consciousness destabilizes perception and behavior loses cohesion until we are no longer in control of our thoughts and actions Destabilization of consciousness can happen all at once. Like (instantaneously without any time lag) in the case of being knocked unconscious, but more often it happens incrementally(with time lag d^1(eb)d^2…….d^n) as various aspects of consciousness enter into a low-power subconscious or unconscious state, as in going to sleep.** The EM spectrum ranges from gamma rays, which have a very short wavelength and very high energy, to radio waves, which have a very long wavelength and very low energy. Visible light makes up a very small portion of the spectrum Highly constrained back-projection (HYPR) is a data acquisition and reconstruction method that provides **very rapid frame update rates and very high spatial resolution for a time series of images while maintaining a good signal-to-noise ratio and high image quality. In this study we used simulations** to evaluate the temporal and spatial characteristics of images produced using the HYPR algorithm. The simulations demonstrate that spatial accuracy is well maintained in the images and the temporal changes in signal intensity are represented with high fidelity. The waveforms representing signal intensity as a function of time obtained from regions-of-interest placed in simulated objects track the true curves very well, with variations from the truth occurring only when objects with very different temporal behavior are very close to each other. However, even when objects with different temporal characteristics are touching, their influences on each other are small.

Keywords: Vision, Perception, Consciousness, Psychedelics, Rapid Frame Updating, Seamless Perception , Hurricanes, Moon Time Lag

INTRODUCTION:

RAPID FRAME UPDATING AND COMPUTERS(Reports from MSBlog)

MICROSOFT has developed an alternative to sequential, frame-by-frame SLAM to tracking in unknown environments. Instead of rigidly linking tracking and mapping, they split these tasks into two separate threads which run asynchronously. Tracking can focus on robustness and real-time performance. Mapping is done using key-frames and standard SFM techniques (read: bundle adjustment) and so scales very differently to our previous EKF-SLAM approaches; linear complexity with map size means that we can use thousands of low-quality point features instead of a few dozen good ones. The trade-off is cubic complexity with number of key-frames, but this is acceptable for our target application (hand-held cameras in small AR workspaces.)Results according to blog reports are very promising - this is easily the most accurate tracking system and it is way more robust than previous SLAM system. It's not quite as robust to rapid motions as previous edge-model/gyro systems but we're working on this (and the ability to recover from failure somewhat makes up for this.)

AR in unknown scenes is always going to be difficult without a remote expert to annotate the map. Here, MS restricted themselves to finding a dominant plane in the scene, and then running simple VR/AR games on this plane: essentially, one can have little AR critters running around on tabletop. At present, no attempt is made to exploit the map to e.g. find occluding geometry; this is an area of future work. It shows the operation of the tracker, followed by a few table-top AR examples: The first merely shows off the system's ability to handle large scale changes, the second shows a lens simulation with which the user can burn the real world, and finally Darth Vader makes a return to AR in ``Ewok Rampage."

July 2007: SLAM delocalization

Instead of trying, to prevent a monocular SLAM system from ever losing track (which is rather futile) MS identified old map features in the image. Hear MS reportedly used a modified version of EPFL's randomized tree classifier, trained on features in the map; when tracking is lost the classifier is used together with 3-point-pose to recover the system's position. **The result is a system**, which is far more useful for handheld SLAM than any we have had before: tracking failures (as long they are detected by the system) do not matter anymore, and the system does not have to be treated like a raw egg. The system operates in three scenarios: an art gallery and two tabletop settings. Two objectives are consummated in the system building a map and recovering from frequent tracking failure; a proof-of-concept AR application which shows an augmented character running around a desk.

April 2006: Edge tracking with a particle filter

Yet more edge Tracking - here MS demonstrate 6-DOF edge tracking using a particle filter instead of the usual least-squares optimizations - essentially this is CONDENSATION with full 3D. This gives some robustness advantages but means more jitter. The tricky thing here was rendering and evaluating hundreds of 6DOF poses (complete with hidden-line removal) per frame; they achieve this using the graphics card, exploiting a GL occlusion extension to read likelihood scores back from the GPU.This process results for four edge models: a box, a printer, the Drummond/Cipolla ship part, and a maze model used for AR. For some of these sequences the blur motion estimator is used. This allows vision-only tracking of the ship-part sequence, for which inertial sensors were needed back in 2002. Tracking fails for the maze model.

2005: A Single-Frame Visual Gyroscope(Based on MS Memorandums and Newspaper reports)

Instead of using rate gyroscopes to predict camera motion in a frame, MS attempted to estimate this information from the video input by analysing the motion blur present in a single video frame. By looking at the parts of the image which remain un-blurred, blur direction and magnitude can be determined very quickly (just over 2 milliseconds per frame on a 2.4GHz machine).

This method only produces a 3-DOF answer and has a sign ambiguity; also the magnitude of blur is often inaccurate. However the system can usefully be combined with edge tracking. Tablet PCs offer an alternative to head-mounted displays for delivering augmented reality. MS developed a tablet-based AR application which combines inside-out edge tracking and outside-in LED tracking for robust registration: the inside-out system provides a high level of registration accuracy while the outside-in system provides robustness and recovery from shake and camera occlusions.

To provide a high level of rendering quality, consideration is given to the specific case of virtual graphics occluded by real objects for which we have a model. Here, instead of just clipping virtual graphics using the real geometry projected into the z-buffer, an individual treatment and refinement of occluding edges produces a far more convincing integration of real and virtual objects. **Alternate frame sequencing**, also known as **alternate image**, **AI**, **alternating field**, **field sequential**, etc., uses the **eclipse method** of displaying stereoscopic 3-D images. It works by openly presenting the image intended for the left eye while blocking the right eye's view, then presenting the right-eye image while blocking the left eye, and repeating this so rapidly that the interruptions do not interfere with the perceived fusion of the two images into a single 3-D image. Ternate frame sequencing is used to present 3-D films in some theaters. It can be used to present 3-D images on CRT, plasma, LCD and other types of video displays.

Although virtually all ordinary unmodified video and computer systems can be used to display 3-D by adding a plug-in interface and LCD shutter glasses, disturbing levels of flicker or ghosting may be apparent with systems or displays not designed for such use. The rate of alternation required to completely eliminate noticeable flicker depends on image brightness and other factors, but is typically well over 30 image pair cycles per second, the maximum possible with a 60 Hz display. A 120 Hz display, allowing 60 images per second per eye, is widely accepted as flicker-free.

WHIRLY SPIRALLY TUNNEL VISION PATTERNS : GEOMETRIC VISIONS

(For complete details and further study see Freiberg M)

Think drug-induced hallucinations, and the whirly, spirally, tunnel-vision-like patterns of psychedelic imagery immediately spring to mind. But it's not just hallucinogenic drugs like LSD, cannabis or mescaline that conjure up these geometric structures. People have reported seeing them in near-death experiences, as a result of disorders like epilepsy and schizophrenia, following sensory deprivation, or even just after applying pressure to the eyeballs. So common are these geometric hallucinations that in the last century scientists began asking themselves if they couldn't tell us something fundamental about how our brains are wired up. And it seems that they can. Geometric hallucinations were first studied systematically in the 1920s by the German-American psychologist Heinrich Klüver. Klüver's interest in visual perception had led him to experiment with peyote, that cactus made famous by Carlos Castaneda, whose psychoactive ingredient mescaline played an important role in the shamanistic rituals of many central American tribes. Mescaline was well-known for inducing striking visual hallucinations. Popping peyote buttons with his assistant in the laboratory, Klüver noticed the repeating geometric shapes in mescaline-induced hallucinations and classified them into four types, which he called form constants**: tunnels and funnels, spirals, lattices including honeycombs and triangles, and cobwebs.**

In the 1970s the mathematicians Jack D. Cowan and G. Bard Ermentrout used Klüver's classification to build a theory describing what is going on in our brain when it tricks us into believing that we are seeing geometric patterns. Other scientists, including Paul Bressloff, Professor of Mathematical and Computational Neuroscience at the newly established Oxford Centre for Collaborative Applied Mathematics, have since elaborated their theory.

TRANSLATION OF VISUAL PATERNS INTO NEURAL ACTIVITY :

V1 is the visual field that is isomorphic to two-dimensional image on the retina. An object or scene in the visual world is projected as a two-dimensional image on the retina of each eye, so what we see can also be treated as flat sheet: the visual field. Every point on this sheet can be pin-pointed by two coordinates, just like a point on a map, or a point on the flat model of V1. The alternating regions of light and dark that make up a geometric hallucination are caused by alternating regions of high and low neural activity in V1 — regions where the neurons are firing very rapidly and regions where they are not firing rapidly. To translate visual patterns to neural activity, what is needed is a coordinate map, a rule which links each point in the visual field to a point on the flat model of V1. In the 1970s scientists including Cowan came up with just such a map, based on anatomical knowledge of how neurons in the retina communicate with neurons in V1. For each light or dark region in the visual field, the map identifies a region of high or low neural activity in V1.

So how does this retino-cortical map transform Klüver's geometric patterns? It turns out that hallucinations comprising spirals, circles, and rays that emanate from the centre correspond to stripes of neural activity in V1 that are inclined at given angles. Lattices like honeycombs or chequer-boards correspond to hexagonal activity patterns in V1. This in itself might not have appeared particularly exciting, but there was a precedent: stripes and hexagons are exactly what scientists had seen when modeling other instances of pattern formation, for example convection in fluids, or, more strikingly, the emergence of spots and stripes in animal coats. The mathematics that drives this pattern formation was well known, and it now suggested a mechanism for modeling the workings of the visual cortex too.

SPATIALLY INHOMOGENEOUS AND STATIC PATTERNS

The first model of pattern formation in animal coats goes back to Alan Turing, better known as the father of modern computer science and Bletchley Park code breaker. Turing was interested in how a spatially homogeneous system, such as a uniform ball of cells making up an animal embryo, can generate a spatially inhomogeneous but static pattern, such as the stripes of a zebra.

Turing hypothesized that these animal patterns are a result of a reaction-diffusion process. Imagine an animal embryo which has two chemicals living in its skin. One of the two chemicals is an inhibitor, which suppresses the production of both itself and the other chemical. The other, an activator, promotes the production of both.

Initially, at time zero in Turing's model, the two chemicals exactly balance each other — they are in equilibrium, and their concentrations at the various points on the embryo do not change over time. But now imagine that, for some reason or other, the concentration of activator increases slightly at one point. This small perturbation sets the system into action. The higher local concentration of activator means that more activator and inhibitor are produced there — this is a reaction. But both chemicals also diffuse through the embryo skin, inhibiting or activating production elsewhere.

For example, if the inhibitor diffuses faster than the activator, then it quickly spreads around the point of perturbation and decreases the concentration of activator there. So you end up with a region of high activator concentration bordered by high inhibitor concentration — in other words, you have a spot of activator on a background of inhibitor. Depending on the rates at which the two chemicals diffuse, it is possible that such a spotty pattern arises all over the skin of the embryo, and eventually stabilizes. If the activator also promotes the generation of a pigment in the skin of the animal, then this pattern can be made visible. (See the article How the leopard got its spotsbyAlanTuring for more detail.)

Turing wrote down a set of differential equations which describe the competition between the two chemicals and which you can let evolve over time, to see if any patterns emerge. The equations depend on parameters capturing the rate at which the two chemicals diffuse: if you choose them correctly, the system will eventually stabilize on a particular pattern, and you can vary the pattern by varying the parameters.

PATTERNS IN THE BRAIN

Neural activity in the brain isn't a reaction-diffusion process, but there are analogies to Turing's model. "Neurons send signals to each other via their output lines called axons," says Bressloff. Neurons respond to each other's signals, so we have a reaction. "[The signals] propagate so quickly relative to the process of pattern formation that you can think of them as instantaneous interactions." So rather than diffusion, which is a local process, we have instantaneous interaction at a distance in this case. The roles of activator and inhibitor are played by two different classes of neurons. "There are neurons which are excitatory — they make other neurons more likely to become active — and there are inhibitory neurons, which make other neurons less likely to become active," says Bressloff. "The competition between the two classes of neurons is the analogue of the activator-inhibitor mechanism in Turing's model."
Inspired by the analogies to Turing's process, Cowan and Ermentrout’s constructed a model of neural activity in V1, using a set of equations that had been formulated by Cowan and Hugh Wilson. Although the equations are more complicated than Turing's, you can still play the same game, letting the system evolve over time and see if patterns in neural activity evolve. "You find that, under certain circumstances, if you turn up a parameter which represents, for example, the effect of a drug on the cortex, and then this leads to a growth of periodic patterns," says Bressloff.
Cowan and Ermentrout's model suggests that geometric hallucinations are a result of an instability in V1: something, for example the presence of a drug, throws the neural network off its equilibrium, kicking into action a snowballing interaction between excitatory and inhibitory neurons, which then stabilizes in a stripy or hexagonal pattern of neural activity in V1. In the visual field we then "see" this pattern in the shape of the geometric structures described by Klüver.

SYMMETRIES IN THE BRAIN

In reality, things aren't quite as simple as in Cowan and Ermentrout's model, because neurons don't only respond to light and dark images. Through the thickness of V1, neurons are arranged in collections of columns, known as hyper columns, with each hyper column roughly responding to a small region of the visual field. But the neurons in a hyper column aren't all the same: apart from detecting light and dark regions, each neuron specializes in detecting local edges — the separation lines between light and dark regions in a part of an image — of a particular orientation. Some detect horizontal edges, others detect vertical edges, others edges that are inclined at a 45° angle, and so on. Each hyper column contains columns of neurons of all orientation preferences, so that a hyper column can respond to edges of all orientations from a particular region of the visual field. It is the lay-out of hyper columns and orientation preferences that enables us to detect contours, surfaces and textures in the visual world. Over recent years, much anatomical evidence has accumulated showing just how neurons with various orientation preferences interact. Within their own hyper column, neurons tend to interact with most other neurons, regardless of their orientation preference. But when it comes to neurons in other hyper columns they are more selective, only interacting with those of similar orientations and in a way which ensures that we can detect continuous contours in the visual world.
Bressloff, in collaboration with Cowan, the mathematician Martin Golubitsky and others, has generalized Cowan and Ermentrout's original model to take account of this new anatomical evidence. **They again used the plane as the basis for a model of V1:** each hyper column is represented by a point (x, y) on the plane, while each point (x, y) in turn corresponds to a hyper column. Neurons with a given orientation preference θ (where θ is an angle between 0 and π) are represented by the location (x,y) of the hyper column they're in, together with the angle θ, that is, they are represented by three bits of information, (x,y,θ). So in this model V1 is not just a plane, but a plane together with a full set of orientations for each point.In keeping with anatomical evidence, Bressloffand his colleagues assumed that a neuron represented by (x_0,y_0,θ_0) **interacts** with all other neurons in the same hyper column $(x_0,y_0).$, But it only **interacts** with neurons in other hyper columns, if these hyper columns lie in their preferred direction θ_0.On the plane, draw a line through (x_0,y_0) of inclination $\theta_0.$. Then the neurons represented by (x_0,y_0,θ_0)**interacts**only with neurons in hyper columns that lie on this line, and which have the same preferred orientation θ_0.This interaction pattern is highly symmetric. For example, the pattern does not appear any different if you shift the plane along in a given direction by a given distance. If two elements (x_0,y_0,θ_0) and (s_0,t_0,ϕ_0) interact, then the elements you get to by shifting along, that is (x_0+a,y_0+b,θ_0) and (s_0+a,t_0+b,ϕ_0) for some a and b, interact in the

same way. In a similar way, the pattern is also **invariant** under rotations and reflections of the plane.
Bressloff and his colleagues used a generalized version of the equations from the original model to let the system evolve. The result was a model that is not only more accurate in terms of the anatomy of V1, but can also **generate** geometric patterns in the visual field that the original model was unable to produce. These include lattice tunnels, honeycombs and cobwebs that are better characterized in terms of the orientation of contours within them, than in terms of contrasting regions of light and dark.What's more, the model is sensitive to the symmetries in the **interaction** patterns between neurons.The mathematics shows that it is these symmetries, which drive the formation of periodic patterns of neural activity. So the model suggests that it is the lay-out of hyper columns and orientation preferences, in other words the mechanisms that **enable us** to detect edges, contours, surfaces and textures in the visual world, that **generate** the hallucinations. It is when these mechanisms become unstable, for example due to the **influence** of a drug, that patterns of neural activity arise, which in turn translates to the visual hallucinations.

BEYOND HALLUCINATIONS

Bressloff'smodel does not only provide insight into the mechanisms that drive visual hallucinations, but also gives clues about brain architecture in a wider sense. In collaboration with his wife, an experimental neuroscientist, Bressloff has looked at the **connection** circuits between hyper columns in normal vision, to see how visual images are processed. "People used to think that neurons in V1 just detect local edges, and that you have to go to higher levels in the brain to put these edges together to detect more complicated features like contours and surfaces. Their work show that these structures in V1 actually allow the earlier visual cortex to detect contours and do more global processing. It used to be thought that you process more and more complex aspects of an image as you go higher up in the brain. But now it's realized that there is a huge amount of feedback between higher and lower cortical areas. It's not a simple hierarchical process, but an incredibly complicated and active system.
Practical applications of this work include computer vision — computer scientists are already building the inter-connectivity structures that Bressloff and his colleagues played around with into their models, with the aim of teaching computers to detect contours and textures. On a more speculative note, Bressloff's research may also one day help to restore vision to visually impaired people. "The question here is if you can somehow stimulate part of the visual cortex, [bypassing the eye], and use that to guide a blind person," says Bressloff. "If one can understand how the cortex is wired up and responds to stimulation, perhaps one would then have a better way of stimulating it in the right way."There are even applications that have nothing at all to do with the brain. Bressloff applied the insights from this work to other situations in which objects are located in space and also have an orientation, for example fibroblast cells found in human and animal tissue. He showed that under certain circumstances these interacting cells and molecules can line up and form patterns analogous to those that arise in V1.People have reported seeing visual hallucinations since the dawn of time and in almost all human cultures — hallucinatory images have even been found in petro glyphs and cave paintings. In shamanistic traditions around the world they have been regarded as messages from the spirit world. Few neuroscientists today would agree that spirits have anything to do with it, but as messengers from a hidden world — this time the hidden world of our brain — these hallucinations seem to have lost none of their potency.
In the first half of the book, DOORS OF PERCEPTION--originally a separate volume--Huxley offers a cogent and erudite argument for the use hallucinogens (specifically, mescaline) as a means for opening up the thinking mind to new ideas and perceptions, or even as a method for jumpstarting human creativity in the common man. Not only does he offer compelling historical precedents and sound medical research, but he also reveals positive details about his own personal experimentation with the drug. As is always the case with Huxley's essays, his various hypotheses are very articulately expressed and not easily dismissed.
The second part of the book, HEAVEN AND HELL--also originally published separately--Huxley introduces the idea that spiritual insight and personal revelation can also be achieved through the use of hallucinogens. (By the time he had written this volume, Huxley had added LSD to his psychedelic repertoire.) While just as articulately written and researched as the first volume, the idea that religious insight can be gained through drugs may offend some readers (theists and atheists alike), and the premise seems odd and contrived or expedient (was he trying to gain support of the clergy?) coming from a generally non-theist thinker-philosopher such as Huxley. Nevertheless, it is still thought-provoking reading for both professionals and amateurs interested in the positive potential of mind-altering drugs. View 3-D system was installed in a single theater in New York City. Several short films and one feature-length film were shown by running left-eye and right-eye prints in a pair of interlocked projectors with their shutters operating out of phase. Each seat in the auditorium was equipped with a viewing device containing a rapidly rotating mechanical shutter synchronized with the projector shutters. The system worked, but the expense of the installation and the unwieldiness of the viewers, which had to be supported on adjustable stands, confined its use to this one engagement.

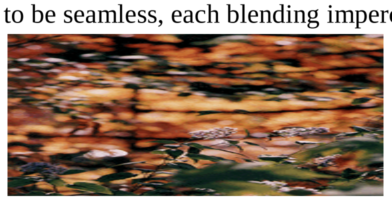
In recent decades, the availability of lightweight optoelectronic shutters has led to an updated revival of this display method.
The movie is filmed with two cameras like most other 3-D films. Then the images are placed into a single strip of film in alternating order. In other words, there is the first left-eye image, then the corresponding right-eye image, then the next left-eye image, followed by the corresponding right-eye image and so on. The film is then run at 48 frames-per-second instead of the traditional 24 frames-per-second. The audience wears very specialized LCD shutter glasses that have lenses that can open and close in rapid succession. The glasses also contain special radio receivers. The projection system has a transmitter that tells the glasses which eye to have open. The glasses switch eyes as the different frames come on the screen.

Applications in gaming

The same method of alternating frames can be used to render modern 3-D games into true 3-D, although a similar method involving alternate fields has been used to give a 3D illusion on consoles as old as the Sega Master System and Nintendo Famicom. Special software or hardware is used generate two channels of images, offset from each other to create the stereoscopic effect. High frame rates (typically ~100fps) are required to produce seamless graphics, as the perceived frame rate will be half the actual rate (each eye sees only half the total number of frames). Again, LCD shutter glasses synchronized with the graphics card complete the effect. Aside from consoles, alternating frames to render 3-D images was used in some arcade games, most notably Sega's Sub-Roc 3D in 1982, Namco's Thunder Ceptor II in 1986, and Taito's 1987 racer, Continental Circus.

How We See: The First Steps of Human Vision (Seefor details Diane M. Szaflarski)

Photograph by Kristin Borgeson Take a look around the room that you are in. Notice how the various images and colors that you see update constantly as you turn your head and re-direct your attention. Although the images appear to be seamless, each blending imperceptibly into the next, they are in reality being updated almost continuously by the



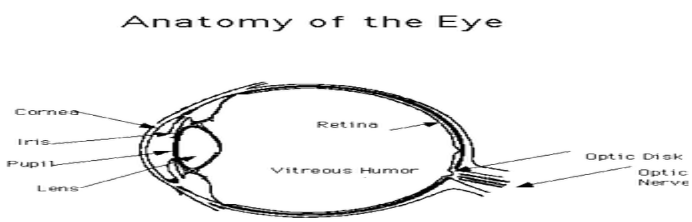
vision apparatus of your eyes and brain. The seamless quality in the images that you see is possible because human vision updates images, including the details of motion and color, on a time scale so rapid that a "break in the action" is almost never perceived. The range of color, the perception of seamless motion, the contrast and the quality, along with the minute details, that most people can perceive make "real-life" images clearer and more detailed than any seen on a television or movie screen. The efficiency and completeness of your eyes and brain is unparalleled in comparison with any piece of apparatus or instrumentation ever invented. We know this amazing function of the eyes and brain as the sense of vision.
From the beginning of time humans have tried to explain the complex process of vision. It is interesting to examine a few of the ancient theories and to compare them to our modern knowledge. Recorded studies of human vision date back at least to the time of Aristotle. Aristotle was a prominent philosopher, scientist, and scholar who lived in ancient Greece around the 4th century BC. Aristotle studied many scientific issues and published his thoughts in a variety of texts. Aristotle's explanation of the process of human vision was that the object being looked at somehow altered the "medium" (now known to be air) between the object itself and the viewer's eye. This alteration of the medium was thought to propagate to the eye, allowing the object to be seen. During the Middle Ages Aristotle's theory was reversed. Instead of postulating that the object itself had innate properties which allowed vision, popular theory of the time suggested that the viewer's eyes sent out emissions to the object and that those emissions enabled vision to occur. These theories may seem strange, unsatisfying or illogical today, but remember that the theories of long ago were not based on today's extensive experimental scientific data. Instead they were based on the conjecture and observation of scholars. Thanks to the knowledge generated by countless generations of scholars and scientists using increasingly sophisticated tools in pursuit of scientific knowledge our understanding of vision has come a very long way!
Vision is a complicated process that requires numerous components of the human eye and brain to work together. The initial step of this fascinating and powerful sense is carried out in the retina of the eye. Specifically, the photoreceptor neurons (called photoreceptors) in the retina collect the light and send signals to a network of neurons

that then generate electrical impulses that go to the brain. The brain then processes those impulses and gives information about what we are seeing. In this unit we will investigate the initial steps in the process of vision. We will discover how the photoreceptors work, and will specifically examine at the photoreceptor proteins to learn how light energy is converted into electrical energy. Additionally, we will examine some of the current studies that are helping to further our understanding of the proteins involved in the vision process.

Eye Anatomy and Function

Human anatomy has been studied since ancient times. For over 1400 years our understanding of anatomy was based on theories of the Greek physician, Galen of Pergamum (130-200 AD). However an accurate and comprehensive understanding of human anatomy was delayed until the Renaissance period, primarily because dissections and autopsies were forbidden by most religions. One of the first systematic studies of human anatomy which involved actual examination and dissection of the human body was carried out by Andreas Vesalius (1514-1564). As a result of his extensive work, many of the previous misconceptions of Galenic medicine were corrected. The accumulated research of scientists over many hundreds of years has led to an excellent understanding of human anatomy.

Figure 1

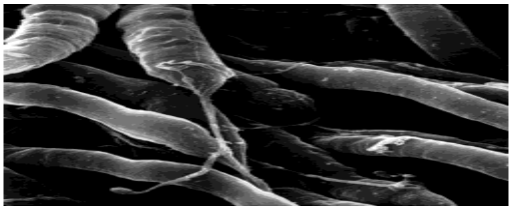


A sketch of the anatomical components of the human eye, as we now **know it, is shown in Figure 1. The main structures are the iris, lens, pupil, cornea, retina, vitreous humor, optic disk and optic nerve. A discussion of the role of each component** will not be presented here. These details are covered in most high school biology **books and even in** many sites on the World Wide Web. For example, try "The Eye". Instead, we will examine the growth of the understanding of the eye's function.

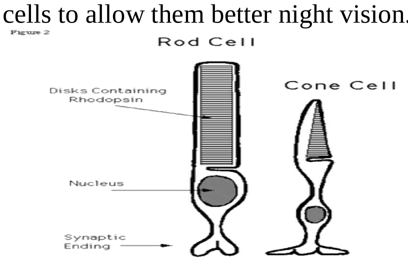
A realistic understanding of the function of the components of the eye began around the 17th century, after the gross anatomy of the eye had been firmly established. It was realized in the 17th century that the retina, not the cornea as was previously thought, was responsible for the detection of light. Johannes Kepler of Germany and Renee Descartes of France, both prominent physicists of their time, made many advances in understanding vision. Much of their work applied the physical concepts of light rays and geometric optics to the vision process. Kepler first proposed that the lens of the eye focuses **images onto the retina. A few decades later Descartes demonstrated that Kepler was correct. In a landmark experiment, Descartes surgically removed an eye from an ox and scraped the** back of the eye to make it transparent. He then placed the eye on a window ledge as if the ox were looking out of the window. He looked at the back of the eye him and saw an inverted image of the scenery outside! Descartes correctly postulated that the image was inverted as a result of being focused onto the retina by the eye's lens.Around the beginning of the 19th century **Thomas Young, a prominent physicist and physician, carried out a number of studies on the eye that resulted in an understanding of how the lens focuses images onto the** retina. He also showed that astigmatism results from an improperly curved cornea. We now understand that a number of vision disorders, including both near- and far-sightedness, also result from an improperly curved cornea. The lenses in eyeglasses function by correcting for the improper corneal curve. We now know the basic function of the components of the human eye and how they participate in the vision process. Light that reflects off of objects around us is imaged onto the retina by the lens. The retina, which consists of three layers of neurons (photoreceptor, bipolar and ganglion), is responsible for detecting the light from these images and then causing impulses to be sent to the brain along the optic nerve. The brain decodes these images into information that we know as vision.

Microscopic Anatomy: Rod Cells and Cone Cells of the Retina

ISSN 2250-3153



A microscopic view of the **rod cells of a zebra fish shows us how** these cells actually look in an animal. Additional research showed that the rod and cone cells were responsive to light. Max Schultze (1825-1874) discovered that the retinal cones are the color receptors of the eye and the retinal rod cells while not sensitive to color, are very sensitive to light at low levels. Selig Hecht showed, in 1938, the exquisite sensitivity of rod cells when he showed that a single photon can initiate a response in a rod cell. Cone cells on the other hand are less sensitive to light but show great sensitivity to different colors. It is the cone cells that allow us to see in color. It is because cone cells remain unstimulated in low light environments that we do not see color in dimly lit places. Try this for yourself. Go into a closet and decrease the light level. Soon you will see only shades of gray. Slowly increase the light levels until you can begin to see color. This demonstration usually works well in a closet because of the many different colors of your clothes.In the human eye, there are **many more** rod cells in the retina than there are cone cells. The number of rod cells and cone cells in animals is often related to the animal's instincts and habits. For example, birds such as hawks have a significantly higher number of cones than do humans. This let them to see small animals from a long distance away, allowing them to hunt for food. Nocturnal animals, on the other hand, have relatively higher numbers of rod cells to allow them better night vision.



A schematic drawing of rod and cone cells is shown in Figure 2. The cells are divided into two sections. The bottom portion is called the inner segment. It contains the nucleus and the synaptic ending. The synaptic ending attaches to the neurons which produce signals that go to the brain. The top portion is called the outer segment. The outer segment is comprised of a membrane which is folded into several layers of disks. The disks are comprised of cells that contain the molecules that absorb the light.

Visual Pigments

During the 1800's the visual pigments were discovered in the retina. Scientists, working by candlelight, dissected the retinas from frog eyes. When the retinas were exposed to day light they changed color. These scientists had discovered that the retina is photosensitive. They realized that the color they were observing was due to presence of a visual pigment, which was given the name rhodopsin. Later studies showed that rhodopsin is a protein that is found in the disks of the rod cell membrane.

Pigments are also found in cone cells. There are three types of cone cells, each of which contains a visual pigment. These pigments are called the red, blue or green visual pigment. The cone cells detect the primary colors, and the brain mixes these colors in seemingly infinitely variable proportions so that we can perceive a wide range of colors. Prolonged exposure to colors, for example when staring at a particular object, can cause fatigue in cone cells. These results in a change in the way that you perceive the color of the object that you are viewing. You will find a demonstration of the color fatigue effect on the Exploratorium's "Bird in a Cage" Web page.

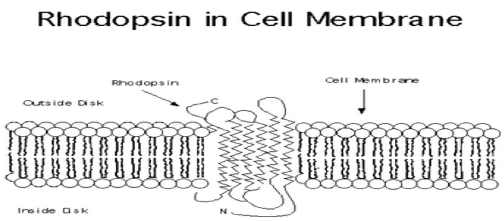
The original theory of color vision was introduced by Thomas Young around 1790, prior to the discovery of the cone cells in the retina. Young was the first to propose that the human eye sees only the three primary colors, red, blue and yellow and that all of the other visible colors are combinations of these. It is now known that color vision is more complicated than this, but Young's work formed the foundation of color vision theory for the scientists that followed. The photoreceptor proteins of the cone cells have not yet been isolated. This may possibly be due to the difficulty in obtaining them. There are many fewer cone cells than rod cells in the retina. Also many animals do not have cone cells and hence do not see in color.

An Important Protein in the Rod Cell: Rhodopsin

George Wald and his coworkers at Harvard University pioneered our understanding of the molecules responsible for the first steps in the vision process. For this and other work on vision he was the recipient of the 1967 Nobel Prize in

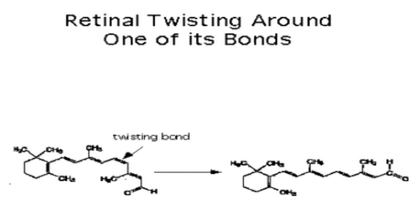
Medicine and Physiology. Wald's group was the first to elucidate the molecular components of the rod cell's functional protein rhodopsin. Prior to his work, rhodopsin was thought to be a chunk of molecular material. Wald and his co-workers determined that the protein consists of two molecular parts: a colorless amino acid sequence called opsin and a yellow organic chromosphere called retinal.

Figure 3



It is now known that the rhodopsin protein has a molecular weight of ~40 kPa. The protein spans the membrane of the rod cell, and is therefore called a trans-membrane protein. The exact structure of rhodopsin has never been determined, however experimental data lead scientist to predict that it contains seven helices or turns. A schematic drawing of rhodopsin in the rod cell membrane is shown in Figure 3. About half of the protein is contained within the membrane with approximately 25% of the protein laying both above and below the membrane.

Figure 4

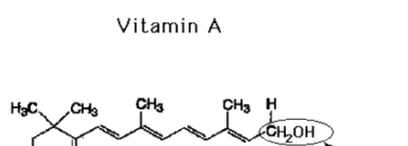


It is the rhodopsin protein in the retina that absorbs the light that enters the eye. Specifically, it is known that the retinal molecule, which is embedded inside rhodopsin, undergoes photo-excitation by absorbing light. In the photo-excitation process, the rhodopsin absorbs light and is excited to a higher electronic state. Numerous studies have been carried out to try to understand what happens after the rhodopsin absorbs light. Research has shown that upon photo-excitation the retinal part of rhodopsin undergoes a twisting around one of its double bonds (see Figure 4). The retinal then dissociates from the opsin. The change in geometry initiates a series of events that eventually cause electrical impulses to be sent to the brain along the optic nerve. Further research is needed to fully understand this complex process.

Vitamin A and Retinal

During the early part of the 20th century work continued on the frontier of research aimed at understanding vision. It was also around this time that the relationship between vision and proper nutrition began being studied at universities and agricultural schools. It had been shown during World War I that a vitamin A deficiency caused night blindness. The link between vitamin A and night blindness, however, did not become clear until George Wald and his coworkers isolated vitamin A from the retina in 1933. Prior to this finding the importance of vitamins was poorly understood. Additionally, the complete role of vitamins in physiological processes was unknown.

Figure 5



It is now understood that the human body makes retinal from vitamin A. A picture of retinal and vitamin A is shown in Figure 5. Both the retinal and vitamin A molecules contain a long chain of double bonds. When retinal dissociates from opsin, some of the retinal is destroyed. To replenish the destroyed retinal, it is important to have a source of vitamin A in your diet. Without this source of vitamin A, night blindness can develop as the rods cannot function effectively without sufficient sources of retinal.

Recent Reports on Photoreceptors and Retinal

Scientists continue to study the role and mechanisms of photoreceptors in vision both to better understand the mechanism of human vision and to try to understand and remedy eye disease and blindness. Additionally, studies on photoreceptors can lead to the development of better electronic and optical devices, as well as improvements in the field of robotics and artificial sensing. Some of the recent publications from the journals, "Science" and "Nature" in the field of photoreceptors are summarized below.

1**) Laser Experiments to Elucidate the Twisting of the Retinal Bond Following Photon Absorption, Science, Volume 254, October 18, 1991, p 412-415.**

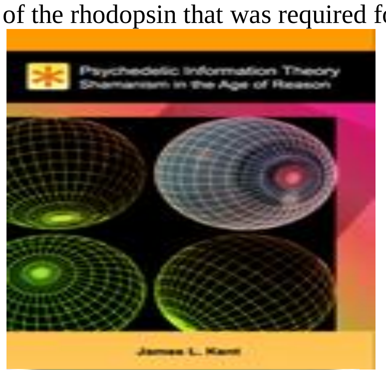
Since the discovery of the laser in the 1960's numerous studies have been carried out on biological molecules, like rhodopsin, in order to try to understand the molecular and atomic action of the molecules. Since rhodopsin function is to absorb light it is not surprising that scientists should use light to elucidate the behavior of the molecule. Even prior to the discovery of lasers, many spectroscopic studies were performed using lamps and other light sources. Recent efforts in laser experimentation to look at the twisting of the molecular double bond following photon absorption include the time measurements for the molecule to twist. Scientists have been examining this question for several years but with recent advancements in laser technology and instrumentation the rate of the twist has now been determined.

2**) Determination of the Structure of Bovine Rhodopsin, Nature, Volume 362, April 22, 1993, pp. 770-772.**

As mentioned above, information on the structure of bovine rhodopsin has recently been obtained. Although many aspects of rhodopsin are known, its structure has never been measured due to the difficulty in producing rhodopsin in crystalline form. Recently the projection map of bovine rhodopsin has been determined from electron micrographs. The results presented show the configuration of the helices. These results confirm the proposal that rhodopsin has seven helices.

3) Making Mutated Forms of Rhodopsin in order to Elucidate its Structure and Function, Science, Volume 250, October 5, 1990, pp. 123-124.

Currently, the exact role (the binding sites, the structure, etc.) of rhodopsin in the generation of the neural signals is not completely understood. Parts of the mechanism are still in the hypothesis stage. In order to further elucidate the mechanisms and to prove or disprove the hypothesis, studies on mutated forms of rhodopsin are being carried out. An example of this was recently published. In this study the binding sites of rhodopsin with its G-protein were examined. The authors of this paper mutated rhodopsin at the sites that were thought to bind to the G protein. The scientist then tested the see if the mutated rhodopsin behaved similarly to its undulated counterpart. The authors identified a portion of the rhodopsin that was required for binding and aiding in the formation of the neural signal.



Psychedelic Information Theory
Limits of Human Perception

ISSN 2250-3153

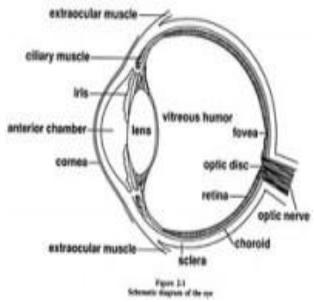


Figure 1: The human eye has evolved to detect visible light in a very thin spectrum, and is functionally limited by density of photoreceptors and compression of visual data sent along the optic nerve.

Any discussion of psychedelic hallucination is a discussion of the spontaneous emergence of perceptual information within human consciousness. Human perception is limited by the capacity of sense organs (**Fig. 1**); the speed and architecture of the neural network; and the number of distinct perceptions the brain can analyze at any one time. Despite functional limitations, human consciousness is seamless, meaning that each perception and behavior flows smoothly from one to the next. When consciousness is stable perception and behavior is seamlessly integrated; when consciousness destabilizes perception and behavior loses cohesion until we are no longer in control of our thoughts and actions. Destabilization of consciousness can happen all at once, in the case of being knocked unconscious, but more often it happens incrementally as various aspects of consciousness enter into a low-power subconscious or unconscious state, as in going to sleep.

Psychedelics are unique in that they can both enhance and degrade perceptual limitations by orders of degrees; psychedelics can obscure and distort perceptual data or they can enhance resolution and generate expanded states of consciousness. These contrasting results may be dose dependent, but it is also possible that psychedelics simultaneously produce perceptual degradation and enhancement. Psychedelic hallucinations are often described as being beyond the limits of human imagination, a trait which is offered as de-facto evidence of expanded consciousness or supernatural origin. Since the boundaries of the human imagination can be modeled with some close degree of accuracy, any substantial discussion about the nature of psychedelic hallucination must therefore start with some basic assumptions about the limitations of human perception, and thus the limitations of expanded consciousness.

The Visual Spectrum

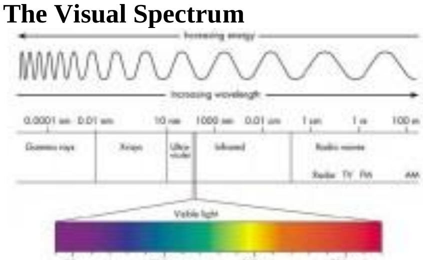


Figure 2: The EM spectrum ranges from gamma rays, which have a very short wavelength and very high energy, to radio waves, which have a very long wavelength and very low energy. Visible light makes up a very small portion of the spectrum.

The human visual spectrum has evolved to work best in a small window of sunlight that penetrates the Earth's atmosphere, comprising the white-light band seen in a rainbow (**Fig. 2**); roughly the 400-790 THz (terahertz) energy range, energy which oscillates on the order of hundreds of trillions of cycles per second. The smallest wavelength of visible light is violet, which is only 380 nm (nanometers) wide and travels with the highest frequency. Red, by contrast, is 750 nm long on the other end of the visible spectrum, and at twice the length it travels at half the frequency.[1]Unlike some organisms, the human eye does not see into ultraviolet or infrared rages, nor does it see microwaves, radio waves, x-rays, gamma rays, or anything that falls out of the visual spectrum. This applies to night vision and dark-adapted vision. The dark-adapted eye utilizes the rod cells as opposed to the cone cells of daylight vision; rod cells are more photosensitive and more numerous, but they lack the color sensitivity and detail resolution of daylight rendering.[2]

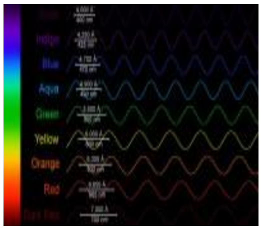


Figure 3: A comparison of light waves and their formal properties.

Subjects on psychedelics often report increased luminosity and saturation of colors, as well as halos or auras of light surrounding objects. In closed-eye or low-light environments subjects report vividly saturated geometric matrices, often rendered in swirling palettes of fluorescent purple and neon green.[3] All of these reports fall within the expected range of visible color spectrum, with the dark-adapted eye finding more sensitivity in the shorter-wavelength, higher-frequency, violet to green ranges (**Fig. 3**).

There is speculation that some aspects of psychedelic hallucination are the result of tuning the brain to receive radiation at a wider range than normal; bands associated with electromagnetic, metaphysical, morphogenetic, Akashic, or geomagnetic fields. The spectral argument posits that the human brain is like a radio receiver for consciousness, and psychedelics allow the user to tune the brain to new perceptual frequencies, possibly quantum or higher dimensional in nature. This metaphor may make intuitive sense, but no research exists to confirm any spectral advantage to psychedelics other than increased photosensitivity and some visual acuity at low doses.[4,5,6] Subjective reports indicate that psychedelics may increase auditory or synesthetic sensitivity to background electromagnetic noise, and the perception of energy fields or auras emanating from living organisms is reported often enough to warrant further scientific scrutiny, but these claims have not been tested rigorously enough to be conclusive.[7]

Visual Frame Aliasing

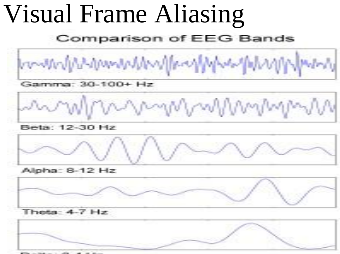


Figure 4: Comparison of EEG bands over one second of activity. Gamma (30-100Hz), Beta (12-30Hz), Alpha (8-12Hz), Theta (4-7Hz), and Delta (0-4Hz).

Seamless perception relies on rapid frame updating to render external changes in real time. Humans can render changes in reality at roughly 13-15 frames per second (fps, or Hz), which means that our perception of reality fully refreshes itself roughly once every 77 milliseconds (ms). Human frame perception is exploited by animation and film, which updates at 24 fps, and television, which updates near 30 fps. Computer monitors and high-definition televisions refresh at 60 Hz or higher, and at this rate human perception of motion are entirely seamless.[8] The rate of human frame perception corresponds roughly to the alert Beta range of waking human consciousness (12-30 Hz) seen in EEG readings (**Fig. 4**). Any event which happens faster than $1/60^{th}$ of a second (16.6 ms) falls between perceptual frames and is considered to be subliminal or imperceptible to human consciousness.[10] Seamless frame rendering is also called temporal aliasing, and can be subverted by a variety of common phenomena, including stroboscopic lights which break motions into jerky snapshots, and wagon-wheel illusions where rotating spokes appear to stop or spin backwards

Figure 5: Video feedback stacked as few as 8 to 16 frames deep are isomorphic of fractal recursion, visual echo, and nonlinear frame destabilization associated with psychedelic hallucination.

In addition to retaining visual information, perceptual frames hold the totality of multi-modal sensory rendering. Smooth frame aliasing preserves semantic state information from one moment to the next, and retains fidelity of the limited information we keep active in our working memory. There is evidence that the brain can track multiple object layers for each frame; [14] possibly corresponding to the number of distinct items we can normally hold in working memory, which is about seven.[15] Frame rendering is a distributed cortical task modulated by the aminergic system. High aminergic modulation of the frontal lobe is a good indicator of external frame alertness. Any drug which interrupts the precise timing of the aminergicmodulator system will also disrupt the seamless nature of temporal frame aliasing in the same way that a strobe light disrupts the motion of a spinning wheel. Temporal aliasing hallucinations include frame stacking, frame delay, frame freezing, frame reverse, frame echo, and infinite frame regression; all of which are considered to be uniquely psychedelic (**Fig. 5**). The sensation of hallucinogenic frame stacking indicates that psychedelics may create a temporary frame decay buffer that allows for simultaneous multi-frame analysis and increased complexity of visual comprehension. Subverting or enhancing the functional limits of visual frame aliasing may be an indication of expanded consciousness.

Visual Frame Resolution

Human visual resolution is limited by a number of factors. The first limitation is the density and distribution of retina in the eye; 130 million photoreceptors feeding into 1.2 million optic projections, with a spatial compression ratio of roughly 100 to 1. Photoreceptors in the eye are distributed in rings with color-sensitive cones clustering towards the center and contrast-sensitive rods filling the periphery Despite the large number of photoreceptors the actual field of vision is incomplete. Including the blind spot where the retina attaches to the optic nerve, as much as 20% of peripheral vision contains gaps that must be filled with progressive rendering. Incoming rings of visual data are then smoothed into completed lines and shades in the visual cortex; the image is then passed forward in two divergent projections for spatial and object analysis; and finally the finished image reaches multi-modal convergence in the PFC. This is a fair bit of signal juggling for a seamless process to handle at 15 frames per second.

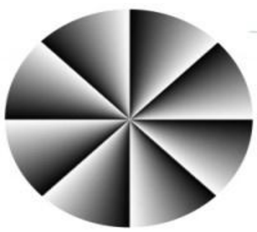


Figure 6: The peripheral drift illusion (PDI) is easily seen when the figure is in the periphery. Research suggests the illusion is based on temporal differences in luminance processing producing a signal that tricks the peripheral motion system. Even though human vision employs elaborate compression and reconstruction techniques, the human eye can detect visual detail at resolutions into the micrometer range. From a meter's distance the human eye cannot detect detail fewer than 100 micrometers in length, making print resolutions of 300 dots-per-inch (DPI) entirely seamless. Some estimates put the detail of human visual resolution at 14 million pixels per the entire visual field; others limit vision by bandwidth of nearly 9000 kilobits per second; or by the 3D topographical field-rendering limit of 10 billion triangles per second, or 760 million triangles per frame.[8] Human detail resolution is only reliable near the center of vision; many optical illusions exploit perceptual filling functions of the periphery (**Fig. 6**) Given the mechanical shortcomings of peripheral rendering, these estimates should be taken as visual saturation points as opposed to functional capacities.

The rendering of visual information may be the most complex and energy-intensive task of the human brain. Seamless visual perception requires precise neural firing. When perception destabilizes the visual field falls apart; the most commonly reported form of visual destabilization is diplopia or double-vision. Since visual rendering is so rich and complex it is potentially the easiest part of the brain to destabilize and the most ripe for exploitation. In other words, visual rendering is so elaborate it can be easily fooled by hallucination and illusion.

Dreaming, Imagination, Psychosis, Hallucination

While the information resolution of imagination and dreams is difficult to measure, it is widely agreed that dream perception is somewhat less resolved in detail than waking perception. Dreams are often incomplete; contextual state data is not retained from frame to frame; and thus the durability of dream data falls apart under close scrutiny. Sometimes dreams can be vivid to the point of being indistinguishable from reality, containing people and places and narratives that retain state information over many different sequences, but more often dreams are fleeting and half remembered, and last for only a few seconds before fading.

Visual rendering of human thought is more durable than dreams but generally of very low detail. Humans can imagine objects, people, and places in their minds, but human memory and imagination are not typically photorealistic. Human memory is more semantic than eidetic, meaning that waking thoughts are mostly verbal, emotional, and only minimally visual. Most humans can imagine basic shapes, silhouettes, and sensual concepts; a smaller percentage can imagine topographical maps and rotate 3D objects in their mind. Visualizing a simple object like a cube or a pyramid is a cognitive task that requires full concentration; and even at peak visualization the internalized form rarely rises beyond a blurry silhouette. The exception to this limitation is dreaming or daydreaming, when eidetic or photographic snapshots bubble up into consciousness almost fully-formed. The emergence of dreamlike eidetic information into waking consciousness is usually a spontaneous reflex; few people have full control over photorealistic rendering of imagination and memory.

Having fully-formed visions spontaneously erupting into consciousness is sometimes called overactive imagination, daydreaming, vivid memory recall, eidetic memory, photographic memory, emergent ideation, hallucination, or psychosis. Each of these modes of internal visualization is characterized by a different intensity and duration of imaginary detail; the more intense and durable the phantom detail the less it looks like imagination and the more it begins to look like psychosis. Mediating hard transitions between external alertness and internal visualization is a baseline for perceptual stability; confusing the two would be problematic. The function of internal visualization is activated by the medial temporal lobe and modulated by neurotransmitter acetylcholine; psychedelics presumably activate this function spontaneously by interrupting aminergic alertness of the forebrain.[25] If psychedelic hallucinations capitalize on the brain's capacity to produce vivid dreamlike images, we would expect the detail of a psychedelic frame to match the information profile of a dream frame; low information resolution, softer attack, elongated decay and sustain, low formal durability from frame to frame. This means that state information such as identity, purpose, and context would also elongate and transition quickly from frame to frame.

If the quality of a hallucinogenic frame matches the formal quality of a dream frame, one could expect psychedelic visions to be of lower resolution than normal vision; but subjective reports indicate that multiple layers of dreaming and waking consciousness can overlap in a single psychedelic frame, creating a complex overlay of both real and imagined perceptions. Being unable to separate imagination from reality is the clinical definition of psychosis, but it also implies an increase in potential frame information density; which implies an expanded state of consciousness.

The Limits of Expanded Consciousness

Figure 7: Fractals generated by computer programs and nature is forms of nonlinear psychedelic hallucinations.

If the human imagination is infinite, and if psychedelics can expand the capacity of human imagination, then psychedelics can paradoxically make the infinite even more infinite. This makes sense if you accept that infinity is a linear concept which starts at zero and goes in one direction forever; but if infinity is bent into a series of repeating loops and spirals then it begins to look more like a fractal than a line, and thus more psychedelic (**Fig. 7**). Human perception is linear, but humans live in a nonlinear system. Psychedelics destabilize linear perceptions of space and time to produce fractal states of frame layering, bifurcation, and infinite frame recursion. This allows perception to exist in multiple states at once, much like a quantum computer that processes multiple simultaneous probabilities. If normal human imagination is bound within the limits of linear infinity, psychedelic perception is expanded to the limits of exponential or fractal infinity. Psychedelic perception presents a progressive nonlinear bifurcation of recursive self-similar information corresponding to both internal and external perceptual space. The psychedelic layering, bifurcating, and regression of internal and external perceptions creates a timeless, transpersonal perspective of what might be called a nonlinear, fractal, or holographic rendering of time and space.

Figure 8: Mandalas and calendars representing universal harmony and knowledge. Top row: a Kalachakra time-wheel mandala; and a Mayan calendar. Bottom row: a mandala of the enlightened Buddha; and a mandala of the Wheel of Life (Bhavacakra, or samara).

The perception of seeing all time and space unfolding in a single moment is a theme that has been reproduced in Eastern mandalas and Mesoamerican calendars for thousands of years, where a central figure sits in the center of concentric interlocking rings of reality (**Fig. 8**). In Sanskrit this great wheel of time is called Kalachakra (time wheel), and Kalachakra yoga emphasizes the interlocking self-similarity of body cycles and celestial cycles. The description of Kalachakra overlaps with Mesoamerican cyclical calendars and spiritual themes, expressed by Maria Sabina, the Oaxacan healer who first shared the magic mushroom known as Teonanacatl with R. Gordon Wasson. Sabina said, “The more you go inside the world of Teonanacatl… you see our past and our future, which are there together as a thing already achieved, already happened…

Rapid frame updating and coordinate, corresponding Seamless perception.

ASSUMPTIONS: a

1) Category1of**Rapid frame updating and coordinate, corresponding Seamless perception**.
2)Category 2 of **Rapid frame updating and coordinate ,corresponding Seamless perception**
3) Category 3of**Rapid frame updating and coordinate, corresponding Seamless perception**.

In this connection, it is to be noted that there is no sacrosanct time scale as far as the above pattern of classification is concerned. Any operationally feasible scale with an eye on **Rapid frame updating and coordinate, corresponding Seamless perception**.Made out of the**Rapid frame updating and coordinate, corresponding Seamless perception** would be in the fitness of things.For category 3.“Over and above”nomenclature could be used to encompass a wider range **Rapid frame updating and coordinate, corresponding Seamless perception**.Similarly, a “less than” scale for category 1 can be used. The dissipation in all the three categories are attributable and ascribable to the age and depletion of rapid frame imaging We give herein below two examples for the same and how the dissipation coefficient gets accentuated therefor.

Hurricanes: Credible Approach to Hurricane Reduction(details see article by Joe Suhayda and Nicholas Tesla))

.

Hurricane Genesis as suggested by Research

The warmer ocean water enables a certain mass of water to EVAPORATE every second, which TRANSFERS a good deal of energy from the water into the air. This is primarily from heat energy that is in the water, and the process is somewhat dependent on the air's relative humidity. THIS step transfers an identifiable amount of energy from the water to the air, as evaporated water. Since the air is cooler than the water, the dew point is lower, and if it is between the two temperatures, then some of the water which had just been evaporated now condenses into fog or cloud droplets. This step RELEASES significant amounts of energy into the air. Again, this is relatively easy to calculate. Some of this energy goes into warming the air and making it rise, but the amount of energy released can be much greater than what can be used up in giving kinetic lift to the air. That remaining amount of energy HAS TO go into ROTARY KINETIC ENERGY of motion of the air (in Conserving Energy). THIS is what supplies the energy (in an easily calculable quantity) to drive the circulation of most vortices, waterspouts and hurricanes, which begin over water. The calculations are easily done, and they nicely confirm the rate of circulation seen in the video. Note that these many circulations began IN DEAD CALM AIR and with NO initial rotary motion or incentive at all! The thousands of spontaneous vortices that I have witnessed seem to have all rotated counter-clockwise, which I attribute to the Coriolis Force due to the rotation of the Earth. I do not yet know whether any clockwise circulations ever form or what happens to them if they do. Once a circulation has begun, THEN the reasoning that is commonly described can have effect, although the supplying of kinetic energy as described here must still remain a primary factor.

De-Stabilizing the Movements of an Existing Hurricane

An entirely unique method might be effective in either stopping hurricanes from first forming or quickly reducing their power once they exist, or both. A method based on the Physics principle of Resonance, and of Destructive Interference, and in certain applications, specifically a second order Quadrupole Resonance seems certainly worth investigating! **The concept is very similar to using a MODERATE INTENSITY constant pitch musical note to induce internal natural vibrations in a wineglass, WHERE THE WINEGLASS THEN SPONTANEOUSLY SHATTERS!** The significant factors here are that the musical note is provided from an external, distant location, it is of extremely constant frequency, and that it has nowhere near enough acoustic power to actually shatter the structure of a glass. That parlor trick only works with a wineglass if the glass is "fine enough" to have **well-defined internal resonant frequencies,** where an external "forcing" vibration that happens to be at exactly the right frequency can cause an effect often referred to as a magnification factor. Very small vibrations first form in the wineglass, and as long as the external forcing vibrations continue at exactly the same frequency for a while, the internal vibrations inside the wineglass then keep magnifying or amplifying, in causing an ultimate consequence far in excess of the causative force being provided. **It has long been my belief that the circulations of hurricanes contain pure enough resonant frequencies to take advantage of this sort of approach.** One resonant frequency is obviously the rotation rate of the entire hurricane, but there appear to be smaller (and therefore faster) resonant structures inside each hurricane.

It has long been known that once a hurricane goes over land, its strength rapidly degrades and also that a lot of tornadoes are reported. No one seems to have ever connected these two facts, but I believe they are intimately related. Each tornado that spawns off of a hurricane immediately carries away a good deal of the rotational energy of the hurricane (as kinetic energy of rotation of the spawned tornadoes), which then rapidly locally dissipates as the tornado disperses. No one has ever been able to accurately measure the power in a tornado, and they also occur in much different strength, but rough calculations suggest that a tornado may contain on the order of 500 million horsepower. Below, we will discuss estimates that the same sort of calculations for a hurricane suggests that its power is likely to be on the order of 10 billion horsepower. If these numbers are reasonably accurate, then if a hurricane over land spawns off just TEN tornadoes (which seems common), that might account for around HALF of the overall power in the circulation of the hurricane. It is not known WHY tornadoes seem to get spawned from hurricanes when over land, but it usually seems to occur very quickly, within the first hour or two over land, and the power of the hurricane is generally seen to rapidly degrade. **Hurricanes over land are generally observed to dissipate power remarkably rapidly, and simple friction with the ground cannot explain the massive reduction in kinetic energy, while the spawning of multiple tornadoes seems to provide such an explanation.** It seems relatively obvious to me that this specific process is a primary one in why hurricanes can lose so much of their strength so very quickly after moving over land. Otherwise, the hurricane should have retained much of its massive kinetic energy for a far longer period of time. After all, it took several days for it to GROW to the immense size and power it had! Any analysis of the frictional losses with the land surface shows that the energy degradation should be far slower than actually occurs. I believe this spawning of multiple tornadoes is critically important in the ending of a hurricane. Energy accounting analysis to determine the real-time energy content of a hurricane as it moves over land, and also the energy content of the multiple tornadoes that appear at the fringes of the dissipating hurricane. Integral diminution of a hurricane over land.is explained this way.

Those spawned tornadoes can only begin as a result of some resonant feature of the hurricane. It would then only be necessary to determine WHAT TRIGGERS that multiple tornado formation. **I believe that it may be possible to ARTIFICIALLY induce tornadoes to spawn off of a hurricane, earlier in the existence of a hurricane. If this could be done while a hurricane is still far at sea, it may be possible to degrade a hurricane's strength,** or perhaps even entirely disrupt its circulation, causing it to simply fade out of existence, and simply become a tropical depression, far at sea and away from causing damage to people or property.

HUNDREDS of tiny tornadoes (actually waterspouts) or hurricanes (vortices) develop, often with **thirty or more very distinct ones of them simultaneously being obvious** on the block-long stretch of Creek that I can easily monitor. Occasionally, there have been far over a hundred visible at some times, but most of those disappear virtually immediately. The videotape on the right is of one of the objects recorded for 34 seconds in April 2006. You may want to enlarge the video to full screen to best see it, where it is first clearly seen beginning toward the left of the screen. All the "experts" have always insisted that strong and circulating winds, fast moving water and very hot water are required out in the ocean to allow hurricanes to form. They ASSUME those things to provide the energy which is certainly needed. But these many thousands of vortices which I get to watch on many Spring mornings describe an entirely different story! The air is always DEAD CALM when I can see them (which often happen right after sunrise). The water is always flowing very smoothly and fairly slowly so there is no spectacular source of kinetic energy there. The water IS warmer than the air, generally by around 10°F or 12°F different, and the humidity is fairly high.

It is fascinating, and it provides an area of research into the starting of hurricanes, waterspouts and tornadoes that no one else yet seems to have considered. As to hurricanes, warm water is definitely realized as somehow being important, but no one seems to have found out WHY the warmth is important! Also, there are always assumptions that moderately strong winds are involved which somehow turn to become circular motion. These objects above my Creek seem to indicate a totally different explanation, since they ONLY seem to develop when there are dead calm winds!Joe Suhayda gave**complete description of how and why the vortices form, including an energy accounting and other mathematics to confirm that it all complies with both the Conservation of Energy and Conservation of Angular Momentum.** Same process or an extremely similar one occurs in certain parts of the oceans to initiate hurricane formation. This research by Joe Suhayda has resulted in concluding that tornadoes CANNOT FORM over dry ground, but damp ground is fine. This reasoning also makes clear why hurricanes would not normally form in other parts of the oceans, including areas that other experts believe should be sources of hurricanes. This logic applies to the formation of tornadoes, waterspouts, and hurricanes. Amounts of energy and power involved appeared to all be very consistent, This is the explanation for the phenomenon of hurricane formation.

The conditions of research seem to be these(See Joe Suhayda)

(1) DEAD CALM air. If there is even a noticeable wind, these things never seem to appear. Sunrise is an excellent time, as winds tend to be most calm then, as nightly air convection circulations begin to reverse into their daytime convection circulations.

(2) Water is calm and smooth, but flowing. When the water flow has been greater than around 4 ft/sec, I have never seen them. If the surface of the water shows any turbulence at all, anything other than nearly glass smooth surface, the helixes seem to not occur.

(3) Water temperature needs to be at least 10° Fahrenheit warmer than the air. I believe this to be important in the formation of the objects, in that temperature difference (and high humidity) tends to cause water to evaporate into water vapor, which then rises from the warm water surface to quickly condense in the colder air, which makes the objects visible to me. The condensation of that large amount of water vapor into water droplets provides very large amounts of energy to be released into the air.

(4) Bright sunlight coming in from a very low angle over the opposite side of the Creek, where these objects are therefore backlit. Otherwise, I cannot see them, as when the sun gets higher or if any clouds interfere.

There are several observations made regarding watching many thousands of these objects, in addition to the conditional issues mentioned above.

Some only last for a few seconds or so, but many of the larger ones are quite persistent, where I can watch specific ones for at least a minute and occasionally for more than two minutes. The videotape here shows one that is distinct for about 34 seconds.

They seem to consistently move, in the same direction the water is flowing, and generally at around 1/3 or 1/2 the velocity of the water. It is certain that there is NO wind causing them to move! But they all move in essentially the same direction the water is flowing, an interesting situation! The one in this video passed me at about a distance of 30 feet and moved approximately 60 feet in those 34 seconds, around 2 feet per second.

The larger ones are generally between 3 and 6 feet in height, and 2 to 3 inches in diameter. Occasional vortices have been more than 15 or 20 feet tall, but even they are still only 2 to 3 inches in diameter. Those seem to be rarer but they are very impressive! One of those very tall ones was so distinct and well defined that it became visible more than a city block upstream (~500 feet) and it was observed for over four minutes before it went past me and the light conditions changed where I could no longer see it.

Extremely few of them are actually very straight. Nearly all have a wiggly shape, although that specific shape is nearly always persistent. In the case of the one in this video, slightly above the middle of the screenshot is a wiggle to the left, which persists throughout the 34 seconds of this scene and for around ten more seconds afterward until it disappeared from view due to losing backlighting.

Even while a few large and persistent objects are nearly always obvious, there are also always hundreds or thousands of very brief tiny objects which appear and disappear. They tend to be around three feet tall and less than an inch in diameter, often only lasting for two or three seconds, or less.

The images seem to blink on and off, but that is mostly due to the many trees on the opposite side of the Creek blocking the sunlight's backlighting of the vortices. I also suspect that if I used some sort of camera filter, the impressive visual appearance might be far better seen in videos.

There seems little doubt to me that this environment can easily be duplicated in a laboratory setting. DEAD CALM AIR, fairly humid. A flow of somewhat warmed water of around 2 to 4 ft/sec, where the water is very smooth and not disturbed, in a room where the air is at least 10°F or 12°F cooler than the water temperature (and suitable humidity levels) should duplicate the situation. A spotlight or floodlight could backlight the objects to be able to watch them reliably. Possibly some camera filters may be appropriate.

Theory of Formation of Tornadoes, Hurricanes and Waterspouts

(1) WARM water evaporates. This increases the local humidity. That process must proceed to a point where the humidity is fairly high. (2) The warmth causes a small amount of the local air to get warmer, due to the absorbed heat from the water. (3) The humidity then increases in the COOLER air, where it must rise to the Dewpoint, 100% relative humidity. IF the air is cooler still, then the air can no longer contain the entire amount of moisture in it, and (4) so some additional water must condense out on dust particles. (5) As this additional water condenses out of the air, it releases very large amounts of energy from the Phase Change from water vapor to water droplets. (6) These two sources of warmth (convection from the water's surface and the heat released in the phase change) causes the air to rise. (7) The amount of heat released is far larger than the amount of heat which can convert to vertical rise speed. (8) The excess of this energy also becomes kinetic energy, but energy of rotation rather than rising. (9) The rotation of the Earth causes the Coriolis Force which causes this rotation to occur in a counter-clockwise direction in the northern hemisphere. (10) We now have a spinning motion which also slowly rises, where the bulk of the energy that had been removed from the water as heat is now kinetic energy of counter-clockwise rotation. (11) This phenomenon becomes visible if ambient lighting is sufficient and there are particles in the rotating air where either water droplets or dust particles can be seen rotating.

The mathematical basis for these steps is very simple and straightforward, and calculations generally seem to confirm the Energy Audit regarding velocities observed.

Terribly destructive hurricanes such as Katrina in 2005 have done such massive damage, where there might actually have been a (remote?) possibility of degrading such hurricanes far before they had ever approached land. If bags of concrete through the Eye of a hurricane and dumping them, in an apparent attempt at paving over the ocean inside the Eye! Unfortunately, he ended the interview by mentioning that he was about to retire shortly and that he no longer had any pull around there. He promised me to try to get some of his colleagues to listen to my concept before he left, but that must not have ever had any effect, as no one ever later contacted me.

Katrina was nowhere near as strong as the hurricane Andrew that devastated Florida or a number of other giants. Had Katrina ACTUALLY remained at Category 5 (which it had earlier been) and ACTUALLY hit New Orleans, the devastation probably would have been far greater than what actually happened. But I guess all that is "politics" and "spin" where leaders keep insisting that New Orleans will be "rebuilt better than ever", essentially without any funding to actually do it. However, spending hundreds of billions of dollars more to rebuild that city would be very foolish, as between future, stronger hurricanes and rising sea levels, it may only be 20 years before New Orleans (currently 7 feet BELOW sea level and still protected by those 117 miles of dikes) will be forever abandoned as being entirely underwater.

As indicated below, this basic concept regarding **enabling hurricanes to become unstable and spontaneously degrade was developed by the beginning of 2001, but in early 2004, two new (simpler) mechanisms were recognized** as possible to create the necessary shock waves in the perimeter of a hurricane. One would be a precise (due to GPS and precise clocks) repetition of a vertical stack of "percussion bombs" (OUTSIDE the perimeter of the hurricane) to create a vertical-source shock wave to disrupt the smooth circulation flow of the outer hurricane winds. The other is the sequential use of several **SLIGHTLY supersonic aircraft a few miles** outside the 50 mph winds of the outer circulation. The sonic boom caused by supersonic objects like aircraft or bullets is actually a shock wave propagating through the air. An aircraft with a nose cone angle of 10°, traveling at Mach 1.1, creates an extremely intense pressure shock wave, as much as 4 PSI, or 100" of barometric pressure, around 68° out away from the tail centerline. If a supersonic aircraft followed a very specific, fairly tight smooth level, **inward logarithmic spiral turn,** the resulting continuous shock waves become closer together in the air inward along the radius of the turn. **It is possible to shape that logarithmic spiral path so that the sonic boom shock waves from as much as 45 seconds of the supersonic aircraft's flight can all be made to arrive at a desired location a few miles to the side at the same instant, creating an extremely intense (vertical line) shock wave at that single location.** Depending on how precisely the aircraft could follow the logarithmic spiral path, an incredible sound intensity could be generated, mathematically around 220 decibels, quite possibly the loudest sound ever heard on Earth! This single wave front of such extremely loud low-frequency sound exists as a compressed-air shock wave. By following that specific curved path, the natural 4 PSI pressure of a sonic boom shock wave might be increased to over 30 PSI, in that single planned target destination inside the periphery of the hurricane. **The premise is that that instantaneous local pressure increase would compress and then expand the air at that location**, suddenly creating new air motions at rather high velocities, which we might pre-design. If that were possible, then it might be possible to repeatedly (with additional supersonic aircraft at very specific intervals to create a resonance) generate such localized air motions to try to disrupt the circulation motions of the hurricane. It is also possible for the aircraft to follow a course of slightly greater radius turn, or a possibly a horizontal somewhat hyperbolic path, to cause a broader (in time) shock wave to appear there, which has the effect of being at a lower frequency. This sudden blast of hurricane-radically-inward wind would act to drive some of the hurricane's winds farther inward, disrupting the normal circular flow, **causing ripples to form in the circulation, and somewhat de-stabilizing the hurricane. Several such aircraft would be flown to create repetitive sonic boom disruptions in the same position in the hurricane, to try to inspire the wineglass-like self-destruction of the hurricane.**

Every year, dozens of hurricanes (and Pacific typhoons, which are the same thing) do enormous damage in lives and property in several parts of the world. They are enormous, being many miles in diameter, and they have phenomenal amounts of energy and power. Over the years, many speculative concepts have been proposed to try to deal with them, but any such efforts would not be like David and Goliath, but a flea and Goliath. The most powerful machinery that we have fades into inconsequentiality in relation to the size and power of even a moderate hurricane. **A "brute force" approach has NO chance of succeeding**, even though some very creative and intriguing ideas have been presented and considered. A very rough estimate of the amount of kinetic energy in a mature hurricane is around 10^{18} joules, or 1,000,000,000,000,000,000 joules. As a comparison, if every one of the hundred million operating cars in America were run at absolutely full throttle, they all would have to run like that for about 20 hours straight to produce that much energy! That gives a rough idea why traditional methods of Engineering would have no noticeable effect on a hurricane, because of the enormous size and strength. All that energy cannot just be made to disappear, but must somehow be dissipated (be converted to other forms of energy, primarily frictional heating of other air).Current research into hurricanes seems to focus on the central areas, where the winds are highest, near the "eye". However, even superficial calculation shows that the majority of the actual kinetic energy contained in a hurricane resides in the huge outer areas. Even though the winds are slower there, the vast quantity of moving air carries most of the energy of movement. This fact has therefore encouraged this new approach at degrading a hurricane, by attempting to cause disruptions, destabilizations, in the **perimeter** of the storm, to cause energy to be dispersed there (probably as tornadoes spawned off).This involves NO attempt to "over-power" the hurricane! Rather, it uses the energy that is already in the hurricane by encouraging some of that energy to get "out-of-phase" with the main circulation of the hurricane. This out-of-phase energy becomes disruptive, with the intended result to create many (small) tornadoes which remove kinetic energy from the main circulation of the hurricane.

It has long been noticed that, in the late stages of a hurricane's existence, many (brief) tornadoes often appear along their borders. Such tornadoes have extremely fast-moving winds, but their relatively small size means they contain only a fraction of the energy of a hurricane. They each therefore remove fairly large amounts of rotational energy from the hurricane in very short periods of time. **These tornadoes are clearly a very energy-expensive aspect of hurricanes, and they are never seen early in the life of a hurricane.** If this tornado-spawning process can be artificially induced, well before a hurricane approaches land, large amounts of the circulation energy should be removable from the hurricane by this process, and the hurricane would then necessarily be degraded in strength. No one could know or plan where the tornadoes might form or where they might go, so it would be critically important to do this process far from all land and human activities. However, the advantage is that tornadoes have very short lifetimes, and never travel very far before self-degrading due to frictional losses, where the main hurricane would have damage-creating potential for many days over a very large region.

It is here believed that this effect of tornado-spawning once over land is a primary reason why many hurricanes degrade so very quickly when they are over land, because so much rotational energy is dissipated to the many tornadoes. The kinetic energy or rotation of the hurricane cannot just disappear, so it must be converted into other forms of energy, almost certainly being frictional heat energy in the air. This seems to imply that the air temperature must rise as a hurricane degrades. Beginning in 2002, technology has become capable of monitoring this data over the entire region of a hurricane, so this premise should soon be proven or disproven, assuming that someone decides to measure it!

The speculation here is that a hurricane that can be artificially caused to spawn hundreds of such tornadoes (while still over the ocean) might thereby quickly give up substantial amounts of its kinetic rotational energy to those tornadoes and the hurricane remaining would thereby rapidly get weaker. Once separated from the hurricane, each tornado would soon lose its kinetic energy by normal friction to the surrounding air. **That two-stage process would therefore accomplish dissipating a great deal of energy rather quickly.** This seems like a possibility worth looking into. One way or another, when a hurricane disappears, all that kinetic energy of rotation must become converted into frictional heating of local air and ground. It has long been believed that friction with the ground is a major cause of the relatively rapid diminution of a hurricane's strength when over land. However, the resulting increase in that ground's temperature would be significant, due to the enormous amount of kinetic energy which must be dissipated. **Clearly, the creation of peripheral tornadoes, which quickly dissipate and therefore give up their rotational kinetic energy into frictional heating of the air, must also represent a significant method of hurricane energy reduction.<u>This concept is here seen as a significant possibility regarding how to remove large amounts of energy from hurricanes, to inspire them to spontaneously spawn tornadoes earlier in their existence.</u>** It seems prudent to try to deal with a hurricane well before it nears any land, out in the open ocean. For one thing, it then has less total kinetic energy of rotating winds to try to dissipate. <u>We wish to (externally) cause small turbulences in the outer circulation of it, with the intent of encouraging it to form those tornadoes at that time. **Being away from land and people, such tornadoes would not cause any damage, but they would collectively remove large amounts of kinetic energy from the hurricane circulation, thereby weakening it.** The premise of this application is that if hundreds of such tornadoes could be artificially spawned from a hurricane, the remaining kinetic energy would be greatly reduced, either degrading or dissipating the hurricane.</u>

<u>The New Concept</u>

Everyone knows that a fine wineglass can be placed in a room, and a standard stereo speaker (or even a singer) placed several feet away from it, and by emitting a very specific pitch of sound from the speaker (or singer) the wineglass can eventually shatter. An important consideration is that the sound does not have to be deafening loud, and a rather moderate loudness can shatter some glasses. The glass does not immediately break, but it gradually builds up internal vibrations that destroy it internally. What IS important is that the tone of the emitted sound be extremely constant and at a very precise frequency, which is dependent on characteristics of the specific wineglass. A standard engineering design principle, called "forced vibration", explains this action. Each arriving air shock wave causes a tiny shock wave to form within the glass, which then proceeds across the glass to the other side where it reflects back to the starting point. If each new arriving wave it timed very carefully, to match vibrations that have already been started within the glass and which are oscillating back and forth across it, the net effect is a gradual increasing in the actual amplitude of the vibration of some areas of the glass. At some point, the localized vibrations grow to become so intense that the very structure of the glass is destroyed. A similar but less spectacular example i when a guitar is placed in front of a loudspeaker of a stereo system. If a long constant note is in the music, one or more of the guitar strings can start to vibrate, seemingly magically. It is really just Forced Vibration. Guitar players sometimes make use of this phenomenon and simply call it feedback. Think of an even simpler example of "forced vibration" where you push a child on a playground swing. If you would randomly time your pushes, not much would be accomplished, but if you select your timing, your small pushes will gradually get the swing to traveling very high. You could never have gotten the child and swing going that high with simple "brute force"! You have recognized and used a natural resonance of the swing to accomplish big swinging.

In a way nearly identical to the wineglass and loudspeaker, now imagine a hurricane and a specially outfitted ship a number of miles away from it. The ship has a mechanism to create shock waves in the air, effectively extremely low frequency sound waves, at a frequency that is determined by the characteristics of the hurricane size and rotation. With just moderate (achievable) power in those emitted sound waves, a gradual, cumulative effect would develop within the hurricane, causing internal disruptive "vibrations", de-stabilizing the peripheral circulation of the hurricane in a way relatively similar to the wineglass shattering. (There is no attempt or intention to immediately affect the central motions of the hurricane, but only an attempt at "peeling off" or developing sub-sub-sonic turbulence in the outer portions of the circulation.)This simplified description is of the cruder of two potential mechanism methods (which we shall call a monopole resonator). Following the logic above, one sees that it is certain to work, but the turbulences that are introduced into a hurricane might tend to be random, and the exact manner of dissipation would have some uncertainty. This may or may not involve some safety considerations. A more sophisticated Quadrupole resonance method would be more difficult to arrange, but the result should be a very "organized" degradation of the hurricane, in known and consistent ways, with no dangerous surprises lurking. Another simple method seems possible to accomplish the same thing. If a series of sturdy aircraft stay near the outer edges of a hurricane, each having GPS (global positioning system) equipment and a supply of "percussion bombs", a similar result might be achieved. Percussion bombs resemble the loudest "bombs" in a fireworks display, where a single very loud shock wave is created. If the aircraft could arrange to be dropping larger percussion bombs at precisely equal intervals in the same position in a hurricane, a series of shock waves would be created. If the timing (frequency) was carefully selected regarding a natural frequency of the hurricane circulation, a Forced Vibration resonance might be generated. The only hazard in this method is that if a tornado suddenly developed unexpectedly, one or more of the aircraft might be in danger.

Yet another and even simpler approach was mentioned above, involving a series of slightly supersonic (Mach 1.1) aircraft. Each would follow a level course, first paralleling the counter-clockwise rotation of the hurricane. At a specified location, the aircraft would turn outward (right) to a direction at about 45° from a radius line to the center of the hurricane, and then immediately make a fairly tight (around 1.5 G) (radius around 5 miles) turn (left) toward the hurricane. The ideal path seems to closely resemble a logarithmic spiral, but other path shapes might also have merit. Once the aircraft has gotten to the point of moving in a direction about 45° inward of tangential, the aircraft would turn right and leave the area. The desired result of this is that the resultant sonic boom from around 45 seconds of flight would all arrive at a single vertical target line destination, around 5 miles radically inward, simultaneously. Aircraft researchers call this a super boom. As mentioned above, the shock wave that is created by a supersonic aircraft at low speeds such as Mach 1.1 is intense, creating a momentary pressure differential of around 8" of atmospheric pressure at the aircraft. Pressure differentials drive wind motions. The premise is that a continued substantial over-pressure, or even drastic fluctuations in local air pressure, in that one target location would artificially create local winds that would travel outward in all directions. These artificial air motions would represent disruptions to the general circulation of the hurricane. This approach should therefore inspire irregular motions in that circulation. If several such supersonic aircraft would follow each other through that flight path, each 45 seconds later, a continuous disruptive effect must certainly occur. It is hard to see how the orderly circulation of the hurricane could continue with this effect occurring. Additionally, if specific resonances of the hurricane have been recognized, the aircraft could follow slightly hyperbolic paths, and their interval spacing could be arranged to inspire more effective disruptions of the circulation due to magnification of those natural resonant motions of the hurricane.

More Technically

Any object that is moving with a relatively regular repetitive motion has a set of "natural frequencies". In general, some frequencies tend to be dominant, and they can usually be determined with standard engineering principles. This premise includes rotating objects. From a Physics perspective, a rotary motion like the circular motion of air in a hurricane, can be considered to be a vibration in two directions, with what is called two degrees of freedom, ninety degrees out of phase with each other. As such, standard engineering analysis of vibratory motion can be applied, including analysis of factors that enhance or degrade that vibratory motion. (Some of the mathematics for this are included later in this article.) This can allow standard resonance concepts to be applied. The engineering concept of "forced vibration" seems especially important, particularly in the natural formation of a hurricane. Such forced-vibration resonances must certainly be instrumental in first enabling a hurricane to form and grow, because a non-resonance situation (i.e., without a "magnification factor") would naturally quickly dissipate the rotary energy as peripheral frictional losses with slower exterior air. Only a resonance situation seems to permit the meta-stable growth of such rotary motion beyond a few seconds.

Energy Analysis of the Beginning of a Hurricane

Regarding the beginning and growth of hurricanes, there is another consideration. The energy content estimate mentioned above is roughly 10^{15} Btus of kinetic energy. Current hurricane research seems to assume that the development and growth of a hurricane occurs due to energy conversions (from heat to kinetic energy) within the eye area. **A rough energy audit can examine this premise.** There are only two available sources of energy, direct energy from sunlight, and energy in water evaporated from the ocean.

Even a substantial sized "eye" (for an early storm) of a ten-mile diameter, (two billion square feet) receives a TOTAL solar energy (around 300 Btu/sqft near noon) input of around $6 * 10^{11}$ Btu/hour. In the unlikely situation where ALL of that energy was somehow converted into kinetic energy of rotation, around 1500 hours of sunlight (or over 150 days) would be required to supply all the kinetic energy in the mature storm.

That same area of warm ocean surface can evaporate up to 25 million pounds of water per second (roughly doubling the moisture in the air from 60°F up to 80°F). This process can occur 24 hours a day. Each pound of water evaporated absorbs around 970 Btu from the ocean's heat (the water initially containing around 180 Btu/pound and the evaporated water vapor containing around 1150 Btu/pound), or around $2.5 * 10^{10}$ Btu/sec. In each hour, this can therefore represent around $9 * 10^{13}$ Btu/hr, 24 hours each day. This represents heat energy from the ocean waters which can be transferred to the air due to the evaporation and then condensation processes.

The evaporation effect therefore can transfer hundreds of times more energy into the air than the maximum that direct sunlight could, and it would operate around five times more hours every day! If there were no frictional losses (which there are), the $9 * 10^{13}$ Btu/hr of energy transfer into the rotary motion could account for all the energy in a mature hurricane in only around 11 hours! This then represents a credible explanation for the energy flow in the growth of a hurricane, both at the very beginning and throughout its existence.

It also confirms the well-known fact that once a hurricane passes over land, it quickly loses much of its power and energy, as the continuing source of energy necessary to overcome the many frictional losses is then no longer operating.

No physical process has perfect efficiency, so if sunlight was the primary energy source, even much longer time would be required. In addition, there is always the frictional energy loss at the perimeter of the circulation that constantly dissipates energy. However, from genesis to maturity, hurricanes tend to take less than 1/10 of that time. This suggests that sunlight energy is NOT the primary source of energy for hurricanes. But the amounts of energy which can be transferred directly from water to the air by evaporation can be far larger, and are easily sufficient to provide all the energy seen in hurricanes. The thousands of vortices that I have watched form and disappear seemingly instantly in calm air over rather calm water seems to confirm this assertion.

The enormous amounts of energy transferred from the water to the air by this evaporation are partially used up in giving upward kinetic velocity to the air, making it rise. But that can only consume a small portion of the energy which is being provided. If the energy remains as water vapor, that energy is not released, but if temperature and humidity conditions are such that the water vapor might condense into cloud/fog droplets, truly immense amounts of energy are then released into the air, far more than can be used up in giving the air upward velocity. This results in MOST of the energy being **converted into** Kinetic Energy of ROTATION. Calculations seem to confirm that this is a realistic hypothesis.I have done this analysis for hundreds of individual vortices that I have watched. I would first calculate the amount of water that could evaporate from the warm water in the size of the footprint of the vortex. Then I would calculate how much energy had to be released when that water vapor would condense into water droplets. Then I would calculate the amount of kinetic energy consumed in the vertical motion seen in the entire structure. And then, assuming Conservation of Energy, the remainder of the energy audit was calculated as giving rotary kinetic energy to the vortex. In virtually all cases of such calculations, the calculated spin rate was very close to the observed spin rate! This seems to be solid experimental evidence that this explanation is valid.

Research suggests that Resonance considerations might be applied to an existing hurricane to incrementally degrade its strength, and thereby cause it to dissipate. With careful planning, it should be possible to artificially introduce destructive harmonic resonances into the outer portions of an existing hurricane, to cause it to eventually break apart into disorganized motion (or into the aforementioned spawned tornadoes), and therefore dissipate. Such efforts would have to recognize that continued effort, at extremely sharply defined frequencies, would likely be required for extended periods, in order to enable the gradual growth of the (desired) self-destructive resonances within the storm's outer circulation. At first, such efforts would appear to have no effect whatever, but gradually, the artificially induced harmonic resonances would "magnify" if introduced at the precise correct frequencies and phase angles. This is in similarity with the effect of constant pitch sound on a wineglass, where no effects seem to even exist until the process is well along.

Consider, for example, an automobile wheel and tire. The diameter of the structure and the weight distribution defines an engineering quantity called the rotational inertia, I. If a wheel and tire are absolutely perfectly balanced, both statically and dynamically, the wheel could spin (on its axis) at essentially any speed very smoothly. However, if the wheel was even slightly unbalanced, by a fraction of an ounce of mud dried on the side of the tire, the wheel will have a tendency to severely vibrate (wobble) at its natural frequencies. As it happens, standard size and weight automobile tires tend to have a dominant natural (or resonant) frequency at around 60 mph vehicle speed. This situation can cause a fraction of an ounce of mud that dried to one side of a tire to cause the entire heavy automobile to violently shake at one very specific speed. Speeding up or slowing down makes the vibration quickly stops. This situation demonstrates both the natural frequency, and the amplifying effect of an extended period of such forced-vibration and resonance. Such a small piece of dried mud does not immediately cause significant vibration, but over time, at very specific frequencies, the vibration can continue to increase each revolution of the wheel until it is very large.
Around a hundred years ago, a brilliant inventor, **Nikola Tesla**, had a laboratory in an upper story loft of a building in Manhattan in New York. In one experiment, he had bolted a rather small vibrating device to one of the main structural beams of the building. He started the device vibrating. Apparently, the small device was vibrating at a particularly unfortunate frequency. Over a period of the next few hours, the vibrations he was creating were being transferred to the building's foundation and into the very bedrock under Manhattan. He wasn't even aware of it but for blocks around, people thought an earthquake was happening and many windows broke and a lot of damage occurred to buildings. A number of blocks away, the local Police Precinct was concerned that their building was going to collapse! Many Officers spread out among the community to make sure the people would be safe, and one happened on Tesla, and realized that there might be a connection and ordered him to shut it off. The "earthquake" immediately stopped. Tacoma Narrows bridge that started twisting and eventually destroyed itself in a fairly constant moderate wind? No enormous wind speed was involved, but the extended constant wind permitted the narrow bridge structure to begin to resonate at a natural frequency.

In these examples, a rather small repetitive motion eventually caused enormously larger consequences, if it is maintained at a consistent, precise specific natural resonant frequency.
This is essentially the basic concept of both the Monopole and the Quadrupole Resonator in dealing with degrading hurricanes.

Frequency

Hurricanes come in many sizes, and that affects their natural resonant frequencies. An obvious resonant frequency is the rotational rate of the storm. There are generally others as well. The amount of water vapor in the clouds of a hurricane affects the amount of mass that is circulating around the eye. This affects a quantity called the rotational inertia. The engineering formulas for this are pretty simple, but a really accurate estimate for the resonant frequencies should probably involve a numerical integration of the normal $I = mr^2$ formula for rotational inertia. For a variety of previous hurricanes, calculations suggest that all of the natural resonant frequencies seem to far below 1/300 cycle per second.
Calculations seem to assure that a special method of (externally) radiating infrasonic sound waves at the exact frequency of the hurricane's resonant frequency will work excellently at de-stabilizing the structure of a hurricane. This conclusion is based on the mathematical analysis of this resonance concept and the gradual building effect of its power. The externally presented tone does not appear to have to be especially loud, but the cumulative resonance effect builds over the hours. It is not really the artificially introduced sound that finally destroys the hurricane but rather it inspires an undamped, magnified, harmonic resonance within the hurricane itself which causes it to destroy itself.
The hurricane application is somewhat more sophisticated than those cited examples, but it is actually based on the exact same basic concept. The only thing necessary is to introduce a regular and consistent frequency of VERY low frequency (resonant) sound waves to the hurricane **from the outside**. The two different methods accomplish the goal in slightly different ways, but gradually, the resonance effect would disrupt the smooth and regular rotating motion of the storm, and the hurricane would essentially self-destruct! There are several possible approaches, including introducing artificial resonance AT the main harmonic resonant frequency but slightly out of phase, or of attacking a higher harmonic frequency to inspire sub-cell rotations of smaller circulations within the main hurricane circulation. This last, for example, could introduce vibratory air motion at one or two octaves above the natural resonant frequency to encourage four smaller circulations to develop within the storm. Once these circulations began to

develop, the friction between the airflows of the developed smaller circulations would rapidly drain energy from the storm's circulation, quickly degrading it by essentially using natural resonances to break it into several smaller adjacent storms, which would then destroy each other.

Monopole Resonator

This approach would be very much like the loudspeaker and wineglass. Shock waves would be created by a mechanism on a single ship, which would simply impact with the perimeter of the storm. In the same way that that causes internal vibrations in a wineglass, radial air movements would occur in the outermost layers of the hurricane. By timing the subsequent air shock waves, instabilities in the circular motion develop. Rather than having to increase until the structural strength of the glass was overcome, the effects would very quickly cause minor alterations to the hurricane's airflows.

As the artificial shock waves impinge on the storm circulation, the effects can be of random character, causing localized airflows to have increased or decreased vector velocities in virtually all directions. Or they could be timed to artificially emphasize some natural resonance of the hurricane circulation. In all cases, this effect would be to effectively de-stabilize the storm's circulation, but the subsequent pattern of the storm's behavior would be uncertain.

Several possible resonant frequencies could be tried with this method. One interesting possibility is related to how quickly the effect of our shock wave impacting the perimeter of the storm takes to disappear. That "rebound effect" certainly exists. If we sent in shock waves that were timed to match that impact/rebound cycle time, a very effective perturbation effect could be accomplished. The outer edges of the storm would then quickly become unstable, no longer moving in circular paths but in wavy paths, which would both use up energy from the storm and inspire turbulent spalling of smaller storms (possibly such as tornadoes) that would remove substantial amounts of energy from the storm.

Quadrupole Resonator

This approach requires two identical ships with their mechanisms, spaced apart a specific distance. These two ships would create their subsonic shock waves at the exact same frequency, but exactly out-of-phase with each other. The result of these pulse trains arriving at the perimeter of the hurricane would be the standard Physics phenomenon of an "interference pattern".

An interesting consequence of such an interference pattern is that there are locations where a "second order" effect occurs, that of a net LATERAL motion of the air molecules. The two ships would each be having the effect of being Monopole sources, which each would act to degrade the hurricane as described above. But, with careful planning, this quadrupole effect would introduce a pulsed lateral acceleration or deceleration in the winds at the perimeter of the hurricane.

By being able to introduce planned tangential velocity gradients into the winds along the perimeter of a hurricane, it would be possible to carefully control the entire process of degrading the hurricane. However many smaller circulations were inspired would be at the choice of the engineer, and so either a series of small "cells" could be "spalled off" of the main body of the hurricane, slowly degrading it methodically, or larger disruptions could be introduced to break it apart in just a single step.

Being able to produce such lateral air motion, at a distance, and at a specific frequency, is the center of this Quadrupole resonator concept. By timing the created wave pulses properly, and spacing the two ships properly, nearly any desired sequence of attrition could be arranged.

A single pulse like any of these would have irrelevant effect. The entire premise is based on the Forced Vibration design engineering concepts, where repetition of those pulses at frequency rates that matched natural frequencies (or harmonics) of the hurricane create a cumulative effect, due to the exact same physics principles that enabled the formation of the hurricane in the first place.

Possible Physical Apparatus to Accomplish This

A reasonably likely scenario for either configuration might involve either one or two (ocean-going) very stable barges, possibly unmanned, maybe a mile apart, or a number of miles away from the perimeter of the hurricane. For the moment, imagine that they would each have an identical vertical rigid sheet surface that would look roughly like a rigid sailing ship sail. Each of these hypothetical barges would have a mechanism much like the steam catapults on aircraft carriers, to rapidly slide the whole sheet forward and backward. The barges would both have their bow pointed toward the same point on the perimeter of the hurricane.

As the large flat surface would move forward and back, it would be acting like an enormous stereo speaker, a REALLY low frequency "woofer" like in a stereo system, with very high effective audio power. Calculations (regarding an early, immature hurricane) suggest that the barges could each oscillate their sheets forward and back at about five minute intervals (or some fixed multiple of that, to create higher order harmonics of the basic natural frequency). The actual timing would be dependent on the characteristics of that particular storm. There are some unknowns here, and laboratory tests on small scale artificial hurricanes should quickly confirm whether the most effective frequency would be the natural frequency, or half of it, or double it.(The hurricane's resonant frequency changes with time, becoming lower as it grows larger and includes more rotating mass. It is fairly easily calculable using standard Physics equations.)The results of the movements of these moving surfaces would feel just like gusts of air, but recurring at very precise intervals. For complicated reasons, the two barges would do that action "180 degrees out of phase with each other" (and that is the 'Quadrupole' part of the concept). The two extremely low frequency 'sound sources' would develop their "interference pattern" at a distance. A major desired effect of this (Quadrupole approach) is a regular, periodic **lateral movement of the air** at the distance where the perimeter of the hurricane was. (If they had been 'in-phase' this effect would generally not exist). That induced (distant) lateral pulsating air movement is what primarily acts to disrupt the hurricane, without any mechanism having to actually be within it. The resonant relationship between the frequency of that repeated movement and the natural frequency of the hurricane is what allows the "amplification effect" to gradually grow more and more effective in disrupting the hurricane. The amount of power generated in the artificial sound waves is infinitesimally smaller than the power in the hurricane itself. This comparatively low power activity of the barges would gradually have a greater and greater effect on the hurricane, because of the resonance between the hurricane and the barge oscillators. As long as the proper frequency is used, the effect would eventually be disruptive to the circular flow of the hurricane, and it would either not initially form or it would disperse.

This is all technology and machinery that is currently available!

The math and engineering behind this is all pretty simple and straightforward. Any decent engineer should be able to confirm these statements. Just based on the above, it should be possible to do the math of the physics and engineering that confirms it, and to design and build suitable equipment.

An Even Better Mechanism

Barges and movable rigid sails are probably not the ideal mechanisms, primarily because of damage they would likely take from the hurricane winds. This concept could use a number of other various mechanisms to accomplish the creation of the sub-sonic sound waves. A seemingly obvious possibility, with such low frequencies involved, might involve accurately timed "fireballs" which could be created above each barge. The rapidly expanding gases of the air and the combustion products (expanding because of the sudden heat present, when all gases expand) would create a sub-sonic shock wave which would propagate outward in all directions. This is essentially the same process where thunder occurs as a result of lightning rapidly heating and expanding air. While attending a wild-west display at a Great America par in the 1990s, they fired a number of large fireballs for dramatic effect. We were sitting around 200 feet away from where the fireballs went off, but we clearly experienced two effects, a blast of heat AND a brief rush of air! This last, the rush of air, was a direct result of the shock wave generated as the air at the fireball rapidly expanded (Ideal gas law) as it heated from 70°F up to over 2,000°F. THAT physical shock wave of air motion is the center of this concept.

An even better configuration of such a concept might be to mount a number of vertical gas supply pipes in a slightly curved line, essentially down the centerline of the barge, with orifices along their whole heights. When gas valves were opened, there would suddenly (and momentarily) be a thin "wall" of combustible gas. When ignited, a momentary "wall of fire" would light up. This would cause rapid heating and expansion of the nearby air, creating a very large and powerful PLANAR sub-sonic audio shock-wave that is desired. These nearly flat shock waves would propagate outward toward both sides, so there would be no rolling reaction to the barge as a result. There should be value in putting the vertical pipes in a very slight arc rather than in an exact straight line. If the concave side of that structure was toward the hurricane, the curvature could act to (optically) "focus" more of the subsonic waves' power into a narrower destination target, to improve effectiveness. Such barges should certainly have stabilizers, so that the orientation of the created shock waves in the air was consistently maintained.

Pre-Testing

It would be possible to erect such a line of vertical gas pipes out in the desert. A person or sensor could sit in a chair five or ten miles away, at the center-point of the slight curvature of the array. When the (distant) wall-of-fire is ignited, it might be visible as a brief flash on the horizon. Then, if the concept works as expected, the person or sensor would feel an intense gust of wind maybe a minute later. If enough power was generated, and if the focusing effect performed acceptably, and if the frictional losses in those miles were not too severe, that single gust of wind would hopefully be of at least gale force. If such an effect can be accomplished, from several miles away, the concept seems almost certain to work at de-stabilizing a hurricane.

Physics of Hurricane Formation

No one yet really understands how and why hurricanes form. Logically, any circulating flow of air should experience frictional energy losses in moving past stationary exterior air. This is why the vast majority of "dust devils" and other small scale vortices dissipate in a matter of seconds. Larger scale vortices, such as the common weather cyclones and anti-cyclones, persist longer, but still eventually succumb soon to these frictional losses.

Obviously, there is something unique in the formation of a hurricane, which overcomes this natural effect of energy dissipation. Whatever those unique characteristics are, they certainly rely on an effective application of a (natural) forced vibration and its resonant effects. A hurricane does not form instantly. It gradually grows in size and strength and intensity. This is an example of the physics concept of amplification (magnification) at a resonant frequency, like in the public address amplifier 'feedback loop' example mentioned above.

Since hurricanes must then necessarily FORM due to an extended exposure to resonant effects that magnify their power and intensity, this approach is meant to use the same concept against them! At very early stages in their development, an assortment of approaches might be effective, from introducing out-of-phase rotational energy AT the natural frequency (in an application of the Quadrupole approach) to introducing entirely different resonant frequencies, either near the resonant frequency or at harmonic multiples of it (with the intention of driving the storm formation into several other, smaller circulations, so that the large later hurricane could not form).The bulk of this presentation is based on the assumption that an organized circulation has already formed and must be dealt with. Once the resonance effect has begun to substantially magnify, attempting to modify the natural frequency is very difficult, and so the basic approaches described here focus on the fact that the natural frequency is already well established. With this fact given, the methods described above seem most likely to best reduce or dissipate the storm. As has been noted though, a number of variations could be tried, to see which approach most effectively de-stabilized the hurricane. It might even be that different approaches are most effect at deterring the initial formation of the storms and at de-stabilizing well-established ones. As should be obvious in all this, since a hurricane initially takes many hours of stable resonant conditions in first forming, it would also certainly take quite a few hours of introducing detrimental harmonic resonant energy in order to degrade it.

Engineering

A more technical presentation of this is that in standard engineering, a forced vibration. In the field of Engineering, the mechanically destructive effects of resonant vibrations due to forced vibrations are analyzed. The differential equations of motion of an object having a natural frequency of ω_n while being forced by an exterior force acting at a frequency defined by ω, can be written in the form of:

$$\ddot{x}+\omega_n^2 * x = e * \omega^2 * \cos(\omega * t)$$

and

$$\ddot{y}+\omega_n^2 * y = e * \omega^2 * \cos(\omega * t)$$

The solution to these differential equations can be written in the form of:

$$x(t) = \frac{e * (\frac{\omega}{\omega_n})^2}{1-(\frac{\omega}{\omega_n})^2} * \cos(\omega * t)$$

And

$$y(t) = \frac{e * (\frac{\omega}{\omega_n})^2}{1-(\frac{\omega}{\omega_n})^2} * \sin(\omega * t)$$

where e represents a variable generally called eccentricity (but which has a different meaning than the astronomical meaning of the term).One can see that if the forcing frequency were exactly the same as the natural frequency, the denominator goes to zero and the amplitude of the oscillatory motion therefore goes to infinity. In mechanical systems, this is akin to the situation when a device disintegrates due to unexpected vibrations. These equations are for the situation for a system which has no damping factor, which cannot actually occur in any real mechanical device. However, the general theme of this reasoning still applies. When a damping factor exists, if the forced frequency is exactly the same as the natural frequency, the denominator of the solutions drop to their lowest value, which causes the amplitude of the resulting resonant motion to reach its greatest value, the so-called 'magnification factor'. The limit on the magnification factor is therefore based on the amount of damping present. With minimal damping present, the

resulting resonant effect can be extreme. In the case of disrupting a circulating storm, such very large amplitude would be desirable, in that it would introduce harmonic radial (and tangential) air pulsations into the winds that would normally circulate relatively smoothly. This all suggests that there are several resultant effects, ALL of which would act to degrade the storm. Introducing repetitive harmonic 'dents' in the exterior of the circulation should act to inspire smaller interior circulations (in a Monopole configuration), with the added benefit of the magnification factor. The 'quadrupole resonance' concept should introduce a modification of peripheral air velocities at certain consistent points, acting to either degrade the circulation (at the natural frequency) or inspire smaller interior circulations (at harmonic multiple frequencies). The 'magnification' factor at certain forced vibration frequencies would act to increase the effectiveness of these degrading efforts. The 'quadrupole resonance' concept should introduce a modification of peripheral air velocities at certain consistent points, acting to either degrade the circulation (at the natural frequency) or inspire smaller interior circulations (at harmonic multiple frequencies). The 'magnification' factor would again act to increase the effectiveness of these degrading efforts.
There is an additional complication in applying forced vibration technology to hurricane dynamics. It is related to the fact that ongoing genesis of the storm acts to keep replenishing the 'free' or 'natural' circulation or vibration. This does not actually change any of the actions described in this article, but it might alter the exact frequency that should be chosen for the artificially introduced subsonic vibrations. Determining the effective damping factor zeta might therefore have to be empirical. It may even be a 'negative damping' since a hurricane acts to grow in energy at its natural frequency rather than having that energy damped out. In addition, with such uncertainty in the effective value of the damping factor, the magnification factor may also depend on empirical findings. Therefore, optimization of this approach may need to be refined from experimental data, in order to select the most effective forced frequency.**The exact same reasoning and equations** can be used to describe the normal growth of a hurricane, where the (naturally provided) forced vibration IS at (or very near) the natural frequency of the growing storm, and so the forced vibration equations would also apply, and the magnification factor explains how a storm could experience the peripheral frictional losses and still grow in size and strength. Without a 'magnification factor', the natural friction losses at **the ocean surface and the outer** perimeter would quickly dissipate an initial tropical depression. The 'magnification factor' is a necessary aspect of the natural growth, and it must be substantially above 1.0 in order to provide growth after also counter-acting the frictional losses. The same calculations and analysis might also explain why standard weather cyclones and anti-cyclones tend to be of relatively consistent sizes, of a few hundred miles across. It seems possible that a forced vibration analysis might 'predict' the approximate size of such relatively stable circulations, given the rotation of the earth and other effects that act on them. If that should be the case, weather forecasting might have another tool available.
The calculations of the disruptive power and effect of the Quadrupole approach is extremely complex, but that for the simpler Monopole approach is pretty straightforward. Imagine a single ship with a row of hollow vertical pipes, say, a foot apart for a 200 foot distance along the length of the ship, and each pipe has around 50 **vertical feet of usable length. The line of these pipes should probably be slightly curved, with the concave side facing the hurricane. Solenoid valves would simultaneously open** natural gas orifices along the 50 foot length of each pipe, and igniters would flash the gas. A "wall of fire" 200 feet long and 50 feet high would therefore be simultaneously created. As this gas ignites, the instantaneous temperature of the local air would rise to around 3600°F, causing very rapid expansion of that air (by about a factor of eight). This wall of horizontally expanding air would create a "shock wave" in the air, which would then propagate outward. The explosive effect of different fuels has a wide range, but an instantaneous pressure of 50 PSIG is a reasonable expectation. The total force created is area times pressure, or 200 (ft) * 50 (ft) * 144 (sq in/sqft) * 50 PSI or around 72 million pounds of total force created in the shock wave. That's insignificant as compared to the full power of the storm, but it is enough to cause slight effects to it. By the way, that much torque would roll the ship over, except that an equally powerful shock wave is also propagated off the back side of the radiator array, and since that is slightly convex, its effects would not be concentrated anywhere, and would not be damaging to any nearby shipping.

NOTATION :
G_{36} : Category 1 of **Rapid frame updating and coordinate, corresponding Seamless perception**
G_{37} : category2: Number of total **Rapid frame updating and coordinate, corresponding Seamless perception**
G_{38} : Category 3: Total number of **Rapid frame updating and coordinate, corresponding Seamless perception**
$(a_{36})^{(7)}, (a_{37})^{(7)}, (a_{38})^{(7)}$: Accentuation coefficients
$(a'_{36})^{(7)}, (a'_{37})^{(7)}, (a'_{38})^{(7)}$: Dissipation coefficients
FORMULATION OF THE SYSTEM :
In the light of the assumptions stated in the foregoing, we infer the following:-

The growth speed in category 1 is the sum of a accentuation term $(a_{36})^{(7)}G_{37}$ and a dissipation term $-(a'_{36})^{(7)}G_{36}$, the amount of dissipation taken to be proportional to the factor in category 1

The growth speed in category 2 is the sum of two parts $(a_{37})^{(7)}G_{36}$ and $-(a'_{37})^{(7)}G_{37}$ the inflow from the category 1 dependent on the total amount standing in that category.

The growth speed in category 3 is equivalent to $(a_{38})^{(7)}G_{37}$ and $-(a'_{38})^{(7)}G_{38}$ dissipation ascribed only to depletion phenomenon.

DISSIPATION:

Dissipation is the result of irreversible processes that take place in inhomogeneous systems. These processes produce entropy (see entropy production) at a certain rate. The entropy production rate times ambient temperature gives the dissipated power. Important examples of irreversible processes are: heat flow through a thermal resistance, fluid flow through a flow resistance, diffusion (mixing), chemical reactions, and electrical current flow through an electrical resistance (Joule heating). The concept of dissipation was introduced in the field of thermodynamics by William Thomson (Lord Kelvin) in 1852.

Dissipating forces are those that cannot be described by Hamiltonian formalism. Loosely speaking, this includes friction, and all similar forces that result in decoherence of energy—that is, conversion of coherent or directed energy flow into an in directed or more isotropic distribution of energy.

Waves or oscillations lose energy over time, typically from friction or turbulence. In many cases the "lost" energy raises the temperature of the system. For example, a wave that loses amplitude is said to **dissipate**. The precise nature of the effects depends on the nature of the wave: an atmospheric wave, for instance, may dissipate close to the surface due to friction with the land mass, and at higher levels due to radiative cooling.

In computational physics, numerical dissipation (also known as "numerical diffusion") refers to certain side-effects that may occur as a result of a numerical solution to a differential equation. When the pure advection equation, which is free of dissipation, is solved by a numerical approximation method, the energy of the initial wave may be reduced in a way analogous to a diffusion process. Such a method is said to contain 'dissipation'. In some cases, "artificial dissipation" is intentionally added to improve the stability characteristics of the solution.[

A formal, mathematical definition of dissipation, as commonly used in the mathematical study of measure-preserving dynamical systems, is given in the article wandering set.

DISSIPATION OF RAPID FRAME UPDATING AND SEAMLESS PERCEPTION-ANEUROPHYSIOLOGICAL PHENEOMENON☹For details see article bySebastiaanMathôt* and Jan Theeuwes)

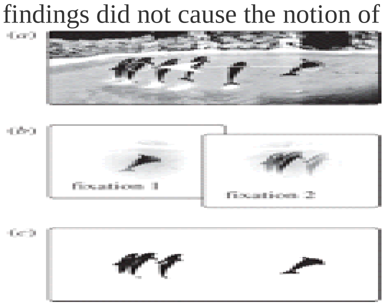
In the present review, we address the relationship between attention and visual stability. Even though with each eye, head and body movement the retinal image changes dramatically, we perceive the world as stable and are able to perform visually guided actions. However, visual stability is not as complete as introspection would lead us to believe. We attend to only a few items at a time and stability is maintained only for those items. There appear to be two distinct mechanisms underlying visual stability. The first is a passive mechanism: the visual system assumes the world to be stable, unless there is a clear discrepancy between the pre- and post-saccadic image of the region surrounding the saccade target. This is related to the pre-saccadic shift of attention, which allows for an accurate preview of the saccade target. The second is an active mechanism: information about attended objects is remapped within retinotopic maps to compensate for eye movements. The locus of attention itself, which is also characterized by localized retinotopic activity, is remapped as well. We conclude that visual attention is crucial in our perception of a stable world. In recent years, many researchers have emphasized that vision is an active process. This emphasis is well justified, since what we see depends as much on internal cognitive processes as it does on what is actually out there to see. An important aspect of active vision is that of all the visual information that is available to us, only a very limited selection is fully processed and ultimately guides action and perception. The remainder of the information is filtered out in the early stages of processing. This mechanism of selection is generally referred to as selective visual attention. By covertly attending (i.e. without making an eye movement) to a stimulus, we perceive that stimulus more clearly than we would if attention were unfocused or directed elsewhere. This increased perceptual ability can be measured as an increased sensitivity to faint stimuli, enhancement of perceived contrast and decreased reaction times to attended stimuli. In addition, visual attention is characterized by an inhibitory surround: processing of stimuli outside of but near the focus of attention is suppressed. These findings are paralleled by neurophysiologic studies which have shown that visual attention enhances neural responsiveness and selectivity and that the neural response to non-attended stimuli near the focus of attention is inhibited; for a review, see. In addition to directing attention to a location in space, it is also possible to direct attention based on non-spatial features, such as colour or direction of motion. However, in the present review, we will focus on spatial attention, which is especially relevant in the context of visual stability.

The effects of attention as studied in the laboratory are generally modest. For example, people respond about 20 ms faster to a validly cued, attended stimulus than to an uncured, neutral stimulus. Presumably, this effect is small, because the display is sparse. In such a display, there is little competition between stimuli and therefore little effect of attention. However, in more natural settings, the effects of attention can be substantial. This has been elegantly demonstrated in experiments on change blindness; see also). In a typical change blindness experiment, participants observe two displays that are presented in alternation and differ in some important respect. If the two pictures are presented in immediate succession, the change is readily detected, because it constitutes a unique visual event. However, if a blank screen is introduced between the two displays, it takes considerable time and effort to detect the change. This is because the entire display now flashes and the change is no longer a unique visual event. In order to nevertheless find the changing element, you have to attend to different parts of the display in a serial fashion. This illustrates that, in natural settings, it is an understatement to say that attention provides us with improved perceptual abilities. Rather, we consciously perceive only what we attend to [16], which will be a recurring theme in the present review.

An equally important aspect of active vision is that we continuously make eye, head and body movements. This way, we actively control which visual input we receive, even prior to any effects of covert visual attention. Eye movements are an integral part of vision, because without eye movements we would only perceive a very small part of the visual field with high acuity and in colour: the part that projects onto the fovea. By making eye movements we sequentially extract information from different parts of the visual field. This method of actively sampling our environment comes so naturally that we are generally not aware of it. Perhaps even more surprisingly, we are also not aware of the fact that with each eye movement there is a corresponding shift in our retinal image of the world. Somehow, despite incomplete and unstable visual input, we feel as though we have a complete and stable percept of the world and are able to effortlessly perform visually guided actions.

In the current review, we focus on the role of attention in visual stability. Section 2 discusses trans-saccadic memory (TSM), a visual memory buffer that allows information to be retained across saccades. Section 3 describes the assumption of stability: we perceive a stable world, simply because we assume the world to be stable. The final three sections discuss remapping of receptive fields (RFs), which has received considerable interest as a potential mechanism underlying visual stability. Sections 4 and 5 deal with neurophysiologic and behavioral studies on remapping, respectively. Section 6 describes a number of alternative views, which challenge the traditional notion of remapping. Trans-saccadic memory

Subjective experience suggests that visual stability is absolute and complete. Not surprisingly, therefore, it has been suggested that conscious experience does not rely directly on retinotopically organized input, but on a representation of the world which is independent of eye position (spatiotopic). In general terms, TSM is such a spatiotopic memory buffer. However, its exact characteristics have been the subject of substantial debate and revision (for a review, see). Initially, TSM was assumed to be a pre-attentive visual buffer, containing all visual detail of the world. In this form, it was also called an integrative visual buffer to emphasize its role in trans-saccadic integration]. Because trans-saccadic integration was believed to occur pre-attentively (at an early stage of processing), it was predicted that people should be able to seamlessly integrate information across saccades. Essentially, it should not matter whether people make eye movements or not. Although there was some initial support for this idea, further scrutiny revealed that people are often unable to integrate information across saccades], whereas they have no difficulty doing so while fixating. These findings did not cause the notion of TSM to be abandoned, but the concept clearly needed modification (figure 1).



View larger version:

Figure 1.

A schematic of trans-saccadic memory (TSM). (a) A leftward eye movement is executed. (b) Visual input consists of two successive fixations. (c) The two fixations are integrated in TSM. Since we generally do not attend to the background, no information about the background is retained. In addition, TSM contains mostly conceptual information (; but see e.g.. For example, the fact that there are dolphins present in the scene is retained, but subtle differences in coloration are lost.

In a series of studies, Irwin investigated the properties of TSM. In one experiment, participants were presented with an array of letters. Next, a saccade target was presented. As soon as participants initiated an eye movement, the array of letters was extinguished. After the eye movement, a cue was presented and participants had to report which letter had been presented at the cued location. This experiment revealed two important properties of TSM. First, people remembered only three to four letters, suggesting a capacity limitation. In addition, memory was best for objects near the saccade target. The importance of this latter finding became apparent when later studies revealed that an eye movement is always preceded by a covert shift of attention, so that the saccade target receives an attentional benefit. This explained why in Irwin's study TSM was best for stimuli near the saccade target: those stimuli received an attentional benefit and were therefore stored in TSM. The idea that attention functions as a ‘gatekeeper’ for TSM was investigated in more detail by Prime et al. (; see also. They instructed participants to remember a number of randomly positioned stimuli (patches of tilted lines known as Gabor patches). One of these stimuli was cued prior to its presentation, indicating that it was likely to be probed in the response phase. Presumably, participants attended to the cued stimulus. After an eye movement, a probe stimulus was presented (another Gabor patch). Participants reported whether the probe was tilted clockwise or counter-clockwise, relative to the original stimulus (the stimulus that had previously been presented at the same location). The crucial finding was that performance was best for stimuli that had been cued, confirming that TSM is best for attended stimuli.

On the basis of these findings, it can be concluded that TSM has a limited capacity and that attention acts as a gatekeeper. Other properties, not directly related to visual attention, are that TSM deals predominantly with abstract, conceptual information] and has a coarse spatial resolution. Low-level, non-conceptual information has some effect on trans-saccadic integration, the extent of which is a matter of debate (e.g.), but there appears to be a type of ‘gradient’: low-level features are not entirely lost, but conceptual features are dominant. Taken together, the properties of TSM are strongly reminiscent of spatial working memory. The natural conclusion is that TSM is not a separate entity, but simply a name for spatial working memory in the context of eye movements.

To conclude, researchers have posited the existence of TSM. TSM contains a spatiotopic representation of the world, which is independent of eye position. In order to be integrated across saccades, stimuli need to be stored in TSM. Rather than a dedicated mechanism for trans-saccadic perception, TSM appears to rely on working memory. TSM has a limited capacity and only information about attended stimuli is retained

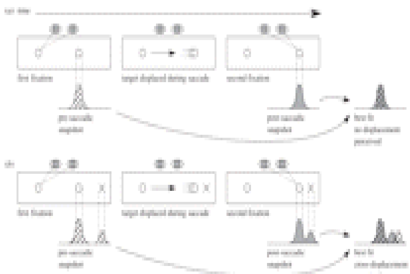
The assumption of stability

As was mentioned in the previous section, every saccade is preceded by a covert shift of attention. In a typical paradigm investigating pre-saccadic shifts of attention, participants are instructed to make an eye movement to a particular location. After participants have been cued to make a saccade, but before the eyes set in motion, a stimulus is presented at the saccade goal. The pre-saccadic shift of attention is reflected by the finding that stimuli presented at the saccade goal are more readily discriminated and elicit stronger priming effects than stimuli presented elsewhere. A related finding is that people subjectively feel that the eyes have already moved to the saccade target, when in fact the saccade is yet to be executed. Presumably, this is due to the pre-saccadic shift of attention, which provides improved perception of the saccade target before it has been foveated.

A number of researchers have suggested that the pre-saccadic shift of attention is integral to visual stability. In this view, attention precedes an eye movement to allow for an accurate preview of the saccade target. After the eye movement, this region is observed again and trans-saccadic integration occurs based on the assumption that the saccade target and its surroundings have remained stable. It is, in a sense, a ‘snapshot’ theory, in which pre- and post-saccadic snapshots are superimposed. This differs from the traditional notion of TSM in that no knowledge of absolute spatial positions is required, since snapshots are integrated based on content rather than location. This also differs from the integrative visual buffer in that these snapshots are believed to contain mostly abstract representations, modulated by attention.

Assuming that the saccade target is stable (at least for the duration of a saccade) makes ecological sense, but in the laboratory it can be violated quite easily by moving the saccade target while the eyes are in motion. Since visual perception is strongly suppressed during eye movements, the exact moment of displacement is not observed and the visual system relies on pre- and post-saccadic snapshots to detect the displacement. Remarkably large displacements of the saccade target go unnoticed confirming the notion that the visual system assumes the saccade target to be stable unless there is strong evidence to the contrary. In situations where the saccade target is clearly not stable, for example if the saccade target is already in motion prior to the saccade [48] or is briefly blanked after the saccade, displacement detection is greatly improved.

Visual attention is intricately related to the assumption of stability, as attention appears to be a determining factor in which objects are assumed to be stable. We can illustrate this by describing the assumption of stability in terms of 'finding the best fit' (figure 2). As mentioned, pre- and post-saccadic snapshots of the saccade goal and its surroundings are constructed. These snapshots contain representations of stimuli to the extent that they are attended. Effectively, this means that the saccade target itself is strongly represented, but nearby stimuli can also be represented, although more weakly. Integration occurs based on the assumption that the best fit between the pre- and post-saccadic snapshots is the true fit. This simple principle explains many findings. For example, if the saccade target is displaced during the saccade, there is still a perfect fit between pre- and post-saccadic snapshots (figure 2a). The only difference lies in absolute spatial position, which is not a factor in determining the best fit. Consequently, the visual system fails to perceive the displacement. We can also consider what happens if a second stimulus (an 'X') is added, which remains stable while the saccade target is displaced (figure 2b). In this case, the best fit still results from matching the pre- and post-saccadic saccade target. The best fit requires a misalignment of the pre- and post-saccadic X, because it receives less attention than the saccade target and therefore contributes less to the overall fit. Consequently, the X is erroneously perceived as being displaced [50]. This principle also explains why, if multiple stimuli are presented, a displacement is generally attributed to the stimulus that is briefly blanked at the moment the eyes arrive at the saccade target, regardless of which stimulus was actually displaced. This is because only the stimuli that are present right after the saccade contribute to the fit. If one of the stimuli is missing (because it has been blanked), the fit will be poor, but the best fit will nevertheless result from aligning the stimuli that are present.



View larger version:

Figure 2.
A description of the assumption of stability in terms of finding the best fit. (a) The saccade target is displaced during the saccade. Because there is nevertheless a perfect fit between the pre- and post-saccadic snapshots, the displacement is not perceived. (b) The saccade target is displaced, while an additional stimulus (an X) remains stable. The saccade target is more strongly attended than the X and therefore has a larger 'bump' of activation. Consequently, the best fit means matching the pre- and post-saccadic saccade target, causing a mismatch of the pre- and post-saccadic X. As a result, the X is erroneously perceived as being displaced.

There are a number of qualifications that should be made. First, we have not considered what would happen if a stimulus is replaced by a qualitatively different stimulus during a saccade. Changing stimulus identity has a definite effect on trans-saccadic integration, which indicates that qualitative factors are important in matching pre- and post-saccadic information. In addition, even if a stimulus is briefly blanked after the saccade, it may still serve as a stable reference point, provided that other stimuli are blanked for a longer period of time]. This suggests that there is substantial temporal 'fuzziness' in the assumption of stability. Perhaps even more surprisingly, effects of stimulus blanking and displacement can also be observed during fixation, suggesting that the assumption of stability is a general phenomenon and not limited to trans-saccadic perception.

An important question is: if only a saccade target is presented, why does post-saccadic blanking improve detection of its displacement [The fact that blanking breaks the assumption of stability is part of the explanation, but leaves us with another question: why do we still have a sense of position when we cannot rely on the assumption of stability? The answer must be that we fall back on different mechanisms (see §§3–5). This is also supported by evidence from corrective saccades. If a saccade target is displaced during the saccade, corrective saccades are executed towards the new location of the saccade target This is the assumption of stability at work. However, if the saccade target is removed (after the eyes set in motion), corrective saccades are executed towards the former location of the saccade target. Clearly, the visual system has a way of maintaining positional information across saccades that does not rely on the assumption of stability.

To conclude, our visual system exploits the fact that the world is a stable place, at least for the duration of an eye movement. Generally, the saccade target dominates the assumption of stability, because it is strongly attended just before each eye movement, but other attended stimuli may serve as a stable reference point as well.

. Remapping and attention: neurophysiology

As visual information enters the primary visual cortex, retinal topography is preserved: adjacent neurons process information from adjacent, and usually largely overlapping parts of the retina [54]. However, as we move further upstream in the visual processing hierarchy, things become considerably less clear. RFs of neurons in these later areas differ in many important respects, but here we focus on the distinction between retinotopy and spatiotopy. In addition, RFs change in different ways in the interval preceding an eye movement (, but here we restrict the discussion to pre-saccadic RF shifts in the direction of the eye movement, usually called predictive remapping.

If the RF of a neuron is retinotopic, it is anchored to a location on the retina, which may correspond to different locations in the world depending on eye position. This is essentially what underlies the problem of visual stability. In contrast, if a neuron has a spatiotopic RF, it is always responsive to the same spatial location, irrespective of eye, body and head position. Because in most studies the head and body are in a fixed position, the term ‘spatiotopic’ is often used loosely and applied to responses that are highly independent of eye position. An important question is whether spatiotopy exists in the brain. It is attractive to assume that it does, since this would effectively solve the problem of visual stability. According to the spatiotopic hypothesis, action and conscious experience are based on spatiotopically organized brain areas. This bears some conceptual resemblance to TSM, although TSM is a cognitive construct that is not necessarily intended to reflect a spatiotopic map at the neural level.

In apparent support of the spatiotopic hypothesis, brain areas have been identified in which RFs are modulated by eye position; but see. RFs in these areas are not retinotopic, but neither is it obvious that they are of the fine-grained spatiotopic sort that would be expected based on the spatiotopic hypothesis. An alternative, perhaps more likely, interpretation is that these RFs are tailored towards a specific modality, rather than being spatiotopic and directly related to visual stability. For example, in the extended dorsal stream, there is a continuum from visual to motor responses, such that observing an object automatically activates an associated motor programme. Since information in retinal coordinates is of little use for programming manual reaching movements, a translation from retinotopic coordinates to a more appropriate frame of reference (for example, body-centred coordinates) seems natural. However, this does not require true spatiotopy and does not provide strong evidence for the spatiotopic hypothesis.

For this reason, the spatiotopic hypothesis has fallen out of favour as the complete solution to the problem of visual stability for a discussion). However, it is well established that many RFs are modulated by eye position, presumably mediated by a corollary discharge. It has been proposed that remapping of RFs might be the solution to the problem of visual stability. Before discussing neurophysiological studies, we will briefly introduce the concept of remapping by analogy.

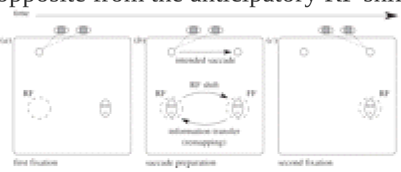
Imagine that you are sitting in a train without windows. You are instructed to remain at the same position—not relative to the train, but relative to the outside world. This is tricky, because the train occasionally moves and you cannot look out of the windows to see where you are. Fortunately, the train operator always announces exactly how far and in what direction the train is going to move, just before the train actually sets in motion. Therefore, if you hear ‘Folks, we are about to move 20 m forward’, you quickly run 20 m to the back of the train, thus compensating for the movement of the train.

How does this example relate to visual stability? Imagine that a stimulus is briefly presented. Even after the stimulus has been extinguished, there is some residual neural activity. This is often called a memory trace , but you can also think of it as an attention-related increase in baseline activity. The problem that the memory trace faces is analogous to that of our example. If the eyes move, the memory trace becomes misaligned with the world: the same spot in the retinotopic map now corresponds to a different location in the real world and therefore the memory trace is not sitting in the right spot of the retinotopic map any more. Fortunately, the corollary discharge informs the visual system of the impending eye movement. Using this information, the memory trace can be transferred onto a different set of neurons in the same retinotopic map, so that it remains correctly aligned with the world). This mechanism is called remapping or spatial updating. In a nutshell, remapping is a transfer of activity between retinotopically organized neurons. This transfer of activity is such that it compensates for eye movements, effectively updating retinotopic representations to prevent a misalignment with the world. This provides a way for the visual system to maintain visual stability without the need for spatiotopic RFs, and therefore it is sometimes called the retinotopic hypothesis.

Remember that the train operator signals movement before the train actually sets in motion. This allows you to get a head start, by running to the back of the train before the train starts moving forward. Similarly, a corollary discharge informs the visual system of an eye movement before it occurs, since it conveys information about intended rather than actual eye movements. This allows remapping to start before an eye movement, in which case it is referred to as predictive remapping. So far, we have looked at remapping from the perspective of the memory trace (of course, the same principles apply to remapping of visual information in general). However, predictive remapping is commonly described in terms of RFs. This distinction is important, because the identity of a memory trace is independent of the neurons that encode it. After all, the memory trace may be remapped from one set of neurons onto another. This shift

ISSN 2250-3153

in perspective is also useful, because it sheds some light on how remapping works. In the interval preceding an eye movement, RFs shift in the direction of the eye movement. This may seem at odds with the fact that the memory trace is remapped in the direction opposite from the eye movement (as you run against the movement of the train), but it is not (figure 3). The anticipatory RF shift allows a neuron to take a 'sneak peak' at the location that will be brought into its RF. This is somewhat analogous to the pre-saccadic shift of attention (see §3) but applies to the visual field as a whole, rather than just the currently fixated location. In this context, the RF-location-to-be is often called the future field (FF). If the memory trace happens to be in a neuron's FF, the neuron will take over some of the memory trace activity, which corresponds to remapping of the memory trace. Remapping of activity is therefore in the direction opposite from the anticipatory RF shift.



View larger version:

Figure 3.

A schematic of predictive remapping [65]. (a) During fixation, a given neuron is responsive to a single part of the visual field, its receptive field (RF). (b) As a saccade is being prepared, but before it has been executed, the neuron also becomes responsive to the location that will be brought into its RF, its future field (FF). Effectively, the neuron takes a sneak peak at its FF, which allows it to take over whatever activation is there. This activation may represent a physical stimulus (such as the face presented here), but also attentional activation [89] or a memory trace of a stimulus that is no longer present. The activation in the FF is therefore being transferred (remapped) in the direction opposite from the RF shift. (c) After the eye movement, the FF has become the RF of the neuron.

GOVERNING EQUATIONS:

The differential equations governing the above system can be written in the following form

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - (a'_{36})^{(7)}G_{36} \tag{1}$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - (a'_{37})^{(7)}G_{37} \tag{2}$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - (a'_{38})^{(7)}G_{38} \tag{3}$$

$(a_i)^{(7)} > 0 \quad , \quad i = 36,37,38$ 4

$(a'_i)^{(7)} > 0 \quad , \quad i = 36,37,38$ 5

$$(a_{37})^{(7)} < (a'_{36})^{(7)} \tag{6}$$

$$(a_{38})^{(7)} < (a'_{37})^{(7)} \tag{7}$$

We can rewrite equation 1,2 and 3 in the following form

$$\frac{dG_{36}}{(a_{36})^{(7)}G_{37} - (a'_{36})^{(7)}G_{36}} = dt \tag{8}$$

$$\frac{dG_{37}}{(a_{37})^{(7)}G_{36} - (a'_{37})^{(7)}G_{37}} = dt \tag{9}$$

Or we write a single equation as

$$\frac{dG_{36}}{(a_{36})^{(7)}G_{37} - (a'_{36})^{(7)}G_{36}} = \frac{dG_{37}}{(a_{37})^{(7)}G_{36} - (a'_{37})^{(7)}G_{37}} = \frac{dG_{38}}{(a_{38})^{(7)}G_{37} - (a'_{38})^{(7)}G_{38}} = dt \tag{10}$$

The equality of the ratios in equation (10) remains unchanged in the event of multiplication of numerator and denominator by a constant factor.

For constant multiples α ,β ,γ all positive we can write equation (10) as

$$\frac{\alpha dG_{36}}{\alpha((a_{36})^{(7)}G_{37} - (a'_{36})^{(7)}G_{36})} = \frac{\beta dG_{37}}{\beta((a_{37})^{(7)}G_{36} - (a'_{37})^{(7)}G_{37})} = \frac{\gamma dG_{38}}{\gamma((a_{38})^{(7)}G_{37} - (a'_{38})^{(7)}G_{38})} = dt \tag{14}$$

The general solution of the consumption of oxygen due to cellular respiration system can be written in the form $\alpha_i G_i + \beta_i G_i + \gamma_i G_i = C_i e_i^{\lambda_i t}$ Where $i = 36,37,38$ and C_{36}, C_{37}, C_{38} are arbitrary constant coefficients.

STABILITY ANALYSIS :

Supposing $G_i(0) = G_i^0(0) > 0$, and denoting by λ_i the characteristic roots of the system, it easily results that

7. If $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} > 0$ all the components of the solution, i.e all the three parts of the tend to zero, and the solution is stable with respect to the initial data.
2. If $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ and $\left(\lambda_{37} + (a'_{36})^{(7)}\right)G^0_{36} - (a_{36})^{(7)}G^0_{37} \neq 0, (\lambda_{37} < 0)$, the first two components of the solution tend to infinity as t→∞, and $G_{38} \to 0$, ie. The category 1 and category 2 parts grows to infinity, whereas the third part category 3 tends to zero.
3. If $(a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$ and $\left(\lambda_{37} + (a'_{36})^{(7)}\right)G^0_{36} - (a_{36})^{(7)}G^0_{37} = 0$ Then all the three parts tend to zero, but the solution is not stable i.e. at a small variation of the initial values of G_i, the corresponding solution tends to infinity.

Prigogine realized that classical thermodynamics is not the appropriate tool to explain systems far from equilibrium, owing to the fact mathematical structure is linear. Close on the heels to equilibrium, there will be "fluxes", "vortices", however weak nevertheless. System shall evolve towards a stationary state in which generation of "entropy" (disorder) is as small as possible. By implication, there shall be a minimization problem mathematically, around the equilibrium state. In and around this range, linear equation would explain the characteristics of the system. On the other hand, away from "equilibrium", the "fluxes" are more emphasized. Result is increase in "entropy". When this occurs, the system no longer tends towards equilibrium. On the contrary, it may encounter instabilities that culminate into newer orders that move away from equilibrium. Thus, dissipative structures revitalize and resurrect complex forms away from equilibrium state.

Seamless perception vis a vis rapid frame updating

Assumptions: Seamless perception vis a vis rapid frame updating is classified in to three categories as was done in hereinabove with respect to rapid frame updating.

The speed of growth of in category 1 is a linear function of the amount of sector in category 2 at the time of reckoning. As before the accentuation coefficient that characterizes the speed of growth in category 1 is the proportionality factor between balance in category 1 and category The dissipation coefficient in the growth model is attributable to two factors; Depletion and age mostly in cases with people who lack dopamine and are in possession of dementia. A brilliant example of the dissipation of seamless perception is given by the analogue of fish in water looking at universe. This is where the truth dissipates. This is essential for our theory be it augmentation or dissipation of the main dissipation coefficient. Stephen Hawking's new book, "The Grand Design" uses analogies to simplify perception, measurements, and even quantum physics. We use perception every day for driving our cars to work, cooking dinner, and even comprehending the computer systems in our environment. As we comprehend how network traffic flows, we always need a frame of reference for measuring speed, quantity of data, and desired results. The analogy Dr. Hawking uses in his book relies on the concept of living in a fish bowl and looking out at the universe. From inside the fishbowl, straight lines would be curved and the shortest distance between any two points is not a straight line, but rather a curve as well. The perception then leads to measurements and ultimately theories and standards. When a set of observations and comparisons leads to standards, laws, and theories we form baselines and benchmarks to guide us through the process and have a frame of reference.

Simply, benchmarks are a set of standards that you can reference observations from and determine deviations. Benchmarks allow us to say that something deviates by some order of units. In the case of computer security, benchmarks allow us to judge how secure a system is based on best practice theory for preventing unwanted threats from compromising a host. They outline all the proper settings and run time parameters for securing a host, provide guidance on how to implement them, and finally a vehicle for testing hosts against these parameters (OVAL). IT Security benchmarks are available from a wide variety of sources such as CIS, NIST, Microsoft, and DISA. All of these can be implemented by SCAP compliant scanning solutions to benchmark how well the IT infrastructure is secured within your organization. This provides a straight line form of reference for gauging how secure you are from the latest security threats using tools created by the most brilliant minds in the industry.

IT Security benchmarks have been around for a long time. Only recently however, have the processes for implementing them and measuring them matured using automated scanning techniques in an open and standardized (non-proprietary) format. Retina CS 2.0 contains a new module called Configuration Compliance Module that allows users to load their own SCAP benchmarks for measuring the security standards within their environment. Benchmarks provide a uniform method for reporting and measuring that is well understood and uniform across businesses. It removes any assumptions or bias based on interpretation or testing criteria. The scan engine and benchmark complier are integrated into the complete multi-tier Retina management solution for a seamless perception for all the assets on the network Determining the state of security threats and even understanding the universe requires both standards and benchmarks. Dr. Hawking's book simplifies this for readers. eye has simplified both IT Security and benchmarks so that everyone can benefit from IT Security lesson

INFLOW IN TO VARIOUS CATEGORIES: Inflow into category 2 is only from category 1 in the form of transfer of balance from the category 1.This is evident from the age wise classification scheme. As a result, the speed of growth of category 2 is dependent upon the amount of inflow, which is a function of the quantum of balance of the category 1.The balance in category 3 is because of transfer of balance from category 2. It is dependent on the amount under category 2.

NOTATION :

T_{36} : Balance standing in the category 1 of Seamless perception vis a vis rapid frame updating
T_{37} : Balance standing in the category 2 ofSeamless perception vis a vis rapid frame updating
T_{38} : Balance standing in the category 3 of Seamless perception vis a vis rapid frame updating
$(b_{36})^{(7)}, (b_{37})^{(7)}, (b_{38})^{(7)}$: Accentuation coefficients
$(b'_{36})^{(7)}, (b'_{37})^{(7)}, (b'_{38})^{(7)}$: Dissipation coefficients

FORMULATION OF THE SYSTEM :

Under the above assumptions, we derive the following :
The growth speed in category 1 is the sum of two parts:
A term $+(b_{36})^{(7)}T_{37}$ proportional to the amount of balance in the category 2

A term $-(b'_{36})^{(7)}T_{36}$ representing the quantum of balance dissipated from category 1.

The growth speed in category 2 is the sum of two parts:
A term $+(b_{37})^{(7)}T_{36}$ constitutive of the amount of inflow from the category 1

A term $-(b'_{37})^{(7)}T_{37}$ the dissipation factor.

The growth speed under category 3 is attributable to inflow from category 2
Dissipation coefficient is also taken in to consideration and account under this head.

GOVERNING EQUATIONS:

Following are the differential equations that govern the growth of the system:

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - (b'_{36})^{(7)}T_{36} \tag{12}$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - (b'_{37})^{(7)}T_{37} \tag{13}$$

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - (b'_{38})^{(7)}T_{38} \tag{14}$$

$(b_i)^{(7)} > 0 \quad , \quad i = 36,37,38$ 15
$(b'_i)^{(7)} > 0 \quad , \quad i = 36,37,38$ 16

$$(b_{37})^{(7)} < (b'_{36})^{(7)} \tag{17}$$

$$(b_{38})^{(7)} < (b'_{37})^{(7)} \tag{18}$$

Following the same procedure outlined in the previous section , the general solution of the governing equations is $\alpha'_i T_i + \beta'_i T_i + \gamma'_i T_i = C'_i e_i^{\lambda'_i t}, i = 36,37,38$ where $C'_{36}, C'_{37}, C'_{38}$ are arbitrary constant coefficients and $\alpha'_{36}, \alpha'_{37}, \alpha'_{38}, \gamma'_{36}, \gamma'_{37}, \gamma'_{38}$ corresponding multipliers to the characteristic roots of the system

Seamless perception vis a vis rapid frame updating: A Dual System Analysis

We will denote
By $T_i(t), i = 36,37,38$, the three parts of the **Seam less perception corresponding to and concomitant with rapid frame updating a**nalogously to the G_i
By$(a''_i)^{(7)}(T_{37}, t)$ $(T_{37} \geq 0, t \geq 0)$,the contribution of the to the dissipation coefficient
By $(-b''_i)^{(7)}(G_{36}, G_{37}, G_{38}, t) = -(b''_i)^{(7)}((G_{39}), t)$, the contribution to the dissipation coefficient.

: Seamless perception vis a vis rapid frame updating: A Dual System Analysis: Governing Equations

The differential system of this model is now

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)} G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right] G_{36}$$ 19

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)} G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37}, t)\right] G_{37}$$ 20

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)} G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37}, t)\right] G_{38}$$ 21

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)} T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}), t\right)\right] T_{36}$$ 22

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)} T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}), t\right)\right] T_{37}$$ 23

$$\frac{dT_{38}}{dt} = (b_{38})^{(7)} T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}), t\right)\right] T_{38}$$ 24

$+(a''_{36})^{(7)}(T_{37}, t) =$ **First augmentation factor**
$-(b''_{36})^{(7)}\left((G_{39}), t\right) =$ **First detritions factor**
Where we suppose

$$(a_i)^{(7)}, (a'_i)^{(7)}, (a''_i)^{(7)}, (b_i)^{(7)}, (b'_i)^{(7)}, (b''_i)^{(7)} > 0, i, j = 36,37,38$$

The functions$(a''_i)^{(7)}, (b''_i)^{(7)}$are positive continuousincreasing and bounded.
<u>Definition of</u>$(p_i)^{(7)}, \ (r_i)^{(7)}$:

$$(a''_i)^{(7)}(T_{37}, t) \le (p_i)^{(7)} \le (\hat{A}_{36})^{(7)}$$ 25

$$(b''_i)^{(7)}(G, t) \le \ (r_i)^{(7)} \le (b'_i)^{(7)} \le (\hat{B}_{36})^{(7)}$$ 26

$$\lim_{T_2 \to \infty} (a''_i)^{(7)} (T_{37}, t) = (p_i)^{(7)}$$ 27

$$\lim_{G \to \infty} (b''_i)^{(7)} \left((G_{39}), t\right) = \ (r_i)^{(7)}$$ 28

<u>Definition of</u>$(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$:
Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}}$ are positive constants and $\boxed{i = 36,37,38}$

They satisfy Lipschitz condition: 29

$$|(a''_i)^{(7)}(T'_{37}, t) - (a''_i)^{(7)}(T_{37}, t)| \le (\hat{k}_{36})^{(7)}|T_{37} - T'_{37}|e^{-(\hat{M}_{36})^{(7)}t}$$

$$|(b''_i)^{(7)}((G_{39})', t) - (b''_i)^{(7)}\left((G_{39}), t\right)| < (\hat{k}_{36})^{(7)}||(G_{39}) - (G_{39})'||e^{-(\hat{M}_{36})^{(7)}t}$$ 30

With the Lipschitzcondition, we place a restriction on the behavior of functions $(a''_i)^{(7)}(T'_{37}, t)and(a''_i)^{(7)}(T_{37}, t)$.$(T'_{37}, t)And(T_{37}, t)$ are points belonging to the interval$\left[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\right]$. It is to be noted that $(a''_i)^{(7)}(T_{37}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 7$ then the function$(a''_i)^{(7)}(T_{37}, t)$,the **first augmentation coefficient**, would be absolutely continuous.
<u>Definition of</u> $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$:
$(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$,are positive constants

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}} \ , \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$$ 31

<u>Definition of</u> $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$:
There exists two constants$(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$which together with$(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)}$and $(\hat{B}_{36})^{(7)}$and the constants$(a_i)^{(7)}, (a'_i)^{(7)}, (b_i)^{(7)}, (b'_i)^{(7)}, (p_i)^{(7)}, \ (r_i)^{(7)}, i = 36,37,38$,
satisfy the inequalities

$$\frac{1}{(\hat{M}_{36})^{(7)}}[\,(a_i)^{(7)} + (a'_i)^{(7)} + \ (\hat{A}_{36})^{(7)} + \ (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$$

$$\frac{1}{(\hat{M}_{36})^{(7)}}[\ (b_i)^{(7)} + (b'_i)^{(7)} + \ (\hat{B}_{36})^{(7)} + \ (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$$

ISSN 2250-3153

Theorem1: if the conditions (A)-(E) above are fulfilled, there exists a solution satisfying the conditions
Definition of $G_i(0)\,,T_i(0)$:
$G_i(t) \leq \left(\hat{P}_{36}\right)^{(7)} e^{(\hat{M}_{36})^{(7)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$
$T_i(t) \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$
Proof:
Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions $G_i\,,\ T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0\,,\ T_i(0) = T_i^0\,,\ G_i^0 \leq (\hat{P}_{36})^{(7)}\,, T_i^0 \leq (\hat{Q}_{36})^{(7)}, \tag{34}$$

$$0 \leq G_i(t) - G_i^0 \leq (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)}t} \tag{35}$$

$$0 \leq T_i(t) - T_i^0 \leq (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)}t} \tag{36}$$

By

$$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{36})^{(7)} + a''_{36})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{36}\left(s_{(36)}\right)\right] ds_{(36)} \tag{37}$$

$$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}\left(s_{(36)}\right) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{37}\left(s_{(36)}\right)\right] ds_{(36)} \tag{38}$$

$$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{38}\left(s_{(36)}\right)\right] ds_{(36)} \tag{39}$$

$$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{36}\left(s_{(36)}\right)\right] ds_{(36)} \tag{40}$$

$$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{37}\left(s_{(36)}\right)\right] ds_{(36)} \tag{41}$$

$$\bar{T}_{38}(t) = T_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{38}\left(s_{(36)}\right)\right] ds_{(36)} \tag{42}$$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

The operator $\mathcal{A}^{(7)}$maps the space of functions satisfying 37,35,36 into itself .Indeed it is obvious that

$$G_{36}(t) \leq G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} \left(G_{37}^0 + (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} s_{(36)}}\right)\right] ds_{(36)} = \tag{43}$$

$$\left(1 + (a_{36})^{(7)} t\right) G_{37}^0 + \frac{(a_{36})^{(7)} (\hat{P}_{36})^{(7)}}{(\hat{M}_{36})^{(7)}} \left(e^{(\hat{M}_{36})^{(7)}t} - 1\right)$$

From which it follows that

$$(G_{36}(t)-G_{36}^0)e^{-(\hat{M}_{36})^{(7)}t} \leq \frac{(a_{36})^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{P}_{36})^{(7)}+G_{37}^0\right)e^{\left(-\frac{(\hat{P}_{36})^{(7)}+G_{37}^0}{G_{37}^0}\right)}+(\hat{P}_{36})^{(7)}\right]$$ 44

$(G_i^0)$is as defined in the statement of theorem 7

Analogous inequalities hold also for $G_{37}, G_{38}, T_{36}, T_{37}, T_{38}$

It is now sufficient to take $\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 7$ and to choose

$(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$large to have

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[(\hat{P}_{36})^{(7)}+\left((\hat{P}_{36})^{(7)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{36})^{(7)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{36})^{(7)}$$ 45

$$\frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}}\left[\left((\hat{Q}_{36})^{(7)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{36})^{(7)}\right] \leq (\hat{Q}_{36})^{(7)}$$ 46

In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions G_i, T_i satisfying 37,35,36 into itself

The operator$\mathcal{A}^{(7)}$ is a contraction with respect to the metric

$$d\left(\left((G_{39})^{(1)},(T_{39})^{(1)}\right),\left((G_{39})^{(2)},(T_{39})^{(2)}\right)\right)=$$
$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\hat{M}_{36})^{(7)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\hat{M}_{36})^{(7)}t}\}$$ 47

Indeed if we denote 48

Definition of$\widetilde{(G_{39})},\widetilde{(T_{39})}:\left(\widetilde{(G_{39})},\widetilde{(T_{39})}\right)=\mathcal{A}^{(7)}((G_{39}),(T_{39}))$

It results

$$\left|\tilde{G}_{36}^{(1)}-\tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{36})^{(7)}\left|G_{37}^{(1)}-G_{37}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\,ds_{(36)}+$$
$$\int_0^t\{(a'_{36})^{(7)}\left|G_{36}^{(1)}-G_{36}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{-(\hat{M}_{36})^{(7)}s_{(36)}}+$$ 49
$$(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)\left|G_{36}^{(1)}-G_{36}^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}+$$
$$G_{36}^{(2)}\left|(a''_{36})^{(7)}\left(T_{37}^{(1)},s_{(36)}\right)-(a''_{36})^{(7)}\left(T_{37}^{(2)},s_{(36)}\right)\right|\ e^{-(\hat{M}_{36})^{(7)}s_{(36)}}e^{(\hat{M}_{36})^{(7)}s_{(36)}}\}ds_{(36)}$$

Where $s_{(36)}$ represents integrand that is integrated over the interval $[0,t]$

From the hypotheses it follows

$$\left|(G_{39})^{(1)}-(G_{39})^{(2)}\right|e^{-(\hat{M}_{36})^{(7)}t}$$
$$\leq\frac{1}{(\hat{M}_{36})^{(7)}}\left((a_{36})^{(7)}+(a'_{36})^{(7)}+(\hat{A}_{36})^{(7)}\right.$$
$$\left.+(\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}\right)d\left(\left((G_{39})^{(1)},(T_{39})^{(1)};\ (G_{39})^{(2)},(T_{39})^{(2)}\right)\right)$$ 50

And analogous inequalities forG_i and T_i.

Remark 7: The fact that we supposed $(a''_{36})^{(7)}$ and $(b''_{36})^{(7)}$depending also ontcan be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\hat{P}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ and $(\hat{Q}_{36})^{(7)}e^{(\hat{M}_{36})^{(7)}t}$ respectively of $\mathbb{R}_+$. 51

If insteadof proving the existence of the solution on$\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a''_i)^{(7)}$ and $(b''_i)^{(7)}, i=36,37,38$ depend only on T_{37} and respectively on (G_{39})(and not on t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i(t)=0$ and $T_i(t)=0$

From 79 to 36 it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t\{(a'_i)^{(7)}-(a''_i)^{(7)}(T_{37}(s_{(36)}),s_{(36)})\}ds_{(36)}\right]} \geq 0$$ 52

$T_i(t) \geq T_i^0 e^{(-(b'_i)^{(7)}t)} > 0$ for $t>0$

Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1, \left((\widehat{M}_{36})^{(7)}\right)_2$ and $\left((\widehat{M}_{36})^{(7)}\right)_3$:

Remark 3: if G_{36} is bounded, the same property have also G_{37} and G_{38} . indeed if $G_{36} < (\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt} \leq \left((\widehat{M}_{36})^{(7)}\right)_1 - (a'_{37})^{(7)} G_{37}$ and by integrating

$$G_{37} \leq \left((\widehat{M}_{36})^{(7)}\right)_2 = G_{37}^0 + 2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1 / (a'_{37})^{(7)}$$ 53

In the same way , one can obtain

$$G_{38} \leq \left((\widehat{M}_{36})^{(7)}\right)_3 = G_{38}^0 + 2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2 / (a'_{38})^{(7)}$$

If G_{37} or G_{38} is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.

Remark 7: If G_{36} is bounded, from below, the same property holds for G_{37} and G_{38} .The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below. 54

Remark 5: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(7)}((G_{39})(t),t)) = (b'_{37})^{(7)}$ then $T_{37} \to \infty$. 55

Definition of $(m)^{(7)}$ and ε_7 :

Indeed let t_7 be so that for $t > t_7$

$(b_{37})^{(7)} - (b_i'')^{(7)}((G_{39})(t),t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$

Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1 - e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b''_{38})^{(7)}\left((G_{39})(t),t\right) = (b'_{38})^{(7)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 72

Behavior of the solutions of equation 37 to 72

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$: 56

$(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying

$$-(\sigma_2)^{(7)} \leq -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37},t) + (a''_{37})^{(7)}(T_{37},t) \leq -(\sigma_1)^{(7)}$$ 57

$$-(\tau_2)^{(7)} \leq -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right) - (b''_{37})^{(7)}\left((G_{39}),t\right) \leq -(\tau_1)^{(7)}$$ 58

Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: 59

By $(\nu_1)^{(7)} > 0, (\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0, (u_2)^{(7)} < 0$ the roots of the equations

$(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ 60

and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and 61

ISSN 2250-3153

Definition of $(\bar{\nu}_1)^{(7)},,(\bar{\nu}_2)^{(7)},(\bar{u}_1)^{(7)},(\bar{u}_2)^{(7)}$: 62

By $(\bar{\nu}_1)^{(7)} > 0$, $(\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0$, $(\bar{u}_2)^{(7)} < 0$ the 63

roots of the equations $(a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ 64

and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ 65

Definition of $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:-

If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by 66

$$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}, \quad \textbf{if} (\nu_0)^{(7)} < (\nu_1)^{(7)}$$

$$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}, \textbf{if} (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)},$$

and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$ 67

$$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}, \quad \textbf{if} (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$$

and analogously

$$(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}, \quad \textbf{if} (u_0)^{(7)} < (u_1)^{(7)}$$

$$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}, \textbf{if } (u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)},$$ 68

and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$ 69

$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \textbf{if} (\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$ 70

are defined by 59 and 67 respectively

Then the solution satisfies the following inequalities

$$G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)}t}$$ 71

where $(p_i)^{(7)}$ is defined by equation 37

$$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)}t}$$ 72

$$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})}\left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^0 e^{-(S_2)^{(7)}t} \leq G_{38}(t)\right.$$ 73

$$\leq \frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a'_{38})^{(7)})}\left[e^{(S_1)^{(7)}t} - e^{-(a'_{38})^{(7)}t}\right] + G_{38}^0 e^{-(a'_{38})^{(7)}t})$$

$$\boxed{T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}}$$ 74

$$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)}t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}$$ 75

$$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b'_{38})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b'_{38})^{(7)}t}\right] + T_{38}^0 e^{-(b'_{38})^{(7)}t} \leq T_{38}(t) \leq$$ 76

$$\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})}\left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^0 e^{-(R_2)^{(7)}t}$$

Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- 77

Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$

$$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$$ 78

$$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$$

$$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$$ 79

Proof : From 19,20,36,22,23,36 we obtain

$$\frac{d\nu^{(7)}}{dt} = (a_{36})^{(7)} - \left((a'_{36})^{(7)} - (a'_{37})^{(7)} + (a''_{36})^{(7)}(T_{37}, t)\right) - (a''_{37})^{(7)}(T_{37}, t)\nu^{(7)} - (a_{37})^{(7)}\nu^{(7)}$$ 80

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows 81

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2+(\sigma_2)^{(7)}\nu^{(7)}-(a_{36})^{(7)}\right)\leq\frac{d\nu^{(7)}}{dt}\leq-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2+(\sigma_1)^{(7)}\nu^{(7)}-(a_{36})^{(7)}\right)$$

From which one obtains

<u>Definition of</u> $(\bar{\nu}_1)^{(7)},(\nu_0)^{(7)}$:-

For $0<\boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}<(\nu_1)^{(7)}<(\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t)\geq\frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)}-(\nu_0)^{(7)}\right)t\right]}}\quad,\quad\boxed{(C)^{(7)}=\frac{(\nu_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)}\leq\nu^{(7)}(t)\leq(\nu_1)^{(7)}$

In the same manner , we get 82

$$\nu^{(7)}(t)\leq\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(7)}=\frac{(\bar{\nu}_1)^{(7)}-(\nu_0)^{(7)}}{(\nu_0)^{(7)}-(\bar{\nu}_2)^{(7)}}}$$

83

From which we deduce $(\nu_0)^{(7)}\leq\nu^{(7)}(t)\leq(\bar{\nu}_1)^{(7)}$

If $0<(\nu_1)^{(7)}<(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}<(\bar{\nu}_1)^{(7)}$ we find like in the previous case,

$$(\nu_1)^{(7)}\leq\frac{(\nu_1)^{(7)}+(C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}((\nu_1)^{(7)}-(\nu_2)^{(7)})t\right]}}{1+(C)^{(7)}e^{\left[-(a_{37})^{(7)}((\nu_1)^{(7)}-(\nu_2)^{(7)})t\right]}}\leq\nu^{(7)}(t)\leq$$

$$\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)})t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)})t\right]}}\leq(\bar{\nu}_1)^{(7)}$$ 84

If $0<(\nu_1)^{(7)}\leq(\bar{\nu}_1)^{(7)}\leq\boxed{(\nu_0)^{(7)}=\frac{G_{36}^0}{G_{37}^0}}$, we obtain

85

$$(\nu_1)^{(7)}\leq\nu^{(7)}(t)\leq\frac{(\bar{\nu}_1)^{(7)}+(\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)})t\right]}}{1+(\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}((\bar{\nu}_1)^{(7)}-(\bar{\nu}_2)^{(7)})t\right]}}\leq(\nu_0)^{(7)}$$ 86

And so with the notation of the first part of condition (c) , we have

<u>Definition of</u> $\nu^{(7)}(t)$:-

$(m_2)^{(7)}\leq\nu^{(7)}(t)\leq(m_1)^{(7)},\quad\boxed{\nu^{(7)}(t)=\frac{G_{36}(t)}{G_{37}(t)}}$ 87

In a completely analogous way, we obtain

<u>Definition of</u> $u^{(7)}(t)$:-

$(\mu_2)^{(7)}\leq u^{(7)}(t)\leq(\mu_1)^{(7)},\quad\boxed{u^{(7)}(t)=\frac{T_{36}(t)}{T_{37}(t)}}$

Now, using this result and replacing it in 79, 20,36,22,23, and 36 we get easily the result stated in the theorem.

<u>Particular case :</u>

If $(a''_{36})^{(7)}=(a''_{37})^{(7)}$, then $(\sigma_1)^{(7)}=(\sigma_2)^{(7)}$ and in this case $(\nu_1)^{(7)}=(\bar{\nu}_1)^{(7)}$ if in addition $(\nu_0)^{(7)}=(\nu_1)^{(7)}$ then $\nu^{(7)}(t)=(\nu_0)^{(7)}$ and as a consequence $G_{36}(t)=(\nu_0)^{(7)}G_{37}(t)$ **this also defines** $(\nu_0)^{(7)}$ **for the special case**.

Analogously if $(b''_{36})^{(7)}=(b''_{37})^{(7)}$, then $(\tau_1)^{(7)}=(\tau_2)^{(7)}$ and then $(u_1)^{(7)}=(\bar{u}_1)^{(7)}$ if in addition $(u_0)^{(7)}=(u_1)^{(7)}$ then $T_{36}(t)=(u_0)^{(7)}T_{37}(t)$ This is an important consequence of the relation between $(\nu_1)^{(7)}$ and $(\bar{\nu}_1)^{(7)}$, **and definition of** $(u_0)^{(7)}$.

STATIONARY SOLUTIONS AND STABILITY

Stationary solutions and stability curve representative of the systemic variation curve lies below the tangent at $(G_{39}) = G_0$ for $(G_{39}) < G_0$ and above the tangent for$(G_{39}) > G_0$ .Wherever such a situation occurs the point $G_0$is called the **"point of inflexion".** In this case, the tangent has a positive slope that simply means the rate of change of the system under consideration is greater than zero. Above factor shows that it is possible, to draw a curve that has a point of inflexion at a point where the tangent (slope of the curve) is horizontal.

Stationary value :

In all the cases$(G_{39}) = G_0$, $(G_{39}) < G_0$,$(G_{39}) > G_0$ the condition that the rate of change of rapid frame updating is maximum or minimum holds. When this condition holds we have stationary value. We now infer that :

A necessary and sufficient condition for there to be stationary value of (G_{39}) is that the rate of change of systemic function at $G_0$is zero.

A sufficient condition for the stationary value at G_0 , to be maximum is that the acceleration of the oxygen consumption is less than zero.

A sufficient condition for the stationary value atG_0, be minimum is that acceleration of system is greater than zero.

With the rate of change of system$(G_{39})$is defined as the accentuation term and the dissipation term, we are sure that the rate of change of second system categorization is always positive.

Concept of stationary state is mere methodology although there might be closed system exhibiting symptoms of stationeries.

We can prove the following 88

__Theorem 3__: If $(a_i'')^{(7)}$and $(b_i'')^{(7)}$ are independent on t , and the conditions

$$(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} < 0$$

$$(a_{36}')^{(7)}(a_{37}')^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36})^{(7)}(p_{36})^{(7)} + (a_{37}')^{(7)}(p_{37})^{(7)} + (p_{36})^{(7)}(p_{37})^{(7)} > 0$$

$(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} > 0$,

$$(b_{36}')^{(7)}(b_{37}')^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - (b_{36}')^{(7)}(r_{37})^{(7)} - (b_{37}')^{(7)}(r_{37})^{(7)} + (r_{36})^{(7)}(r_{37})^{(7)} < 0$$

with $(p_{36})^{(7)}, (r_{37})^{(7)}$ as defined by equation 37 are satisfied , then the system

$$(a_{36})^{(7)}G_{37} - \left[(a_{36}')^{(7)} + (a_{36}'')^{(7)}(T_{37})\right]G_{36} = 0 \quad 89$$

$$(a_{37})^{(7)}G_{36} - \left[(a_{37}')^{(7)} + (a_{37}'')^{(7)}(T_{37})\right]G_{37} = 0 \quad 90$$

$$(a_{38})^{(7)}G_{37} - \left[(a_{38}')^{(7)} + (a_{38}'')^{(7)}(T_{37})\right]G_{38} = 0 \quad 91$$

$$(b_{36})^{(7)}T_{37} - [(b_{36}')^{(7)} - (b_{36}'')^{(7)}(G_{39})]T_{36} = 0 \quad 92$$

$$(b_{37})^{(7)}T_{36} - [(b_{37}')^{(7)} - (b_{37}'')^{(7)}(G_{39})]T_{37} = 0 \quad 93$$

$$(b_{38})^{(7)}T_{37} - [(b_{38}')^{(7)} - (b_{38}'')^{(7)}(G_{39})]T_{38} = 0 \quad 94$$

has a unique positive solution , which is an equilibrium solution for the system

__Proof:__

(a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if

$$F(T_{39}) = (a'_{36})^{(7)}(a'_{37})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a'_{36})^{(7)}(a''_{37})^{(7)}(T_{37}) + (a'_{37})^{(7)}(a''_{36})^{(7)}(T_{37}) + (a''_{36})^{(7)}(T_{37})(a''_{37})^{(7)}(T_{37}) = 0$$ 95

Definition and uniqueness of T^*_{37} :-

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a''_i)^{(7)}(T_{37})$ are increasing, it follows that there exists a unique T^*_{37} for which $f(T^*_{37}) = 0$. With this value , we obtain from the three first equations 96

$G_{36} = \frac{(a_{36})^{(7)} G_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G_{38} = \frac{(a_{38})^{(7)} G_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$

By the same argument, the equations 92,93 admit solutions G_{36}, G_{37} if 97

$$\varphi(G_{39}) = (b'_{36})^{(7)}(b'_{37})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} - \left[(b'_{36})^{(7)}(b''_{37})^{(7)}(G_{39}) + (b'_{37})^{(7)}(b''_{36})^{(7)}(G_{39})\right] + (b''_{36})^{(7)}(G_{39})(b''_{37})^{(7)}(G_{39}) = 0$$

Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0, \varphi(\infty) < 0$ it follows that there exists a unique G^*_{37} such that $\varphi(G^*) = 0$

Finally we obtain the unique solution of 89 to 97

G^*_{37} given by $\varphi((G_{39})^*) = 0$, T^*_{37} given by $f(T^*_{37}) = 0$ and 98

$G^*_{36} = \frac{(a_{36})^{(7)} G^*_{37}}{[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T^*_{37})]}$, $G^*_{38} = \frac{(a_{38})^{(7)} G^*_{37}}{[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T^*_{37})]}$

$T^*_{36} = \frac{(b_{36})^{(7)} T^*_{37}}{[(b'_{36})^{(7)} - (b''_{36})^{(7)}((G_{39})^*)]}$, $T^*_{38} = \frac{(b_{38})^{(7)} T^*_{37}}{[(b'_{38})^{(7)} - (b''_{38})^{(7)}((G_{39})^*)]}$ 99

Obviously, these values represent an equilibrium solution of 79,20,36,22,23,36

ASYMPTOTIC STABILITY ANALYSIS

Theorem4: If the conditions of the previous theorem are satisfied and if the functions $(a''_i)^{(7)}$ and $(b''_i)^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$G_i = G^*_i + \mathbb{G}_i$, $T_i = T^*_i + \mathbb{T}_i$ 100

$\frac{\partial (a''_{37})^{(7)}}{\partial T_{37}}(T^*_{37}) = (q_{37})^{(7)}$, $\frac{\partial (b''_i)^{(7)}}{\partial G_j}((G_{39})^{**}) = s_{ij}$ 101

Then taking into account equations 89 to 97 and neglecting the terms of power 2, we obtain from 79 to 36

$$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)} G^*_{36}\mathbb{T}_{37}$$ 102

$$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)} G^*_{37}\mathbb{T}_{37}$$ 103

$$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)} G^*_{38}\mathbb{T}_{37}$$ 104

$$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)} T^*_{36}\mathbb{G}_j\right)$$ 105

$$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)} T^*_{37}\mathbb{G}_j\right)$$ 106

$$\frac{d\mathbb{T}_{38}}{dt} = -\left((b'_{38})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)} T^*_{38}\mathbb{G}_j\right)$$ 107

The characteristic equation of this system is

$$
\begin{gathered}
\left((\lambda)^{(7)}+(b'_{38})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a'_{38})^{(7)}+(p_{38})^{(7)}\right) \\
\left[\left(\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G^{*}_{37}+(a_{37})^{(7)}(q_{36})^{(7)}G^{*}_{36}\right)\right] \\
\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(37)}T^{*}_{37}\right) \\
+\left(\left((\lambda)^{(7)}+(a'_{37})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G^{*}_{36}+(a_{36})^{(7)}(q_{37})^{(7)}G^{*}_{37}\right) \\
\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(36)}T^{*}_{36}\right) \\
\left(\left((\lambda)^{(7)}\right)^{2}+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right) \\
\left(\left((\lambda)^{(7)}\right)^{2}+\left((b'_{36})^{(7)}+(b'_{37})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right) \\
+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38} \\
+\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G^{*}_{37}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^{*}_{36}\right) \\
\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(38)}T^{*}_{36}\right)\}=0
\end{gathered}
\tag{108}
$$

And as one sees, all the coefficients are positive. It follows that all the roots have negative real part, and this proves the theorem.

<u>ACKNOWLEDGEMENTS</u>: all concerted efforts, sustained endeavors, and protracted efforts are made to include each and every source from which the introductory part and its concomitant and tantamount derivations be it literary or heuristic or mathematical,epistemological,ontological,morphological or phenomenological in the eventuality of the fact if there are any acts of omission and commission of the authors, the authors with a deep sense of regret, remorse, compunction, contrition beg pardon and regret such an omission . References are only illustrative and not exhaustive .it is because eminent, illustrious, and exemplary people allowed to look in to their papers we got little ideas and we like kids are showing off with pride. There is nothing more to it. As Newton said, the entire ocean of reality remains to be explored and the very existence of that ocean in front bears ample testimony, infallible observatory and impeccable demonstration to the sense of inadequacy and the limitations of human perception.

REFERENCES

A HAIMOVICI:"On the growth of a two species ecological system divided on age groups". Tensor, Vol37 (1982),Commemoration volume dedicated to ProfessorAkitsuguKawaguchi on his 80th birthday

FRTJOF CAPRA: "The web of life"Flamingo, Harper Collins See "Dissipative structures" pages 172-188

(3)HEYLIGHEN F. (2001): "The Science of Self-organization and Adaptivity", in L. D. Kiel, (ed). KnowledgeManagement, Organizational Intelligence and Learning, and Complexity, in: TheEncyclopedia of Life Support Systems ((EOLSS), (Eolss Publishers, Oxford) [http://www.eolss.net

(4)MATSUI, T, H. Masunaga, S. M. Kreidenweis, R. A. Pielke Sr., W.-K. Tao, M. Chin, and Y. J Kaufman (2006), "Satellite-based assessment of marine low cloud variability associated withAerosol,atmospheric stability, and the diurnal cycle", J. Geophys. Res., 141, D17201,doi:10.1029/2005JD006097

(5)STEVENS, B, G. Feingold, W.R. Cotton and R.L. Walko, "Elements of the microphysical structure of numerically simulated nonprecipitating stratocumulus" J. Atmos. Sci., 53, 980-1006

(6)FEINGOLD, G,Koren, I; Wang, HL; Xue, HW; Brewer, WA (2010), "Precipitation-generated oscillations in open cellular cloud fields"Nature, 166 (7308) 819-852, doi: 10.1038/nature09314, Published 12-Aug 2010

(7)R WOOD"The rate of loss of cloud droplets by coalescence in warm clouds"J.Geophys. Res., 141, doi: 10.1029/2006JD007553, 2006
(8)H. RUND, "The Differential Geometry of Finsler Spaces", Grund. Math. Wiss. Springer-Verlag, Berlin, 1959
(9)A. Dold, "Lectures on Algebraic Topology", 1972, Springer-Verlag
(10)S LEVIN "Some Mathematical questions in Biology vii ,Lectures on Mathematics in life sciences,vol8"The American Mathematical society, Providence , Rhode island 1976
(11) Archer,A.W.Reliability of lunar orbital periods extracted from ancient cyclic tidal rhythmitesEarth and Planetary Science Letters 141(1-4): 1-10, June 1996
(12)Barnes, Thomas G.Young Age for the Moon and EarthInstitute for Creation Research, Impact 110, August 1982
(13)Barnes, Thomas G.Earth's young magnetic age: An answer to DalrympleCreation Research Society Quarterly 21: 109-113, December 1984
(14)Bills, B.G. & R.D. Ray Lunar Orbital Evolution: A Synthesis of Recent ResultsGeophysical Research Letters 26(19): 3045-3048, October 1, 1999
(15)Brown, WalterIn the Beginning: Compelling Evidence for Creation and the FloodCenter for Scientific Creation, 1995
(16)Darwin, G.H.On the influence of geological changes on the Earth's axis of rotationPhilosophical Transactions of the Royal Society of London, 167, 271, 1877
(17)Darwin, G.H.On the precession of a viscous spheroid and on the remote history of the earthPhilosophical Transactions of the Royal Society of London, 170, 447-530, 1879
(18)Darwin, G.H.On the secular change of the orbit of a satellite revolving about a tidally distorted planet Philosophical Transactions of the Royal Society of London, 171, 713-891, 1880
(19)DeYoung, DonIs the Moon Really Old? Creation Ex Nihilo 14(4): 43, September-November, 1992
(20)Dickey, J.O. et al.Lunar laser Ranging: A Continuing Legacy of the Apollo Program Science 265: 482-490, July 22, 1994
(21)Goodrich, PeterHistory of the Lunar orbit Reviews of Geophysics 4(4): 411-439, November 1966
(22)Hansen, Kirk S.Secular Effects of Oceanic Tidal Dissipation on the Moon's Orbit and the Earth's Rotation Reviews of Geophysics and Space Physics 20(3): 457-480, August 1982(journal title has since then changed to Reviews of Geophysics)
(23)Jeffreys, HaroldTheEarth Cambridge University Press, 1st edition, 1924 (multiple expanded editions since then; 4th edition 1959)Kagan, B.A. &Maslova, N.B.A stochastic model of the Earth-moon tidal evolution accounting for cyclic variations of resonant properties of the ocean: An asymptotic solution Earth, Moon and Planets 66: 173-188, 1994
(24)Kagan, B.A.Earth-Moon tidal evolution: model results and observational evidence Progress in Oceanography 40(1-4): 109-124, 1997
(25)Lambeck, Kurt The Earth's Variable Rotation - Geophysical causes and consequences Cambridge University Press, 1980
(26)Munk, W.H. & McDonald, G.J.F.The Rotation of the Earth - A Geophysical Discussion Cambridge University Press, 1960 (reprinted with corrections 1975)
(27)Ray R.D., Bills B.G., Chao B.F.Lunar and solar torques on the oceanic tides Journal of Geophysical Research - Solid Earth 104(B8): 17653-17659, August 10, 1999
(28)Slichter, Louis S.Secular Effects of Tidal Friction upon the Earth's Rotation Journal of Geophysical Research 68(14), July 15, 1963(JGR has since broken into 5 separate journals published by the American Geophysical Union)
(29)Stacey, Frank D.Physics of the Earth John Wiley & Sons, 1977 (2nd edition)Touma, Jihad & Wisdom, Jack Evolution of the Earth-moon system Astronomical Journal 108(5): 1943-1961, November 1994
(30)Williams, G.E.Tidal Rhythmites - Key to the History of the Earth's Rotation and the Moon's Orbit Journal of the Physics of the Earth 38(6): 475-491, 1990
(31)Williams,G.E.Precambrian Length of Day and the Validity of Tidal Rhythmite paleotidal Values Geophysical Research Letters 24(4): 421-424, February 15, 1997